

GLOBAL
EDITION



Management Information Systems

Managing the Digital Firm

SEVENTEENTH EDITION

Kenneth C. Laudon • Jane P. Laudon

MANAGEMENT INFORMATION SYSTEMS

MANAGING THE DIGITAL FIRM

SEVENTEENTH EDITION

GLOBAL EDITION

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Smart Stores Reinvent the Retail Space

Will the Coronavirus Pandemic Make Working from Home the New Normal?

Digital Transformation of Healthcare at Singapore's Jurong Health Services

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Chapter 8: Securing Information Systems

Cyberattacks in the Asia-Pacific Target the Weakest Link: People
Capital One: A Big Bank Heist from the Cloud
PayPal Ups Its Digital Resiliency
Bulgaria: A Whole Nation Hacked

Chapter 9: Achieving Operational Excellence and Customer Intimacy: Enterprise Applications

Lenzing Sustainably Balances Supply and Demand
CRM Helps Adidas Know Its Customers One Shoe Buyer at a Time
Versum's ERP Transformation
The Coronavirus Pandemic Disrupts Supply Chains Around the World

Chapter 10: E-commerce: Digital Markets, Digital Goods

E-commerce Comes to the Dashboard: The Battle for the "Fourth Screen"
Deliveroo: Global Food Delivery App
Engaging "Socially" with Customers
An iDEAL Solution to the Single Online EU Market

Chapter 11: Managing Knowledge and Artificial Intelligence

Artificial Intelligence Beats Radiologists in Reading Mammograms
Do You Know Who Is Using Your Face?
Will AI Kill Jobs?
Are Self-Driving Cars Ready for the Road?

Chapter 12: Enhancing Decision Making

Eastspring: Targeted Enterprise System Building
Predictive Maintenance in the Oil and Gas Industry
GIS Help Land O'Lakes Manage Assets Strategically
Should an Algorithm Make Our Decisions?

Chapter 13: Building Information Systems

Vinci Energies Builds a New Mobile Employee Time Sheet App
Business Process Redesign at DP World
McAfee Turns to Automated Software Testing
Pick n Pay's Cloud Migration to Enhance Business Intelligence

Chapter 14: Making the Business Case for Information Systems and Managing Projects

Al-Asayah Implements a Modern ERP Solution
Sauder Woodworking Gets ERP Implementation Right
Arup Moves Project Management to the Cloud
Pennsylvania's Unemployment Compensation Modernization System: Unfinished Business

Chapter 15: Managing Global Systems

The Bel Group: Laughing All the Way to Success
Rethinking Global Supply Chains
Digital Nationalism
Souq.com: Amazon's Entry into the Middle East

New to This Edition

Management Information Systems, 17th Global Edition has been thoroughly updated to cover the latest industry and technology changes that impact the course.

MyLab MIS

The goal of *Management Information Systems* is to provide students and instructors with an authoritative, up-to-date, interactive, and engaging introduction to the MIS field. MyLab MIS for *Management Information Systems* is an extension of this goal in an interactive digital environment.

MyLab is the teaching and learning platform that empowers you to reach *every* student. By combining trusted author content with digital tools and a flexible platform, MyLab personalizes the learning experience and improves results for each student.

MyLab MIS features videos, animations, interactive quizzes to foster student comprehension of concepts, theories, and issues. The MyLab MIS environment reflects the new learning styles of students, which are more social, interactive, and usable on digital devices such as smartphones and tablets.

What's Included

- **Pearson eText** – Enhances learning both in and out of the classroom. Students can highlight, take notes, and review key vocabulary all in one place, even when offline. Seamlessly integrated interactivities and Conceptual Animations bring concepts to life via MyLab or the app.
- **New Conceptual Animations** – Have author Ken Laudon walk students through three of the most important concepts in each chapter (45 total) using a contemporary animation platform. Available not only in the Pearson eText that lives in MyLab MIS but can also be purchased as a standalone eText.
- **New Video Cases** – Collections of video cases (two or more per chapter) and 6 additional instructional videos cover key concepts and experiences in the MIS world. The video cases illustrate how real-world corporations and managers are using information technology and systems. Each case is paired with a brief quiz. Video cases are listed at the beginning of each chapter.
- **MIS Decision Simulations** – Foster critical decision making skills with these interactive exercises that allow students to play the role of a manager and make business decisions.
- **Chapter Warm Ups, Chapter Quizzes** – These objective-based quizzes evaluate comprehension.
- **Discussion Questions** – Threaded discussion topics taken from the end of chapter encourage critical thinking.
- **Excel & Access Grader Projects** – Live in the application auto-graded Grader projects provided inside MyLab MIS to support classes covering Office tools. In addition, Hands-On MIS Projects from the book are also available.

- **Running Case** on Dirt Bikes USA provides additional hands-on projects for each chapter.
- **Dynamic Study Modules** help students study chapter topics and the language of MIS on their own by continuously assessing their knowledge application and performance in real time. These are available as graded assignments prior to class, and are accessible on smartphones, tablets, and computers.
- **Learning CatalyticsTM** is a student response tool that helps you generate class discussion, customize your lecture, and promote peer-to-peer learning based on real-time analytics. Learning Catalytics uses students' devices to engage them in more interactive tasks.
- **Learning Tracks:** 38 Learning Tracks in MyLab MIS provide additional coverage of selected topics. (See pages 28–29 for list of Learning Tracks available.)

ENHANCED STAND-ALONE PEARSON ETEXT

Management Information Systems is also available as a stand-alone eText, which extends the learning experience, anytime and anywhere: The mobile app lets students use their eText whenever they have a moment in their day, on Android and iPhone mobile phones and tablets. Offline access ensures students never miss a chance to learn. The eText engages students with compelling media: Videos and animations written and produced by the authors bring key concepts to life, helping students place what they are reading into context. Other features include highlights that allow educators to share information directly with students within their eText, and analytics that let educators gain insight into how students use their eText, and plan more effective instruction.

Both the MyLab MIS and eText platforms provide an affordable, simple-to-use mobile-optimized reading experience that lets instructors and students extend learning beyond class time.

New and Updated Topics

The 17th Global Edition features all new or updated opening, closing, and Interactive Session cases. The text, figures, tables, and cases have been updated through July 2020 with the latest sources from industry and MIS research. New topics and coverage include:

- **Updated and expanded coverage of artificial intelligence (AI):** Chapter 11 has been rewritten to include new expanded coverage of machine learning, “deep learning,” natural language systems, computer vision systems, and robotics, reflecting the surging interest in business uses of AI and “intelligent” techniques.
- **Making the business case for systems:** Chapter 14 has been rewritten to provide expanded coverage of techniques and decision-making criteria for developing a business case for the acquisition and deployment of information systems and related technologies. The chapter shows how to evaluate and select systems projects and technologies that will deliver the greatest value to the firm.
- **System impacts of the coronavirus pandemic:** Up-to-date coverage of the impact of the coronavirus pandemic on business uses of information systems. Three Interactive Sessions and two chapter-ending case studies cover topics such as working remotely, supply chain disruptions, and rethinking global supply chains.

- **Big Data and the Internet of Things:** In-depth coverage of big data, big data analytics, and the Internet of Things (IoT) in Chapters 1, 6, 7, and 12. Includes big data analytics, analyzing IoT data streams, Hadoop, in-memory computing, nonrelational databases, data lakes, and analytic platforms.
- **Cloud Computing:** Updated and expanded coverage of cloud computing in Chapter 5 (IT infrastructure) with more detail on types of cloud services, private and public clouds, hybrid clouds, managing cloud services, and a new Interactive Session on using cloud services. Cloud computing is also covered in Chapter 6 (databases in the cloud), Chapter 8 (cloud security), Chapter 9 (cloud-based CRM and ERP), Chapter 10 (e-commerce), and Chapter 13 (cloud-based systems development).
 - Digital resiliency
 - Expanded coverage on privacy and intellectual property laws and regulations in the EU and other countries
 - Low-code and no-code development and automated testing
 - Software for the web: Javascript, Java, HTML, and HTML5
 - Data governance
 - Dark web

The Laudon text, MyLab MIS, and eText provide the most up-to-date and comprehensive overview of information systems used by business firms today. After reading this book, we expect students will be able to participate in, and even lead, management discussions of information systems for their firms and understand how to use information technology in their jobs to achieve bottom-line business results. Regardless of whether students are accounting, finance, management, operations management, marketing, or information systems majors, the knowledge and information in this book will be valuable throughout their business careers.

Solving Teaching and Learning Challenges

MyLab MIS is the teaching and learning platform that empowers you to reach every student. By combining trusted authors' content with digital tools and a flexible platform, MyLab MIS personalizes the learning experience and improves results for each student. And with MIS Decision-Making Sims and auto-graded Excel and Access Projects, students understand how MIS concepts will help them succeed in their future careers.

MyLab MIS and Pearson eText offer unique digital interactive features that hold student attention spans longer and make learning more effective, including 45 conceptual animations that walk students through key concepts in each chapter, a collection of online video cases, and interactive quizzes. All of this is available anytime, anywhere, on any digital device. The result is a comprehensive learning environment that will heighten student engagement and learning in the MIS course.

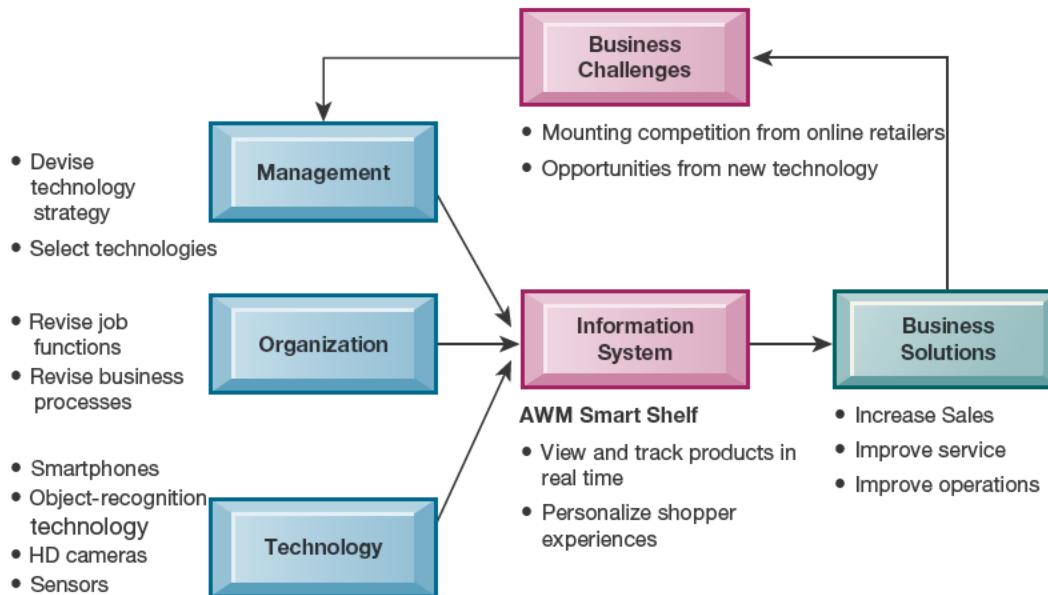
The Laudon learning package is more current, real-world, and authoritative than competitors. Laudon *Management Information Systems* 17th Global Edition, MyLab MIS, and Pearson eText help students understand MIS concepts and issues through extensive use of real-world company examples, a wide variety of text and video cases based on real-world organizations, and numerous line art illustrations, interactive animations, and hands-on software projects.

The Laudons are known for their outstanding real-world case studies, which describe how well-known business firms are using IT to solve problems and achieve objectives. Students are often asked to analyze the business problem and propose alternative solutions. The Laudons also provide hands-on MIS software and management decision-making problems in each chapter that are based on real-world companies and business scenarios.

The Laudon text and learning package now has a very strong career focus, which incentivizes students to learn by showing exactly how each chapter will help them prepare for future jobs. In addition to Career Opportunities, MyLab MIS features Career Resources, including how to incorporate MIS knowledge into resumes, cover letters, and job interviews.

The Core Text

The Core text provides an overview of fundamental MIS concepts using an integrated framework for describing and analyzing information systems. This framework shows information systems composed of management, organization, and technology elements and is reinforced in student projects and case studies. The Core text consists of 15 chapters with hands-on projects covering the most essential topics in MIS. An important part of the Core text is the Video Case Study and Instructional Video Package: video case studies (two to three per chapter) plus 6 instructional videos that illustrate business uses of information systems, explain new technologies, and explore concepts. Videos are keyed to the topics of each chapter.



◀ A diagram accompanying each chapter-opening case graphically illustrates how management, organization, and technology elements work together to create an information system solution to the business challenges discussed in the case.

Chapter Organization

Each chapter contains the following elements:

- A Chapter Outline based on Learning Objectives
- Lists of all the Case Studies and Video Cases for each chapter
- A chapter-opening case describing a real-world organization to establish the theme and importance of the chapter

- A diagram analyzing the opening case in terms of the management, organization, and technology model used throughout the text
- Two Interactive Sessions with Case Study Questions
- A Career Opportunities section showing students how to use the text for job hunting and career preparation
- A Review Summary keyed to the Student Learning Objectives
- A list of Key Terms that students can use to review concepts
- Review questions for students to test their comprehension of chapter material
- Discussion questions raised by the broader themes of the chapter
- A series of Hands-on MIS Projects consisting of two Management Decision Problems, a hands-on application software project, and a project to develop Internet skills
- A Collaboration and Teamwork Project to develop teamwork and presentation skills with options for using open source collaboration tools
- A chapter-ending case study for students to apply chapter concepts
- Chapter references

Student Learning-Focused

Student Learning Objectives are organized around a set of study questions to focus student attention. Each chapter concludes with a Review Summary and Review Questions organized around these study questions, and each major chapter section is based on a Learning Objective.

Key Features

We have enhanced the text to make it more interactive, leading edge, and appealing to both students and instructors. The features and learning tools are described in the following sections.

Business-Driven with Real-World Business Cases and Examples

The text helps students see the direct connection between information systems and business performance. It describes the main business objectives driving the use of information systems and technologies in corporations all over the world: operational excellence, new products and services, customer and supplier intimacy, improved decision making, competitive advantage, and survival. In-text examples and case studies show students how specific companies use information systems to achieve these objectives. We use current (2020) examples from business and public organizations throughout the text to illustrate the important concepts in each chapter. Most of the case studies describe companies or organizations that are familiar to students, such as Facebook, Google, Amazon, PayPal, the Bel Group, and Deliveroo.

Hands-On Text Activities

Real-world business scenarios and data to learn firsthand what MIS is all about. These projects heighten student involvement in this exciting subject.

- **Interactive Sessions.** Two short cases in each chapter have been redesigned as Interactive Sessions that can be used to stimulate student

interest and active learning. Each case concludes with case study questions. The case study questions provide topics for discussion or written assignments.

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INTERACTIVE SESSION TECHNOLOGY

New Cloud Database Tools Help Vodafone Fiji Make Better Decisions

Vodafone Fiji Limited is a 100 percent locally owned wireless telecommunications services provider, with more than 760,000 subscribers on its network, 260 employees, and revenue of U.S. \$185 million. Vodafone Fiji works closely with the Vodafone Group, a British multinational telecommunications conglomerate, which predominantly services Asia, Africa, Europe, and Oceania, and other operating companies to deliver cutting-edge technology to the people of Fiji. It has 85 percent of that country's market share in telecommunications services.

Prepaid customers account for 96 percent of Fiji's mobile communications market. (Less than 25 percent of U.S. mobile customers use prepaid services.) Prepaid customers are not bound by mobile service contracts, and thus are always looking for better ways to save. Consequently, Vodafone Fiji has to come up with better deals for its customers to persuade them to continue with its services. Unfortunately Vodafone Fiji's systems were not able to deliver the information for the task.

The company lacked the computing power, storage, and data management tools to analyze data quickly to make informed decisions about which deals to offer to which customers and the right times to do so. The data were stored on premises in multiple databases. Making matters worse, Amalgamated Telecom Holdings (Vodafone Fiji's major shareholder) had recently acquired several other telecommunications companies serving nearby markets in Samoa, American Samoa, Vanuatu, Cook Islands, and Kiribati. The data to be managed and mined for insights increased threefold. All those businesses had

Data Warehouse provides an easy-to-use, fully autonomous database that scales elastically as workloads increase, delivers fast query performance, and requires no database administration. Vodafone Fiji would be able to extract, move, and transform data from disparate sources in the cloud, where it could be analyzed much more rapidly.

By automating many of the routine tasks required to manage Oracle databases, Oracle Autonomous Database can free up database administrators (DBAs) to do higher-level and more strategic work. The warehouse system handles a great deal of tedious technical work on its own. Vodafone Fiji would not need to hire people with specialized database management skills, which would be challenging in a small job market such as Fiji's. An on-premises data warehouse would have taken the company two months to implement, whereas it set up Oracle Autonomous Data Warehouse Cloud within 30 minutes and reporting functionality within one week. Vodafone Fiji pays only for computing resources consumed.

Oracle Analytics Cloud is a cloud-based platform that can take data in almost any form or size from almost any source (desktop, enterprise, data center), with capabilities for collecting, consolidating and transforming data, and creating transactional and analytical reports and dashboards. Oracle Analytics Cloud provides self-service capabilities for users to perform what-if modeling and analysis. Users are empowered to visualize and discover data including working with Big Data

Vodafone Fiji can now easily obtain insights from

◀ Each chapter contains two Interactive Sessions on Management, Organizations, or Technology using real-world companies to illustrate chapter concepts and issues.

CASE STUDY QUESTIONS

1. Define the problem faced by Vodafone Fiji. What management, organization, and technology factors contributed to the problem?
2. Evaluate Oracle Autonomous Data Warehouse and Oracle Analytics Cloud as a solution for Vodafone Fiji.
3. How did the new Oracle tools change decision making at Vodafone Fiji?
4. Was using cloud services advantageous for Vodafone Fiji? Explain your answer.

◀ Case Study Questions encourage students to apply chapter concepts to real-world companies in class discussions, student presentations, or writing assignments.

- **Hands-On MIS Projects** Every chapter concludes with a Hands-On MIS Projects section containing three types of projects: two Management Decision Problems; a hands-on application software exercise using Microsoft Excel, Access, or web page and blog creation tools; and a project that develops Internet business skills. Files for these projects are available in MyLab. As mentioned, the Dirt Bikes USA running case in MyLab MIS provides additional hands-on projects for each chapter.
- **Collaboration and Teamwork Projects.** Each chapter features a collaborative project that encourages students working in teams to use Google Drive, Google Docs, or other open source collaboration tools. The first team project in Chapter 1 asks students to build a collaborative Google site.

The screenshot shows a Microsoft Access window with the title bar "Microsoft Access". The ribbon tabs are "File", "Home", "Create", "External Data", "Database Tools", "Fields", and "Table". The main area displays a table titled "Store & Region Sales Database". The columns are: I, Store N, Sales Regic, Item I, Item Descripti, Unit Pri, Units So, Week Ending, and Click to Add. The data includes rows for 17" Monitors, 101 Keyboards, and 6050 PC Mice from stores 1 and 2 across different weeks.

I	Store N	Sales Regic	Item I	Item Descripti	Unit Pri	Units So	Week Ending	Click to Add
1	1 South	2005	17" Monitor	\$229.00	28	10/27/2020		
2	1 South	2005	17" Monitor	\$229.00	30	11/24/2020		
3	1 South	2005	17" Monitor	\$229.00	9	12/29/2020		
4	1 South	3006	101 Keyboard	\$19.95	30	10/27/2020		
5	1 South	3006	101 Keyboard	\$19.95	35	11/24/2020		
6	1 South	3006	101 Keyboard	\$19.95	39	12/29/2020		
7	1 South	6050	PC Mouse	\$8.95	28	10/27/2020		
8	1 South	6050	PC Mouse	\$8.95	3	11/24/2020		
9	1 South	6050	PC Mouse	\$8.95	38	12/29/2020		
10	1 South	8500	Desktop CPU	\$849.95	25	10/27/2020		
11	1 South	8500	Desktop CPU	\$849.95	27	11/24/2020		
12	1 South	8500	Desktop CPU	\$849.95	33	12/29/2020		
13	2 South	2005	17" Monitor	\$229.00	8	10/27/2020		
14	2 South	2005	17" Monitor	\$229.00	8	11/24/2020		
15	2 South	2005	17" Monitor	\$229.00	10	12/29/2020		
16	2 South	3006	101 Keyboard	\$19.95	8	10/27/2020		
17	2 South	3006	101 Keyboard	\$19.95	8	11/24/2020		
18	2 South	3006	101 Keyboard	\$19.95	8	12/29/2020		
19	2 South	6050	PC Mouse	\$8.95	9	10/27/2020		
20	2 South	6050	PC Mouse	\$8.95	9	11/24/2020		
21	2 South	6050	PC Mouse	\$8.95	8	12/29/2020		
22	2 South	8500	Desktop CPU	\$849.95	18	10/27/2020		
23	2 South	8500	Desktop CPU	\$849.95	18	11/24/2020		
24	2 South	8500	Desktop CPU	\$849.95	20	12/29/2020		
25	3 South	2005	17" Monitor	\$229.00	38	10/27/2020		
26	3 South	2005	17" Monitor	\$229.00	30	11/24/2020		
27	3 South	2005	17" Monitor	\$229.00	2	12/29/2020		

► Students practice using software in real-world settings for achieving operational excellence and enhancing decision making.

► Each chapter features a project to develop Internet skills for accessing information, conducting research, and performing online calculations and analysis.

Improving Decision Making: Using Web Tools to Configure and Price an Automobile

Software skills: Internet-based software

Business skills: Researching product information and pricing

3-11 In this exercise, you will use software at car websites to find product information about a car of your choice and use that information to make an important purchase decision. You will also evaluate two of these sites as selling tools.

Developing Career Skills

For students to succeed in a rapidly changing job market, they should be aware of their career options and how to go about developing a variety of skills. With MyLab MIS and *Management Information Systems* 17th Global Edition, we focus on these skills in the following ways.

Career Opportunities and Resources

Every student who reads this text wants to know: How will this book help my career? The Career Opportunities feature shows how to use this text, MyLab MIS, and eText as tools for job-hunting and career-building. Job interviewers will typically ask about why you want the job, along with your ability to communicate, multitask, work in a team, show leadership, solve problems, and meet goals. These are general skills and behaviors you'll need to succeed in any job, and you should be prepared to provide examples from your course work and job experiences that demonstrate these skills. But there are also business knowledge and professional skills that employers will ask you about. Career Opportunities will show you how to use what you have learned in this text to demonstrate these skills.

The Career Opportunities section, identified by this icon is the last major section of each chapter under the heading “How will MIS help my career?”. There you will find a description of an entry-level job for a recent college graduate based on a real-world job description from major online job sites related to the topics covered in that chapter. The name of the company offering the job and its location have been changed. Each chapter’s job posting describes the

required educational background and specific job skills, and suggests some of the business-related questions that might arise during the job interview. The authors provide tips for answering the questions and preparing for the interview. Career Opportunities also show where students can find out more information about the technical and business knowledge required for the job in this text and on the web and social media.

Below are the job descriptions used in this edition based on postings from both large and small businesses. A few of these jobs call for an MIS major, others for MIS course work, but many postings are not that specific. Some require some previous internship or job experience, but many are entry-level positions suitable for new college graduates, and some of these positions provide on-the-job training. However, all require knowledge of business information systems and applications and the ability to work in a digital environment.

CHAPTER	CAREER OPPORTUNITY JOB DESCRIPTION
1. Information Systems in Global Business Today	Financial Client Support and Sales Assistant
2. Global E-business and Collaboration	Entry Level Sales Support Specialist
3. Information Systems, Organizations, and Strategy	Entry Level Business Development Representative
4. Ethical and Social Issues in Information Systems	Junior Privacy Analyst
5. IT Infrastructure and Emerging Technologies	Entry Level IT Consultant
6. Foundations of Business Intelligence: Databases and Information Management	Entry Level Data Analyst
7. Telecommunications, the Internet, and Wireless Technology	Automotive Digital Advisor
8. Securing Information Systems	Entry Level Identity Access and Management Support Specialist
9. Achieving Operational Excellence and Customer Intimacy: Enterprise Applications	Manufacturing Management Trainee
10. E-commerce: Digital Markets, Digital Goods	Junior E-Commerce Data Analyst
11. Managing Knowledge and Artificial Intelligence	AI Technology Sales Assistant
12. Enhancing Decision Making	Entry Level Data Analyst
13. Building Information Systems	Entry Level Junior Business Systems Analyst
14. Making the Business Case for Information Systems and Managing Projects	IT Project Management Assistant
15. Managing Global Systems	Global Data Services Sales and Marketing Trainee

Students can use Career Opportunities to shape their resumes and career plans as well as to prepare for interviews. For instructors, Career Opportunities are potential projects for student research and in-class discussion.

In MyLab MIS we have provided additional Career Resources, including job hunting guides and instructions on how to build a Digital Portfolio demonstrating the business knowledge, application software proficiency, and Internet skills acquired from using the text. The portfolio can be included in a resume or job application or used as a learning assessment tool for instructors.

Instructor Teaching Resources

SUPPLEMENTS AVAILABLE TO INSTRUCTORS AT WWW. PEARSONGLOBALEDITIONS.COM		FEATURES OF THE SUPPLEMENT
Instructor's Manual		<ul style="list-style-type: none"> • Chapter-by-chapter summaries • Examples and activities not in the main book • Teaching outlines • Teaching tips • Solutions to all questions and problems in the book
Test Bank authored by Professor Kenneth Laudon, New York University		<p>The authors have worked closely with skilled test item writers to ensure that higher-level cognitive skills are tested. Test bank multiple-choice questions include questions on content but also include many questions that require analysis, synthesis, and evaluation skills.</p> <p>AACSB Assessment Guidelines</p> <p>As a part of its accreditation activities, the AACSB has developed an Assurance of Learning Program designed to ensure that schools do in fact teach students what they promise. Schools are required to state a clear mission, develop a coherent business program, identify student learning objectives, and then prove that students do in fact achieve the objectives.</p> <p>We have attempted in this book to support AACSB efforts to encourage assessment-based education. The end papers of this edition identify student learning objectives and anticipated outcomes for our Hands-On MIS projects. The authors will provide custom advice on how to use this text in colleges with different missions and assessment needs. Please email the authors or contact your local Pearson representative for contact information.</p>
Computerized TestGen		<p>TestGen allows instructors to:</p> <ul style="list-style-type: none"> • Customize, save, and generate classroom tests • Edit, add, or delete questions from the Test Item Files • Analyze test results • Organize a database of tests and student results
PowerPoints authored by Professor Kenneth Laudon, New York University		<p>The authors have prepared a comprehensive collection of 50 PowerPoint slides for each chapter to be used in your lectures. Many of these slides are the same as used by Ken Laudon in his MIS classes and executive education presentations. Each of the slides is annotated with teaching suggestions for asking students questions, developing in-class lists that illustrate key concepts, and recommending other firms as examples in addition to those provided in the text. The annotations are like an Instructor's Manual built into the slides and make it easier to teach the course effectively.</p> <p>PowerPoints meet accessibility standards for students with disabilities. Features include but are not limited to:</p> <ul style="list-style-type: none"> • Keyboard and Screen Reader access • Alternative text for images • High color contrast between background and foreground colors

Learning Tracks

There are 38 Learning Tracks in MyLab MIS available to instructors and students. This supplementary content takes students deeper into MIS topics, concepts, and debates and reviews basic technology concepts in hardware, software, database design, and other areas.

CHAPTER	LEARNING TRACKS
Chapter 1: Information Systems in Global Business Today	How Much Does IT Matter? Information Systems and Your Career The Mobile Digital Platform
Chapter 2: Global E-business and Collaboration	Systems from a Functional Perspective IT Enables Collaboration and Teamwork Challenges of Using Business Information Systems Organizing the Information Systems Function
Chapter 3: Information Systems, Organizations, and Strategy	The Changing Business Environment for IT
Chapter 4: Ethical and Social Issues in Information Systems	Developing a Corporate Code of Ethics for IT
Chapter 5: IT Infrastructure and Emerging Technologies	How Computer Hardware and Software Work Service Level Agreements The Open Source Software Initiative Cloud Computing
Chapter 6: Foundations of Business Intelligence: Databases and Information Management	Database Design, Normalization, and Entity-Relationship Diagramming Introduction to SQL Hierarchical and Network Data Models
Chapter 7: Telecommunications, the Internet, and Wireless -Technology	Wireless Applications for Customer Relationship Management, Supply Chain Management, and Healthcare
Chapter 8: Securing Information Systems	The Booming Job Market in IT Security The Sarbanes-Oxley Act Computer Forensics General and Application Controls for Information Systems Management Challenges of Security and Control Software Vulnerability and Reliability
Chapter 9: Achieving Operational Excellence and Customer Intimacy: Enterprise Applications	Best-Practice Business Processes in CRM Software
Chapter 10: E-commerce: Digital Markets, Digital Goods	E-commerce Challenges: The Story of Online Groceries Build an E-commerce Business Plan Hot New Careers in E-Commerce E-commerce Payment Systems
Chapter 11: Managing -Knowledge and Artificial Intelligence	Challenges of Knowledge Management Systems Case-Based Reasoning Fuzzy Logic
Chapter 12: Enhancing Decision Making	Building and Using Pivot Tables
Chapter 13: Building Information Systems	Unified Modeling Language Primer on Business Process Design and Documentation Primer on Business Process Management
Chapter 14: Making the Business Case for Information Systems and Managing Projects	Capital Budgeting Methods for Information Systems Investments Enterprise Analysis (Business Systems Planning) and Critical Success Factors Information Technology Investments and Productivity

Video Cases and Instructional Videos

Instructors can download step-by-step instructions for accessing the video cases from the Instructor Resources Center.

CHAPTER	VIDEO
Chapter 1: Information Systems in Global Business Today	Business in the Cloud: Facebook, Google, and eBay Data Centers UPS Global Operations with the DIAD and Worldport Instructional Video: Tour IBM's Raleigh Data Center
Chapter 2: Global E-business and Collaboration	VisionX Grows with SAP Business One CEMEX: Becoming a Social Business
Chapter 3: Information Systems, Organizations, and Strategy	GE Becomes a Digital Firm: The Emerging Industrial Internet National Basketball Association: Competing on Global Delivery with Akamai OS Streaming
Chapter 4: Ethical and Social Issues in Information Systems	What Net Neutrality Means for You Facebook and Google Privacy: What Privacy? United States vs. Terrorism: Data Mining for Terrorists and Innocents Instructional Video: Viktor Mayer-Schönberger on the Right to Be Forgotten
Chapter 5: IT Infrastructure and Emerging Technologies	Rockwell Automation Fuels the Oil and Gas Industry with the Internet of Things (IoT) ESPN.com: The Future of Sports Coverage in the Cloud Netflix: Building a Business in the Cloud
Chapter 6: Foundations of Business Intelligence: Databases and Information Management	Brooks Brothers Closes In on Omnichannel Retail Maruti Suzuki Business Intelligence and Enterprise Databases
Chapter 7: Telecommunications, the Internet, and Wireless Technology	Telepresence Moves out of the Boardroom and into the Field Virtual Collaboration with IBM Sametime
Chapter 8: Securing Information Systems	Stuxnet and Cyberwarfare Cyberespionage: The Chinese Threat Instructional Video: Sony PlayStation Hacked; Data Stolen from 77 Million Users Instructional Video: Meet the Hackers: Anonymous Statement on Hacking Sony
Chapter 9: Achieving Operational Excellence and Customer Intimacy: Enterprise Applications	Maersk Develops a Global Shipping Management System
Chapter 10: E-commerce: Digital Markets, Digital Goods	Walmart Takes On Amazon: A Battle of IT and Management Systems Groupon: Deals Galore Etsy: A Marketplace and Community
Chapter 11: Managing Knowledge and Artificial Intelligence	How IBM's Watson Became a Jeopardy Champion Alfresco: Open Source Document Management and Collaboration
Chapter 12: Enhancing Decision Making	PSEG Leverages Big Data and Business Analytics Using GE's Predix Platform FreshDirect Uses Business Intelligence to Manage Its Online Grocery Business Intelligence Helps the Cincinnati Zoo Work Smarter
Chapter 13: Building Information Systems	IBM: Business Process Management in a SaaS Environment IBM Helps the City of Madrid with Real-Time BPM Software Instructional Video: BPM Business Process Management Customer Story Instructional Video: Workflow Management Visualized

CHAPTER	VIDEO
Chapter 14: Making the Business Case for Information Systems and Managing Projects	NASA Project Management Challenges
Chapter 15: Managing Global Systems	Daum Runs Oracle Apps on Linux Lean Manufacturing and Global ERP: Humanetics and Global Shop

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PART ONE

Organizations, Management, and the Networked Enterprise

CHAPTER 1

Information Systems in Global Business Today

CHAPTER 2

Global E-business and Collaboration

CHAPTER 3

Information Systems, Organizations, and Strategy

CHAPTER 4

Ethical and Social Issues in Information Systems

PART ONE introduces the major themes of this book, raising a series of important questions: What is an information system, and what are its management, organization, and technology dimensions? Why are information systems so essential in businesses today? Why are systems for collaboration and social business so important? How can information systems help businesses become more competitive? What broader ethical and social issues are raised by widespread use of information systems?

1

Information Systems in Global Business Today

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 1-1** How are information systems transforming business, and why are they so essential for running and managing a business today?
- 1-2** What is an information system? How does it work? What are its management, organization, and technology components? Why are complementary assets essential for ensuring that information systems provide genuine value for organizations?
- 1-3** What academic disciplines are used to study information systems, and how does each contribute to an understanding of information systems?
- 1-4** How will MIS help my career?

CHAPTER CASES

- Smart Stores Reinvent the Retail Space
- Will the Coronavirus Pandemic Make Working from Home the New Normal?
- Digital Transformation of Healthcare at Singapore's Jurong Health Services
- Changes in the Financial Industry: Adyen and Fintech

VIDEO CASES

- Business in the Cloud: Facebook, Google, and eBay Data Centers
- UPS Global Operations with the DIAD and Worldport

*Instructional Video:
Tour IBM's Raleigh Data Center*

MyLab MIS

Discussion Questions: 1-4, 1-5, 1-6; Hands-On MIS Projects: 1-7, 1-8, 1-9, 1-10;
eText with Conceptual Animations

Smart Stores Reinvent the Retail Space

Although there has been an upsurge in online shopping, retail stores are not going away. Some traditional retailers are fighting back by using information technology to provide new ways to bring people into physical stores or enhance their in-store experiences, even with new requirements for social distancing.

Acrelec, a French digital signage company, is piloting technology to help retailers manage store curbside pickups by customers placing orders online. Customers can use a retailer's smartphone app to indicate they are coming to pick up an order, and the Acrelec system will estimate when a customer will arrive at a particular store. Object-recognition cameras identify exactly when a customer's car arrives and where it is parked. Acrelec is especially useful for big-box retailers, grocery stores, and home-improvement stores.

Shelves have become more than just a surface for storing and displaying objects. New systems for "smart" shelves use proximity sensors, 3D cameras, microphones, RFID readers, and weight sensors to enable interactions between shoppers in physical stores and the shelves they're standing in front of. These systems can create a highly personalized shopping experience that fundamentally improves the way shoppers move inside physical stores.

Brands and retailers such as Pepsi, Walmart, and Albertsons are starting to use Smart Shelf by AWM to replicate the benefits of the online experience in physical retail environments. Using super-wide-angle low-light HD cameras, retailers deploying Smart Shelf are able to view and track their products in real-time. The solution improves operational efficiencies by highlighting specific shelves that need product stocking and allows for real-time on-shelf marketing to consumers. When retailers connect Smart Shelf to their mobile apps, they can help shoppers locate products themselves through their smartphones and tablets.

AWM Frictionless is a walk-in, walk-out solution enabling customers to shop as normal and check out by simply exiting the store. The system uses digital shelving and object-recognition cameras to keep track of which customers leave with which items. When customers enter a store, they are required to have mobile device and facial recognition scans, which allow the system to charge their digital accounts when they leave with purchases and receive a receipt via email or text message.



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In March 2020 AWM opened a low-contact cashierless micromarket called QuickEats at a luxury apartment community owned by Greenwood & McKenzie in Santa Ana California. QuickEats utilizes AWM Frictionless and features grab-and-go products such as sodas, water, juice drinks, sandwiches, cheese plates, fruit, and household cleaning items.

AWM Smart Shelf is able to personalize shoppers' experiences when they are in stores based on the items they pick up, even if they don't purchase them. For example, if a customer picks up a box of cookies and then puts it back, the retailer can use the system to offer a discount on the shelf beneath that item the next time the shopper encounters it in the store. Cofounder Kurtis Van Horn believes that Smart Shelf can provide the same level of customization and personalization as found in online shopping to brick-and-mortar stores.

AWM also offers an anonymous consumer behavior tracking application that can direct customers to other parts of a store using digital signage, enabling up-to-the-minute advertising and pricing. AWM solutions can be implemented in a wide range of store sizes and formats, from micromarkets, to convenience stores, to larger-format retailers. Technology is redefining the role of the shelf in retail marketing.

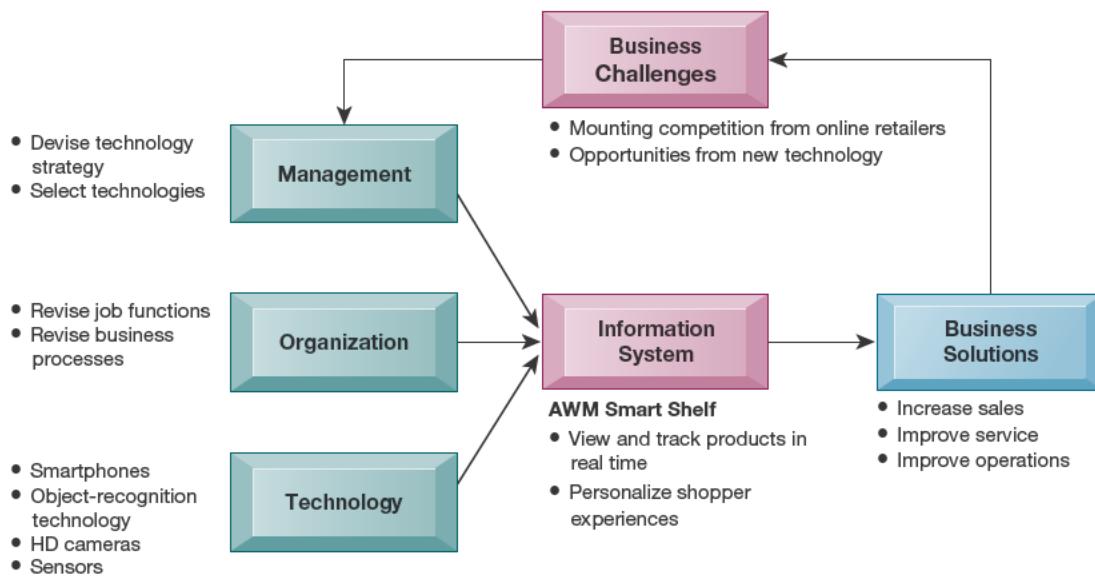
Sources: www.smartshelf.com, accessed April 29, 2020; AWM SmartShelf Launches Southern California's First Autonomous Micromarket in Santa Ana's Nineteen01 Community," Businesswire, March 24, 2020; Jared Council, "Retailers Hope In-Store Tech Will Keep Shoppers in Stores," *Wall Street Journal*, January 15, 2020.

The companies and technologies described here show how essential information systems are today. Today, retail stores are struggling to stay alive and relevant as more shoppers gravitate to online shopping and the Internet. One solution is to use leading-edge innovative information technology to provide new ways of drawing buyers into physical stores and making the in-store buying experience more efficient, safe, and pleasant. The information flows that drive these reimaged retail businesses have become much more digital, making use of mobile tools and object-recognition technology.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. To compete more effectively against online retailers and take advantage of new technology solutions, brick-and-mortar retail stores are using innovative systems based on object-recognition technology, sensors, and smartphones. The use of leading-edge digital technologies to drive business operations and management decisions is a key topic today in the MIS world and will be discussed throughout this text.

It is also important to note that deploying information technology has changed the way customers of Acrelec and AWM Smart Shelf run their businesses. To effectively use new digital tools, these companies had to redesign jobs and procedures for gathering, inputting, and accessing information. These changes had to be carefully planned to make sure they enhanced efficiency, service, and profitability.

Here are some questions to think about: How do Acrelec's and AWM's systems change retail operations? How do they improve the customer experience?



1-1 How are information systems transforming business, and why are they so essential for running and managing a business today?

It's not business as usual in the global economy anymore. Information systems and technologies are transforming the global business environment. In 2019, global spending on information technology (IT) and IT services was nearly \$3.8 trillion (Gartner, 2019). In addition, firms spent another \$160 billion on management consulting and services—much of which involves redesigning firms' business operations to take advantage of these new technologies (Statista, 2020). In fact, most of the business value of IT investment derives from these organizational, management, and cultural changes inside firms (Saunders and Brynjolfsson, 2016). Figure 1.1 shows that between 1999 and 2019, capital investment in information technology consisting of IT equipment, software, and research and development (R&D) accounted for over 40 percent of US total capital spending. A similar pattern has occurred globally.

As managers, most of you will work for firms that are intensively using information systems and making large investments in information technology. You will certainly want to know how to invest this money wisely. If you make wise choices, your firm can outperform competitors. If you make poor choices, you will be wasting valuable capital. This book is dedicated to helping you make wise decisions about information technology and information systems.

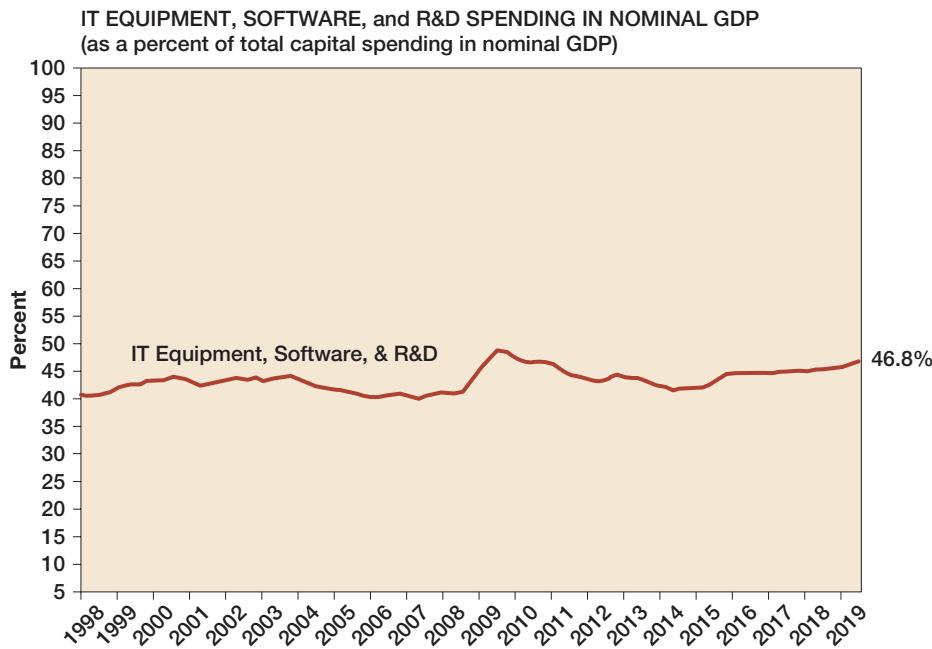
What's New in Management Information Systems?

Plenty. In fact, there's a whole new world of doing business using new technologies for managing and organizing. What makes the MIS field the most exciting area of study in schools of business is the continuous change in technology, management, and business processes. Five changes are of paramount importance.

FIGURE 1.1 INFORMATION TECHNOLOGY CAPITAL INVESTMENT

Information technology capital investment, defined as IT equipment, software and research and development (R&D) spending, amounted to over 40 percent of total US capital spending (in nominal GDP) between 1999 and 2019. A similar pattern has occurred globally.

Source: US Bureau of Economic Analysis.



IT Innovations A continuing stream of information technology innovations is transforming the traditional business world. Examples include the emergence of cloud computing, the growth of a mobile digital business platform based on smartphones and tablet computers, big data and the Internet of Things (IoT), business analytics, machine learning systems, and the use of social networks by managers to achieve business objectives. Most of these changes have occurred in the past few years. These innovations are enabling entrepreneurs and innovative traditional firms to create new products and services, develop new business models, and transform the day-to-day conduct of business. In the process, some old businesses, even industries, are being destroyed while new businesses are springing up.

New Business Models For instance, the emergence of online video services for streaming or downloading, such as Netflix, Apple TV Channels, and Amazon, has forever changed how premium video is distributed and even created. Netflix by early 2020 had attracted more than 167 million subscribers worldwide to what it calls the “Internet TV revolution.” Netflix has moved into premium TV show production with nearly 1,200 original shows in 2019, such as *American Vandal*, *Suburra*, *The Crown*, *Friends From College*, *House of Cards*, and *Orange Is the New Black*, challenging cable and broadcast producers of TV shows, and potentially disrupting cable network dominance of TV show production. Apple has struck deals with major Hollywood studios for recent movies and TV shows. A growing trickle of viewers are unplugging from cable and using only the Internet for entertainment.

E-commerce Expansion E-commerce sales worldwide amounted to nearly \$3.6 trillion in 2019 and are expected to approach \$5 trillion by 2021 (Lipsman, 2019). E-commerce is changing how firms design, produce, and deliver their products and services. E-commerce has reinvented itself again, disrupting the traditional marketing and advertising industry and putting major media and content firms

in jeopardy. Facebook and other social networking sites such as YouTube, Twitter, and Tumblr, along with Netflix, Apple Music, and many other media firms, exemplify the new face of e-commerce in the twenty-first century. They sell services. When we think of e-commerce, we tend to think of selling physical products. While this iconic vision of e-commerce is still very powerful and the fastest-growing form of retail worldwide, growing up alongside is a whole new value stream based on selling services, not goods. It's a services model of e-commerce. Growth in social commerce is spurred by powerful growth of the mobile platform: 98 percent of Facebook's users access the service from mobile phones and tablets. Information systems and technologies are the foundation of this new services-based e-commerce. Mobile retail e-commerce worldwide approached \$2.55 billion in 2020 (and is growing at almost 20 percent a year) (eMarketer, 2020).

Management Changes The management of business firms has changed: With new mobile smartphones, high-speed wireless Wi-Fi networks, and tablets, remote salespeople on the road are only seconds away from their managers' questions and oversight. Management is going mobile. Managers on the move are in direct, continuous contact with their employees. The growth of enterprise-wide information systems with extraordinarily rich data means that managers no longer operate in a fog of confusion but instead have online, nearly instant access to the really important information they need for accurate and timely decisions. In addition to their public uses on the web, social networking tools, wikis, and blogs are becoming important corporate tools for communication, collaboration, and information sharing.

Changes in Firms and Organizations Compared to industrial organizations of the previous century, new fast-growing twenty-first-century business firms put less emphasis on hierarchy and structure and more emphasis on employees taking on multiple roles and tasks and collaborating with others on a team. They put greater emphasis on competency and skills rather than position in the hierarchy. They emphasize higher-speed and more-accurate decision making based on data and analysis. They are more aware of changes in technology, consumer attitudes, and culture. They use social media to enter into conversations with consumers and demonstrate a greater willingness to listen to consumers, in part because they have no choice. They show better understanding of the importance of information technology in creating and managing business firms and other organizations. To the extent organizations and business firms demonstrate these characteristics, they are twenty-first-century digital firms.

You can see some of these trends at work in the Interactive Session on Organizations, which examines the impact on work and management as many companies had their employees work remotely during the coronavirus pandemic of 2020.

Globalization Challenges and Opportunities: A Flattened World

Prior to AD 1500, there was no truly global economic system of trade that connected all the continents on earth although there were active regional trade markets. After the sixteenth century, a global trading system began to emerge based on advances in navigation and ship technology. The world trade that ensued after these developments has brought the peoples and cultures of the world much closer together. The Industrial Revolution was really a worldwide phenomenon energized by expansion of trade among nations, making nations both competitors and collaborators in business. The Internet has greatly heightened the competitive tensions among nations as global trade expands

INTERACTIVE SESSION

ORGANIZATIONS

Will the Coronavirus Pandemic Make Working from Home the New Normal?

As COVID-19 continued to spread around the globe, companies large and small started to make changes to the way they work, shuttering their offices and requiring most or all of their employees to work remotely from their homes.

- During the pandemic, ClearRisk, which offers integrated, cloud-based software solutions for claims, fleet, incident, and insurance certificate management had its entire staff working from home.
- Many large law firms, including Reed Smith, Baker McKenzie, and Nixon Peabody, closed offices and required work at home during the pandemic. The law firms emphasized that they could continue to serve clients despite office closings and remote work.
- OpenText Corp., a Canadian provider of enterprise information management products, plans to eliminate more than half of its 120 offices globally, with 2000 of its 15,000-person workforce working from home permanently.
- In mid-May 2020, Twitter Inc. notified employees that most of them could work from home indefinitely.

According to a recent MIT report, 34 percent of Americans who previously commuted to work stated that they were working from home by the first week of April 2020 due to the coronavirus outbreak. Prior to the pandemic, the number of people regularly working from home remained in the single digits, with only about 4 percent of the US workforce working from home at least half the time. However, the trend of working from home had been slowly gaining momentum thanks to advances in information technology for remote work and changes in corporate work culture. The coronavirus pandemic may mark a tipping point.

It's likely that many people who started working from home for the first time during the pandemic will continue to do so thereafter. New health guidelines about distancing will require some workplaces to expand to accommodate all their employees or to have a significant percentage of employees work permanently from home.

Information technologies driving these changes include broadband high-speed Internet connections,

laptop computers, tablets, smartphones, email, messaging, and videoconferencing tools. As companies shift their work from face-to-face to remote, video conferencing is becoming the new normal for meetings. People are trying to have good conversations, share critical information, generate new ideas, reach consensus, and make decisions quickly on this platform.

Although less than ideal for face-to-face interactions, videoconferencing is becoming more powerful and affordable. There are many options, including Skype, Skype for Business, Zoom, Microsoft Teams, Amazon Chime, BlueJeans, Cisco's WebEx, GoToMeeting, and Google Meet. Some business people are using the same tools they do in their personal communications, such as FaceTime and Facebook Messenger. (FaceTime now supports group video chat with up to 32 people.)

Video conference software such as WebEx and BlueJeans appears designed for more corporate uses. Other software such as Microsoft's Skype and Zoom feels more consumer-friendly and easier to set up, with free or low-cost versions suitable for smaller businesses. Skype works for video chats, calls, and instant messaging and can handle up to 50 people in a single video call. Skype allows calls to be recorded in case someone misses a meeting. Skype also provides file-sharing capabilities, caller ID, voicemail, a split view mode to keep conversations separate, and screen share on mobile devices.

Up to 1,000 users can participate in a single Zoom video call, and 49 videos can appear on the screen at once. Zoom includes collaboration tools like simultaneous screen-sharing and co-annotation, and the ability to record meetings and generate transcripts. Users can adjust meeting times, select multiple hosts, and communicate via chat if microphones and cameras are turned off.

There are definite benefits to remote work: lower overhead, more flexible schedules, reductions in employee commuting time and attrition rates, and increases in productivity. (Many companies reported that productivity did not suffer when employees worked at home during the pandemic.) According to Global Workplace Analytics, a typical company saves about \$11,000 per half-time telecommuter per year. Working remotely also poses challenges.

Not all employees have access to the Internet at home, and many work in industries that require on-site work. About 80 percent of American adults have high-speed broadband Internet service at home. However, according to a Pew Research Center study, racial minorities, older adults, rural residents, and people with lower levels of education and income are less likely to have in-home broadband service. In addition, one in five American adults access the Internet only through their smartphones. Employees with little children or small apartments find working at home more difficult.

Full-time employees are four times more likely to have remote work options than part-time employees. According to Global Workplace Analytics, a typical remote worker is college-educated, at least 45 years old, and earns an annual salary of \$58,000 while working for a company with more than 100 employees.

Although email and text messaging are very useful, they are not effective tools for communication compared to the information exchange and personal

connection of face-to-face conversations. Remote work also inhibits the creativity and innovative thinking that take place when people interact with each other face-to-face, and videoconferencing is only a partial solution. Studies have found that people working together in the same room tend to solve problems more quickly than remote collaborators, and that team cohesion suffers when members work remotely.

Sources: Dana Mattioli and Konrad Putzier, "The End of the Office," *Wall Street Journal*, May 16-17, 2020; Rani Molla, "This Is the End of the Office as We Know It," *Vox*, April 14, 2020; Josh Lowy, "Overcoming Remote Work Challenges," *MIT Sloan Management Review*, April 9, 2020; Cate Pye, "Coronavirus: What Does the 'New Normal' Mean for How We Work?" *Computer Weekly*, April 3, 2020; Lindsey Jacobson, "As Coronavirus Forces Millions to Work Remotely, the US Economy May Have Reached a 'Tipping Point' in Favor of Working from Home," *CNBC*, March 23, 2020; Derek Thompson, "The Coronavirus Is Creating a Huge, Stressful Experiment in Working from Home," *The Atlantic*, March 13, 2020; Kevin Roose, "Sorry, but Working from Home Is Overrated," *New York Times*, March 10, 2020.

CASE STUDY QUESTIONS

1. Define the problem described in this case. What are the management, organization, and technology issues raised by this problem?
2. Identify the information technologies used to provide a solution to this problem. Was this a successful solution? Why or why not?
3. Will working from home become the dominant way of working in the future? Why or why not?

and strengthened the benefits that flow from trade, and also created significant dislocations in labor markets.

In 2005, journalist Thomas Friedman wrote an influential book declaring the world was now flat, by which he meant that the Internet and global communications had greatly expanded the opportunities for people to communicate with one another and reduced the economic and cultural advantages of developed countries. The United States and European countries were in a fight for their economic lives, according to Friedman, competing for jobs, markets, resources, and even ideas with highly educated, motivated populations in low-wage areas in the less developed world (Friedman, 2007). This globalization presents you and your business with both challenges and opportunities.

A growing percentage of the economy of the United States and other advanced industrial countries in Europe and Asia depends on imports and exports. In 2019, an estimated 30 percent of the world economy resulted from foreign trade of goods and services, both imports and exports. Half of *Fortune* 500 US firms obtain nearly 50 percent of their revenue from foreign operations. For instance, more than 50 percent of Intel's revenues in 2019 came from overseas sales of its microprocessors.

It's not just goods that move across borders. So too do jobs, some of them high-level jobs that pay well and require a college degree. For instance, since 2000, the United States has lost an estimated 5 million manufacturing jobs to offshore, low-wage producers, so manufacturing is now a small part of US employment (less than 9 percent). In a normal year, about 300,000 service jobs move offshore to lower-wage countries, many of them in less-skilled information system occupations but also in tradable service jobs in architecture, financial services, customer call centers, consulting, engineering, and even radiology.

On the plus side, the US economy created 2.6 million new jobs in 2018. Employment in information systems and the other service occupations listed previously has rapidly expanded in sheer numbers, wages, productivity, and quality of work. Outsourcing has actually accelerated the development of new systems in the United States and worldwide by reducing the cost of building and maintaining them. In 2019 job openings in information systems and technologies far exceeded the supply of applicants.

The challenge for you as a business student is to develop high-level skills through education and on-the-job experience that cannot be outsourced. The challenge for your business is to avoid markets for goods and services that can be produced offshore much less expensively. The opportunities are equally immense. Throughout this book you will find examples of companies and individuals who either failed or succeeded in using information systems to adapt to this new global environment.

What does globalization have to do with management information systems? That's simple: everything. The emergence of the Internet into a full-blown international communications system has drastically reduced the costs of operating and transacting on a global scale. Communication between a factory floor in Shanghai and a distribution center in Rapid City, South Dakota, is now instant and virtually free. Customers can now shop in a worldwide marketplace, obtaining price and quality information reliably 24 hours a day. Firms producing goods and services on a global scale achieve extraordinary cost reductions by finding low-cost suppliers and managing production facilities in other countries. Internet service firms, such as Google and eBay, are able to replicate their business models and services in multiple countries without having to redesign their expensive fixed-cost information systems infrastructure. Briefly, information systems enable globalization.

The Emerging Digital Firm

All of the changes we have just described, coupled with equally significant organizational redesign, have created the conditions for a fully digital firm. A digital firm can be defined along several dimensions. A **digital firm** is one in which nearly all of the organization's *significant business relationships* with customers, suppliers, and employees are digitally enabled and mediated. *Core business processes* are accomplished through digital networks spanning the entire organization or linking multiple organizations.

Business processes refer to the set of logically related tasks and behaviors that organizations develop over time to produce specific business results and the unique manner in which these activities are organized and coordinated. Developing a new product, generating and fulfilling an order, creating a marketing plan, and hiring an employee are examples of business processes, and the ways organizations accomplish their business processes can be a source of competitive strength. (A detailed discussion of business processes can be found in Chapter 2.)

Key corporate assets—intellectual property, core competencies, and financial and human assets—are managed through digital means. In a digital firm, any piece of information required to support key business decisions is available at any time and anywhere in the firm.

Digital firms sense and respond to their environments far more rapidly than traditional firms, giving them more flexibility to survive in turbulent times. Digital firms offer extraordinary opportunities for more-flexible global organization and management. In digital firms, both time shifting and space shifting are the norm. *Time shifting* refers to business being conducted continuously, 24/7, rather than in narrow “work day” time bands of 9 a.m. to 5 p.m. *Space shifting* means that work takes place in a global workshop as well as within national boundaries. Work is accomplished physically wherever in the world it is best accomplished.

Many firms, such as Cisco Systems, 3M, and GE, are close to becoming digital firms, using the Internet to drive every aspect of their business. Most other companies are not fully digital, but they are moving toward close digital integration with suppliers, customers, and employees.

Strategic Business Objectives of Information Systems

What makes information systems so essential today? Why are businesses investing so much in information systems and technologies? In the United States, more than 25 million business and financial managers, and 36 million professional workers in the labor force rely on information systems to conduct business. Information systems are essential for conducting day-to-day business in most advanced countries as well as achieving strategic business objectives.

Entire sectors of the economy are nearly inconceivable without substantial investments in information systems. E-commerce firms such as Amazon, eBay, Google, and E*Trade simply would not exist. Today's service industries—finance, insurance, and real estate as well as personal services such as travel, medicine, and education—could not operate without information systems. Similarly, retail firms such as Walmart and Tesco and manufacturing firms such as General Motors and Siemens require information systems to survive and prosper. Just as offices, telephones, filing cabinets, and efficient tall buildings with elevators were once the foundations of business in the twentieth century, information technology is a foundation for business in the twenty-first century.

There is a growing interdependence between a firm's ability to use information technology and its ability to implement corporate strategies and achieve corporate goals (see Figure 1.2). What a business would like to do in five years often depends on what its systems will be able to do. Increasing market share, becoming the high-quality or low-cost producer, developing new products, and increasing employee productivity depend more and more on the kinds and quality of information systems in the organization. The more you understand about this relationship, the more valuable you will be as a manager.

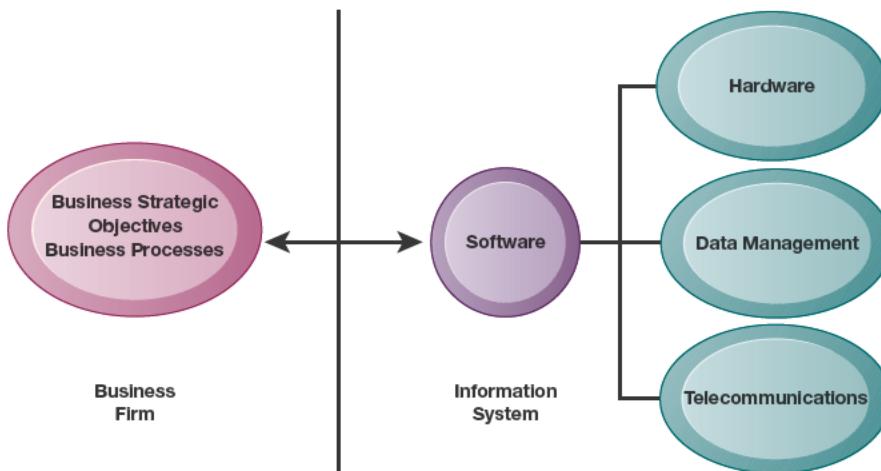
Specifically, business firms invest heavily in information systems to achieve six strategic business objectives: operational excellence; new products, services, and business models; customer and supplier intimacy; improved decision making; competitive advantage; and survival.

Operational Excellence

Businesses continuously seek to improve the efficiency of their operations in order to achieve higher profitability. Information systems and technologies are some of the most important tools available to managers for achieving higher

FIGURE 1.2 THE INTERDEPENDENCE BETWEEN ORGANIZATIONS AND INFORMATION SYSTEMS

In contemporary systems, there is a growing interdependence between a firm's information systems and its business capabilities. Changes in strategy, rules, and business processes increasingly require changes in hardware, software, databases, and telecommunications. Often, what the organization would like to do depends on what its systems will permit it to do.



levels of efficiency and productivity in business operations, especially when coupled with changes in business practices and management behavior.

Walmart, the largest retailer on earth, exemplifies the power of information systems coupled with state-of-the-art business practices and supportive management to achieve world-class operational efficiency. In fiscal year 2019, Walmart achieved \$524 billion in sales—nearly one-tenth of retail sales in the United States—in large part because of its Retail Link system, which digitally links its suppliers to every one of Walmart's stores. As soon as a customer purchases an item, the supplier monitoring the item knows to ship a replacement to the shelf. Walmart is the most efficient retail store in the industry.

New Products, Services, and Business Models

Information systems and technologies are a major enabling tool for firms to create new products and services as well as entirely new business models. A **business model** describes how a company produces, delivers, and sells a product or service to create wealth.

Today's music industry is vastly different from the industry a decade ago. Apple Inc. transformed an old business model of music distribution based on vinyl records, tapes, and CDs into an online, legal distribution model based on its own technology platform. Apple has prospered from a continuing stream of innovations, including the iTunes music service, the iPad, and the iPhone.

Customer and Supplier Intimacy

When a business really knows its customers and serves them well, the customers generally respond by returning and purchasing more. This raises revenues and profits. Likewise with suppliers—the more a business engages its suppliers, the better the suppliers can provide vital inputs. This lowers costs. How to really know your customers or suppliers is a central problem for businesses with millions of offline and online customers.

High-end hotels, such as the Mandarin Oriental hotel group, which operates hotels in Asia, Europe, and the Americas, exemplify the use of information

systems and technologies to achieve customer intimacy. These hotels use computers to keep track of guests' preferences, such as their preferred room temperature, check-in time, frequently dialed telephone numbers, and television programs, and store these data in a large data repository. Individual rooms in the hotels are networked to a central network server computer so that they can be remotely monitored and controlled. When a customer arrives at one of these hotels, the system automatically changes the room conditions, such as dimming the lights, setting the room temperature, or selecting appropriate music, based on the customer's digital profile. The hotels also analyze their customer data to identify their best customers and to develop individualized marketing campaigns based on customers' preferences.

Charles Tyrwhitt, a UK retailer specializing in dress shirts, and JCPenney, a US department store chain, exemplify the use of information systems to enable supplier and customer intimacy. Every time a dress shirt is bought one of their stores, the record of the sale appears immediately on computers in Hong Kong at their supplier, TAL Apparel, a contract manufacturer that produces one in six dress shirts sold in the United States. TAL runs the numbers through a computer model it developed and then decides how many replacement shirts to make and in what styles, colors, and sizes. TAL then sends the shirts to each store, bypassing the retailer's warehouses. These systems reduce inventory costs and ensure that what customers want are actually on the shelves.

Improved Decision Making

Many business managers operate in an information fog bank, never really having the right information at the right time to make an informed decision. Instead, managers rely on forecasts, best guesses, and luck. The result is over- or underproduction of goods and services, misallocation of resources, and poor response times. These poor outcomes raise costs and lose customers. In the past decade, information systems and technologies have made it possible for managers to use real-time data from the marketplace when making decisions.

For instance, Privi Organics Ltd., a leading Indian company that manufactures, supplies, and exports aroma chemical products worldwide, uses the Oracle Human Capital Management system for real-time insight into individual employee information—including performance rating and compensation history. The system helps managers make faster human resource decisions, such as promotions or transfers, by integrating all employee records across the organization. Managers are able to quickly review employee performance ratings for the previous three years and drill down into more details. A digital dashboard helps management view and monitor hiring status in multiple locations, such as the number of open positions and the time taken to fill these positions.

Competitive Advantage

When firms achieve one or more of these business objectives—operational excellence; new products, services, and business models; customer/supplier intimacy; and improved decision making—chances are they have already achieved a competitive advantage. Doing things better than your competitors, charging less for superior products, and responding to customers and suppliers in real time all add up to higher sales and higher profits that your competitors cannot match. Apple Inc., Walmart, and UPS, described later in this chapter, are industry leaders because they know how to use information systems for this purpose.

Survival

Business firms also invest in information systems and technologies because they are necessities of doing business. Sometimes these “necessities” are driven by industry-level changes. For instance, after Barclays Bank introduced the first automated teller machines (ATMs) in London in 1967, its competitors rushed to provide ATMs to their customers to keep up. Today, virtually all large banks around the world have regional ATMs and link to national and international ATM networks, such as Cirrus. Providing ATM services to retail banking customers is simply required in the retail banking business.

Most nations have statutes and regulations that create a legal duty for companies and their employees to retain records, including digital records. For instance, the European Council's Regulation on Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) and the U.S. Toxic Substances Control Act (1976), which regulates the exposure of employees to toxic chemicals, require firms to retain records on employee exposure for a certain period of time. Many other pieces of national and regional legislation impose significant information retention and reporting requirements on US businesses. Firms turn to information systems to provide the capability to respond to these record management requirements.

1-2 What is an information system? How does it work? What are its management, organization, and technology components? Why are complementary assets essential for ensuring that information systems provide genuine value for organizations?

So far we've used *information systems* and *technologies* informally without defining the terms. **Information technology (IT)** consists of all the hardware and software that a firm needs to use in order to achieve its business objectives. This includes not only computer machines, storage devices, and handheld mobile devices but also software, such as the Windows or Linux operating systems, the Microsoft Office desktop productivity suite, and the many thousands of computer programs that can be found in a typical large firm. “Information systems” are more complex and can be best understood by looking at them from both a technology and a business perspective.

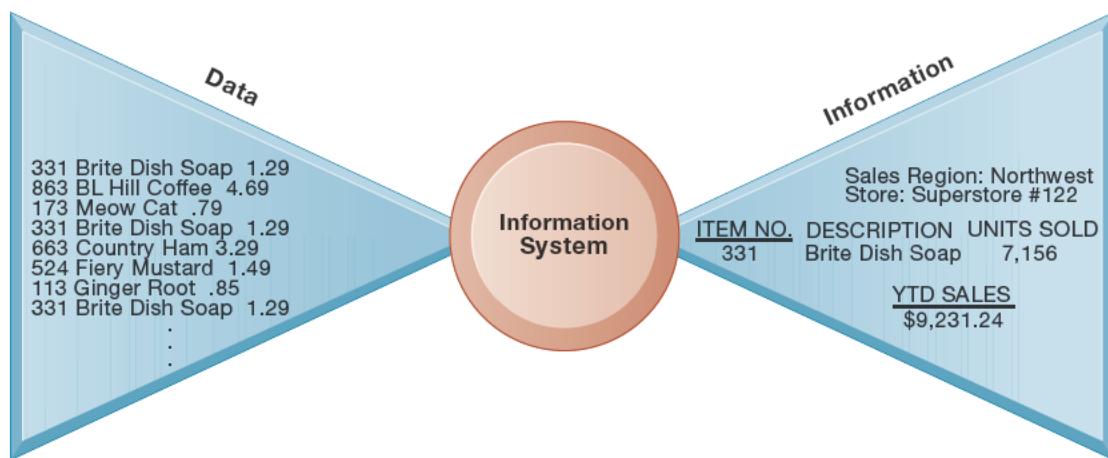
What Is an Information System?

An **information system** can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products.

Information systems contain information about significant people, places, and things within the organization or in the environment surrounding it. By **information** we mean data that have been shaped into a form that is meaningful and useful to human beings. **Data**, in contrast, are streams of raw facts representing events occurring in organizations or the physical environment before they have been organized and arranged into a form that people can understand and use.

FIGURE 1.3 DATA AND INFORMATION

Raw data from a supermarket checkout counter can be processed and organized to produce meaningful information, such as the total unit sales of dish detergent or the total sales revenue from dish detergent for a specific store or sales territory.



A brief example contrasting information and data may prove useful. Supermarket checkout counters scan millions of pieces of data from bar codes, which describe each product. Such pieces of data can be totaled and analyzed to provide meaningful information, such as the total number of bottles of dish detergent sold at a particular store, which brands of dish detergent were selling the most rapidly at that store or sales territory, or the total amount spent on that brand of dish detergent at that store or sales region (see Figure 1.3).

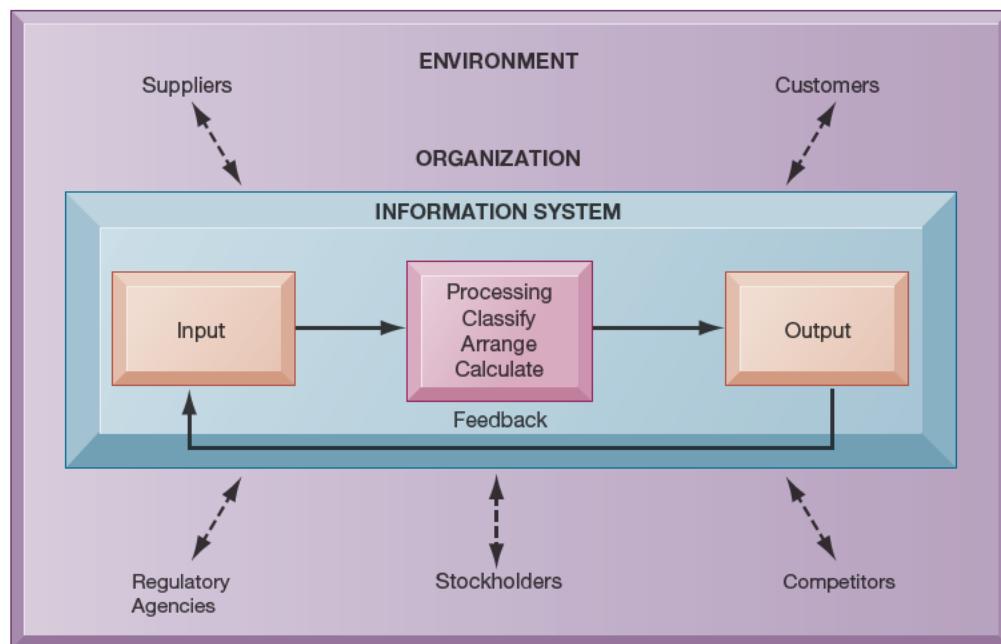
Three activities in an information system produce the information that organizations need to make decisions, control operations, analyze problems, and create new products or services. These activities are input, processing, and output (see Figure 1.4). **Input** captures or collects raw data from within the organization or from its external environment. **Processing** converts this raw input into a meaningful form. **Output** transfers the processed information to the people who will use it or to the activities for which it will be used. Information systems also require **feedback**, which is output that is returned to appropriate members of the organization to help them evaluate or correct the input stage.

In the AWM Smart Shelf system, input includes the digital results from scanning on-shelf products and store shelf identification codes, along with scanned images of items customers have selected for purchase. Computers store and process these data to keep track of the items on each shelf, the items each customer purchases or examines, and a history of the customer's purchases and items of interest. The system then determines what items on what shelves need restocking, and what items should be recommended to each customer. The system provides meaningful information such as all the items sold in a particular store or on a particular store shelf on a specific day, what items have been purchased by a specific customer, and which items need restocking.

Although computer-based information systems use computer technology to process raw data into meaningful information, there is a sharp distinction between a computer and a computer program on the one hand and an information system on the other. Computers and related software programs are the technical foundation, the tools and materials, of modern information systems. Computers provide the equipment for storing and processing information. Computer programs, or software, are sets of operating instructions that direct and control computer processing. Knowing how computers and computer

FIGURE 1.4 FUNCTIONS OF AN INFORMATION SYSTEM

An information system contains information about an organization and its surrounding environment. Three basic activities—input, processing, and output—produce the information organizations need. Feedback is output returned to appropriate people or activities in the organization to evaluate and refine the input. Environmental actors, such as customers, suppliers, competitors, stockholders, and regulatory agencies, interact with the organization and its information systems.



programs work is important in designing solutions to organizational problems, but computers are only part of an information system.

A house is an appropriate analogy. Houses are built with hammers, nails, and wood, but these do not make a house. The architecture, design, setting, landscaping, and all of the decisions that lead to the creation of these features are part of the house and are crucial for solving the problem of putting a roof over one's head. Computers and programs are the hammers, nails, and lumber of computer-based information systems, but alone they cannot produce the information a particular organization needs. To understand information systems, you must understand the problems they are designed to solve, their architectural and design elements, and the organizational processes that lead to the solutions.

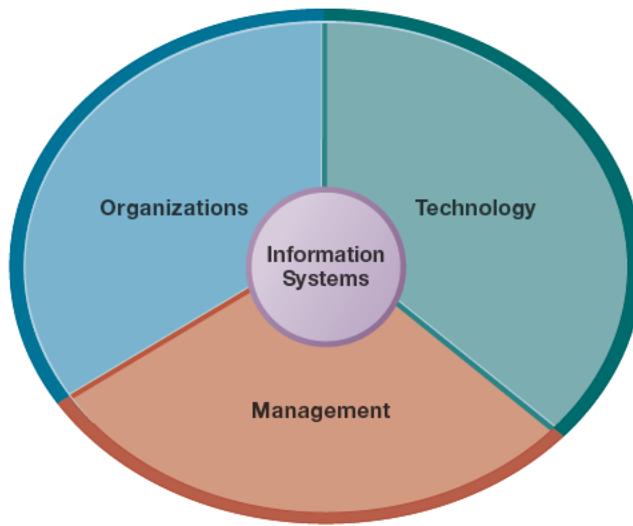
Dimensions of Information Systems

To fully understand information systems, you must understand the broader organization, management, and information technology dimensions of systems (see Figure 1.5) and their power to provide solutions to challenges and problems in the business environment. We refer to this broader understanding of information systems, which encompasses an understanding of the management and organizational dimensions of systems as well as the technical dimensions of systems, as **information systems literacy**. **Computer literacy**, in contrast, focuses primarily on knowledge of information technology.

The field of **management information systems (MIS)** tries to achieve this broader information systems literacy. MIS deals with behavioral issues as well as technical issues surrounding the development, use, and impact of information systems used by managers and employees in the firm.

FIGURE 1.5 INFORMATION SYSTEMS ARE MORE THAN COMPUTERS

Using information systems effectively requires an understanding of the organization, management, and information technology shaping the systems. An information system creates value for the firm as an organizational and management solution to challenges posed by the environment.



Let's examine each of the dimensions of information systems—organizations, management, and information technology.

Organizations

Information systems are an integral part of organizations. Indeed, for some companies, such as credit reporting firms, there would be no business without an information system. The key elements of an organization are its people, structure, business processes, politics, and culture. We introduce these components of organizations here and describe them in greater detail in Chapters 2 and 3.

Organizations have a structure that is composed of different levels and specialties. Their structures reveal a clear-cut division of labor. Authority and responsibility in a business firm are organized as a hierarchy, or a pyramid structure. The upper levels of the hierarchy consist of managerial, professional, and technical employees, whereas the lower levels consist of operational personnel.

Senior management makes long-range strategic decisions about products and services as well as ensures financial performance of the firm. **Middle management** carries out the programs and plans of senior management, and **operational management** is responsible for monitoring the daily activities of the business. **Knowledge workers**, such as engineers, scientists, or architects, design products or services and create new knowledge for the firm, whereas **data workers**, such as secretaries or clerks, assist with scheduling and communications at all levels of the firm. **Production or service workers** actually produce the product and deliver the service (see Figure 1.6).

Experts are employed and trained for different business functions. The major **business functions**, or specialized tasks performed by business organizations, consist of sales and marketing, manufacturing and production, finance and accounting, and human resources (see Table 1.1). Chapter 2 provides more detail on these business functions and the ways in which they are supported by information systems.

An organization coordinates work through its hierarchy and through its *business processes*. Most organizations' business processes include formal rules that

TABLE 1.1 MAJOR BUSINESS FUNCTIONS

FUNCTION	PURPOSE
Sales and marketing	Selling the organization's products and services
Manufacturing and production	Producing and delivering products and services
Finance and accounting	Managing the organization's financial assets and maintaining the organization's financial records
Human resources	Attracting, developing, and maintaining the organization's labor force; maintaining employee records

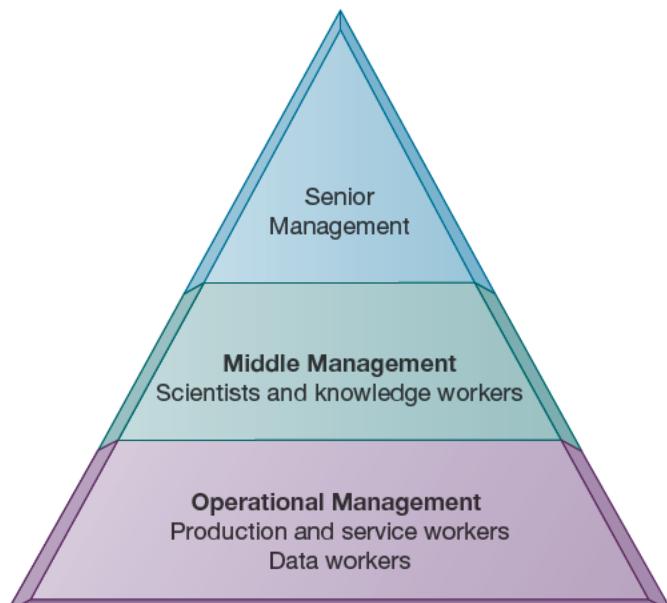
have been developed over a long time for accomplishing tasks. These rules guide employees in a variety of procedures, from writing an invoice to responding to customer complaints. Some of these business processes have been written down, but others are informal work practices, such as a requirement to return telephone calls from coworkers or customers, that are not formally documented. Information systems automate many business processes. For instance, how a customer receives credit or how a customer is billed is often determined by an information system that incorporates a set of formal business processes.

Each organization has a unique **culture**, or fundamental set of assumptions, values, and ways of doing things, that has been accepted by most of its members. You can see organizational culture at work by looking around your university or college. Some bedrock assumptions of university life are that professors know more than students, that the reason students attend college is to learn, and that classes follow a regular schedule.

Parts of an organization's culture can always be found embedded in its information systems. For instance, UPS's first priority is customer service, which is an aspect of its organizational culture that can be found in the company's package tracking systems, which we describe in this section.

FIGURE 1.6 LEVELS IN A FIRM

Business organizations are hierarchies consisting of three principal levels: senior management, middle management, and operational management. Information systems serve each of these levels. Scientists and knowledge workers often work with middle management.



Different levels and specialties in an organization create different interests and points of view. These views often conflict over how the company should be run and how resources and rewards should be distributed. Conflict is the basis for organizational politics. Information systems come out of this cauldron of differing perspectives, conflicts, compromises, and agreements that are a natural part of all organizations. In Chapter 3, we examine these features of organizations and their role in the development of information systems in greater detail.

Management

Management's job is to make sense out of the many situations faced by organizations, make decisions, and formulate action plans to solve organizational problems. Managers perceive business challenges in the environment, they set the organizational strategy for responding to those challenges, and they allocate the human and financial resources to coordinate the work and achieve success. Throughout, they must exercise responsible leadership. The business information systems described in this book reflect the hopes, dreams, and realities of real-world managers.

But managers must do more than manage what already exists. They must also create new products and services and even re-create the organization from time to time. A substantial part of management responsibility is creative work driven by new knowledge and information. Information technology can play a powerful role in helping managers design and deliver new products and services and redirecting and redesigning their organizations. Chapter 12 treats management decision making in detail.

Information Technology

Information technology is one of many tools managers use to cope with change.

Computer hardware is the physical equipment used for input, processing, and output activities in an information system. It consists of the following: computers of various sizes and shapes (including mobile handheld devices); various input, output, and storage devices; and telecommunications devices that link computers together.

Computer software consists of the detailed, preprogrammed instructions that control and coordinate the computer hardware components in an information system. Chapter 5 describes the contemporary software and hardware platforms used by firms today in greater detail.

Data management technology consists of the software governing the organization of data on physical storage media. More detail on data organization and access methods can be found in Chapter 6.

Networking and telecommunications technology, consisting of both physical devices and software, links the various pieces of hardware and transfers data from one physical location to another. Computers and communications equipment can be connected in networks for sharing voice, data, images, sound, and video. A **network** links two or more computers to share data or resources, such as a printer.

The world's largest and most widely used network is the **Internet**. The Internet is a global "network of networks" that uses universal standards (described in Chapter 7) to connect millions of networks in more than 230 countries around the world.

The Internet has created a new "universal" technology platform on which to build new products, services, strategies, and business models. This same technology platform has internal uses, providing the connectivity to link different systems and networks within the firm. Internal corporate networks based on Internet

technology are called **intranets**. Private intranets extended to authorized users outside the organization are called **extranets**, and firms use such networks to coordinate their activities with other firms for making purchases, collaborating on design, and other interorganizational work. For most business firms today, using Internet technology is both a business necessity and a competitive advantage.

The **World Wide Web** is a service provided by the Internet that uses universally accepted standards for storing, retrieving, formatting, and displaying information in a page format on the Internet. Web pages contain text, graphics, animations, sound, and video and are linked to other web pages. By clicking on highlighted words or buttons on a web page, you can link to related pages to find additional information and links to other locations on the web. The web can serve as the foundation for new kinds of information systems such as UPS's web-based package tracking system described below.

All of these technologies, along with the people required to run and manage them, represent resources that can be shared throughout the organization and constitute the firm's **information technology (IT) infrastructure**. The IT infrastructure provides the foundation, or *platform*, on which the firm can build its specific information systems. Each organization must carefully design and manage its IT infrastructure so that it has the set of technology services it needs for the work it wants to accomplish with information systems. Chapters 5 through 8 of this book examine each major technology component of information technology infrastructure and show how they all work together to create the technology platform for the organization. The Interactive Session on Technology describes some examples of the technologies used in computer-based information systems today.

UPS's global delivery system provides another example. UPS invests heavily in information systems technology to make its business more efficient and customer oriented. It uses an array of information technologies, including bar code scanning systems, wireless networks, large mainframe computers, handheld computers, the Internet, and many different pieces of software for tracking packages, calculating fees, maintaining customer accounts, and managing logistics.

Let's identify the organization, management, and technology elements in the UPS package tracking system. The organization element anchors the package tracking system in UPS's sales and production functions (the main product of UPS is a service—package delivery). It specifies the required procedures for identifying packages with both sender and recipient information, taking inventory, tracking the packages en route, and providing package status reports for UPS customers and customer service representatives.

The system must also provide information to satisfy the needs of managers and workers. UPS drivers need to be trained in both package pickup and delivery procedures and in how to use the package tracking system so that they can work efficiently and effectively. UPS customers may need some training to use UPS in-house package tracking software or the UPS website.

UPS's management is responsible for monitoring service levels and costs and for promoting the company's strategy of combining low cost and superior service. Management decided to use computer systems to increase the ease of sending a package using UPS and of checking its delivery status, thereby reducing delivery costs and increasing sales revenues.

The technology supporting this system consists of handheld computers, bar code scanners, desktop computers, wired and wireless communications networks, UPS's data center, storage technology for the package delivery data, UPS in-house package tracking software, and software to access the web. The result is an information system solution to the business challenge of providing a high level of service with low prices in the face of mounting competition.

INTERACTIVE SESSION TECHNOLOGY

Digital Transformation of Healthcare at Singapore's Jurong Health Services

Jurong Health Services (JurongHealth) is one of Singapore's six public healthcare clusters. Healthcare clusters provide holistic and integrated care when patients move from one care setting, like a clinic, to another, like a hospital. JurongHealth primarily manages the 700-bed Ng Teng Fong General Hospital, the 400-bed Jurong Community Hospital, and the Jurong Medical Center, all of which are located in western Singapore.

JurongHealth's goal is to provide transformative medical care for its patients through the use of innovative information technologies. Underscoring this commitment, in 2016 JurongHealth's Ng Teng Fong General Hospital became the first hospital in Singapore and the ASEAN region, and fifth in Asia-Pacific, to receive the highest level of the Healthcare Information and Management Systems Society (HIMSS) Electronic Medical Record Adoption Model Award, which measures a hospital's implementation of IT systems.

JurongHealth has integrated more than 50 healthcare IT systems as part of the Project OneCare initiative. The systems' implementation and integration took four years and has enabled the hospital to become paperless, chartless, and filmless. For instance, self-service kiosks now enable patients to register themselves merely by scanning their national identification cards and obtaining a queue number generated by the Enterprise Queue Management System. This unique number is used throughout the patient's visit for all service itineraries in the hospital. Patients refer to live screens located in the waiting areas that display a real-time queue status showing their turn. This system has not only helped JurongHealth to cut down on expenses but also to improve efficiency, as patients do not need different numbers for different services. It reduces waiting time and increases patient satisfaction.

Similarly, the Visitor Management System self-service kiosks enable visitors to scan their identification cards and register themselves to gain access to hospital wards. Visitors can also register themselves and obtain an e-pass from the Visitor Registration counters. The identification card or e-pass is scanned at the gantry when entering and leaving the ward. The gantry not only logs visitor information but also tracks staff, who must also use the same gantries to enter the wards. The Visitor Management

System enables the hospital to both control access to the wards and track or contact visitors and staff if necessary.

Another IT system implemented is the Warehouse Management System, which eliminates the tedious process of manually counting inventory. The system uses passive radio frequency identification (RFID) technology and a two-bin shelving system to automate inventory top-up requests and improve inventory management. Once the primary compartment of the storage bin is empty, the clinical staff transfers the relevant RFID tag into a drop-box, where the reader automatically sends a request for drug replenishment, thus avoiding stock-outs.

JurongHealth has also implemented a Real-Time Location Tracking System to automatically track patients and medical equipment using Wi-Fi triangulation, low frequency excitors, and about 6,000 active RFID tags attached to patients or medical equipment. These tags continuously communicate with the low frequency excitors to transmit data to the backend system for processing, allowing hospital staff to precisely locate patients and equipment, thus eliminating the need for tedious manual searching.

JurongHealth made a conscious effort to ensure that the different IT systems would not be stand-alone. The hospital thus implemented an integrated Electronic Medical Record (EMR) system that combines all the functional modules of the hospital in addition to being interfaced with 140 medical devices and equipment. Using the vendor-neutral Medical Devices Middleware Integration System, data from these medical devices is directly uploaded into the EMR system, so that the clinical staff no longer has to manually enter such readings, reducing the likelihood of charting errors. Being vendor-neutral also means the freedom to adopt best-of-breed individual modules as well as a lack of reliance on a single vendor.

Since the implementation of the EMR system, JurongHealth has continued to move forward, particularly in response to the COVID-19 pandemic. In September 2020, the hospital introduced a series of measures to make the facilities more secure and infection-free. For instance, they deployed a security robot to patrol the grounds and a second "Kenobi" (a security and concierge robot) to carry out thermal scanning of visitors. Drones have also been deployed

to carry out inspections and surveillance. In addition, as an immediate response to the pandemic, and as a longer-term solution to infection control, new touch-free technology has been introduced to operate patient and visitor lifts.

IT has played a key role in enabling JurongHealth to achieve its mission of providing world-class medical care at an affordable cost. As a result, JurongHealth has developed a reputation as a leading technology-driven healthcare provider as well as a role model not only in Singapore but also the entire region. This is also evident from its many accolades, which include awards for IT-driven transformation and for overall organizational transformation.

CASE STUDY QUESTIONS

1. What technologies are used by JurongHealth? What purpose do they serve?
2. Search the web for RFID. Suggest an example of how RFID can be used for locating and tracking people.
3. What information systems are implemented by JurongHealth? Describe the input, processing, and output of any one such system.
4. Why are information systems important for JurongHealth?

*Case contributed by Neerja Sethi and Vijay Sethi,
Nanyang Technological University*

Sources: "Combating Covid-19: A Birth of Innovations," *The Straits Times*, September 29, 2020; Salma Khalik, "Singapore on Track to Have One of World's Most IT-enabled Healthcare Systems," *The Straits Times*, June 2, 2017; JurongHealth, "Awards & Accolades," www.juronghealth.com.sg, accessed January 5, 2017; P. Bhunia, "The JurongHealth IT Journey—Integrating IT from the Ground-Up into a New Digital Hospital," opengovasia.com, November 13, 2016; IHIS, "Ng Teng Fong General Hospital Becomes First in Singapore and ASEAN to Achieve HIMSS Analytics EMRAM Stage 7 Award," Press Release, www.ihis.com, October 7, 2016; "Our Milestones," www.juronghealth.com.sg, October 2016; Ai Lei Tao, "Singapore's Jurong Health Services: Transforming Healthcare Through Data Technologies," computerweekly.com, April 16, 2016; A. Shukla, "Singapore Hospitals Deliver Enhanced Care to Patients by Integrating Their IT Systems," www.cio-asia.com, March 17, 2016; IHIS, "Integrated Healthcare IT Systems at Ng Teng Fong General Hospital and Jurong Community Hospital Win the Project of the Year Award at the SPMI Symposium 2016," Press Release, www.ihis.com, March 14, 2016; J. Kelleher, "JurongHealth Services CIO Discusses the Fully Integrated EMR Suite, Hospital ICT Systems and Achieving HIMSS EMRAM Stage 6," opengovasia.com, February 18, 2016.

It Isn't Just Technology: A Business Perspective on Information Systems

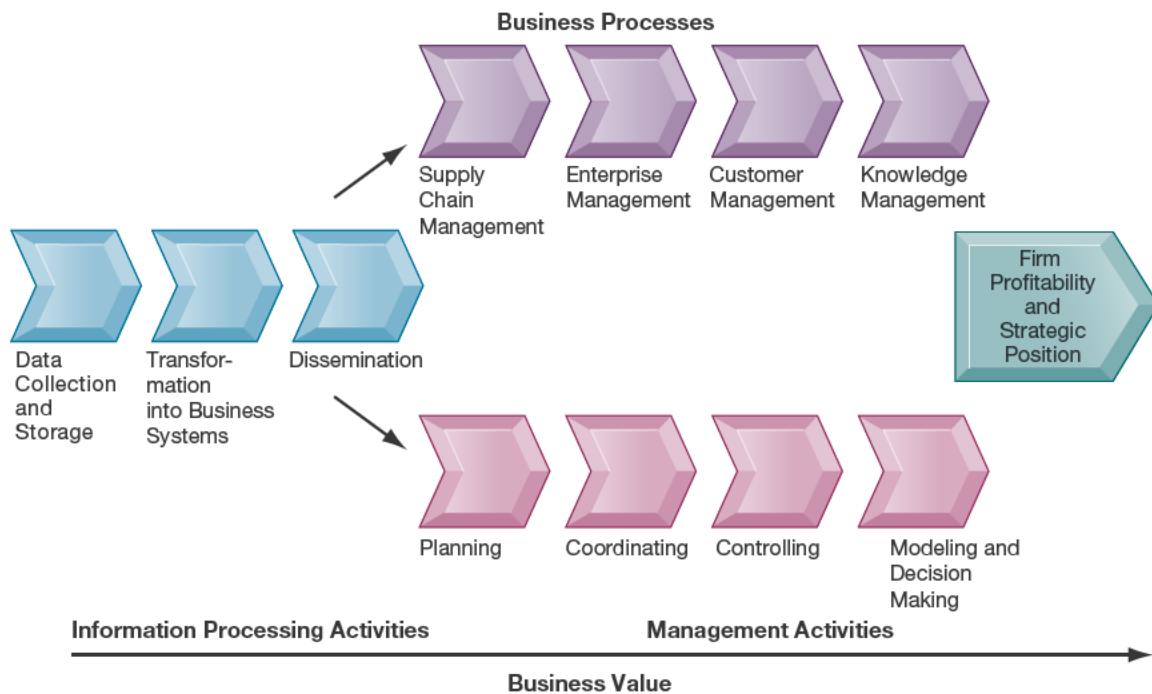
Managers and business firms invest in information technology and systems because they provide real economic value to the business. The decision to build or maintain an information system assumes that the returns on this investment will be superior to other investments in buildings, machines, or other assets. These superior returns will be expressed as increases in productivity, as increases in revenues (which will increase the firm's stock market value), or perhaps as superior long-term strategic positioning of the firm in certain markets (which will produce superior revenues in the future).

We can see that from a business perspective, an information system is an important instrument for creating value for the firm. Information systems enable the firm to increase its revenue or decrease its costs by providing information that helps managers make better decisions or that improves the execution of business processes. For example, the information system for analyzing supermarket checkout data illustrated in Figure 1.3 can increase firm profitability by helping managers make better decisions as to which products to stock and promote in retail supermarkets.

Every business has an information value chain, illustrated in Figure 1.7, in which raw information is systematically acquired and then transformed through various stages that add value to that information. The value of an information system to a business, as well as the decision to invest in any new information system, is, in large part, determined by the extent to which the system will lead to better management decisions, more efficient business processes, and higher

FIGURE 1.7 THE BUSINESS INFORMATION VALUE CHAIN

From a business perspective, information systems are part of a series of value-adding activities for acquiring, transforming, and distributing information that managers can use to improve decision making, enhance organizational performance, and, ultimately, increase firm profitability.



firm profitability. Although there are other reasons why systems are built, their primary purpose is to contribute to corporate value.

The business perspective calls attention to the organizational and managerial nature of information systems. An information system represents an organizational and management solution, based on information technology, to a challenge or problem posed by the environment. Every chapter in this book begins with a short case study that illustrates this concept. A diagram at the beginning of each chapter illustrates the relationship between a business challenge and resulting management and organizational decisions to use IT as a solution to challenges generated by the business environment. You can use this diagram as a starting point for analyzing any information system or information system problem you encounter.

Review the diagram at the beginning of this chapter. The diagram shows how the AWM Smart Shelf system helps solve the business problem of brick-and-mortar stores losing market share to online retailers. This system provides a solution that takes advantage of opportunities provided by new object-recognition and wireless digital technology.

AWM Smart Shelf digitally enables key business processes for inventory management, sales, and marketing, helping retailers improve their overall business performance. The diagram also illustrates how management, technology, and organizational elements work together to create the systems.

Complementary Assets: Organizational Capital and the Right Business Model

Awareness of the organizational and managerial dimensions of information systems can help us understand why some firms achieve better results from their information systems than others. Studies of returns from information

TABLE 1.2

COMPLEMENTARY SOCIAL, MANAGERIAL, AND ORGANIZATIONAL ASSETS REQUIRED TO OPTIMIZE RETURNS FROM INFORMATION TECHNOLOGY INVESTMENTS

Organizational assets	Supportive organizational culture that values efficiency and effectiveness Appropriate business model Efficient business processes Decentralized authority Distributed decision-making rights Strong IS development team
Managerial assets	Strong senior management support for technology investment and change Incentives for management innovation Teamwork and collaborative work environments Training programs to enhance management decision skills Management culture that values flexibility and knowledge-based decision making
Social assets	The Internet and telecommunications infrastructure IT-enriched educational programs raising labor force computer literacy Standards (both government and private sector) Laws and regulations creating fair, stable market environments Technology and service firms in adjacent markets to assist implementation

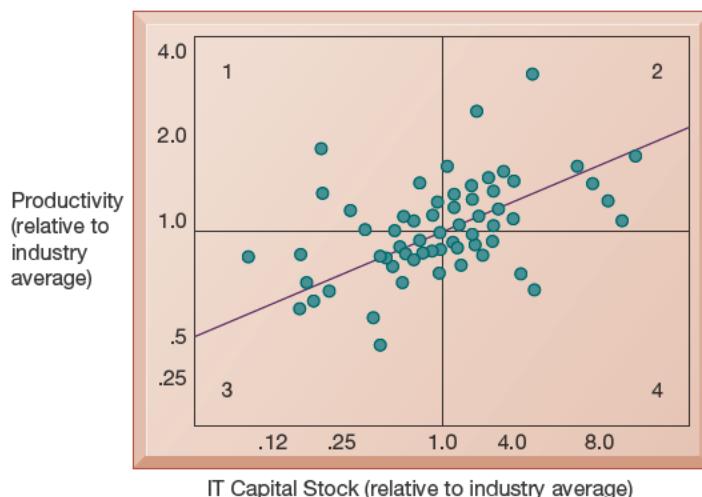
technology investments show that there is considerable variation in the returns firms receive (see Figure 1.8). Some firms invest a great deal and receive a great deal (quadrant 2); others invest an equal amount and receive few returns (quadrant 4). Still other firms invest little and receive much (quadrant 1), whereas

FIGURE 1.8

VARIATION IN RETURNS ON INFORMATION TECHNOLOGY INVESTMENT

Although, on average, investments in information technology produce returns far above those returned by other investments, there is considerable variation across firms.

Source: Brynjolfsson, Erik, and Lorin M. Hitt. "Beyond Computation: Information Technology, Organizational Transformation, and Business Performance." *Journal of Economic Perspectives* 14, No. 4 (2000).



IT Capital Stock (relative to industry average)

others invest little and receive little (quadrant 3). This suggests that investing in information technology does not by itself guarantee good returns. What accounts for this variation among firms?

The answer lies in the concept of complementary assets. Information technology investments alone cannot make organizations and managers more effective unless they are accompanied by supportive values, structures, and behavior patterns in the organization and other complementary assets. Business firms need to change how they do business before they can really reap the advantages of new information technologies.

Complementary assets are those assets required to derive value from a primary investment (Teece, 1998). For instance, to realize value from automobiles requires substantial complementary investments in highways, roads, gasoline stations, repair facilities, and a legal regulatory structure to set standards and control drivers.

Research indicates that firms that support their technology investments with investments in complementary assets, such as new business models, new business processes, management behavior, organizational culture, or training, receive superior returns, whereas those firms failing to make these complementary investments receive less or no returns on their information technology investments (Brynjolfsson, 2005; Brynjolfsson and Hitt, 2000; Laudon, 1974). These investments in organization and management are also known as **organizational and management capital**.

Table 1.2 lists the major complementary investments that firms need to make to realize value from their information technology investments. Some of this investment involves tangible assets, such as buildings, machinery, and tools. However, the value of investments in information technology depends to a large extent on complementary investments in management and organization.

Key organizational complementary investments are a supportive business culture that values efficiency and effectiveness, an appropriate business model, efficient business processes, decentralization of authority, highly distributed decision rights, and a strong information system (IS) development team.

Important managerial complementary assets are strong senior management support for change, incentive systems that monitor and reward individual innovation, an emphasis on teamwork and collaboration, training programs, and a management culture that values flexibility and knowledge.

Important social investments (not made by the firm but by the society at large, other firms, governments, and other key market actors) are the Internet and the supporting Internet culture, educational systems, network and computing standards, regulations and laws, and the presence of technology and service firms.

Throughout the book, we emphasize a framework of analysis that considers technology, management, and organizational assets and their interactions. Perhaps the single most important theme in the book, reflected in case studies and exercises, is that managers need to consider the broader organization and management dimensions of information systems to understand current problems as well as to derive substantial above-average returns from their information technology investments. As you will see throughout the text, firms that can address these related dimensions of the IT investment are, on average, richly rewarded.

1-3 What academic disciplines are used to study information systems, and how does each contribute to an understanding of information systems?

The study of information systems is a multidisciplinary field. No single theory or perspective dominates. Figure 1.9 illustrates the major disciplines that contribute problems, issues, and solutions in the study of information systems. In general, the field can be divided into technical and behavioral approaches. Information systems are sociotechnical systems. Though they are composed of machines, devices, and “hard” physical technology, they require substantial social, organizational, and intellectual investments to make them work properly.

Technical Approach

The technical approach to information systems emphasizes mathematically based models to study information systems as well as the physical technology and formal capabilities of these systems. The disciplines that contribute to the technical approach are computer science, management science, and operations research.

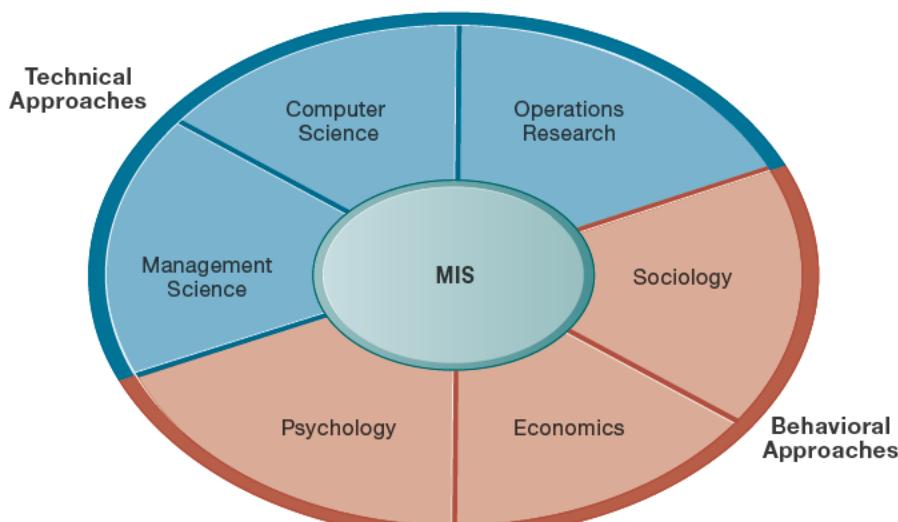
Computer science is concerned with establishing theories of computability, methods of computation, and methods of efficient data storage and access. Management science emphasizes the development of models for decision-making and management practices. Operations research focuses on mathematical techniques for optimizing selected parameters of organizations, such as transportation, inventory control, and transaction costs.

Behavioral Approach

An important part of the information systems field is concerned with behavioral issues that arise in the development and long-term maintenance of information systems. Issues such as strategic business integration, design, implementation,

FIGURE 1.9 CONTEMPORARY APPROACHES TO INFORMATION SYSTEMS

The study of information systems deals with issues and insights contributed from technical and behavioral disciplines.



utilization, and management cannot be explored usefully with the models used in the technical approach. Other behavioral disciplines contribute important concepts and methods.

For instance, sociologists study information systems with an eye toward how groups and organizations shape the development of systems and also how systems affect individuals, groups, and organizations. Psychologists study information systems with an interest in how human decision makers perceive and use formal information. Economists study information systems with an interest in understanding the production of digital goods, the dynamics of digital markets, and how new information systems change the control and cost structures within the firm.

The behavioral approach does not ignore technology. Indeed, information systems technology is often the stimulus for a behavioral problem or issue. But the focus of this approach is generally not on technical solutions. Instead, it concentrates on changes in attitudes, management and organizational policy, and behavior.

Approach of This Text: Sociotechnical Systems

Throughout this book, you will find a rich story with four main actors: suppliers of hardware and software (the technologists); business firms making investments and seeking to obtain value from the technology; managers and employees seeking to achieve business value (and other goals); and the contemporary legal, social, and cultural context (the firm's environment). Together these actors produce what we call *management information systems*.

The study of management information systems (MIS) arose to focus on the use of computer-based information systems in business firms and government agencies. MIS combines the work of computer science, management science, and operations research with a practical orientation toward developing system solutions to real-world problems and managing information technology resources. It is also concerned with behavioral issues surrounding the development, use, and impact of information systems, which are typically discussed in the fields of sociology, economics, and psychology.

Our experience as academics and practitioners leads us to believe that no single approach effectively captures the reality of information systems. The successes and failures of information systems are rarely all technical or all behavioral. Our best advice to students is to understand the perspectives of many disciplines. Indeed, the challenge and excitement of the information systems field are that it requires an appreciation and tolerance of many different approaches.

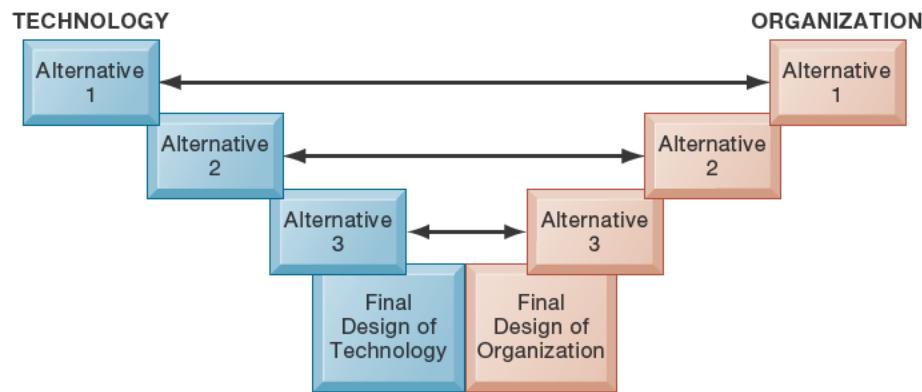
The view we adopt in this book is best characterized as the **sociotechnical view** of systems. In this view, optimal organizational performance is achieved by jointly optimizing both the social and technical systems used in production.

Adopting a sociotechnical systems perspective helps to avoid a purely technological approach to information systems. For instance, the fact that information technology is rapidly declining in cost and growing in power does not necessarily or easily translate into productivity enhancement or bottom-line profits. The fact that a firm has recently installed an enterprise-wide financial reporting system does not necessarily mean that it will be used, or used effectively. Likewise, the fact that a firm has recently introduced new business procedures and processes does not necessarily mean employees will be more productive in the absence of investments in new information systems to enable those processes.

In this book, we stress the need to optimize the firm's performance as a whole. Both the technical and behavioral components need attention. This means that technology must be changed and designed in such a way as to fit

FIGURE 1.10 A SOCIOTECHNICAL PERSPECTIVE ON INFORMATION SYSTEMS

In a sociotechnical perspective, the performance of a system is optimized when both the technology and the organization mutually adjust to one another until a satisfactory fit is obtained.



organizational and individual needs. Sometimes, the technology may have to be “de-optimized” to accomplish this fit. For instance, mobile phone users adapt this technology to their personal needs, and as a result manufacturers quickly seek to adjust the technology to conform to user expectations. Organizations and individuals must also be changed through training, learning, and planned organizational change to allow the technology to operate and prosper. Figure 1.10 illustrates this process of mutual adjustment in a sociotechnical system.



1-4 How will MIS help my career?

Here is how Chapter 1 and this text can help you find an entry-level job as a financial client support and sales assistant.

The Company

Power Financial Analytics Data Services, a data and software company serving the financial industry with offices in London, New York, Sydney, and Singapore, is looking to fill an entry-level position for a financial client support and sales assistant. The company has 1,600 employees, many of whom are consultants showing clients how to work with its powerful financial analytics software and data products.

Position Description

The financial client support and sales assistant will be part of a team in the company's consulting services. Consulting teams combine a thorough understanding of finance and technology with specific expertise in Power Financial Analytics Data Services software and assist clients in a variety of ways. The

company provides on-the-job training in its software and consulting methods. Job responsibilities include:

- Supporting Financial Analytics Data Services applications.
- Helping the team create custom models and screens.
- Training clients in their offices and at seminars.
- Providing expert consultation to clients by telephone and on-site.

Job Requirements

- Recent college graduate or investment professional with one to two years of experience. Applicants with backgrounds in finance, MIS, economics, accounting, business administration, and mathematics are preferred
- Knowledge of or interest in learning about financial markets
- Sound working knowledge of spreadsheets
- Very strong communication and interpersonal skills
- Strong desire to learn in rapidly changing environment

Interview Questions

1. What is your background in finance? What courses did you take? Have you ever worked in the financial industry? What did you do there?
2. What is your proficiency level with spreadsheet software? What work have you done with Excel spreadsheets? Can you show examples of your work?
3. Are you able to discuss current trends in the financial industry and how they impact Power Financial's business model and client base?
4. Did you ever work with clients? Can you give examples of how you provided client service or support?
5. Can you give us an example of a finance-related problem or other business problem that you helped solve? Did you do any writing and analysis? Can you provide examples?

Author Tips

1. Use the web to learn about financial markets and the financial industry.
2. Use the web to research the company, its financial products, and the tools and services it offers customers. Learn what you can about its consulting services. Additionally, examine the company's social medial channels, such as LinkedIn and Facebook, for trends and themes.
3. Inquire exactly how you would be using spreadsheets for this job. Provide examples of how you used spreadsheets to solve problems in the classroom or for a job assignment. Show the spreadsheet work you did in finance.
4. Bring examples of your writing (including some from your Digital Portfolio described in MyLab MIS) demonstrating your analytical skills and project experience. Be prepared to discuss how you helped customers solve a business problem or the business problem solving you did for your courses.

REVIEW SUMMARY

1-1 How are information systems transforming business, and why are they so essential for running and managing a business today?

Organizations are trying to become more competitive and efficient by digitally enabling their core business processes and evolving into digital firms. The Internet has stimulated globalization by dramatically reducing the costs of producing, buying, and selling goods on a global scale. New information system trends include the emerging mobile digital platform, big data (including IoT), more remote management, democratization of decision making, machine learning systems, and the growing use of social media in business.

Information systems are a foundation for conducting business today. In many industries, survival and the ability to achieve strategic business goals are difficult without extensive use of information technology. Businesses today use information systems to achieve six major objectives: operational excellence; new products, services, and business models; customer/supplier intimacy; improved decision making; competitive advantage; and day-to-day survival.

1-2 What is an information system? How does it work? What are its management, organization, and technology components? Why are complementary assets essential for ensuring that information systems provide genuine value for organizations?

From a technical perspective, an information system collects, stores, and disseminates information from an organization's environment and internal operations to support organizational functions and decision making, communication, coordination, control, analysis, and visualization. Information systems transform raw data into useful information through three basic activities: input, processing, and output.

From a business perspective, an information system provides a solution to a problem or challenge facing a firm and represents a combination of management, organization, and technology elements. The management dimension of information systems involves issues such as leadership, strategy, and management behavior. The technology dimension consists of computer hardware, software, data management technology, and networking/telecommunications technology (including the Internet). The organization dimension of information systems involves issues such as the organization's hierarchy, functional specialties, business processes, culture, and political interest groups.

In order to obtain meaningful value from information systems, organizations must support their technology investments with appropriate complementary investments in organizations and management. These complementary assets include new business models and business processes, supportive organizational culture and management behavior, and appropriate technology standards, regulations, and laws. New information technology investments are unlikely to produce high returns unless businesses make the appropriate managerial and organizational changes to support the technology.

1-3 What academic disciplines are used to study information systems, and how does each contribute to an understanding of information systems?

The study of information systems deals with issues and insights contributed from technical and behavioral disciplines. The disciplines that contribute to the technical approach focusing on formal models and capabilities of systems are computer science, management science, and operations research. The disciplines contributing to the behavioral approach focusing on the design, implementation, management, and business impact of systems are psychology, sociology, and economics. A sociotechnical view of systems considers both technical and social features of systems and solutions that represent the best fit between them.

Key Terms

<i>Business functions</i> , 49	<i>Information technology (IT) infrastructure</i> , 52
<i>Business model</i> , 44	<i>Input</i> , 47
<i>Business processes</i> , 42	<i>Internet</i> , 51
<i>Complementary assets</i> , 57	<i>Intranets</i> , 52
<i>Computer hardware</i> , 51	<i>Knowledge workers</i> , 49
<i>Computer literacy</i> , 48	<i>Management information systems (MIS)</i> , 48
<i>Computer software</i> , 51	<i>Middle management</i> , 49
<i>Culture</i> , 50	<i>Network</i> , 51
<i>Data</i> , 46	<i>Networking and telecommunications technology</i> , 51
<i>Data management technology</i> , 51	<i>Operational management</i> , 49
<i>Data workers</i> , 49	<i>Organizational and management capital</i> , 57
<i>Digital firm</i> , 42	<i>Output</i> , 47
<i>Extranets</i> , 52	<i>Processing</i> , 47
<i>Feedback</i> , 47	<i>Production or service workers</i> , 49
<i>Information</i> , 46	<i>Senior management</i> , 49
<i>Information system</i> , 46	<i>Sociotechnical view</i> , 59
<i>Information systems literacy</i> , 48	<i>World Wide Web</i> , 52
<i>Information technology (IT)</i> , 46	

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

1-1 How are information systems transforming business, and why are they so essential for running and managing a business today?

- Describe how information systems have changed the way businesses operate and their products and services.
- Identify three major new information system trends.
- Describe the characteristics of a digital firm.
- Describe the challenges and opportunities of globalization in a “flattened” world.
- List and describe six reasons why information systems are so important for business today.

1-2 What is an information system? How does it work? What are its management, organization, and technology components? Why are complementary assets essential for ensuring that information systems provide genuine value for organizations?

- Explain the differences between information and data. Why is the former essential to the latter?
- Describe the three activities in an information system that produce the information that organizations need.

- Explain why organizations have a structure composed of different levels and specialties.

- Describe how the parts of an organization's culture can be found embedded in its information systems.
- Describe the features of an organization's information value chain.
- Based on what you have read, identify the key elements of organizational and management capital.

1-3 What academic disciplines are used to study information systems, and how does each contribute to an understanding of information systems?

- List and describe each discipline that contributes to a technical approach to information systems.
- List and describe each discipline that contributes to a behavioral approach to information systems.
- Describe the sociotechnical perspective on information systems.

Discussion Questions

1-4 MyLab MIS Information systems are too important to be left to computer specialists. Do you agree? Why or why not?

1-5 MyLab MIS If you were setting up the website for a professional football team, what management, organization, and technology issues might you encounter?

1-6 MyLab MIS What are some of the organizational, managerial, and social complementary assets that help make UPS's information systems so successful?

Hands-On MIS Projects

The projects in this section give you hands-on experience in analyzing financial reporting and inventory management problems, using data management software to improve management decision making about increasing sales, and using Internet software for researching job requirements. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

1-7 Magical Toys is a South African toy store chain. The toys are sold in their five stores and from their own web shop. Each Tuesday, management needs sales reports from last week's activities. Work at the stores is hectic, so usually at least one store fails to deliver the report, making it impossible to sum up the previous week's sales. The reports, sent by email as spreadsheets, sometimes have inconclusive or erroneous data, and following up means that employees are unable to give their full focus to the customers. Some errors in the spreadsheets may also cause the purchasing manager to place unnecessary purchase orders. What are the main issues that Magical Toys faces in the absence of an information system? How could an information system be of help, and what issues can an information system not solve?

1-8 Diskonto operates deep-discount stores in Estonia offering housewares, cleaning supplies, clothing, health and beauty aids, and packaged food, with most items selling for a very low price. Its business model calls for keeping costs as low as possible. The company has no automated method for keeping track of inventory at each store. Managers know approximately how many cases of a particular product the store is supposed to receive when a delivery truck arrives, but the stores lack technology for scanning the cases or verifying the item count inside the cases. Merchandise losses from theft or other mishaps have been rising and now represent more than 3 percent of total sales. What decisions have to be made before investing in an information system solution?

Improving Decision Making: Using Databases to Analyze Sales Trends

Software skills: Database querying and reporting

Business skills: Sales trend analysis

1-9 In this project, you will start out with raw transactional sales data and use Microsoft Access database software to develop queries and reports that help managers make better decisions about product pricing, sales promotions, and inventory replenishment. In MyLab MIS, you can find a Store and Regional Sales Database developed in Microsoft Access. The database contains raw data on weekly store sales of computer equipment in various sales regions. The database includes fields for store identification number, sales region, item number, item description, unit price, units sold, and the weekly sales period when the sales were made. Use Access to develop some reports and queries to make this information more useful for running the business. Sales and production managers want answers to the following questions:

- Which products should be restocked?
- Which stores and sales regions would benefit from a promotional campaign and additional marketing?
- When (what time of year) should products be offered at full price, and when should discounts be used?

You can easily modify the database table to find and report your answers. Print your reports and results of queries.

Improving Decision Making: Using the Internet to Locate Jobs Requiring Information Systems Knowledge

Software skills: Internet-based software

Business skills: Job searching

- 1-10** Visit a job-posting website such as EURES, the European Job Mobility Portal run by the European Commission. Spend some time at the site examining jobs for accounting, finance, sales, marketing, and human resources. Find two or three descriptions of jobs that require some information systems knowledge. What information systems knowledge do these jobs require? What do you need to do to prepare for these jobs? Write a one- to two-page report summarizing your findings.

Collaboration and Teamwork Project

Selecting Team Collaboration Tools

- 1-11** Form a team with three or four classmates and review the capabilities of Google Drive and Google Sites for your team collaboration work. Compare the capabilities of these two tools for storing team documents, project announcements, source materials, work assignments, illustrations, electronic presentations, and web pages of interest. Learn how each works with Google Docs. Explain why Google Drive or Google Sites is more appropriate for your team. If possible, use Google Docs to brainstorm and develop a presentation of your findings for the class. Organize and store your presentation using the Google tool you have selected.

Changes in the Financial Industry: Adyen and Fintech

CASE STUDY

Although 2020 was a very difficult year for many companies, it was a very successful one for Adyen, a Dutch company that mostly focuses on processing Internet payments. As the COVID-19 pandemic boosted the volume of online payments, business soared. Adyen announced in November 2020 that it was expanding in the Middle East, opening a new office in Dubai. Earlier that year, Internet retailer Zalando chose Adyen to process its credit card payments in all European markets. Raffles Hotel Singapore selected Adyen as its preferred payment provider to offer a seamless and more customer-centric digital payment experience across all of the hotel's touchpoints. The company also signed a new agreement with Microsoft, expanding and deepening their cooperation on payments processing. These are just the latest in a long series of successes for Adyen. In 2018, American Internet giant eBay announced that Adyen would become eBay's primary payments provider. This was significant for two reasons. First, eBay is, of course, a huge company: in 2019, the value of goods sold on the platform amounted to a staggering \$90.2 billion. For Adyen, this meant a huge increase of its business. Second, and perhaps more importantly, eBay gave preference to Adyen over PayPal, which is very often the first choice of online companies. For a startup like Adyen to beat a market leader like PayPal was remarkable.

As a result of all these successes, Adyen has been the star of the Amsterdam stock exchange for several years. In 2018, Adyen had a very successful initial public offering (IPO) and its shares, which were priced at €240, nearly doubled in price during the first trading day. Since then Adyen's share price has continued to increase, reaching over €740 by the end of 2019. Then the coronavirus crisis broke and more and more people started to shop online and make payments through Adyen. The company's share price more than doubled over the following months and by December 11, 2020, it had risen to €1834.50.

What explains Adyen's success? The answer to that rests primarily in the technology it uses. To put it simply, Adyen makes payment transactions easier. Making payments on the Internet is a much more complicated business than many people think it is,

and requires several companies to work together to ensure that the payment is successful. To start with, there is, of course, the merchant, but there are also companies providing a gateway for the payments, assessing the risk, and so on. Because of this crowded field of facilitators, many things can go wrong. For instance, software may be outdated, or programs used by one provider may be incompatible with those of another.

According to Forrester, a market research firm that focuses on information technology, around 10 percent of all payments fail for "technical" reasons. Adyen is reducing this performance gap by integrating several components of the payment chain (such as the gateway, risk assessment, and processing) into one platform. It has thus been successful in ensuring a higher success rate in its payments chain than other facilitators.

Auden's second advantage is that its payments platform is connected to most payment systems being used in the world. Payment systems can differ greatly from country to country. In the Netherlands, for instance, most online payments are done through the iDEAL system, which links payments to checking accounts. In other countries, most payments are done through credit cards or debit cards like Visa or Mastercard. When it comes to processing payments, this variety of methods complicates things enormously, as the payment processors need to have several platforms. Adyen, however, has one integrated platform that can link with most payment methods being used all over the world. This is, of course, an attractive option for merchants or online companies that sell their goods worldwide. When eBay decided to work with Adyen, it gave two reasons for its decision: Adyen processes payments more cheaply and gives more control to merchants that use the platform.

Adyen is a good example of a company that works in the field of fintech (financial technology). Companies that use technology to facilitate financial transactions have been highly successful over the last decade. Founded in 2006, Adyen is relatively old for a fintech company, but it has grown enormously—in 2019 it had €240 billion in processed volume. Remarkable as Adyen's case is, it is definitely not unique; other firms have used technology to find a

new niche in the international payments universe. The company TransferWise (which was founded in Estonia but now mostly operates from the United Kingdom) is another example: it facilitates money transfers from Country A to Country B while avoiding currency conversion.

Initially, traditional banks found it hard to compete with companies like Adyen. It is in the DNA of fintech companies to develop and focus on state-of-the-art information systems. Traditional banks are very different; they tend to value direct, physical contact with the customer and often have branches in various countries that function more or less independently. Their IT staff often has a supporting role and not, as in the case of Adyen, a guiding one. Traditional banks use IT systems to facilitate business operations, not to compete with other financial providers. Their IT systems are usually at the national level and may differ from country to country. The heart of Adyen is its technical platform, and the IT staff works continuously to make it cheaper and more user-friendly. The data received on this platform are analyzed and used to upgrade and update it. The data that Adyen gets are global (the platform processes payments from all over the world) and highly diverse (from payment transactions on the Internet as well as transactions performed in physical shops). This wealth of data ensures that Adyen has better opportunities to analyze the market of payment transactions and its developments than traditional banks do.

Fintech is a good example of what economists call "creative destruction." This term, originally coined by the Austrian economist Joseph Schumpeter, describes the influence of technology on the economy. According to his theory, new technologies inevitably result in winners and in losers. One famous example of a disruption is the Spinning Jenny, a device invented in Britain during the eighteenth century. The Spinning Jenny made the production of cloth more efficient, cheaper, and—critically—reduced the number of laborers needed in the textiles industry. Over the last 30 years, the Internet has had the same effect: some jobs have disappeared, and others have come into existence. A good example is travel agencies. Forty years ago, there was a travel agency on every high street, but today, the vast majority of travel is booked online. Likewise, traditional hotels now have to compete with sites like Airbnb.

Creative destruction comes in waves, and the banking industry is now in the frontline of change because of the emergence of fintech companies. Adyen has

incorporated many stages of the payment chain, and traditional companies that used to provide, for instance, risk assessment now have to either make their business model more efficient or face the very real possibility of going out of business. The German firm N26 is also a good example of how fintech is changing the banking industry. This company provides payment services just like a normal bank does, but it does not have physical locations where customer agents give advice to the customers; everything is online. In 2020, N26 had over 5 million customers in 25 markets. One of its founders, Maximilian Tayenthal, remarked that traditional banks had not taken N26 seriously when the company was launched. See the Chapter 3 opening case for more information on N26.

Fintech companies that make online banking much easier have already had a huge impact on the physical presence of banks in many countries. The number of bank branches in Europe has declined dramatically, from 240,000 a decade ago to around 165,000 in 2020. In the Netherlands, the digital banking experience progressed so rapidly that the Dutch government felt it necessary to make it clear that it would not allow the loss of cash payments from the Dutch High Streets as this would severely limit the participation in society of vulnerable groups such as the elderly.

According to experts, the next wave of technology will be even more disruptive. In 2018, Antony Jenkins, who ran Barclays from 2012 to 2015, told the BBC that in the coming years around 50 percent of all jobs in banking (including those of middle managers and customer agents) would be replaced by some kind of artificial intelligence. Andy Haldane, the chief economist of the Bank of England, warned in the same year of a fourth industrial revolution that would cause severe disruptions in the job market, and at the heart of it would be artificial intelligence—a modern counterpart to the Spinning Jenny.

This does not mean that success is automatically guaranteed for new companies like Adyen and TransferWise. Research shows that around 90 percent of new fintech companies go bankrupt without ever having been profitable. Many require large investments of capital before they can generate profits. Even when they generate profits, these are often, for a time at least, rather small. Fintech companies are now also being challenged by the major traditional banks, who are rapidly developing their own versions of online payment systems, from peer-to-peer payments for retail customers, to highly automated online payment and billing systems for global businesses.

As consumers and firms have moved towards mobile and online payments, many traditional banks have invested heavily in new technologies in part using the funds saved by closing down traditional physical bank branches. Where in-house innovation has not worked, the large banks have purchased fintech firms and folded them into their existing business and technology platforms. Traditional banks have a decided advantage over fintech startups: extraordinary cash flow and tens of millions of loyal customers and firms. In this scenario, fintech firms have been early to the party but typically do not survive to the end of the party, at least not as independent firms.

Adyen's founders were very experienced entrepreneurs when they started their company. They had already created another company, Bibit, which they sold to The Royal Bank of Scotland for €100 million. Indeed, the word adyen means "again" in a language from Surinam, meaning that Adyen is their second endeavor in the field of financial technology. Adyen appears likely to be one of the survivors. The volume of payments it processes has grown from €32 billion in 2015 to €240 billion in 2019. Adyen's revenues during this time period have also grown, from €98.5 billion in 2015 to almost €500 billion by 2019. Unlike many fintech company, Adyen has also been able to show a profit, with net income rising from €131 million in 2018 to €204 million in 2019, up 56 percent, and with

CASE STUDY QUESTIONS

- 1-12** According to Adyen, the payments platform has two advantages compared to other payment platforms. Describe these advantages in your own words.
- 1-13** Many fintech companies are very valuable on the stock exchange even though they make little or no profit. Explain this situation. Why

expectations that it will surpass all of those benchmarks for 2020. Adyen illustrates how fintech startups are changing the traditional bank and payment systems using new technologies and business models.

Sources: Bernard Vogelsang, "AEX Lager Het Weekend In Door Brexit-Zorgen," *Telegraaf*, December 11, 2020; "Adyen Breidt Samenwerking Met Microsoft Uit," *deaandeelhouder.nl*, December 10, 2020; Ayden, "Raffles Hotel Singapore Takes Its Legendary Guest Experience to the Next Level with Adyen," www.adyen.com, November 24, 2020; Robert Vink, "How Adyen Is Simultaneously Disrupting Banks and the Payments Industry," www.seekingalpha.com, November 18, 2020; Adyen, "Adyen to Expand in the Middle East, Opens Dubai Office," www.adyen.com, November 10, 2020; Ben Dummet, "A Little-Known Payments Provider Grows into One of Europe's Most Valuable Finance Form," *Wall Street Journal*, November 16, 2020; "Quarter of Bank Branches Will Close in Coming Three Years," *Consultancy.uk*, September 14, 2020; Adyen, "Adyen to Process European Credit Card Payments for Zalando," www.adyen.com, August 13, 2020; Ryan Browne, "Fintech Firm Adyen Posts 34% Surge in First-Quarter Revenue as Coronavirus Bolsters Online Payments," www.cnbc.com, April 21, 2020; Adyen, "2019 Annual Report," www.adyen.com, March 24, 2020; eBay, "eBay Inc. Reports Fourth Quarter and Full Year 2019 Results," www.ebay.com, January 28, 2020; Tomasz Grynkiewicz, "This Fintech Attracts 10,000 Customers a Day," www.netguru.com, December 4, 2019; Kamal Ahmed, "Bank of England Chief Economist Warns on AI Jobs Threat," BBC News, www.bbc.com, August 20, 2018; Jan Hammer, "Adyen: A Global Success Born in Amsterdam," Index Ventures, www.indexventures.com, June 13, 2018.; "Bank Jobs Could Fall by 50% in 10 Years, Says Ex-Barclays Boss," BBC News, www.bbc.com, November 26, 2015.

do investors pay so much for shares of companies that hardly make any profits?

- 1-14** Explain the term "creative destruction." Is the German bank N26 destroying jobs or creating new jobs?
- 1-15** Explain why such a high percentage of fintech startups go bankrupt before making any profits at all.

Case contributed by Bernard Bouwman

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2

Global E-business and Collaboration

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 2-1** What are business processes? How are they related to information systems?
- 2-2** How do systems serve the different management groups in a business, and how do systems that link the enterprise improve organizational performance?
- 2-3** Why are systems for collaboration and social business so important, and what technologies do they use?
- 2-4** What is the role of the information systems function in a business?
- 2-5** How will MIS help my career?

CHAPTER CASES

- Enterprise Social Networking Transforms Sharp Corporation into a More Innovative Connected Organization
- The City of Mississauga Goes Digital
- Higher Education Redefined: Virtual Education at Ahlia University
- Is Social Business Good Business?

VIDEO CASES

- IS in Action: VisionX Lighting Grows with Business One
- CEMEX: Becoming a Social Business

MyLab MIS

Discussion Questions: 2-5, 2-6, 2-7; Hands-On MIS Projects: 2-8, 2-9, 2-10, 2-11;
eText with Conceptual Animations

Enterprise Social Networking Transforms Sharp Corporation into a More Innovative Connected Organization

Sharp Corporation is a Japanese multinational corporation that manufactures and sells telecommunications equipment, electric and electronic equipment, and electronic components, including LCDs (liquid crystal displays), multifunction printing devices, calculators, radios, microwave ovens, and sensors. Sharp's business philosophy emphasizes that the company does not merely strive to increase business volume, but is also dedicated to using unique innovative technology to contribute to the culture and welfare of people throughout the world. Since 2016 Sharp has been a subsidiary of Taiwan-based Foxconn Group and employs more than 52,000 people worldwide. Collaboration and sharing information are essential for the company's ongoing innovation and business success.

Despite an impressive product lineup, Sharp ran into financial trouble as new Asian competitors challenged its consumer electronics business. The company's core electronic manufacturing service was based on razor-thin profit margins. Foxconn has been working with Sharp's management to diversify Sharp's business portfolio and reorganize the company to be more effective and profitable.

Sharp management believed that to strengthen its global business, the company needed to change the way it worked—both its business processes and its organizational culture. In the past employees had to follow decisions made from the top down. Directives flowed downward. Sharp needed to move to an organizational culture based on two-way dialogue where lower-level employees as well as upper management could play leadership roles. The company's younger employees were looking for systems where they could share ideas and opinions freely with each other.

Sharp implemented Microsoft Yammer for this purpose. Microsoft Yammer is an enterprise social networking platform for internal business uses, although it can also create external networks linking to suppliers, customers, and others outside the organization. Yammer enables employees to create groups to collaborate on projects and share and edit documents, and it includes a news feed to find out what's happening within the



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company. A People Directory provides a searchable database of contact information, skills, and expertise. Yammer can be accessed through the web, desktop, and mobile devices and can be integrated with other Microsoft tools such as SharePoint and Office 365 to make other applications more “social.” (SharePoint is Microsoft’s platform for collaboration, document sharing, and document management. Office 365 is Microsoft’s online service for its desktop productivity applications such as word processing, spreadsheet, electronic presentations, and data management.)

Sharp created a pilot Yammer program in February 2013, with employee adoption voluntary and employees allowed to write about hobbies and interests as well as work-related topics. Within months there were 6,000 adopters, and the number of Yammer users within the company has passed 10,000. Sharp wants to deploy Yammer to all domestic employees in Japan and eventually to overseas offices.

Yammer has improved the flow of information between senior management and rank-and-file employees. Communication among employees themselves has increased appreciably, with some conversations occurring among different departments and different regions. For example, smartphone developers are able to share opinions about functions and user-friendliness throughout the company and also learn about activities in other departments that they would not normally hear about by reading Yammer postings.

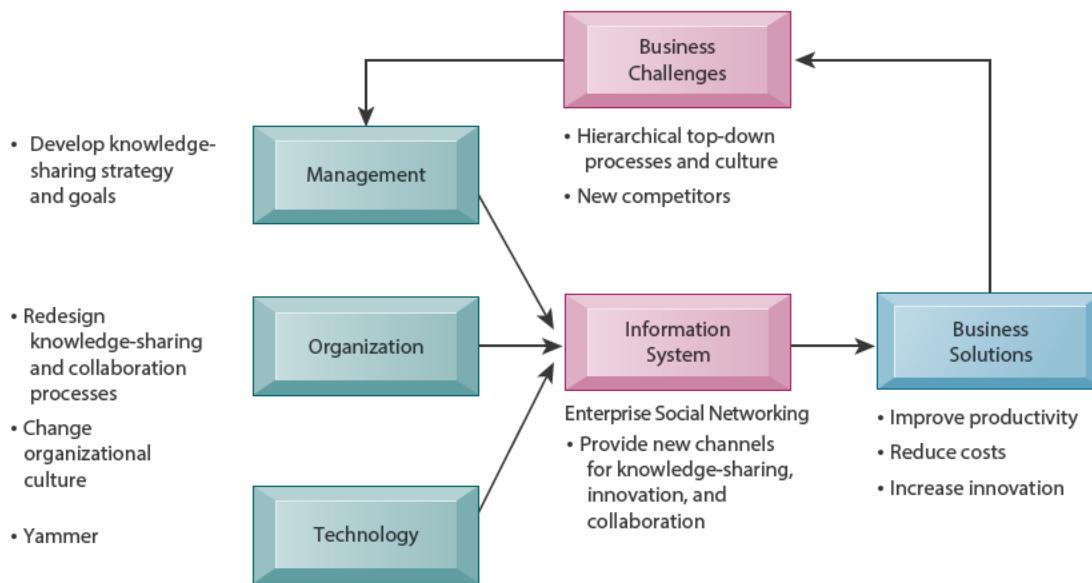
Some department leaders use Yammer to solicit ideas from their staff on how to use the latest technology in the business. Sharp is able to incorporate such feedback into product development and company policies. This ability to collect dispersed information from all over the company and have managers freely exchange ideas and learn from employees represents a major cultural change for the company.

Sources: “Sharp: A Culture Reborn Through Enterprise Social,” www.microsoft.com, accessed February 12, 2020; www.globalsharp.com, accessed January 21, 2020; and Sharp Corporation, “Sharp Is Back With Big Screens,” Hexus, February 5, 2019.

Sharp's experience illustrates how much organizations today rely on information systems to improve their performance and remain competitive. It also shows how much systems supporting collaboration and teamwork make a difference in an organization's ability to innovate, execute, grow profits, and remain competitive.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. Sharp Corporation is a knowledge-intensive technology company that depends on innovation, but it was hampered by hierarchical top-down processes and a culture that prevented employees and managers from freely sharing information and innovating. This impacted the company's ability to create and deliver new leading-edge products, maintain high profit margins, and fend off increasing competition from other companies.

Sharp management found that the best solution was to deploy new technology to help the company move from a hierarchical corporate knowledge and work environment to one that was more democratized. Enterprise social networking actively engaged employees and enabled them to obtain more knowledge from colleagues and managers. The company took advantage of Microsoft



Yammer's social tools to increase employee collaboration and engagement and to open up dialogues with management. There is now more effective sharing of employee knowledge, and the company has become more innovative and effective.

New technology alone would not have solved Sharp Corporation's problem. To make the solution effective, Sharp had to change its organizational culture and business processes for knowledge dissemination and collaborative work, and the new technology made these changes possible.

Here are some questions to think about: How are collaboration and employee engagement helping Sharp Corporation to be more competitive? How did using Yammer change corporate culture and the way work was performed at Sharp Corporation?

2-1 What are business processes? How are they related to information systems?

In order to operate, businesses must deal with many different pieces of information about suppliers, customers, employees, invoices, payments, and of course their products and services. They must organize work activities that use this information to operate efficiently and enhance the overall performance of the firm. Information systems make it possible for firms to manage all their information, make better decisions, and improve the execution of their business processes.

Business Processes

Business processes, which we introduced in Chapter 1, refer to the manner in which work is organized, coordinated, and focused to produce a valuable product or service. Business processes are the collection of activities required to produce a product or service. These activities are supported by flows of material, information, and knowledge among the participants in business processes. Business processes also refer to the unique ways in which organizations

coordinate work, information, and knowledge, and the ways in which management chooses to coordinate work.

To a large extent, the performance of a business firm depends on how well its business processes are designed and coordinated. A company's business processes can be a source of competitive strength if they enable the company to innovate or to execute better than its rivals. Business processes can also be liabilities if they are based on inefficient ways of working that impede organizational responsiveness and efficiency. The chapter-opening case describing Sharp Corporation's improvements in knowledge-sharing processes clearly illustrates these points, as do many of the other cases in this text.

Every business can be seen as a collection of business processes, some of which are part of larger encompassing processes. For instance, uses of mentoring, wikis, blogs, and videos are all part of the overall knowledge management process. Many business processes are tied to a specific functional area. For example, the sales and marketing function is responsible for identifying customers, and the human resources function is responsible for hiring employees. Table 2.1 describes some typical business processes for each of the functional areas of business.

Other business processes cross many different functional areas and require coordination across departments. For instance, consider the seemingly simple business process of fulfilling a customer order (see Figure 2.1). Initially, the sales department receives a sales order. The order passes first to accounting to ensure the customer can pay for the order either by a credit verification or request for immediate payment prior to shipping. Once the customer credit is established, the production department pulls the product from inventory or produces the product. Then the product is shipped (and this may require working with a logistics firm, such as UPS or FedEx). A bill or invoice is generated by the accounting department, and a notice is sent to the customer indicating that the product has shipped. The sales department is notified of the shipment and prepares to support the customer by answering calls or fulfilling warranty claims.

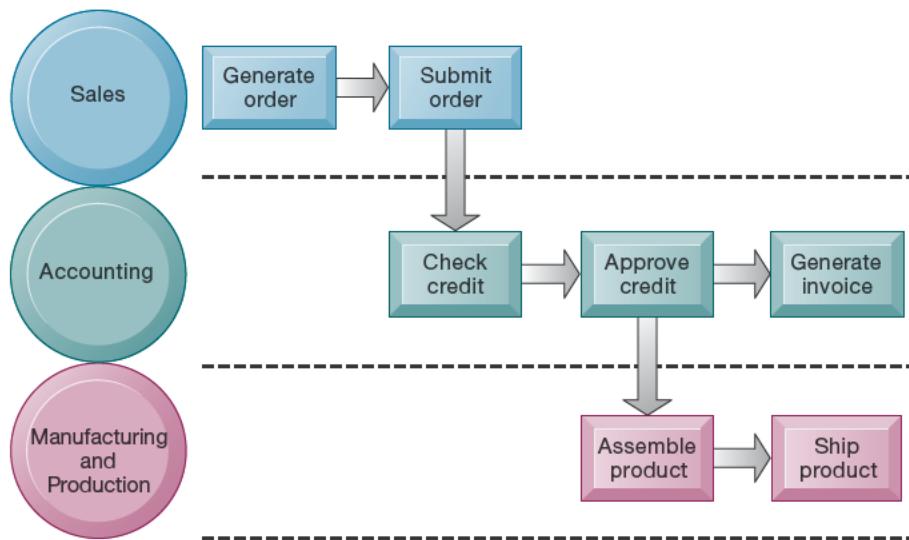
What at first appears to be a simple process, fulfilling an order, turns out to be a very complicated series of business processes that require the close

TABLE 2.1 EXAMPLES OF FUNCTIONAL BUSINESS PROCESSES

FUNCTIONAL AREA	BUSINESS PROCESS
Manufacturing and production	Assembling the product Checking for quality Producing bills of materials
Sales and marketing	Identifying customers Making customers aware of the product Selling the product
Finance and accounting	Paying creditors Creating financial statements Managing cash accounts
Human resources	Hiring employees Evaluating employees' job performance Enrolling employees in benefits plans

FIGURE 2.1 THE ORDER FULFILLMENT PROCESS

Fulfilling a customer order involves a complex set of steps that requires the close coordination of the sales, accounting, and manufacturing functions.



coordination of major functional groups in a firm. Moreover, to efficiently perform all these steps in the order fulfillment process requires a great deal of information. The required information must flow rapidly within the firm from one decision maker to another; with business partners, such as delivery firms; and with the customer. Computer-based information systems make this possible.

How Information Technology Improves Business Processes

Exactly how do information systems improve business processes? Information systems automate many steps in business processes that were formerly performed manually, such as checking a client's credit or generating an invoice and shipping order. But today, information technology can do much more. New technology can actually change the flow of information, making it possible for many more people to access and share information, replacing sequential steps with tasks that can be performed simultaneously, and eliminating delays in decision making. New information technology frequently changes the way a business works and supports entirely new business models. Downloading a Kindle e-book from Amazon, buying a computer online at Scan UK, and streaming a music track from Apple Music are entirely new business processes based on new business models that would be inconceivable without today's information technology.

That's why it's so important to pay close attention to business processes, both in your information systems course and in your future career. By analyzing business processes, you can achieve a very clear understanding of how a business actually works. Moreover, by conducting a business process analysis, you will also begin to understand how to change the business by improving its processes to make it more efficient or effective. Throughout this book, we examine business processes with a view to understanding how they might be improved by using information technology to achieve greater efficiency, innovation, and customer service.

2-2 How do systems serve the different management groups in a business, and how do systems that link the enterprise improve organizational performance?

Now that you understand business processes, it is time to look more closely at how information systems support the business processes of a firm. Because there are different interests, specialties, and levels in an organization, there are different kinds of systems. No single system can provide all the information an organization needs.

A typical business organization has systems supporting processes for each of the major business functions—sales and marketing, manufacturing and production, finance and accounting, and human resources. You can find examples of systems for each of these business functions in the Learning Tracks for this chapter. Functional systems that operate independently of each other are becoming a thing of the past because they cannot easily share information to support cross-functional business processes. Many have been replaced with large-scale cross-functional systems that integrate the activities of related business processes and organizational units. We describe these integrated cross-functional applications later in this section.

A typical firm also has different systems supporting the decision-making needs of each of the main management groups we described in Chapter 1. Operational management, middle management, and senior management each use systems to support the decisions they must make to run the company. Let's look at these systems and the types of decisions they support.

Systems for Different Management Groups

A business firm has systems to support different groups or levels of management. These systems include transaction processing systems and systems for business intelligence.

Transaction Processing Systems

Operational managers need systems that keep track of the elementary activities and transactions of the organization, such as sales, receipts, cash deposits, payroll, credit decisions, and the flow of materials in a factory. **Transaction processing systems (TPS)** provide this kind of information. A transaction processing system is a computerized system that performs and records the daily routine transactions necessary to conduct business, such as sales order entry, hotel reservations, payroll, employee record keeping, and shipping.

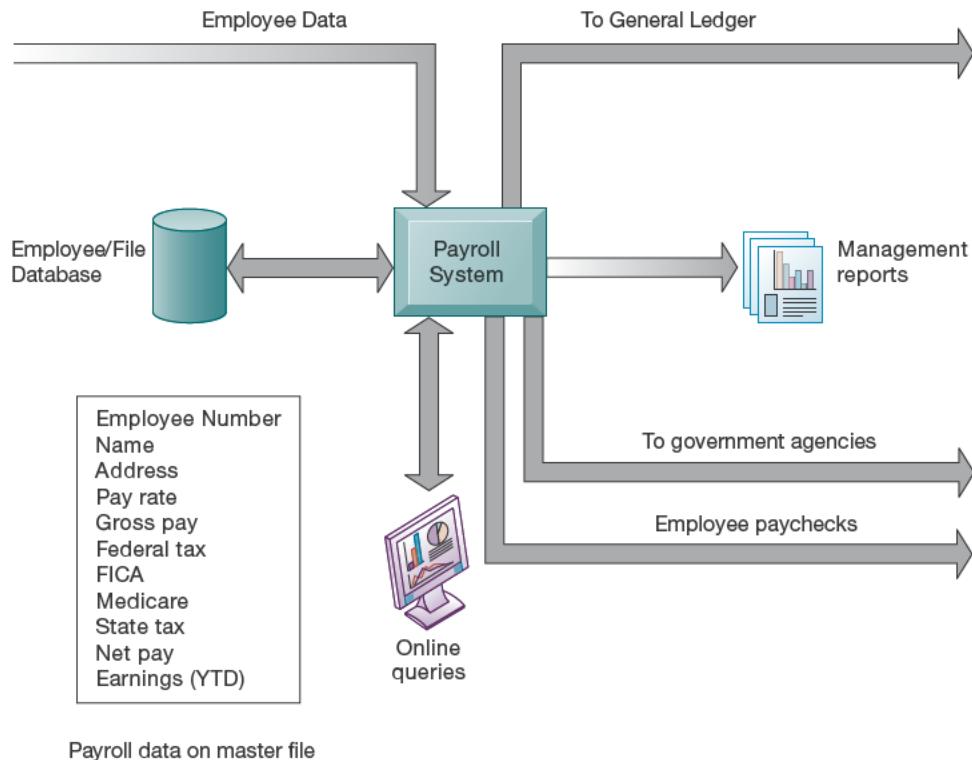
The principal purpose of systems at this level is to answer routine questions and to track the flow of transactions through the organization. How many parts are in inventory? What happened to Mr. Smith's payment? To answer these kinds of questions, information generally must be easily available, current, and accurate.

At the operational level, tasks, resources, and goals are predefined and highly structured. The decision to grant credit to a customer, for instance, is made by a lower-level supervisor according to predefined criteria. All that must be determined is whether the customer meets the criteria.

Figure 2.2 illustrates a TPS for payroll processing. A payroll system keeps track of money paid to employees. An employee time sheet with the employee's name, social security number, and number of hours worked per week

FIGURE 2.2 A PAYROLL TPS

A TPS for payroll processing captures employee payment transaction data (such as a time card). System outputs include online and hard-copy reports for management and employee paychecks.



represents a single transaction for this system. Once this transaction is input into the system, it updates the system's master file (or database—see Chapter 6) that permanently maintains employee information for the organization. The data in the system are combined in different ways to create reports of interest to management and government agencies and to send paychecks to employees.

Managers need TPS to monitor the status of internal operations and the firm's relations with the external environment. TPS are also major producers of information for the other systems and business functions. For example, the payroll system illustrated in Figure 2.2, along with other accounting TPS, supplies data to the company's general ledger system, which is responsible for maintaining records of the firm's income and expenses and for producing reports such as income statements and balance sheets. It also supplies employee payment history data for insurance, pension, and other benefits calculations to the firm's human resources function and employee payment data to government agencies.

Transaction processing systems are often so central to a business that TPS failure for a few hours can lead to a firm's demise and perhaps that of other firms linked to it. Imagine what would happen to UPS if its package tracking system was not working! What would the airlines do without their computerized reservation systems?

Systems for Business Intelligence

Firms also have business intelligence systems that focus on delivering information to support management decision making. **Business intelligence** is a contemporary term for data and software tools for organizing, analyzing, and

providing access to data to help managers and other enterprise users make more informed decisions. Business intelligence addresses the decision-making needs of all levels of management. This section provides a brief introduction to business intelligence. You'll learn more about this topic in Chapters 6 and 12.

Business intelligence systems for middle management help with monitoring, controlling, decision-making, and administrative activities. In Chapter 1, we defined management information systems as the study of information systems in business and management. The term **management information systems (MIS)** also designates a specific category of information systems serving middle management. MIS provide middle managers with reports on the organization's current performance. This information is used to monitor and control the business and predict future performance.

MIS summarize and report on the company's basic operations using data supplied by transaction processing systems. The basic transaction data from TPS are compressed and usually presented in reports that are produced on a regular schedule. Today, many of these reports are delivered online. Figure 2.3 shows how a typical MIS transforms transaction-level data from inventory, production, and accounting into MIS files that are used to provide managers with reports. Figure 2.4 shows a sample report from this system.

MIS typically provide answers to routine questions that have been specified in advance and have a predefined procedure for answering them. For instance, MIS reports might list the total pounds of lettuce used this quarter by a fast-food chain or, as illustrated in Figure 2.4, compare total annual sales figures for specific products to planned targets. These systems generally are not flexible and have little analytical capability. Most MIS use simple routines, such as summaries and comparisons, as opposed to sophisticated mathematical models or statistical techniques.

Other types of business intelligence systems support more nonroutine decision making. **Decision-support systems (DSS)** focus on problems that are unique and rapidly changing, for which the procedure for arriving at a solution may not be fully predefined in advance. They try to answer questions such as

FIGURE 2.3 HOW MANAGEMENT INFORMATION SYSTEMS OBTAIN THEIR DATA FROM THE ORGANIZATION'S TPS

In the system illustrated by this diagram, three TPS supply summarized transaction data to the MIS reporting system at the end of the time period. Managers gain access to the organizational data through the MIS, which provides them with the appropriate reports.

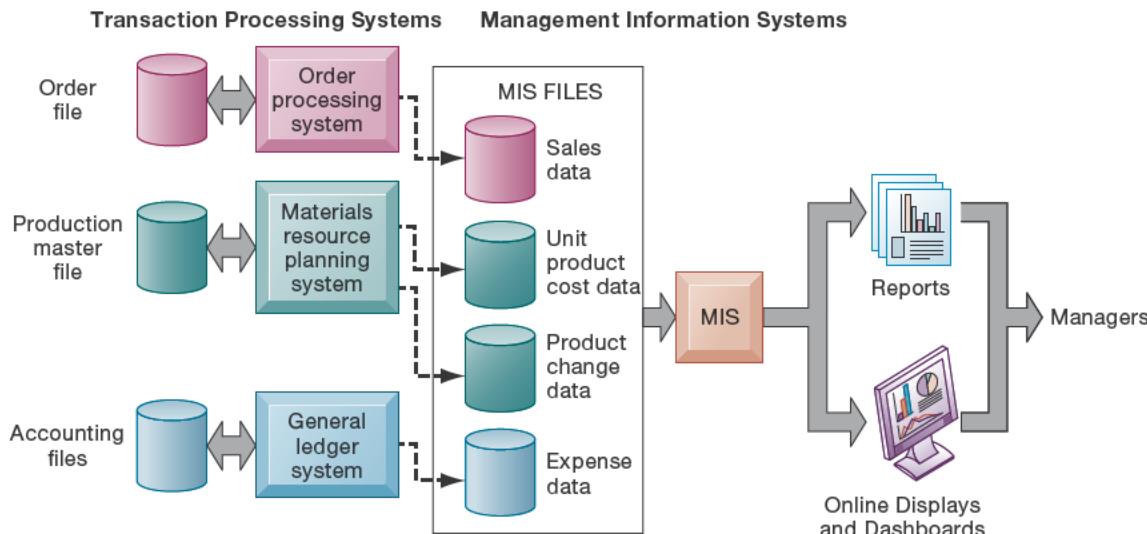


FIGURE 2.4 SAMPLE MIS REPORT

This report, showing summarized annual sales data, was produced by the MIS in Figure 2.3.

Consolidated Consumer Products Corporation Sales by Product and Sales Region: 2020

PRODUCT CODE	PRODUCT DESCRIPTION	SALES REGION	ACTUAL SALES	PLANNED	ACTUAL versus PLANNED
4469	Carpet Cleaner	Northeast	4,066,700	4,800,000	0.85
		South	3,778,112	3,750,000	1.01
		Midwest	4,867,001	4,600,000	1.06
		West	4,003,440	4,400,000	0.91
	TOTAL		16,715,253	17,550,000	0.95
5674	Room Freshener	Northeast	3,676,700	3,900,000	0.94
		South	5,608,112	4,700,000	1.19
		Midwest	4,711,001	4,200,000	1.12
		West	4,563,440	4,900,000	0.93
	TOTAL		18,559,253	17,700,000	1.05

these: What would be the impact on production schedules if we were to double sales in the month of December? What would happen to our return on investment if a factory schedule were delayed for six months?

Although DSS use internal information from TPS and MIS, they often bring in information from external sources, such as current stock prices or product prices of competitors. These systems are employed by “super-user” managers and business analysts who want to use sophisticated analytics and models to analyze data.

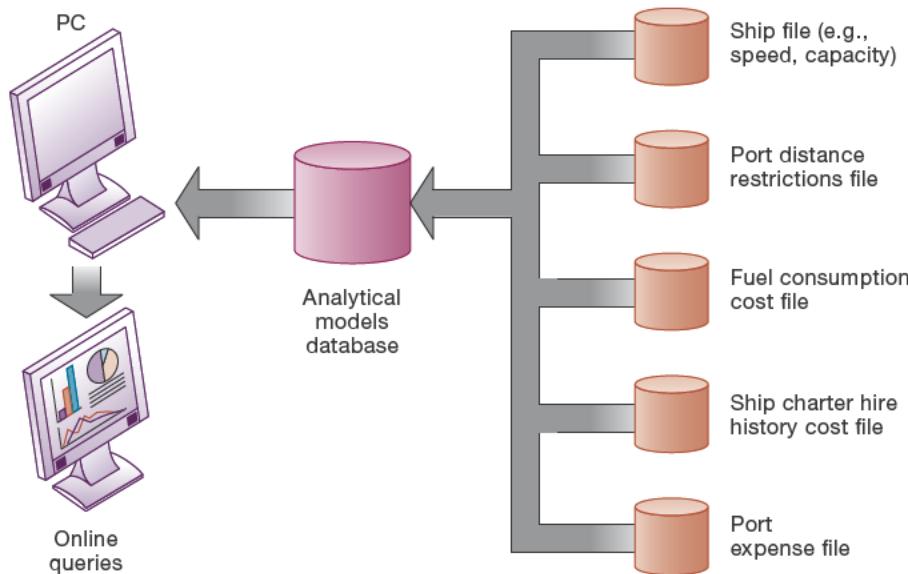
An interesting, small, but powerful DSS is the voyage-estimating system of a large global shipping company that transports bulk cargoes of coal, oil, ores, and finished products. The firm owns some vessels, charters others, and bids for shipping contracts in the open market to carry general cargo. A voyage-estimating system calculates financial and technical voyage details. Financial calculations include ship/time costs (fuel, labor, capital), freight rates for various types of cargo, and port expenses. Technical details include myriad factors, such as ship cargo capacity, speed, port distances, fuel and water consumption, and loading patterns (location of cargo for different ports).

The system can answer questions such as the following: Given a customer delivery schedule and an offered freight rate, which vessel should be assigned at what rate to maximize profits? What is the optimal speed at which a particular vessel can optimize its profit and still meet its delivery schedule? What is the optimal loading pattern for a ship bound for the U.S. West Coast from Malaysia? Figure 2.5 illustrates the DSS built for this company. The system operates on a powerful desktop personal computer, providing a system of menus that makes it easy for users to enter data or obtain information.

The voyage-estimating DSS we have just described draws heavily on models. Other business intelligence systems are more data-driven, focusing instead on extracting useful information from very large quantities of data. For example, large ski resort companies such as Intrawest and Vail Resorts collect and store large amounts of customer data from call centers, lodging and dining reservations, ski schools, and ski equipment rental stores. They use special software to analyze these data to determine the value, revenue potential, and loyalty of each customer to help managers make better decisions about how to target their marketing programs.

FIGURE 2.5 VOYAGE-ESTIMATING DECISION-SUPPORT SYSTEM

This DSS operates on a powerful PC. It is used daily by managers who must develop bids on shipping contracts.

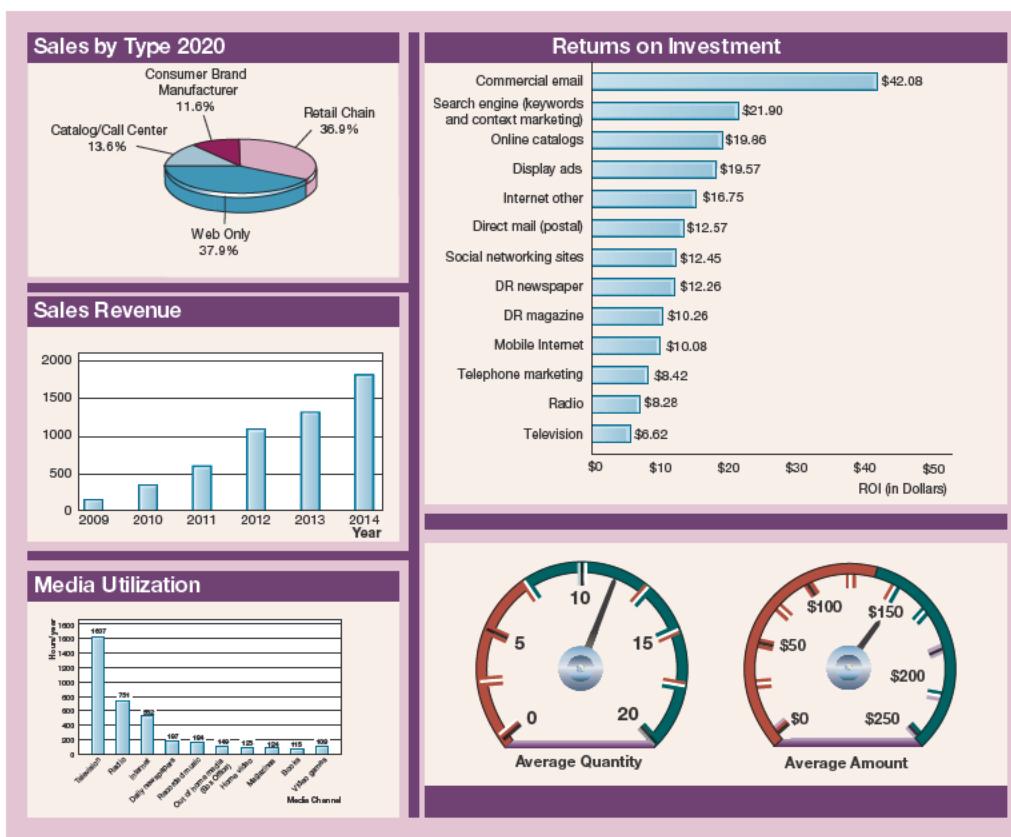


Business intelligence systems also address the decision-making needs of senior management. Senior managers need systems that focus on strategic issues and long-term trends, both in the firm and in the external environment. They are concerned with questions such as: What will employment levels be in five years? What are the long-term industry cost trends? What products should we be making in five years?

Executive support systems (ESS) help senior management make these decisions. They address nonroutine decisions requiring judgment, evaluation, and insight because there is no agreed-on procedure for arriving at a solution. ESS present graphs and data from many sources through an interface that is easy for senior managers to use. Often the information is delivered to senior executives through a **portal**, which uses a web interface to present integrated personalized business content.

ESS are designed to incorporate data about external events, such as new tax laws or competitors, but they also draw summarized information from internal MIS and DSS. They filter, compress, and track critical data, displaying the data of greatest importance to senior managers. Increasingly, such systems include business intelligence analytics for analyzing trends, forecasting, and “drilling down” to data at greater levels of detail.

For example, the chief operating officer (COO) and plant managers at Valero, the world's largest independent petroleum refiner, use a Refining Dashboard to display real-time data related to plant and equipment reliability, inventory management, safety, and energy consumption. With the displayed information, the COO and his team can review the performance of each Valero refinery in the United States and Canada in terms of how each plant is performing compared to the production plan of the firm. The headquarters group can drill down from executive level to refinery level and individual system-operator level displays of performance. Valero's Refining Dashboard is an example of a **digital dashboard**, which displays on a single screen graphs and charts of key performance indicators for managing a company. Digital dashboards are becoming an increasingly popular tool for management decision makers.



A digital dashboard delivers comprehensive and accurate information for decision making, often using a single screen. The graphical overview of key performance indicators helps managers quickly spot areas that need attention.

Systems for Linking the Enterprise

Reviewing all the different types of systems we have just described, you might wonder how a business can manage all the information in these different systems. You might also wonder how costly it is to maintain so many different systems. And you might wonder how all these different systems can share information and how managers and employees are able to coordinate their work. In fact, these are all important questions for businesses today.

Enterprise Applications

Getting all the different kinds of systems in a company to work together has proven a major challenge. Typically, corporations are put together both through normal “organic” growth and through acquisition of smaller firms. Over a period of time, corporations end up with a collection of systems, most of them older, and face the challenge of getting them all to “talk” with one another and work together as one corporate system. There are several solutions to this problem.

One solution is to implement **enterprise applications**, which are systems that span functional areas, focus on executing business processes across the firm, and include all levels of management. Enterprise applications help businesses become more flexible and productive by coordinating their business processes more closely and integrating groups of processes so they focus on efficient management of resources and customer service.

There are four major enterprise applications: enterprise systems, supply chain management systems, customer relationship management systems, and knowledge management systems. Each of these enterprise applications

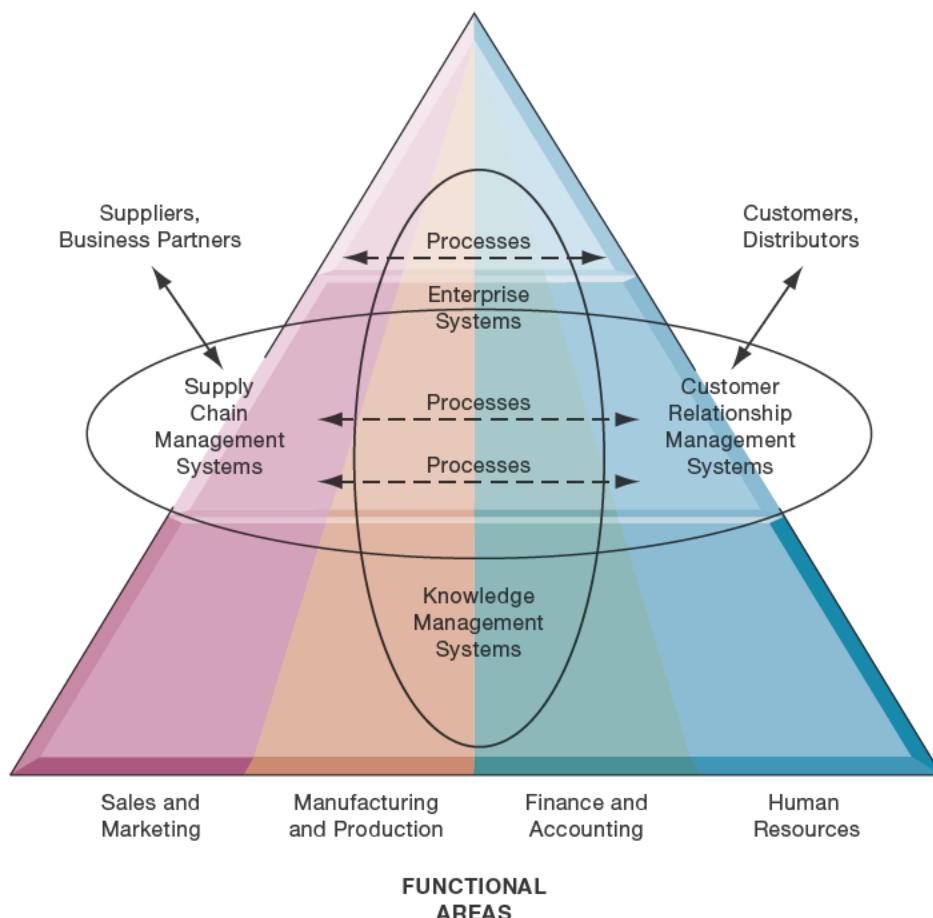
integrates a related set of functions and business processes to enhance the performance of the organization as a whole. Figure 2.6 shows that the architecture for these enterprise applications encompasses processes spanning the entire organization and, in some cases, extending beyond the organization to customers, suppliers, and other key business partners.

Enterprise Systems Firms use **enterprise systems**, also known as enterprise resource planning (ERP) systems, to integrate business processes in manufacturing and production, finance and accounting, sales and marketing, and human resources into a single software system. Information that was previously fragmented in many different systems is stored in a single comprehensive data repository where it can be used by many different parts of the business.

For example, when a customer places an order, the order data flow automatically to other parts of the company that are affected by them. The order transaction triggers the warehouse to pick the ordered products and schedule shipment. The warehouse informs the factory to replenish whatever has been depleted. The accounting department is notified to send the customer an invoice. Customer service representatives track the progress of the order through every step to inform customers about the status of their orders. Managers are able to use firmwide information to make more-precise and timely decisions about daily operations and longer-term planning.

FIGURE 2.6 ENTERPRISE APPLICATION ARCHITECTURE

Enterprise applications automate processes that span multiple business functions and organizational levels and may extend outside the organization.



Supply Chain Management Systems Firms use **supply chain management (SCM) systems** to help manage relationships with their suppliers. These systems help suppliers, purchasing firms, distributors, and logistics companies share information about orders, production, inventory levels, and delivery of products and services so they can source, produce, and deliver goods and services efficiently. The ultimate objective is to get the right amount of their products from their source to their point of consumption in the least amount of time and at the lowest cost. These systems increase firm profitability by lowering the costs of moving and making products and by enabling managers to make better decisions about how to organize and schedule sourcing, production, and distribution.

Supply chain management systems are one type of **interorganizational system** because they automate the flow of information across organizational boundaries. You will find examples of other types of interorganizational information systems throughout this text because such systems make it possible for firms to link digitally to customers and to outsource their work to other companies.

Customer Relationship Management Systems Firms use **customer relationship management (CRM) systems** to help manage their relationships with their customers. CRM systems provide information to coordinate all of the business processes that deal with customers in sales, marketing, and service to optimize revenue, customer satisfaction, and customer retention. This information helps firms identify, attract, and retain the most profitable customers; provide better service to existing customers; and increase sales.

Knowledge Management Systems Some firms perform better than others because they have better knowledge about how to create, produce, and deliver products and services. This firm knowledge is unique, is difficult to imitate, and can be leveraged into long-term strategic benefits. **Knowledge management systems (KMS)** enable organizations to better manage processes for capturing and applying knowledge and expertise. These systems collect all relevant knowledge and experience in the firm and make it available wherever and whenever it is needed to improve business processes and management decisions. They also link the firm to external sources of knowledge. We examine enterprise systems and systems for supply chain management and customer relationship management in greater detail in Chapter 9. We discuss collaboration systems that support knowledge management in this chapter and cover other types of knowledge management applications in Chapter 11.

Intranets and Extranets

Enterprise applications create deep-seated changes in the way the firm conducts its business, offering many opportunities to integrate important business data into a single system. They are often costly and difficult to implement. Intranets and extranets deserve mention here as alternative tools for increasing integration and expediting the flow of information within the firm and with customers and suppliers.

Intranets are simply internal company websites that are accessible only by employees. The term *intranet* refers to an internal network, in contrast to the Internet, which is a public network linking organizations and other external networks. Intranets use the same technologies and techniques as the larger Internet, and they often are simply a private access area in a larger company website. Likewise with extranets, which are company websites that are accessible to authorized vendors and suppliers and are often used to coordinate the movement of supplies to the firm's production apparatus.

For example, Six Flags, which operates 18 theme parks throughout North America, maintains an intranet for its 1,900 full-time employees that provides company-related news and information on each park's day-to-day operations,

including weather forecasts, performance schedules, and details about groups and celebrities visiting the parks. The company also uses an extranet to broadcast information about schedule changes and park events to its 30,000 seasonal employees. We describe the technology for intranets and extranets in more detail in Chapter 7.

E-business, E-commerce, and E-government

The systems and technologies we have just described are transforming firms' relationships with customers, employees, suppliers, and logistic partners into digital relationships using networks and the Internet. So much business is now enabled by or based upon digital networks that we use the terms *electronic business* and *electronic commerce* frequently throughout this text.

Electronic business, or e-business, refers to the use of digital technology and the Internet to execute the major business processes in the enterprise. E-business includes activities for the internal management of the firm and for coordination with suppliers and other business partners. It also includes **electronic commerce, or e-commerce**.

E-commerce is the part of e-business that deals with the buying and selling of goods and services over the Internet. It also encompasses activities supporting those market transactions, such as advertising, marketing, customer support, security, delivery, and payment.

The technologies associated with e-business have also brought about similar changes in the public sector. Governments on all levels are using Internet technology to deliver information and services to citizens, employees, and businesses with which they work. **E-government** refers to the application of the Internet and networking technologies to digitally enable government and public sector agencies' relationships with citizens, businesses, and other arms of government.

In addition to improving delivery of government services, e-government makes government operations more efficient and also empowers citizens by giving them easier access to information and the ability to network electronically with other citizens. For example, citizens in some states can renew their driver's licenses or apply for unemployment benefits online, and the Internet has become a powerful tool for instantly mobilizing interest groups for political action and fundraising. The Interactive Session on Organizations describes the Canadian City of Mississauga's e-government program.

INTERACTIVE SESSION ORGANIZATIONS

The City of Mississauga Goes Digital

The City of Mississauga, a Toronto suburb, is Canada's sixth-largest city and a leading user of digital technology to improve its operations and services. It tries to integrate technology into its operations and strategic and business planning, with technology roadmaps for each municipal service defined in business plans and budgets.

Mississauga has a vibrant multicultural population and a thriving central business district, with many Canadian and multinational corporations headquartered there. Since 1970, however, the Greater Toronto Area, including Mississauga, has experienced a noticeable increase in low-income families and a similar decrease in middle-income families. Mississauga developed a Smart City Master Plan to provide a vision and framework to guide the city's adoption of digital technology. The city's leaders believe that digital technology should be available for everyone and provide opportunities to startups, schools, and households at risk.

Mississauga has been a leader in technology initiatives such as social media and "bring your own device" (BYOD), which allows employees to use their own mobile devices for their jobs. Mississauga's website and online services are hosted in remote cloud computing centers accessible via the Internet. (Chapter 5 of this text provides a detailed discussion of these technologies.) In deploying these technologies, the city tries to focus on usability, a high-quality customer experience, and making information technology and technology services available to residents of all income and educational levels.

Mississauga is trying as much as possible to go paperless, with meetings and collaboration via videoconferencing where participants can "attend" meetings and share documents remotely. These efforts have significantly reduced paper use and the need to travel via car or airplane to meetings.

Mobile tools have made it possible for city staff, including transit operators and work operations staff in the field, who previously lacked computers, to access employee information and operational data to support real-time operations and decision making. Working with cellular provider Rogers Wireless, Mississauga connected over 600 buses that are collecting information about bus operations and routes,

so that the public has real-time information about bus locations. The bus data collected also are used for timing maintenance, warranty, and mileage routines so that buses can be removed from service at optimal times to minimize service interruption.

Mississauga has additionally connected 700 city vehicles such as fire trucks and vehicles for snow, public works, and parks operations, and facility maintenance to provide real-time location-based information. For example, connected snow vehicles provide real-time snow plow information to the public as well as the expected level of service for snow removal. Onboard sensors track when snow blades are active, where and when salt or sand is applied, and the rate at which these materials are applied. Mississauga recently implemented an Advanced Traffic Management System (ATMS), which connected over 700 traffic intersections using its own high-capacity fiber optic and wireless Wi-Fi networks (see Chapter 7) along with the Rogers cellular network.

A City Hall pilot project created individual workspaces and collaboration units on the fifth floor so that staff can choose where they want to sit and work. Over 90 percent of the staff on that floor have no defined desk or desk phone, but they do have mobile technology to connect anywhere. A mobile working environment has helped the city attract younger employees, and it has transformed the way top management works as well. The city manager, commissioners, and directors are trading desktops for mobile devices.

Partnering with three other municipalities, Mississauga built its own high-speed fiber optic network known as the Public Sector Network (PSN). It is the largest municipally owned fiber optic network in Canada. This supports a citywide high-speed fiber network for transmitting large quantities of data and a wireless Wi-Fi network that supplies wireless connectivity to the public for many city services. Enterprise networking giant Cisco Canada helped the city build an extensive Wi-Fi network for all its community centers, libraries, arenas, and many outdoor locations such as parks and small business areas. This free Wi-Fi network is available as a "virtual campus" to college and university students around

the world. In 2018 over 8 million hours of free public Wi-Fi were used across the City. Providing public Wi-Fi access in so many locations across the city is one way for Mississauga to level the “digital divide” between residents who are technology “haves” and those who are technology “have-nots.”

Mississauga is working with the United Way, Region of Peel, University of Toronto at Mississauga, Sheridan College, and its Business Improvement Areas (BOAs) to build a mobile-friendly ecosystem across the city that can deliver services and digital technology to the entire community. The plan divides Mississauga into 23 defined communities, with one Hub center and 500 mobility kits to residents enrolled in social support programs per community. Each mobility kit consists of a connected laptop. Hubs will be developed jointly with several of the

large technology firms with Canadian headquarters in Mississauga and they will provide coworking spaces where their employees can do their work. Eventually the city will have 100 Hubs. The city is also planning to build 500 “Connects” across its 23 communities that will provide indoor and outdoor spaces with voice-supported digital screens and free Wi-Fi access. A “Connect” could be in a park, beside a bus stop, or inside a mall, and there citizens will find free Wi-Fi, a place to sit, and access to services and programs.

Sources: “SMRTCTY Master Plan,” smartcity.mississauga.ca, accessed February 9, 2020; Sophie Chapman, “Inside the City of Mississauga’s Technology Transformation Journey,” *Gigabit*, February 18, 2019; and Eric Emin Wood, “How the City of Mississauga Uses Mobile Technology to Engage Workers and Citizens Alike,” *IT World Canada*, May 7, 2018.

CASE STUDY QUESTIONS

1. Describe the problems the City of Mississauga hoped to address using digital technology.
2. What technologies did Mississauga employ for a solution? Describe each of these technologies and the role each played in a solution.
3. What management, organization, and technology issues did the City of Mississauga have to address in developing a solution?
4. How did the technologies in this case improve operations and decision making at the City of Mississauga?

2-3 Why are systems for collaboration and social business so important, and what technologies do they use?

With all these systems and information, you might wonder how it is possible to make sense of them. How do people working in firms pull it all together, work toward common goals, and coordinate plans and actions? In addition to the types of systems we have just described, businesses need special systems to support collaboration and teamwork.

What Is Collaboration?

Collaboration is working with others to achieve shared and explicit goals. Collaboration focuses on task or mission accomplishment and usually takes place in a business or other organization and between businesses. You collaborate with a colleague in Tokyo who has expertise on a topic about which you know nothing. You collaborate with many colleagues in publishing a company blog. If you’re in a law firm, you collaborate with accountants in an accounting firm in servicing the needs of a client with tax problems.

Collaboration can be short-lived, lasting a few minutes, or longer term, depending on the nature of the task and the relationship among participants. Collaboration can be one-to-one or many-to-many.

Employees may collaborate in informal groups that are not a formal part of the business firm's organizational structure, or they may be organized into formal teams. **Teams** have a specific mission that someone in the business assigned to them. Team members need to collaborate on the accomplishment of specific tasks and collectively achieve the team mission. The team mission might be to "win the game" or "increase online sales by 10 percent." Teams are often short-lived, depending on the problems they tackle and the length of time needed to find a solution and accomplish the mission.

Collaboration and teamwork are more important today than ever for a variety of reasons.

- *Changing nature of work.* The nature of work has changed from factory manufacturing and precomputer office work where each stage in the production process occurred independently of one another and was coordinated by supervisors. Work was organized into silos. Within a silo, work passed from one machine tool station to another, from one desktop to another, until the finished product was completed. Today, jobs require much closer coordination and interaction among the parties involved in producing the service or product. For instance, a report from the consulting firm McKinsey & Company estimated that 41 percent of the U.S. labor force is now composed of jobs where interaction (talking, emailing, presenting, and persuading) is the primary value-adding activity (McKinsey Global Institute, 2012). Even in factories, workers today often work in production groups, or pods.
- *Growth of professional work.* "Interaction" jobs tend to be professional jobs in the service sector that require close coordination and collaboration. Professional jobs require substantial education and the sharing of information and opinions to get work done. Each actor on the job brings specialized expertise to the problem, and all the actors need to take one another into account in order to accomplish the job.
- *Changing organization of the firm.* For most of the industrial age, managers organized work in a hierarchical fashion. Orders came down the hierarchy, and responses moved back up the hierarchy. Today, work is organized into groups and teams, and the members are expected to develop their own methods for accomplishing the task. Senior managers observe and measure results but are much less likely to issue detailed orders or operating procedures. In part, this is because expertise and decision-making power have been pushed down in organizations.
- *Changing scope of the firm.* The work of the firm has changed from a single location to multiple locations—offices or factories throughout a region, a nation, or even around the globe. For instance, Henry Ford developed the first mass-production automobile plant at a single Dearborn, Michigan factory. In 2020, Ford employed 199,000 people at 61 plants worldwide. With this kind of global presence, the need for close coordination of design, production, marketing, distribution, and service obviously takes on new importance and scale. Large global companies need to have teams working on a global basis.
- *Emphasis on innovation.* Although we tend to attribute innovations in business and science to great individuals, these great individuals are most likely working with a team of brilliant colleagues. Think of Bill Gates and Steve Jobs (founders of Microsoft and Apple), both of whom are highly regarded innovators and both of whom built strong collaborative teams to nurture and support innovation in their firms. Their initial innovations derived from close collaboration with colleagues and partners. Innovation, in other words, is a group and social process, and most innovations derive from collaboration among individuals in a lab, a business, or government agencies. Strong collaborative practices and technologies are believed to increase the rate and quality of innovation.

- *Changing culture of work and business.* Most research on collaboration supports the notion that diverse teams produce better outputs faster than individuals working on their own. Popular notions of the crowd (“crowdsourcing” and the “wisdom of crowds”) also provide cultural support for collaboration and teamwork.

What Is Social Business?

Many firms today enhance collaboration by embracing **social business**—the use of social networking platforms, including Facebook, Twitter, and internal corporate social tools—to engage their employees, customers, and suppliers. These tools enable workers to set up profiles, form groups, and “follow” each other’s status updates. The goal of social business is to deepen interactions with groups inside and outside the firm to expedite and enhance information sharing, innovation, and decision making.

A key word in social business is *conversations*. Customers, suppliers, employees, managers, and even oversight agencies continually have conversations about firms, often without the knowledge of the firm or its key actors (employees and managers).

Supporters of social business argue that if firms could tune in to these conversations, they would strengthen their bonds with consumers, suppliers, and employees, increasing their emotional involvement in the firm.

All of this requires a great deal of information transparency. People need to share opinions and facts with others quite directly, without intervention from executives or others. Employees get to know directly what customers and other employees think, suppliers will learn very directly the opinions of supply chain partners, and even managers presumably will learn more directly from their employees how well they are doing. Nearly everyone involved in the creation of value will know much more about everyone else.

If such an environment could be created, it is likely to drive operational efficiencies, spur innovation, and accelerate decision making. If product designers can learn directly about how their products are doing in the market in real time, based on consumer feedback, they can speed up the redesign process. If employees can use social connections inside and outside the company to capture new knowledge and insights, they will be able to work more efficiently and solve more business problems.

Table 2.2 describes important applications of social business inside and outside the firm. This chapter focuses on enterprise social business—its internal corporate uses. Chapters 7 and 10 describe social business applications relating to customers and suppliers outside the company.

TABLE 2.2 APPLICATIONS OF SOCIAL BUSINESS

SOCIAL BUSINESS APPLICATION	DESCRIPTION
Social networks	Connect through personal and business profiles
Crowdsourcing	Harness collective knowledge to generate new ideas and solutions
Shared workspaces	Coordinate projects and tasks; cocreate content
Blogs and wikis	Publish and rapidly access knowledge; discuss opinions and experiences
Social commerce	Share opinions about purchasing on social platforms
File sharing	Upload, share, and comment on photos, videos, audio, text documents
Social marketing	Use social media to interact with customers; derive customer insights
Communities	Discuss topics in open forums; share expertise

Business Benefits of Collaboration and Social Business

Much of the research on collaboration has been anecdotal, but there is a general belief among both business and academic communities that the more a business firm is “collaborative,” the more successful it will be, and that collaboration within and among firms is more essential than in the past. *MIT Sloan Management Review’s* research found that a focus on collaboration is central to how digitally advanced companies create business value and establish competitive advantage (Kiron, 2017). A global survey of business and information systems managers found that investments in collaboration technology produced organizational improvements that returned more than four times the amount of the investment, with the greatest benefits for sales, marketing, and research and development functions (Frost & Sullivan, 2009). McKinsey & Company consultants predict that social technologies used within and across enterprises could potentially raise the productivity of interaction workers by 20 to 25 percent (McKinsey Global Institute, 2012).

Table 2.3 summarizes some of the benefits of collaboration and social business that have been identified. Figure 2.7 graphically illustrates how collaboration is believed to affect business performance.

Building a Collaborative Culture and Business Processes

Collaboration won’t take place spontaneously in a business firm, especially in the absence of supportive culture or business processes. Business firms, especially large firms, had a reputation in the past for being “command and control” organizations where the top leaders thought up all the really important matters and then ordered lower-level employees to execute senior management plans. The job of middle management supposedly was to pass messages back and forth, up and down the hierarchy.

Command and control firms required lower-level employees to carry out orders without asking too many questions, with no responsibility to improve processes, and with no rewards for teamwork or team performance. If your work group needed help from another work group, that was something for the bosses to figure out. You never communicated horizontally, always vertically, so management could control the process. Together, the expectations of management

TABLE 2.3 BUSINESS BENEFITS OF COLLABORATION AND SOCIAL BUSINESS

BENEFIT	RATIONALE
Productivity	People interacting and working together can capture expert knowledge and solve problems more rapidly than the same number of people working in isolation from one another. There will be fewer errors.
Quality	People working collaboratively can communicate errors and corrective actions faster than if they work in isolation. Collaborative and social technologies help reduce time delays in design and production.
Innovation	People working collaboratively can come up with more innovative ideas for products, services, and administration than the same number working in isolation from one another. There are advantages to diversity and the “wisdom of crowds.”
Customer service	People working together using collaboration and social tools can solve customer complaints and issues faster and more effectively than if they were working in isolation from one another.
Financial performance (profitability, sales, and sales growth)	As a result of all of the above, collaborative firms have superior sales, sales growth, and financial performance.

FIGURE 2.7 REQUIREMENTS FOR COLLABORATION

Successful collaboration requires an appropriate organizational structure and culture along with appropriate collaboration technology.

Collaboration Capability

- Open culture
- Decentralized structure
- Breadth of collaboration

Collaboration Technology

- Use of collaboration and social technology for implementation and operations
- Use of collaborative and social technology for strategic planning

Collaboration Quality

Firm Performance

and employees formed a culture, a set of assumptions about common goals and how people should behave. Many business firms still operate this way.

A collaborative business culture and business processes are very different. Senior managers are responsible for achieving results but rely on teams of employees to achieve and implement the results. Policies, products, designs, processes, and systems are much more dependent on teams at all levels of the organization to devise, to create, and to build. Teams are rewarded for their performance, and individuals are rewarded for their performance in a team. The function of middle managers is to build the teams, coordinate their work, and monitor their performance. The business culture and business processes are more “social.” In a collaborative culture, senior management establishes collaboration and teamwork as vital to the organization, and it actually implements collaboration for the senior ranks of the business as well.

Tools and Technologies for Collaboration and Social Business

A collaborative, team-oriented culture won’t produce benefits without information systems in place to enable collaboration, group decision making, and social business. Currently there are hundreds of tools designed to deal with the fact that, in order to succeed in our jobs, we are all much more dependent on one another, our fellow employees, customers, suppliers, and managers. Some of these tools are expensive, but others are available online for free (or with premium versions for a modest fee). Let’s look more closely at some of these tools.

Email and Instant Messaging (IM)

Email and instant messaging (including text messaging) have been major communication and collaboration tools for interaction jobs. Their software operates

on computers, mobile phones, tablets, and other wireless devices and includes features for sharing files as well as transmitting messages. Many instant messaging systems allow users to engage in real-time conversations with multiple participants simultaneously. In recent years, email use has declined, with messaging and social media becoming preferred channels of communication.

Wikis

Wikis are a type of website that makes it easy for users to contribute and edit text content and graphics without any knowledge of web page development or programming techniques. The most well-known wiki is Wikipedia, the largest collaboratively edited reference project in the world. It relies on volunteers, makes no money, and accepts no advertising.

Wikis are very useful tools for storing and sharing corporate knowledge and insights. Enterprise software vendor SAP AG has a wiki that acts as a base of information for people outside the company, such as customers and software developers who build programs that interact with SAP software. In the past, those people asked and sometimes answered questions in an informal way on SAP online forums, but that was an inefficient system, with people asking and answering the same questions over and over.

Virtual Worlds

Virtual worlds, such as Second Life, are online 3D environments populated by "residents" who have built graphical representations of themselves known as avatars. Companies like IBM, Cisco, and Intel Corporation have used the online world for meetings, interviews, guest speaker events, and employee training. Real-world people represented by avatars meet, interact, and exchange ideas at these virtual locations using gestures, chat conversations, and voice communication.

Collaboration and Social Business Platforms

There are now software suites providing multifunction platforms for collaboration and social business among teams of employees who work together from different locations. The most widely used are Internet-based audio conferencing and videoconferencing systems, cloud collaboration services such as Google's online services and tools, corporate collaboration systems such as Microsoft SharePoint and IBM Notes, and enterprise social networking tools such as Salesforce Chatter, Microsoft Yammer, Facebook Workplace, and IBM Connections. Some of these are now being used by educational institutions to deal with the impact of COVID-19 (see the Interactive Session on Technology).

Virtual Meeting Systems In an effort to reduce travel expenses and enable people in different locations to meet and collaborate, many companies, both large and small, are adopting videoconferencing and web conferencing technologies. More companies are using these systems to enable their employees to work remotely as well as in the office.

A videoconference allows individuals at two or more locations to communicate simultaneously through two-way video and audio transmissions. High-end videoconferencing systems feature **telepresence** technology, an integrated audio and visual environment that allows a person to give the appearance of being present at a location other than his or her true physical location. Free or low-cost Internet-based systems such as Microsoft Teams, Google Meet, and Amazon Chime are lower quality but improving, and they are very useful for smaller companies. Apple's FaceTime is useful for one-to-one or small group videoconferencing. Zoom has emerged as a powerful videoconferencing tool with many features of high-end systems but is much less expensive and easier to use. Some of these tools are available on mobile devices.

INTERACTIVE SESSION TECHNOLOGY

Higher Education Redefined: Virtual Education at Ahlia University

Collaboration in educational institutions usually involves cooperation among students, faculties, sponsors, and universities. Unlike the corporate world, higher education institutions have generally fallen behind in adopting the latest technologies and have continued to rely primarily on face-to-face (F2F) collaboration. F2F learning predominates because of the widespread view that it helps students stay focused, connect with each other, follow a standard timetable, and improve their physical wellness and mental alertness. Faculties believe that it enables them to better understand and assess their students' qualities and shortcomings and to fulfill their roles as mentors. F2F learning enables students to share their perspectives and have their questions addressed with a level of personal interaction that digital learning cannot replicate.

However, the COVID-19 pandemic has forced universities to rethink their assumptions. Although many universities worldwide had already begun to implement virtual learning before the pandemic hit, they were at varying degrees of implementation when the lockdowns began, and many had to rush to catch up.

Ahlia University Bahrain, the country's first private university, has effectively moved the bulk of its operations and services online: teaching, academic advising, career development services, counseling services, digital library services, payment services, document management, internship programs, student activities, and student complaint services. The university prepared itself for the online transition by implementing a series of measures spread over a period of two to three months. This included addressing infrastructural requirements for online education: optimum Internet speed, network upgrades, and licensing of Microsoft and other open-source or affordable software packages. Short videos and manuals on how to use different technologies and e-learning platforms were prepared to help students, faculties, and administrative bodies. Online training and support were provided through a hotline, its official website, virtual training courses, as well as through WhatsApp, other social media, and YouTube videos. The university provided its members with access to Microsoft Office 365 and a library of e-books as well. Security policies were implemented to enhance the protection of information and privacy. Faculty underwent intensive training to strengthen the

educational process itself and ensure that there would be no disruption in the event of an emergency.

Microsoft SharePoint, a web-based cloud collaboration tool for information storage and management, had already been implemented by the university toward the end of 2019. SharePoint is used to share and maintain up-to-date information and to expand awareness of the university's plans, decisions, events, rules, and policies among students and faculty. SharePoint has built cohesion, harnessed collective knowledge, and driven organizational efficiency by sharing common resources. It has also promoted collaboration between the internal units of the university and external bodies.

To conduct classes online, Ahlia University chose Microsoft Teams, a collaborative tool that allows users to chat, make calls, share documents, and conduct meetings. The university's IT team linked time tables and class lists from the university's Student Information System database, which stores and tracks all student information, including grades and attendance records, to Microsoft Teams using application programming interfaces (APIs) to import relevant course details. Using Microsoft Teams has enabled the university to create a secure environment where access to Teams chats and groups is barred to outsiders. All classes are recorded so students can review and recall all that has been taught. Advice, career development, and counseling services for mental health issues have also been made available through Microsoft Teams chats and calls.

The course details and class list from the Student Information System have also been linked with Moodle, an open-source learning management system. This has contributed significantly to mass enrollment and secured authentication. Through Moodle, instructors use quizzes, chat messages, forums, workshops, uploaded course materials, assessments, and surveys with tracking and reminder options to improve their students' efficiency in studying and to ensure the timely completion of assignments and courses.

To conduct online webinars and conferences with industry specialists and other universities, Ahlia University has used Zoom in addition to Microsoft Teams. As of September 2020, the university has participated in 9 webinars, 12 local conferences, and 34 international debates and conferences involving universities and industry specialists from Asia, the United Kingdom, the United States, and the Middle

East. Before the adoption of platforms like Zoom and Microsoft Teams, the number of Ahlia University's international collaborations were limited to only around 11 per year. Moving discussions online has greatly reduced expenses due to travel while facilitating the exchange of knowledge and encouraging academic contributions. The success of these collaborations has

prompted Ahlia University to consider focusing on online platforms even after the pandemic is over.

Sources: Ahlia University-Bahrain, "COVID-19," www.ahlia.edu.bh, accessed December 17, 2020; Ahlia University, "WTUN Webinar Series—Online Learning and Teaching: Lessons Learned from COVID-19-Part 2," [Youtube.com](https://www.youtube.com/watch?v=JLjyfzXWQHw), July 21, 2020; Ahlia University, "WTUN Webinar Series—Online Learning and Teaching: Lessons Learned from COVID-19-Part 1," [Youtube.com](https://www.youtube.com/watch?v=JLjyfzXWQHw), July 21, 2020; Ahlia University, "How Virtual Learning Is Becoming a Key Ingredient in Delivering University Courses," [Facebook.com](https://www.facebook.com/ahliauniversity), April 9, 2020.

CASE STUDY QUESTIONS

1. How does Microsoft Teams promote efficient collaboration in universities and colleges?
2. What management, organization, and technology-based issues did Ahlia University address before pivoting its operations to deal with the pandemic?
3. What advantages has using collaboration tools provided for Ahlia University?

*Case contributed by Subhashini Bhaskaran,
Ahlia University*

Cloud Collaboration Services Google offers many online tools and services, and some are suitable for collaboration. They include Google Drive, Google Docs, G Suite, and Google Sites. Most are free of charge.

Google Drive is a file storage and synchronization service for cloud storage, file sharing, and collaborative editing. Such web-based online file-sharing services allow users to upload files to secure online storage sites from which the files can be shared with others. Microsoft OneDrive and Dropbox are other leading cloud storage services. They feature both free and paid services, depending on the amount of storage space and administration required. Users are able to synchronize their files stored online with their local PCs and other kinds of devices, with options for making the files private or public and for sharing them with designated contacts.

Google Drive and Microsoft OneDrive are integrated with tools for document creation and sharing. OneDrive provides online storage for Microsoft Office documents and other files and works with Microsoft Office apps, both installed and on the web. It can share to Facebook as well. Google Drive is integrated with Google Docs, Sheets, and Slides (often called Google Docs), a suite of productivity applications that offer collaborative editing on documents, spreadsheets, and presentations. Google's cloud-based productivity suite for businesses, called G Suite, also works with Google Drive. Google Sites allows users to quickly create online team-oriented sites where multiple people can collaborate and share files.

Microsoft SharePoint and IBM Notes Microsoft SharePoint is a browser-based collaboration and document management platform, combined with a powerful search engine, that is installed on corporate servers. SharePoint has a web-based interface and close integration with productivity tools such as Microsoft Office. SharePoint software makes it possible for employees to share their documents and collaborate on projects using Office documents as the foundation.

SharePoint can be used to host internal websites that organize and store information in one central workspace to enable teams to coordinate work activities, collaborate on and publish documents, maintain task lists, implement workflows, and share information via wikis and blogs. Users are able to control versions of documents and document security. Because SharePoint stores and organizes information in one place, users can find relevant information

TABLE 2.4 ENTERPRISE SOCIAL NETWORKING SOFTWARE CAPABILITIES

SOCIAL SOFTWARE CAPABILITY	DESCRIPTION
Profiles	Ability to set up member profiles describing who individuals are, educational background, interests. Includes work-related associations and expertise (skills, projects, teams).
Content sharing	Share, store, and manage content including documents, presentations, images, and videos.
Feeds and notifications	Real-time information streams, status updates, and announcements from designated individuals and groups.
Groups and team workspaces	Establish groups to share information, collaborate on documents, and work on projects with the ability to set up private and public groups and to archive conversations to preserve team knowledge.
Tagging and social bookmarking	Indicate preferences for specific pieces of content, similar to the Facebook Like button. Tagging lets people add keywords to identify content they like.
Permissions and privacy	Ability to make sure private information stays within the right circles, as determined by the nature of relationships. In enterprise social networks, there is a need to establish who in the company has permission to see what information.

quickly and efficiently while working closely together on tasks, projects, and documents. Enterprise search tools help locate people, expertise, and content. SharePoint now features social tools.

IBM Notes (formerly Lotus Notes) is a collaborative software system with capabilities for sharing calendars, email, messaging, collective writing and editing, shared database access, and online meetings. Notes software installed on desktop or laptop computers obtains applications stored on an IBM Domino server. Notes is web-enabled and offers an application development environment so that users can build custom applications to suit their unique needs. Notes has also added capabilities for blogs, microblogs, wikis, online content aggregators, help desk systems, voice and video conferencing, and online meetings. IBM Notes promises high levels of security and reliability and the ability to retain control over sensitive corporate information.

Enterprise Social Networking Tools The tools we have just described include capabilities for supporting social business, but there are also more specialized social tools for this purpose, such as Salesforce Chatter, Microsoft Yammer, Facebook Workplace, and IBM Connections. Enterprise social networking tools create business value by connecting the members of an organization through profiles, updates, and notifications similar to Facebook features but tailored to internal corporate uses. Table 2.4 provides more detail about these internal social capabilities.

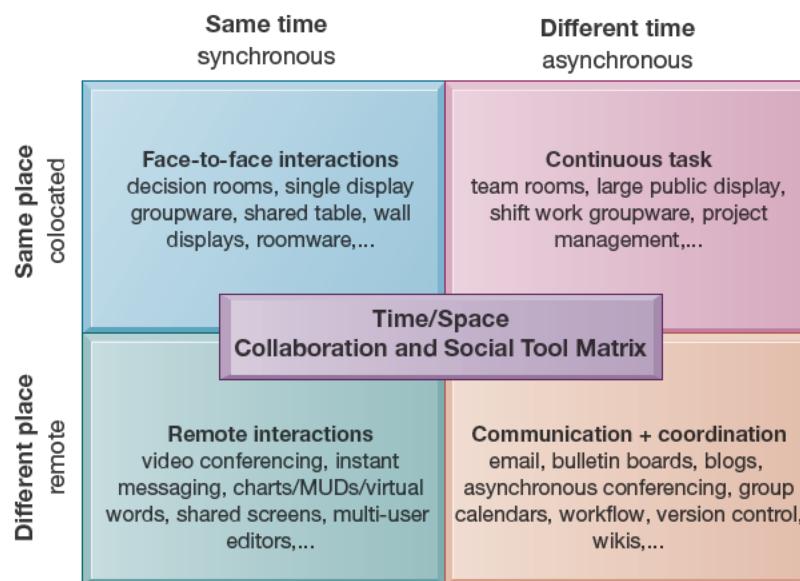
Although companies have benefited from enterprise social networking, internal social networking has not always been easy to implement. The chapter-ending case study addresses this topic.

Checklist for Managers: Evaluating and Selecting Collaboration and Social Software Tools

With so many collaboration and social business tools and services available, how do you choose the right collaboration technology for your firm? To answer this question, you need a framework for understanding just what problems these tools are designed to solve. One framework that has been helpful for us to talk about collaboration tools is the time/space collaboration and social tool matrix developed in the early 1990s by a number of collaborative work scholars (Figure 2.8).

FIGURE 2.8 THE TIME/SPACE COLLABORATION AND SOCIAL TOOL MATRIX

Collaboration and social technologies can be classified in terms of whether they support interactions at the same or different times or places, and whether these interactions are remote or colocated.



The time/space matrix focuses on two dimensions of the collaboration problem: time and space. For instance, you need to collaborate with people in different time zones, and you cannot all meet at the same time. Midnight in New York is noon in Mumbai, so this makes it difficult to have a videoconference (the people in New York are too tired). Time is clearly an obstacle to collaboration on a global scale.

Place (location) also inhibits collaboration in large global or even national and regional firms. Assembling people for a physical meeting is made difficult by the physical dispersion of distributed firms (firms with more than one location), the cost of travel, and the time limitations of managers.

The collaboration and social technologies we have just described are ways of overcoming the limitations of time and space. Using this time/space framework will help you to choose the most appropriate collaboration and teamwork tools for your firm. Note that some tools are applicable in more than one time/place scenario. For example, Internet collaboration suites such as IBM Notes have capabilities for both synchronous (instant messaging, meeting tools) and asynchronous (email, wikis, document editing) interactions.

Here's a "to-do" list to get started. If you follow these six steps, you should be led to investing in the correct collaboration software for your firm at a price you can afford and within your risk tolerance.

1. What are the collaboration challenges facing the firm in terms of time and space? Locate your firm in the time/space matrix. Your firm can occupy more than one cell in the matrix. Different collaboration tools will be needed for each situation.
2. Within each cell of the matrix where your firm faces challenges, exactly what kinds of solutions are available? Make a list of vendor products.

3. Analyze each of the products in terms of its cost and benefits to your firm. Be sure to include the costs of training in your cost estimates and the costs of involving the information systems department, if needed.
4. Identify the risks to security and vulnerability involved with each of the products. Is your firm willing to put proprietary information into the hands of external service providers over the Internet? Is your firm willing to expose its important operations to systems controlled by other firms? What are the financial risks facing your vendors? Will they be here in three to five years? What would be the cost of making a switch to another vendor in the event the vendor firm fails?
5. Seek the help of potential users to identify implementation and training issues. Some of these tools are easier to use than others.
6. Make your selection of candidate tools, and invite the vendors to make presentations.

2-4 What is the role of the information systems function in a business?

We've seen that businesses need information systems to operate today and that they use many different kinds of systems. But who is responsible for running these systems? Who is responsible for making sure the hardware, software, and other technologies used by these systems are running properly and are up to date? End users manage their systems from a business standpoint, but managing the technology requires a special information systems function.

The Information Systems Department

In all but the smallest of firms, the **information systems department** is the formal organizational unit responsible for information technology services. The information systems department is responsible for maintaining the hardware, software, data storage, and networks that comprise the firm's IT infrastructure. We describe IT infrastructure in detail in Chapter 5.

The information systems department consists of specialists, such as programmers, systems analysts, project leaders, and information systems managers. **Programmers** are highly trained technical specialists who write the software instructions for computers. **Systems analysts** constitute the principal liaisons between the information systems groups and the rest of the organization. It is the systems analyst's job to translate business problems and requirements into information requirements and systems. **Information systems managers** are leaders of teams of programmers and analysts, project managers, physical facility managers, telecommunications managers, or database specialists. They are also managers of computer operations and data entry staff. Also, external specialists, such as hardware vendors and manufacturers, software firms, and consultants, frequently participate in the day-to-day operations and long-term planning of information systems.

In many companies, the information systems department is headed by a **chief information officer (CIO)**. The CIO is a senior manager who oversees the use of information technology in the firm. Today's CIOs are expected to have a strong business background as well as information systems expertise and to play a leadership role in exploring new technologies and integrating technology into the firm's business strategy. Large firms today also have

positions for a chief security officer, chief knowledge officer, chief data officer, and chief privacy officer, all of whom work closely with the CIO.

The **chief security officer (CSO)** is in charge of information systems security for the firm and is responsible for enforcing the firm's information security policy (see Chapter 8). (Sometimes this position is called the chief information security officer [CISO] where information systems security is separated from physical security.) The CSO is responsible for educating and training users and information systems specialists about security, keeping management aware of security threats and breakdowns, and maintaining the tools and policies chosen to implement security.

Information systems security and the need to safeguard personal data have become so important that corporations collecting vast quantities of personal data have established positions for a **chief privacy officer (CPO)**. The CPO is responsible for ensuring that the company complies with existing data privacy laws.

The **chief knowledge officer (CKO)** is responsible for the firm's knowledge management program. The CKO helps design programs and systems to find new sources of knowledge or to make better use of existing knowledge in organizational and management processes.

The **chief data officer (CDO)** is responsible for enterprise-wide governance and utilization of information to maximize the value the organization can realize from its data. The CDO ensures that the firm is collecting the appropriate data to serve its needs, deploying appropriate technologies for analyzing the data, and using the results to support business decisions. This position arose to deal with the very large amounts of data organizations are now generating and collecting (see Chapter 6).

End users are representatives of departments outside the information systems group for whom applications are developed. These users are playing an increasingly large role in the design and development of information systems.

In the early years of computing, the information systems group was composed mostly of programmers who performed highly specialized but limited technical functions. Today, a growing proportion of staff members are systems analysts and network specialists, with the information systems department acting as a powerful change agent in the organization. The information systems department suggests new business strategies and new information-based products and services and coordinates both the development of the technology and the planned changes in the organization.

Information technology occupations in the United States were projected to grow 12 percent from 2018 through 2028, adding 546,200 new jobs (U.S. Bureau of Labor Statistics, 2020). Although all IT/IS occupations show above-average growth, jobs for information security analysts, data scientists, network analysts, machine learning engineers, cloud engineers, application developers, web developers, and business intelligence analysts are especially in demand. Demand for computer programmers has been declining, in part because the process of creating computer programs is becoming increasingly efficient with the growth of online software services, cloud computing, and outsourcing of coding to low-wage countries.

Organizing the Information Systems Function

There are many types of business firms, and there are many ways in which the IT function is organized within the firm. A very small company will not have a formal information systems group. It might have one employee who

is responsible for keeping its networks and applications running, or it might use consultants for these services. Larger companies will have a separate information systems department, which may be organized along several different lines, depending on the nature and interests of the firm. Our Learning Track describes alternative ways of organizing the information systems function within the business.

The question of how the information systems department should be organized is part of the larger issue of IT governance. **IT governance** includes the strategy and policies for using information technology within an organization. It specifies the decision rights and framework for accountability to ensure that the use of information technology supports the organization's strategies and objectives. How much should the information systems function be centralized? What decisions must be made to ensure effective management and use of information technology, including the return on IT investments? Who should make these decisions? How will these decisions be made and monitored? Firms with superior IT governance will have clearly thought out the answers.



2-5 How will MIS help my career?

Here is how Chapter 2 and this book can help you find a job as a sales support specialist.

The Company

Comprehensive Supplemental Insurance is a leading provider of individual supplemental accident, disability, health, and life insurance products. It is headquartered in Amsterdam and has an open position for an entry-level sales support specialist. The company offers supplemental insurance to complement existing employer benefits programs, maintaining a field sales force and corporate staff of over 5,000 people worldwide. It is known for investing in its employees and their career development.

Position Description

This position will provide overall systems, administrative, and data management support to the national sales organization for the company's division that markets to small businesses. Job responsibilities include:

- Daily administration and support of the firm's Salesforce.com customer relationship management system, including managing user setup, profiles and roles, and validating data.
- Assisting with data management and providing system training and ongoing support to the field.
- Preparing routine weekly, monthly, and quarterly sales and key performance indicator reports for sales management.
- Preparing agent commission reports and creating new reports as requested.
- Supporting various projects related to agent licensing and agent compensation.

Job Requirements

- Strong Excel skills plus some knowledge of data management
- Strong customer service skills
- Strong analytical, critical thinking, and communication skills
- Ability to multitask in a fast-paced environment
- College degree or two years of equivalent experience

Interview Questions

1. What do you know about customer relationship management? Have you ever worked with Salesforce.com? If so, what have you used the system for?
2. What do you know about data management? Have you ever worked with data management software? If so, what exactly have you done with it?
3. Tell us what you can do with Excel. What kinds of problems have you used Excel to solve? Did you take courses in Excel?
4. Have you ever worked in customer service? What exactly did you do? What do you think is required to take on a successful client-oriented role for this company's agents and customers?
5. Can you give an example of a client service challenge you had to face? How did you approach this challenge?

Author Tips

1. Review the section of this chapter on enterprise applications, the Chapter 9 discussion of customer relationship management, and Chapter 6 on data management.
2. Use the web and the professional networking site LinkedIn to find out more about the company, its insurance products and services, and the way it operates. Think about what it needs to do to support its agents and its customers and why customer relationship management and data management are so important. You might inquire about your responsibilities for data management in this job position.
3. Learn what you can about Salesforce.com, especially how to set up user profiles and roles and how to validate data. Indicate you want to learn more about Salesforce and work with this tool.
4. Inquire how you would be using Excel; for example, calculating agent commissions. If you've never done that before, show some of the Excel work you have done (and perhaps bring examples with you to the interview). Show that you would be eager to learn what you don't know in Excel to fulfill your job assignments.

REVIEW SUMMARY

2-1 What are business processes? How are they related to information systems?

A business process is a logically related set of activities that defines how specific business tasks are performed, and it represents a unique way in which an organization coordinates work, information, and knowledge. Managers need to pay attention to business processes because they determine how well the organization can execute its business, and they may be a source of strategic advantage. There are business processes specific to each of the major business functions, but many business processes are cross-functional. Information systems automate parts of business processes, and they can help organizations redesign and streamline these processes.

2-2 How do systems serve the different management groups in a business, and how do systems that link the enterprise improve organizational performance?

Systems serving operational management are transaction processing systems (TPS), such as payroll or order processing, that track the flow of the daily routine transactions necessary to conduct business. Management information systems (MIS) produce reports serving middle management by condensing information from TPS, and these are not highly analytical. Decision-support systems (DSS) support management decisions that are unique and rapidly changing using advanced analytical models. All of these types of systems provide business intelligence that helps managers and enterprise employees make more-informed decisions. These systems for business intelligence serve multiple levels of management and include executive support systems (ESS) for senior management that provide data in the form of graphs, charts, and dashboards delivered via portals using many sources of internal and external information.

Enterprise applications are designed to coordinate multiple functions and business processes. Enterprise systems integrate the key internal business processes of a firm into a single software system to improve coordination and decision making. Supply chain management systems help the firm manage its relationship with suppliers to optimize the planning, sourcing, manufacturing, and delivery of products and services. Customer relationship management (CRM) systems coordinate the business processes surrounding the firm's customers. Knowledge management systems enable firms to optimize the creation, sharing, and distribution of knowledge. Intranets and extranets are private corporate networks based on Internet technology that assemble information from disparate systems. Extranets make portions of private corporate intranets available to outsiders.

2-3 Why are systems for collaboration and social business so important, and what technologies do they use?

Collaboration is working with others to achieve shared and explicit goals. Social business is the use of internal and external social networking platforms to engage employees, customers, and suppliers, and it can enhance collaborative work. Collaboration and social business have become increasingly important in business because of globalization, the decentralization of decision making, and growth in jobs where interaction is the primary value-adding activity. Collaboration and social business enhance innovation, productivity, quality, and customer service. Tools for collaboration and social business include email and instant messaging, wikis, virtual meeting systems, virtual worlds, cloud-based file-sharing services, corporate collaboration systems such as Microsoft SharePoint and IBM Notes, and enterprise social networking tools such as Chatter, Yammer, and IBM Connections.

2-4 What is the role of the information systems function in a business?

The information systems department is the formal organizational unit responsible for information technology services. It is responsible for maintaining the hardware, software, data storage, and networks that comprise the firm's IT infrastructure. The department consists of specialists, such as programmers, systems analysts, project leaders, and information systems managers, and is often headed by a CIO.

Key Terms

Business intelligence, 77
Chief data officer (CDO), 97
Chief information officer (CIO), 96
Chief knowledge officer (CKO), 97
Chief privacy officer (CPO), 97
Chief security officer (CSO), 97
Collaboration, 86
Customer relationship management (CRM) systems, 83
Decision-support systems (DSS), 78
Digital dashboard, 80
Electronic business (e-business), 84
Electronic commerce (e-commerce), 84
E-government, 84
End users, 97
Enterprise applications, 81
Enterprise systems, 82

Executive support systems (ESS), 80
Information systems department, 96
Information systems managers, 96
Interorganizational system, 83
IT governance, 98
Knowledge management systems (KMS), 83
Management information systems (MIS), 78
Portal, 80
Programmers, 96
Social business, 88
Supply chain management (SCM) systems, 83
Systems analysts, 96
Teams, 87
Telepresence, 91
Transaction processing systems (TPS), 76

MyLab MIS

To complete the problems marked with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

2-1 What are business processes? How are they related to information systems?

- Describe with examples how business processes are tied to the specific functional area of an organization.
- List and describe the business processes involved in fulfilling a customer order.

2-2 How do systems serve the different management groups in a business, and how do systems that link the enterprise improve organizational performance?

- Describe the characteristics of transaction processing systems (TPS) and the roles they play in a business.
- Describe the characteristics of business intelligence and explain why it is important in terms of decision-making.
- Identify which layer of management is most likely to use MIS and why.
- Describe how business intelligence systems also address the decision-making needs of senior management.
- Explain how a digital dashboard works.
- Explain how and why an organization might want to implement enterprise applications. What might be involved?

- Explain how customer relationship management helps an organization manage their interactions with customers.

2-3 Why are systems for collaboration and social business so important, and what technologies do they use?

- Define collaboration and social business and explain why they have become so important in business today.
- List and describe the business benefits of collaboration and social business.
- Describe a supportive organizational culture and business processes for collaboration.
- List and describe the various types of collaboration and social business tools.

2-4 What is the role of the information systems function in a business?

- Describe how the information systems function supports a business.
- Compare the roles played by programmers, systems analysts, information systems managers, the chief information officer (CIO), the chief security officer (CSO), the chief data officer (CDO), and the chief knowledge officer (CKO).

Discussion Questions

- 2-5** MyLab MIS How could information systems be used to support the order fulfillment process illustrated in Figure 2.1? What are the most important pieces of information these systems should capture? Explain your answer.
- 2-6** MyLab MIS Identify the steps that are performed in the process of selecting and checking out a book from your college library and
- 2-7** MyLab MIS the information that flows among these activities. Diagram the process. Are there any ways this process could be changed to improve the performance of your library or your school? Diagram the improved process.
- Use the time/space collaboration and social tool matrix to classify the collaboration and social technologies used by the Sharp Corporation.

Hands-On MIS Projects

The projects in this section give you hands-on experience analyzing opportunities to improve business processes with new information system applications, using a spreadsheet to improve decision making about suppliers, and using Internet software to plan efficient transportation routes. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 2-8** Heli is a manager at MoiMoiPixel, a Finnish startup developing free, fast-paced casual games for mobile platforms. MoiMoiPixel has been a success, gathering over 10 million returning players within a very short time. Nevertheless, the company is bleeding due to associated costs of hosting the game for all these players and paying salaries to the current staff of 40. Heli realizes the company doesn't know the players at all—when they play, why they play, where they live, and so on. Further, there is no communication at all with the players, and simply meeting at the coffee machine and sending emails is not enough to communicate efficiently with the growing staff. Help Heli by providing three suggestions for improving revenue and communication using information systems.
- 2-9** PetFence is based in Birmingham, in the United Kingdom, and makes custom-made fences to protect cats and dogs in household gardens. The company takes orders via email, designs the fence together with the client, and builds it in the client's garden. Finally, an invoice is sent to the client. PetFence depends on having just the right amount of necessary parts—too few and the work is delayed; too many and the storage fills up quickly. As business transactions are agreed on over the phone or by email, they sometimes forget to charge clients and pay suppliers. Moreover, email requests from prospective clients are often lost in the email flood, leading to missed sales opportunities and credibility issues. In what ways could information systems help PetFence? What issues can information systems not help them with?

Improving Decision Making: Using a Spreadsheet to Select Suppliers

Software skills: Spreadsheet date functions, data filtering, DAVERAGE function

Business skills: Analyzing supplier performance and pricing

- 2-10** In this exercise, you will learn how to use spreadsheet software to improve management decisions about selecting suppliers. You will filter transactional data on suppliers based on several different criteria to select the best suppliers for your company.

You run a company that manufactures aircraft components. You have many competitors who are trying to offer lower prices and better service to customers, and you are trying to determine whether you can benefit from better supply chain management. In MyLab MIS, you will find a spreadsheet file that contains a list of all of the items that your firm has ordered from its suppliers during the past three months. The fields in the spreadsheet file include vendor name, vendor identification number, purchaser's order number, item identification number and item description (for each item ordered from the vendor), cost per item, number of units of the item ordered (quantity), total cost of each order, vendor's accounts payable terms, order date, and actual arrival date for each order.

Prepare a recommendation of how you can use the data in this spreadsheet database to improve your decisions about selecting suppliers. Some criteria to consider for identifying preferred suppliers include the supplier's track record for on-time deliveries, suppliers offering the best accounts payable terms, and

suppliers offering lower pricing when the same item can be provided by multiple suppliers. Use your spreadsheet software to prepare reports to support your recommendations.

Achieving Operational Excellence: Using Internet Software to Plan Efficient Transportation Routes

Software skills: Internet-based software

Business skills: Transportation planning

- 2-11** In this exercise, you will use Google Maps to map out transportation routes for a business and select the most efficient route.

You have just started working as a dispatcher for Kräiz Land Transport, a new trucking and delivery service based in Luxembourg. Your first assignment is to plan a delivery of office equipment and furniture from Esch-sur-Alzette to Niederanven. To guide your trucker, you need to know the most efficient route between the two cities. Use Google Maps to find the route that is the shortest distance between the two cities. Use Google Maps again to find the route that takes the least time. Compare the results. Which route should Cross-Country use?

Collaboration and Teamwork Project

Identifying Management Decisions and Systems

- 2-12** With a team of three or four other students, find a description of a manager in a corporation in *The Financial Times*, *Forbes*, *Fortune*, the *The Economist*, or another business publication, or do your research on the web. Gather information about what the manager does and the role he or she plays in the company. Identify the organizational level and business function where this manager works. Make a list of the kinds of decisions this manager has to make and the kind of information the manager would need for those decisions. Suggest how information systems could supply this information. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Is Social Business Good Business?

CASE STUDY

As companies become more dispersed in the global marketplace, businesses are turning increasingly to workplace collaboration technology, including tools for internal social networking. These tools can promote employee collaboration and knowledge sharing, and help employees make faster decisions, develop more innovative ideas for products and services, and become more engaged in their work and their companies.

Adoption of internal enterprise social networking is also being driven by the flood of email that employees typically receive each day and are increasingly unable to handle. Hundreds of email messages must be opened, read, answered, forwarded, or deleted. For example, Winnipeg, Manitoba-based Duha Group, which produces color paint samples and color systems for paint companies across the globe, was able to eliminate 125,000 excess emails per year by adopting Salesforce Chatter social collaboration tools. Managing Director Emeric Duha, who used to receive 50 emails each morning from Asia, Europe, and Australia, now has a Chatter feed of everything going on in the company.

Another driver of enterprise social networking is "app fatigue." In order to collaborate, many employees have to log on to numerous apps, creating additional work. Contemporary enterprise social networking systems often integrate multiple capabilities in one place.

Recent studies have found that collaboration tools could be effective in boosting efficiency and productivity, while enabling users to make better business decisions. The products also expanded the potential for innovation. Not all companies, however, are successfully using them. Implementation and adoption of enterprise social networking depends not only on the capabilities of the technology but on the organization's culture and the compatibility of these tools with the firm's business processes. The technologies won't provide benefits if they are applied to flawed business processes and organizational behaviors. Digital collaboration tools such as Microsoft Teams, Chatter, Yammer, Zoom, and WebEx added to email, texting, and messaging may enmesh employees in too many interactions, leaving even less time for in-depth individual thinking and problem-solving.

When firms introduce new social media technology (as well as other technologies), a sizable number of employees resist the new tools, clinging to old ways of working, including email, because they are more familiar and comfortable. There are companies where employees have duplicated communication on both social media and email, increasing the time and cost of performing their jobs. BASF, the world's largest chemical producer with subsidiaries and joint ventures in more than 80 countries, prohibited some project teams from using email to encourage employees to use new social media tools.

Social business requires a change in thinking, including the ability to view the organization more democratically in a flatter and more horizontal way. A social business is much more open to everyone's ideas. A secretary, assembly line worker, or sales clerk might be the source of the next big idea. As a result, getting people to espouse social business tools requires more of a "pull" approach, one that engages workers and offers them a significantly better way to work. In most cases, they can't be forced to use social apps.

Enterprise capabilities for managing social networks and sharing digital content can help or hurt an organization. Social networks can provide rich and diverse sources of information that enhance organizational productivity, efficiency, and innovation, or they can be used to support preexisting groups of like-minded people that are reluctant to communicate and exchange knowledge with outsiders. Productivity and morale will fall if employees use internal social networks to criticize others or pursue personal agendas.

Social business applications modeled on consumer-facing platforms such as Facebook and Twitter will not necessarily work well in an organization or organizational department that has incompatible objectives. Will the firm use social business for operations, human resources, or innovation? The social media platform that will work best depends on its specific business purpose. Additionally employees who have actively used Facebook and Twitter in their personal lives are often hesitant to use similar social tools for work

purposes because they see social media primarily as an informal, personal means of self-expression and communication with friends and family. Most managers want employees to use internal social tools to communicate informally about work, but not to discuss personal matters. Employees accustomed to Facebook and Twitter may have trouble imagining how they could use social tools without getting personal.

This means that instead of focusing on the technology, businesses should first identify how social initiatives will actually improve work practices for employees and managers. They need a detailed understanding of social networks: how people are currently working, with whom they are working, what their needs are, and measures for overcoming employee biases and resistance.

A successful social business strategy requires leadership and behavioral changes. Just sponsoring a social project is not enough—managers need to demonstrate their commitment to a more open, transparent work style. Employees who are used to collaborating and doing business in more traditional ways need an incentive to use social software. Changing an organization to work in a different way requires enlisting those most engaged and interested in helping, and designing and building the right workplace environment for using social technologies.

Management needs to ensure that the internal and external social networking efforts of the company are providing genuine value to the business. Content on the networks needs to be relevant, up-to-date, and easy to access; users need to be able to connect to people who have the information they need and would otherwise be out of reach or difficult to reach. Social business tools should be appropriate for the tasks on hand and the organization's business processes, and users need to understand how and why to use them.

For example, NASA's Goddard Space Flight Center had to abandon a custom-built enterprise social network called Spacebook because no one knew how its social tools would help people do their jobs. Spacebook had been designed and developed without taking into consideration the organization's culture and politics. This is not an isolated phenomenon. Dimension Data found that one-fourth of the 900 enterprises it surveyed focused more on the successful implementation of collaboration technology, rather than how it's used and adopted.

Despite the challenges associated with launching an internal social network, there are companies using these networks successfully. One company that has made social business work is Standard Bank, Africa's largest financial services provider, which operates in 33 countries (including 19 in Africa). Standard Bank has embraced social business to keep up with the pace of twenty-first-century business. The bank is using Microsoft Yammer to help it become a more dynamic organization.

Use of Yammer at Standard Bank started to take off in 2013, when the bank staged an important conference for its executives around the world and was looking for a collaborative platform for communicating conference logistics and posting content such as PowerPoint presentations. Many agencies and consultants who worked for the bank used Yammer and liked the tool. Once conference participants saw how intuitive and useful Yammer was, they wanted to use it in their own operations. Usage exploded, and the Yammer social network grew to over 20,000 users just six months after Standard Bank adopted the Enterprise version. Belinda Carreira, Standard Bank's Executive Head of Interactive Marketing, is also reaching out to departments most likely to benefit from enterprise social networking.

Standard Bank has over 400 Yammer social groups. Many are organized around projects and problem-solving, such as finding credit card solutions that work well in African countries. Yammer has become a platform for listening, where employees can easily share their concerns and insights. Yammer is also used for internal education. Yammer enables trainers to present more visual and varied material than in the past, including videos from the Internet. In some locations, the Internet may be down for half the day, but Standard's employees are still able to access Yammer on their mobile phones.

Carreira notes that successful adoption and use of a social tool such as Yammer will hit roadblocks without proper planning and organizational buy-in. Many factors must be considered. Carreira recommends that Yammer implementors work closely with their organization's IT department, risk and compliance teams, human resources, communications department, and executive leadership across the organization. In addition to internal resources, Standard Bank drew on expertise provided by Yammer and Microsoft.

Northwards Housing, a nonprofit organization providing affordable housing services in Manchester, England, has an open organizational culture, which encourages two-way communication and information transparency. Northwards has 340 employees, who do everything from rent collection to scheduling repairs and cleaning maintenance. The organization wanted a way of exchanging information internally and with its customers that was easy to use and did not require much time for technical updates. Northwards introduced Yammer in 2012 and now has 85 percent of employees engaged with the network.

Steve Finegan, Northward's Head of Business Effectiveness and Communication, believes executive support was critical to the network's growth. The Northwards CEO regularly participates in discussions, posts links to news stories of interest, and publishes a blog. The organization's executive directors, who were initially skeptical about Yammer's benefits, now actively post content on the network and answer questions.

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CASE STUDY QUESTIONS

- 2-13** Identify the management, organization, and technology factors affecting adoption of internal corporate social networks.
- 2-14** Compare the experiences implementing internal social networks of the organizations described in this case. Why was Standard Bank successful? What role did management play in this process?
- 2-15** Should all companies implement internal enterprise social networks? Why or why not?

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3

Information Systems, Organizations, and Strategy

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 3-1** Which features of organizations do managers need to know about to build and use information systems successfully?
- 3-2** What is the impact of information systems on organizations?
- 3-3** How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network economics help companies develop competitive strategies using information systems?
- 3-4** What are the challenges posed by strategic information systems, and how should they be addressed?
- 3-5** How will MIS help my career?

CHAPTER CASES

- N26: A Bank Without Branches
- Shipping Wars
- Singapore as a Smart Nation
- Offline, Online, and Back: The Evolution of the UK Grocery Market

VIDEO CASES

- GE Becomes a Digital Firm: The Emerging Industrial Internet
- National Basketball Association: Competing on Global Delivery with Akamai OS Streaming

MyLab MIS

Discussion Questions: 3-5, 3-6, 3-7; Hands-On MIS Projects: 3-8, 3-9, 3-10, 3-11;
eText with Conceptual Animations

N26: A Bank Without Branches

N26, a mobile bank, was founded in 2013 by Valentin Stalf and Maximilian Tayenthal. Since its launch, N26 has built a network of more than 5 million customers in 24 European countries. In 2019, N26 began operation in the United States in partnership with Axos Bank, and in 2020 it applied for a banking license in Brazil. In total, N26 has raised close to \$800 million from investors and, with a market value of \$3.5 billion as of May 2020, it is one of the most valuable and well-funded fintech startups in Europe.

Traditional banks typically employ a distributed IT landscape. Banks usually operate numerous self-developed software applications, but many of these are only partially adaptable to changing processes and needs. An online bank, however, has the scope to optimally design its IT landscape and customer interaction processes based on current needs—such as compatibility with a mobile app—without having to take legacy systems into consideration. N26 is one of the few fintech banks that is hosted entirely in the cloud on a single system. N26 is able to take advantage of a modern technology stack and has over 100 microservices running in production in different software languages and frameworks. For instance, in connection with its expansion into the United States and Brazil, N26 software engineers introduced a new layer for the configuration of geographic regions into their software application and infrastructure architecture. In the modern mobile economy, this can be an important competitive advantage.

Stalf and Tayenthal conceived N26 as offering simple and customer-centric processes that could be used anywhere in the world. All of the bank's processes can be carried out completely online, from identification via video chat to opening an account. In its advertising, N26 boasts that an account can be opened within 8 minutes. And N26 aims to grow further: the number of customers worldwide was expected to double in 2020 from 5 to 10 million, with COVID-19 hastening the adoption of digital banking. N26 has responded by accelerating the development of various new features, such as an instant banking feature that allows customers to add a digital version of a new card to their mobile wallet, giving them immediate access to contactless payments.

N26 previously introduced Cash26 to further improve their services in cash-based operations. This service allows customers to deposit or withdraw cash at



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checkout across a network of partner companies: the N26 app generates a barcode that controls the withdrawal or deposit, and this is simply scanned at the partner company's checkout to complete the transaction.

Banks have always been an attractive target for criminals, and their IT systems get more than their fair share of cyberattacks. N26 is investing heavily in the development of security systems, including the use of artificial intelligence, to combat phishing, a common problem in online banking, as well as other forms of cyberattack. It has also increased the number of customer service personnel to over 600 people in order to be able to offer better customer support. It expects to operate at a break-even level by the end of 2021.

Sources: Nadine Schimroszik, "German Fintech N26 Eyes More Fundraising before IPO in 2022—CEO," Reuters.com, December 17, 2020; Trotz Corona-Krise: "Smartphone-Bank N26 wächst weiter," *Der Standard*, August 11, 2020; N26 Corporation, "N26 Raises More Than \$100M in Extension of Its Series D Funding," Press Release, n26.com, May 4, 2020; "Smartphone-Bank N26 hat mehr als fünf Millionen Kunden," *Der Standard*, January 23, 2020; Ben Linders, "Scaling Infrastructure as Code at Challenger Bank N26," www.infoq.com, January 2, 2020; N26 Corporation, "The N26 History," n26.com, September 11, 2019; Jürgen Stüber, "Onlinebank Revolut greift mit Bitcoin-Handel N26 an," Gründerszene, December 7, 2019; Christian Gattringer, "Die Online Bank N26 ist mit Gratiskonten zum Milliardenwert geworden—bald kommt sie in die Schweiz," Neue Zürcher Zeitung, July 18, 2019; Valentin Stalf, Maximilian Tayenthal, "N26 startet in den USA!," n26.com, July 11, 2019; Jauernig Henning, "Phishing-Attacken und schlechter Service bei N26," Spiegel Online, March 28, 2019; Horst von Buttler, "N26 wird gefeiert, die Deutsche Bank bedauert," Capital, January 12, 2019; OTS, "N26 gibt Finanzierungsrunde in Höhe von 300 Millionen US-Dollar bekannt," APA-OTS, January 10, 2019; Emilie Rauschütz, "Ein Meilenstein bei N26—500 Angestellte," N26 Magazine, mag.n26.com, October 16, 2018; Raj Saxena, "Tech at N26—The Bank in the Cloud," medium.com, May 22, 2018; Andreas Dörnfelder, "Seine Bank gewinnt gerade Kunden wie kaum eine zweite in Europa," orange.handelsblatt.com, March 20, 2018.

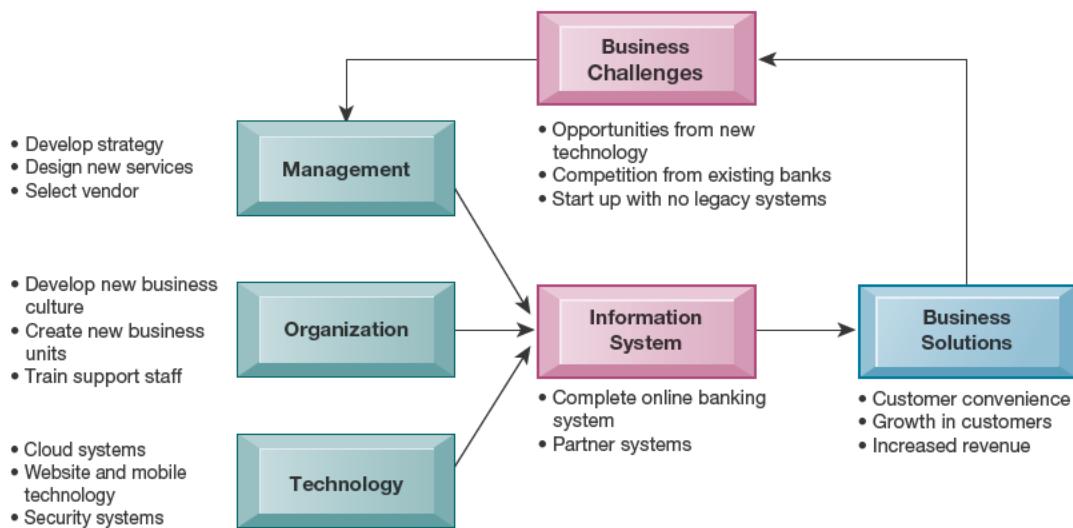
Case contributed by Bernd Schenk, University of Liechtenstein

N26's strategy illustrates some of the ways that information systems help businesses compete as well as the challenges of finding the right mixture of technology to establish a unique position in the market.

At each stage of the value chain, operational efficiency and customer intimacy can be improved by using information technology. Furthermore, value chain analysis points to opportunities for further development for N26. The bank should focus on operations to further improve services by focusing on customers' needs and improve sales and marketing by initiating customer referral campaigns. They should also take advantage of existing complementary technologies (such as wearables) that customers already own and are familiar with.

The chapter-opening diagram calls attention to important points raised by this case and chapter. N26's business model is based on using the latest technology to create new services and improve customer satisfaction. N26 is using information technology both to increase security and to create a completely virtual bank that does not have physical branches.

Here are some questions to think about: What are the components of N26's business strategy? How much does technology support that strategy?



3-1 Which features of organizations do managers need to know about to build and use information systems successfully?

Information systems and organizations influence one another. Information systems are built by managers to serve the interests of the business firm. At the same time, the organization must be aware of and open to the influences of information systems to benefit from new technologies.

The interaction between information technology and organizations is complex and is influenced by many mediating factors, including the organization's structure, business processes, politics, culture, surrounding environment, and management decisions (see Figure 3.1). You will need to understand how information systems can change social and work life in your firm. You will not be able to design new systems successfully or understand existing systems without understanding your own business organization.

As a manager, you will be the one to decide which systems will be built, what they will do, and how they will be implemented. You may not be able to anticipate all of the consequences of these decisions. Some of the changes that occur in business firms because of new information technology (IT) investments cannot be foreseen and have results that may or may not meet your expectations. Who would have imagined 15 years ago, for instance, that email and instant messaging would become a dominant form of business communication and that many managers would be inundated with more than 200 email messages each day?

What Is an Organization?

An **organization** is a stable, formal social structure that takes resources from the environment and processes them to produce outputs. This technical definition focuses on three elements of an organization. Capital and labor are primary production factors provided by the environment. The organization (the firm) transforms these inputs into products and services in a production function. The products and services are consumed by environments in return for supply inputs (see Figure 3.2).

FIGURE 3.1 THE TWO-WAY RELATIONSHIP BETWEEN ORGANIZATIONS AND INFORMATION TECHNOLOGY

This complex two-way relationship is mediated by many factors, not the least of which are the decisions made—or not made—by managers. Other factors mediating the relationship include the organizational culture, structure, politics, business processes, and environment.

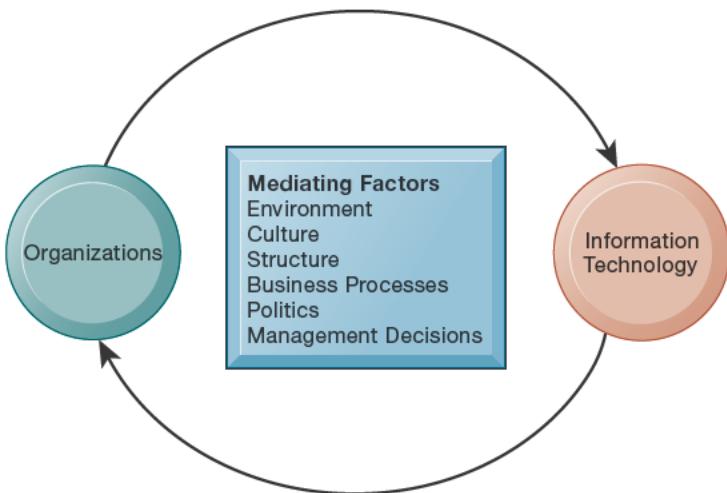
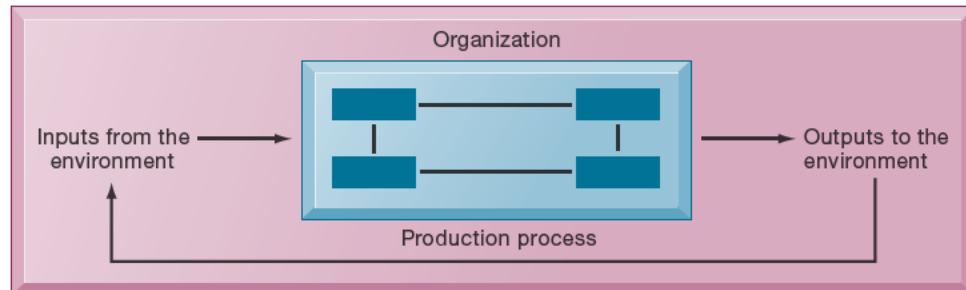


FIGURE 3.2 THE TECHNICAL MICROECONOMIC DEFINITION OF THE ORGANIZATION

In the microeconomic definition of organizations, capital and labor (the primary production factors provided by the environment) are transformed by the firm through the production process into products and services (outputs to the environment). The products and services are consumed by the environment, which supplies additional capital and labor as inputs in the feedback loop.

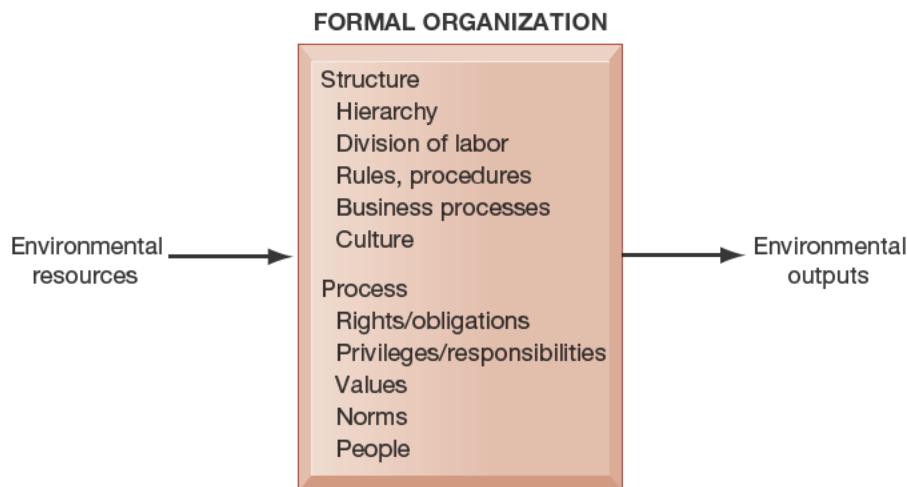


An organization is more stable than an informal group (such as a group of friends that meets every Friday for lunch) in terms of longevity and routine-ness. Organizations are formal legal entities with internal rules and procedures that must abide by laws. Organizations are also social structures because they are collections of social elements, much as a machine has a structure—a particular arrangement of valves, cams, shafts, and other parts.

This definition of organizations is powerful and simple, but it is not very descriptive or even predictive of real-world organizations. A more realistic behavioral definition of an organization is a collection of rights, privileges, obligations, and responsibilities delicately balanced over a period of time through conflict and conflict resolution (see Figure 3.3).

FIGURE 3.3 THE BEHAVIORAL VIEW OF ORGANIZATIONS

The behavioral view of organizations emphasizes group relationships, values, and structures.



In this behavioral view of the firm, people who work in organizations develop customary ways of working; they gain attachments to existing relationships; and they make arrangements with subordinates and superiors about how work will be done, the amount of work that will be done, and under what conditions work will be done. Most of these arrangements and feelings are not discussed in any formal rulebook.

How do these definitions of organizations relate to information systems technology? A technical view of organizations encourages us to focus on how inputs are combined to create outputs when technology changes are introduced into the company. The firm is seen as infinitely malleable, with capital and labor substituting for each other quite easily. But the more realistic behavioral definition of an organization suggests that building new information systems, or rebuilding old ones, involves much more than a technical rearrangement of machines or workers—that some information systems change the organizational balance of rights, privileges, obligations, responsibilities, and feelings that have been established over a long period of time.

Changing these elements can take a long time, be very disruptive, and requires more resources to support training and learning. For instance, the length of time required to implement a new information system effectively is much longer than usually anticipated simply because there is a lag between implementing a technical system and teaching employees and managers how to use the system.

Technological change requires changes in who owns and controls information, who has the right to access and update that information, and who makes decisions about whom, when, and how. This more complex view forces us to look at the way work is designed and the procedures used to achieve outputs.

The technical and behavioral definitions of organizations are not contradictory. Indeed, they complement each other: The technical definition tells us how thousands of firms in competitive markets combine capital, labor, and information technology, whereas the behavioral model takes us inside the individual firm to see how that technology affects the organization's inner workings. Section 3-2 describes how each of these definitions of organizations can help explain the relationships between information systems and organizations.

Features of Organizations

All modern organizations share certain characteristics. They are bureaucracies with clear-cut divisions of labor and specialization. Organizations arrange specialists in a hierarchy of authority in which everyone is accountable to someone and authority is limited to specific actions governed by abstract rules or procedures. These rules create a system of impartial and universal decision making. Organizations try to hire and promote employees on the basis of technical qualifications and professionalism (not personal connections). The organization is devoted to the principle of efficiency: maximizing output using limited inputs. Other features of organizations include their business processes, organizational culture, organizational politics, surrounding environments, structure, goals, constituencies, and leadership styles. All of these features affect the kinds of information systems used by organizations.

Routines and Business Processes

All organizations, including business firms, become very efficient over time because individuals in the firm develop **routines** for producing goods and services. Routines—sometimes called *standard operating procedures*—are precise rules, procedures, and practices that have been developed to cope with virtually all expected situations. As employees learn these routines, they become highly productive and efficient, and the firm is able to reduce its costs over time as efficiency increases. For instance, when you visit a doctor's office, receptionists have a well-developed set of routines for gathering basic information from you, nurses have a different set of routines for preparing you for an interview with a doctor, and the doctor has a well-developed set of routines for diagnosing you. *Business processes*, which we introduced in Chapters 1 and 2, are collections of such routines. A business firm, in turn, is a collection of business processes (Figure 3.4).

Organizational Politics

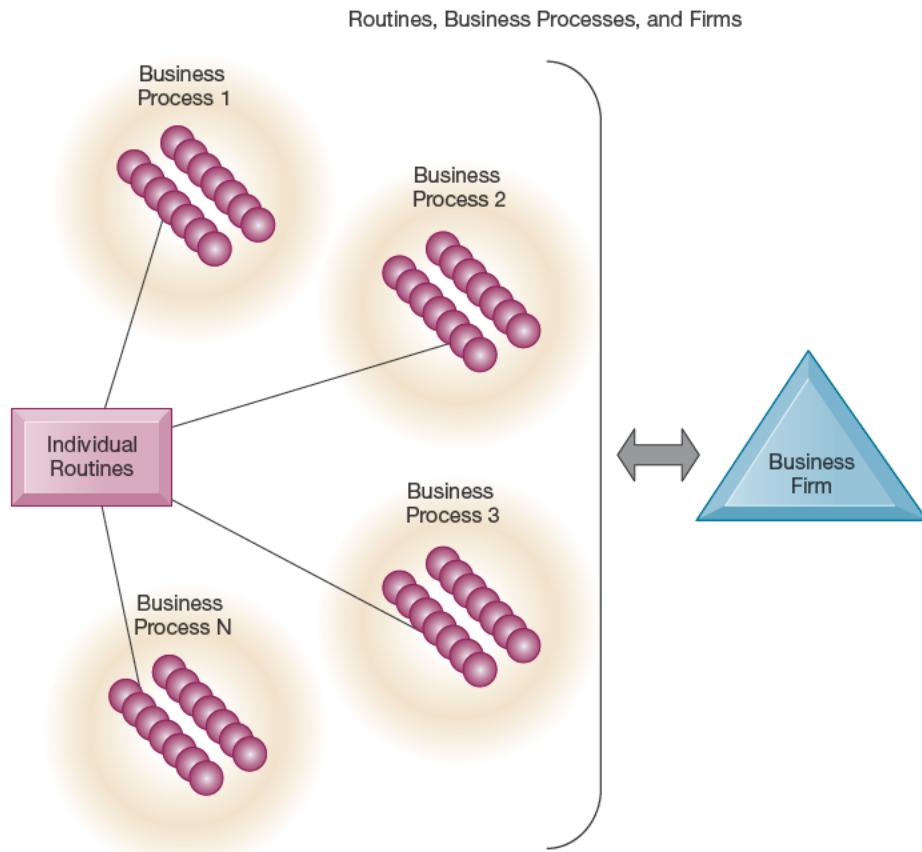
People in organizations occupy different positions with different specialties, concerns, and perspectives. As a result, they naturally have divergent viewpoints about how resources, rewards, and punishments should be distributed. These differences matter to both managers and employees, and they result in political struggles for resources, competition, and conflict within every organization. Political resistance is one of the great difficulties of bringing about organizational change—especially the development of new information systems. Virtually all large information systems investments by a firm that bring about significant changes in strategy, business objectives, business processes, and procedures become politically charged events. Managers who know how to work with the politics of an organization will be more successful than less-skilled managers in implementing new information systems.

Organizational Culture

All organizations have bedrock, unassailable, unquestioned (by the members) assumptions that define their goals and products. Organizational culture encompasses this set of assumptions about what products the organization should produce, how it should produce them, where, and for whom. Generally, these cultural assumptions are taken totally for granted and are rarely publicly announced or discussed. Business processes—the actual way business firms produce value—are usually ensconced in the organization's culture.

FIGURE 3.4 ROUTINES, BUSINESS PROCESSES, AND FIRMS

All organizations are composed of individual routines and behaviors, a collection of which make up a business process. A collection of business processes make up the business firm. New information system applications require that individual routines and business processes change to achieve high levels of organizational performance.



You can see organizational culture at work by looking around your university or college. Some bedrock assumptions of university life are that professors know more than students, the reason students attend college is to learn, and classes follow a regular schedule. Organizational culture is a powerful unifying force that restrains political conflict and promotes common understanding, agreement on procedures, and common practices. If we all share the same basic cultural assumptions, agreement on other matters is more likely.

At the same time, organizational culture is a powerful restraint on change, especially technological change. Most organizations will do almost anything to avoid making changes in basic assumptions. Any technological change that threatens commonly held cultural assumptions usually meets a great deal of resistance. However, there are times when the only sensible way for a firm to move forward is to employ a new technology that directly opposes an existing organizational culture. When this occurs, the technology is often stalled while the culture slowly adjusts.

Organizational Environments

Organizations reside in environments from which they draw resources and to which they supply goods and services. Organizations and environments have a reciprocal relationship. On the one hand, organizations are open to

and dependent on the social and physical environment that surrounds them. Without financial and human resources—people willing to work reliably and consistently for a set wage or revenue from customers—organizations could not exist. Organizations must respond to legislative and other requirements imposed by government as well as the actions of customers and competitors. On the other hand, organizations can influence their environments. For example, business firms form alliances with other businesses to influence the political process; they advertise to influence customer acceptance of their products.

Figure 3.5 illustrates the role of information systems in helping organizations perceive changes in their environments and also in helping organizations act on their environments. Information systems are key instruments for *environmental scanning*, helping managers identify external changes that might require an organizational response.

Environments generally change much faster than organizations. New technologies, new products, and changing public tastes and values (many of which result in new government regulations) put strains on any organization's culture, politics, and people. Most organizations are unable to adapt to a rapidly changing environment. Inertia built into an organization's standard operating procedures, the political conflict raised by changes to the existing order, and the threat to closely held cultural values inhibit organizations from making significant changes. Young firms typically lack resources to sustain even short periods of troubled times. It is not surprising that only 10 percent of the *Fortune* 500 companies in 1919 still exist today.

Disruptive Technologies: Riding the Wave Sometimes a technology and resulting business innovation come along to radically change the business landscape and environment. These innovations are loosely called “disruptive” (Christensen, 2003; Christensen, Raynor, and McDonald, 2015). What makes a technology disruptive? In some cases, **disruptive technologies** are substitute products that

FIGURE 3.5 ENVIRONMENTS AND ORGANIZATIONS HAVE A RECIPROCAL RELATIONSHIP

Environments shape what organizations can do, but organizations can influence their environments and decide to change environments altogether. Information technology plays a critical role in helping organizations perceive environmental change and in helping organizations act on their environment.

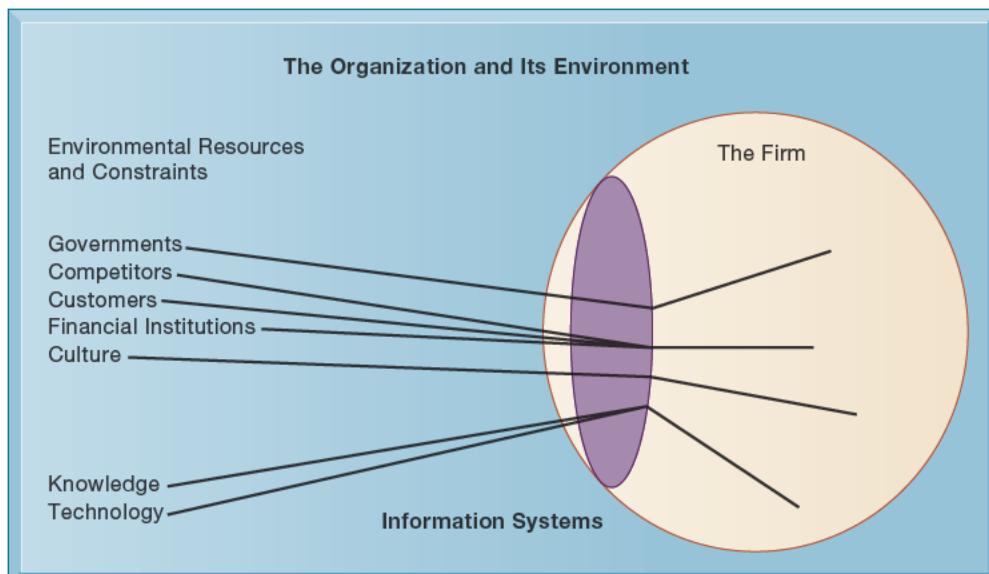


TABLE 3.1 DISRUPTIVE TECHNOLOGIES: WINNERS AND LOSERS

TECHNOLOGY	DESCRIPTION	WINNERS AND LOSERS
Microprocessor chips (1971)	Thousands and eventually millions of transistors on a silicon chip	Microprocessor firms win (Intel, Texas Instruments), while transistor firms (GE) decline.
Personal computers (1975)	Small, inexpensive, but fully functional desktop computers	PC manufacturers (HP, Apple, IBM) and chip manufacturers prosper (Intel), while mainframe (IBM) and minicomputer (DEC) firms lose.
World Wide Web (1989)	A global database of digital files and "pages" instantly available	Owners of online content and news benefit, while traditional publishers (newspapers, magazines, and broadcast television) lose.
Internet music, video, TV services (1998)	Repositories of downloadable music, video, and TV broadcasts on the web	Owners of Internet platforms, telecommunications providers owning Internet backbone (ATT, Verizon), and local Internet service providers win, while content owners and physical retailers (Tower Records, Blockbuster) lose.
Software as web service	Using the Internet to provide remote access to online software	Online software services companies (Salesforce.com) win, while traditional "boxed" software companies (Microsoft, SAP, Oracle) lose.

perform as well as or better (often much better) than anything currently produced. The car substituted for the horse-drawn carriage, the word processor for typewriters, streaming music services for portable CD players, and digital photography for process film photography. Table 3.1 describes just a few disruptive technologies from the past.

In these cases, entire industries were put out of business. In other cases, disruptive technologies simply extend the market, usually with less functionality and much less cost than existing products. Eventually they turn into low-cost competitors for whatever was sold before. Disk drives are an example: Small hard disk drives used in PCs extended the market for disk drives by offering cheap digital storage for small files.

Some firms are able to create these technologies and ride the wave to profits; others learn quickly and adapt their business; still others are obliterated because their products, services, and business models become obsolete. They may be very efficient at doing what no longer needs to be done! There are also cases where no firms benefit and all the gains go to consumers (firms fail to capture any profits). Moreover, not all change or technology is disruptive (King and Baatartogtokh, 2015). Managers of older businesses often do make the right decisions and find ways to continue competing. Disruptive technologies are tricky. Firms that invent disruptive technologies as "first movers" do not always benefit if they lack the resources to exploit the technology or fail to see the opportunity. The MITS Altair 8800 is widely regarded as the first PC, but its inventors did not take advantage of their first mover status. Second movers, so-called fast followers, such as IBM and Microsoft, reaped the rewards. Barclays' ATMs revolutionized retail banking, but they were copied by other banks. Now all banks use ATMs, with the benefits going mostly to the consumers.

Organizational Structure

All organizations have a structure or shape. Mintzberg's classification, described in Table 3.2, identifies five basic kinds of organizational structure (Mintzberg, 1971).

The kind of information systems you find in a business firm—and the nature of problems with these systems—often reflects the type of organizational structure. For instance, in a professional bureaucracy such as a hospital, it is not unusual to find parallel patient record systems operated by the administration, another by doctors, and another by other professional staff such as nurses

TABLE 3.2 ORGANIZATIONAL STRUCTURES

ORGANIZATIONAL TYPE	DESCRIPTION	EXAMPLES
Entrepreneurial structure	Young, small firm in a fast-changing environment. It has a simple structure and is managed by an entrepreneur serving as its single chief executive officer.	Small start-up business
Machine bureaucracy	Large bureaucracy existing in a slowly changing environment, producing standard products. It is dominated by a centralized management team and centralized decision making.	Midsize manufacturing firm
Divisionalized bureaucracy	Combination of multiple machine bureaucracies, each producing a different product or service, all topped by one central headquarters.	Fortune 500 firms, such as General Motors
Professional bureaucracy	Knowledge-based organization where goods and services depend on the expertise and knowledge of professionals. Dominated by department heads with weak centralized authority.	Law firms, school systems, hospitals
Adhocracy	Task force organization that must respond to rapidly changing environments. Consists of large groups of specialists organized into short-lived multidisciplinary teams and has weak central management.	Consulting firms, such as the Rand Corporation

and social workers. In small entrepreneurial firms, you will often find poorly designed systems developed in a rush that quickly outgrow their usefulness. In huge multidivisional firms operating in hundreds of locations, you will frequently find there is not a single integrating information system, but instead each locale or each division has its own set of information systems.

Other Organizational Features

Organizations have goals and use different means to achieve them. Some organizations have coercive goals (e.g., prisons); others have utilitarian goals (e.g., businesses). Still others have normative goals (universities, religious groups). Organizations also serve different groups or have different constituencies, some primarily benefiting their members, others benefiting clients, stockholders, or the public. The nature of leadership differs greatly from one organization to another—some organizations may be more democratic or authoritarian than others. Another way organizations differ is by the tasks they perform and the technology they use. Some organizations perform primarily routine tasks that can be reduced to formal rules that require little judgment (such as manufacturing auto parts), whereas others (such as consulting firms) work primarily with nonroutine tasks.

3-2 What is the impact of information systems on organizations?

Information systems have become integral, online, interactive tools deeply involved in the minute-to-minute operations and decision making of large organizations. Over the past decade, information systems have fundamentally altered the economics of organizations and greatly increased the possibilities for organizing work. Theories and concepts from economics and sociology help us understand the changes brought about by IT.

Economic Impacts

From the point of view of economics, IT changes both the relative costs of capital and the costs of information. Information systems technology can be viewed as a factor of production that can be substituted for traditional capital

and labor. As the cost of information technology decreases, it is substituted for labor, which historically has been a rising cost. Hence, information technology should result in a decline in the number of middle managers and clerical workers as information technology substitutes for their labor.

As the cost of information technology decreases, it also substitutes for other forms of capital such as buildings and machinery, which remain relatively expensive. Hence, over time we should expect managers to increase their investments in IT because of its declining cost relative to other capital investments.

IT also affects the cost and quality of information and changes the economics of information. Information technology helps firms contract in size because it can reduce transaction costs—the costs incurred when a firm buys on the marketplace what it cannot make itself. According to **transaction cost theory**, firms and individuals seek to economize on transaction costs, much as they do on production costs. Using markets is expensive because of costs such as locating and communicating with distant suppliers, monitoring contract compliance, buying insurance, obtaining information on products, and so forth (Coase, 1937; Williamson, 1985). Traditionally, firms have tried to reduce transaction costs through vertical integration, by getting bigger, hiring more employees, and buying their own suppliers and distributors, as both General Motors and Ford used to do.

Information technology, especially the use of networks, can help firms lower the cost of market participation (transaction costs), making it worthwhile for firms to contract with external suppliers instead of using internal sources. As a result, firms can shrink in size (numbers of employees) because it is far less expensive to outsource work to a competitive marketplace rather than hire employees.

For instance, by using computer links to external suppliers, automakers such as Ford, Toyota, and Honda can achieve economies by obtaining more than 70 percent of their parts from the outside. Information systems make it possible for companies such as Apple to outsource assembly of iPhones to contract manufacturers such as Foxconn instead of making their products themselves.

As transaction costs decrease, firm size (the number of employees) should shrink because it becomes easier and cheaper for the firm to contract for the purchase of goods and services in the marketplace rather than to make the product or offer the service itself. Firm size can stay constant or contract even as the company increases its revenues. For example, when Eastman Chemical Company split off from Kodak in 1994, it had \$3.3 billion in revenue and 24,000 full-time employees. In 2019, it generated \$9.3 billion in revenue with only 14,500 employees.

Information technology also can reduce internal management costs. According to **agency theory**, the firm is viewed as a “nexus of contracts” among self-interested individuals rather than as a unified, profit-maximizing entity (Jensen and Meckling, 1976). A principal (owner) employs “agents” (employees) to perform work on his or her behalf. However, agents need constant supervision and management; otherwise, they will tend to pursue their own interests rather than those of the owners. As firms grow in size and scope, agency costs or coordination costs rise because owners must expend more and more effort supervising and managing employees.

Information technology, by reducing the costs of acquiring and analyzing information, permits organizations to reduce agency costs because it becomes easier for managers to oversee a greater number of employees. By reducing overall management costs, information technology enables firms to increase revenues while shrinking the number of middle managers and clerical workers. We have seen examples in earlier chapters where information technology expanded the power and scope of small organizations by enabling them to perform coordinated activities such as processing orders or keeping track of inventory with very few clerks and managers.

Because IT reduces both agency and transaction costs for firms, we should expect firm size to shrink over time as more capital is invested in IT. Firms should have fewer managers, and we expect to see revenue per employee increase over time.

Organizational and Behavioral Impacts

Theories based in the sociology of complex organizations also provide some understanding about how and why firms change with the implementation of new IT applications.

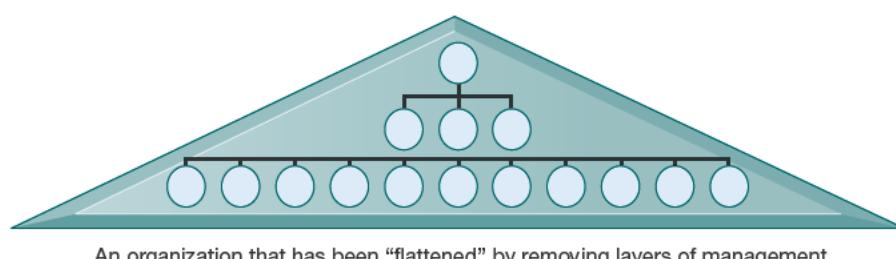
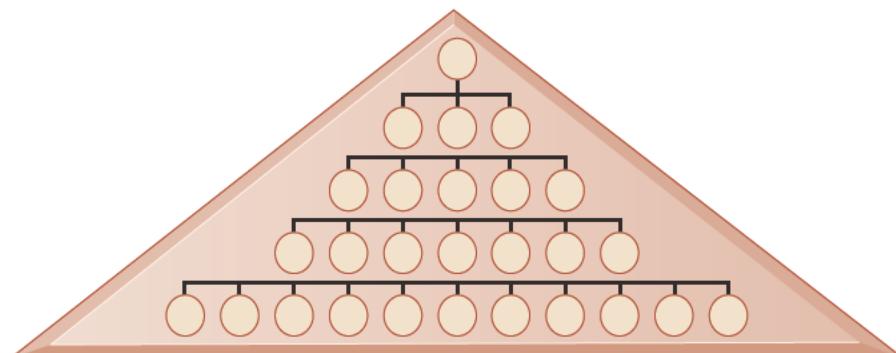
IT Flattens Organizations

Large, bureaucratic organizations, which primarily developed before the computer age, are often inefficient, slow to change, and less competitive than newly created organizations. Some of these large organizations have downsized, reducing the number of employees and the number of levels in their organizational hierarchies.

Behavioral researchers have theorized that information technology facilitates flattening of hierarchies by broadening the distribution of information to empower lower-level employees and increase management efficiency (see Figure 3.6). IT pushes decision-making rights lower in the organization because lower-level employees receive the information they need to make decisions without supervision. (This empowerment is also possible because of higher educational levels among the workforce, which give employees more capabilities to make intelligent decisions.) Because managers now receive so much more accurate information on time, they become much faster at making decisions, so fewer managers are required. Management costs decline as a percentage of revenues, and the hierarchy becomes much more efficient.

FIGURE 3.6 FLATTENING ORGANIZATIONS

Information systems can reduce the number of levels in an organization by providing managers with information to supervise larger numbers of workers and by giving lower-level employees more decision-making authority.



These changes mean that the management span of control has also been broadened, enabling high-level managers to manage and control more workers spread over greater distances. Many companies have eliminated thousands of middle managers as a result of these changes.

Postindustrial Organizations

Postindustrial theories based more on history and sociology than economics also support the notion that IT should flatten hierarchies. In postindustrial societies, authority increasingly relies on knowledge and competence and not merely on formal positions. Hence, the shape of organizations flattens because professional workers tend to be self-managing, and decision making should become more decentralized as knowledge and information become more widespread throughout the firm.

Information technology may encourage task force–networked organizations in which groups of professionals come together—face-to-face or electronically—for short periods of time to accomplish a specific task (e.g., designing a new automobile); once the task is accomplished, the individuals join other task forces. The global consulting service Accenture is an example. Many of its 492,000 employees move from location to location to work on projects at client locations in more than 50 different countries.

Who makes sure that self-managed teams do not head off in the wrong direction? Who decides which person works on which team and for how long? How can managers evaluate the performance of someone who is constantly rotating from team to team? How do people know where their careers are headed? New approaches for evaluating, organizing, and informing workers are required, and not all companies can make virtual work effective.

Understanding Organizational Resistance to Change

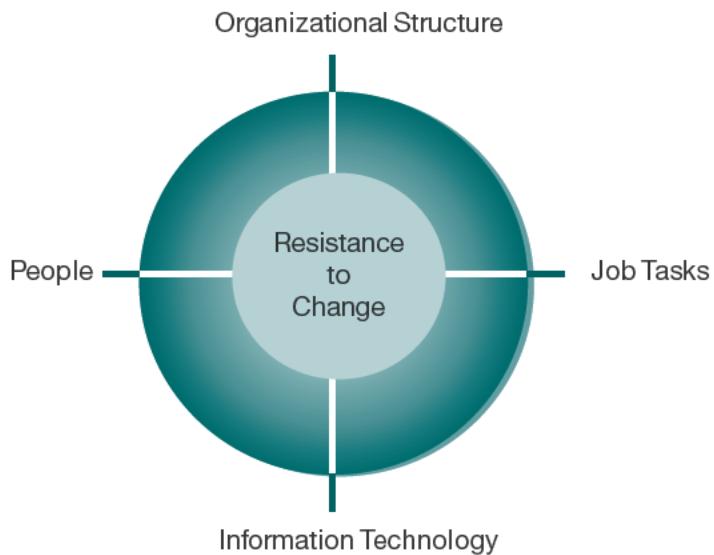
Information systems inevitably become bound up in organizational politics because they influence access to a key resource—namely, information. Information systems can affect who does what to whom, when, where, and how in an organization. Many new information systems require changes in personal, individual routines that can be painful for those involved and require retraining and additional effort that may or may not be compensated. Because information systems potentially change an organization's structure, culture, business processes, and strategy, there is often considerable resistance to them when they are introduced.

There are several ways to visualize organizational resistance. Research on organizational resistance to innovation suggests that four factors are paramount: the nature of the IT innovation, the organization's structure, the culture of people in the organization, and the tasks affected by the innovation (see Figure 3.7). Here, changes in technology are absorbed, interpreted, deflected, and defeated by organizational task arrangements, structures, and people. In this model, the only way to bring about change is to change the technology, tasks, structure, and people simultaneously. Other authors have spoken about the need to “unfreeze” organizations before introducing an innovation, quickly implementing it, and “refreezing” or institutionalizing the change (Kolb and Frohman, 1970).

Because organizational resistance to change is so powerful, many information technology investments flounder and do not increase productivity. Indeed, research on project implementation failures demonstrates that the most common reason for failure of large projects to reach their objectives is not the failure of the technology but organizational and political resistance to change. Chapter 14 treats this issue in detail. Therefore, as a manager involved in future IT investments, your ability to work with people and organizations is just as important as your technical awareness and knowledge.

FIGURE 3.7 ORGANIZATIONAL RESISTANCE TO INFORMATION SYSTEM INNOVATIONS

Implementing information systems has consequences for task arrangements, structures, and people. According to this model, to implement change, all four components must be changed simultaneously.



The Internet and Organizations

The Internet, especially the World Wide Web, has an important impact on the relationships between many firms and external entities and even on the organization of business processes inside a firm. The Internet increases the accessibility, storage, and distribution of information and knowledge for organizations. In essence, the Internet is capable of dramatically lowering the transaction and agency costs facing most organizations. For instance, a global sales force can receive nearly instant product price information updates using the web or instructions from management sent by email or text messaging on smartphones or mobile laptops. Vendors of some large retailers can access retailers' internal websites directly to find up-to-the-minute sales information and to initiate replenishment orders instantly.

Businesses are rapidly rebuilding some of their key business processes based on Internet technology and making this technology a key component of their IT infrastructures. If prior networking is any guide, one result will be simpler business processes, fewer employees, and flatter organizations than in the past.

Implications for the Design and Understanding of Information Systems

To deliver genuine benefits, information systems must be built with a clear understanding of the organization in which they will be used. In our experience, the central organizational factors to consider when planning a new system are the following:

- The environment in which the organization must function
- The structure of the organization: hierarchy, specialization, routines, and business processes
- The organization's culture and politics
- The type of organization and its style of leadership

- The principal interest groups affected by the system and the attitudes of workers who will be using the system
- The kinds of tasks, decisions, and business processes that the information system is designed to assist

3-3 How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network economics help companies develop competitive strategies using information systems?

In almost every industry you examine, you will find that some firms do better than most others. There's almost always a standout firm. In the automotive industry, Toyota is considered a superior performer. In pure online retail, Amazon is the leader; in off-line retail, Walmart, the largest retailer on earth, is the leader. In web search, Google is considered the leader.

Firms that "do better" than others are said to have a competitive advantage over others: They either have access to special resources that others do not, or they are able to use commonly available resources more efficiently—usually because of superior knowledge and information assets. In any event, they do better in terms of revenue growth, profitability, or productivity growth (efficiency), all of which ultimately in the long run translate into higher stock market valuations than their competitors.

But why do some firms do better than others, and how do they achieve competitive advantage? How can you analyze a business and identify its strategic advantages? How can you develop a strategic advantage for your own business? And how do information systems contribute to strategic advantages? One answer to that question is Michael Porter's competitive forces model.

Porter's Competitive Forces Model

Arguably, the most widely used model for understanding competitive advantage is Michael Porter's **competitive forces model** (see Figure 3.8). This model provides a general view of the firm, its competitors, and the firm's environment. Earlier in this chapter, we described the importance of a firm's environment and the dependence of firms on environments. Porter's model is all about the firm's general business environment. In this model, five competitive forces shape the fate of the firm.

Traditional Competitors

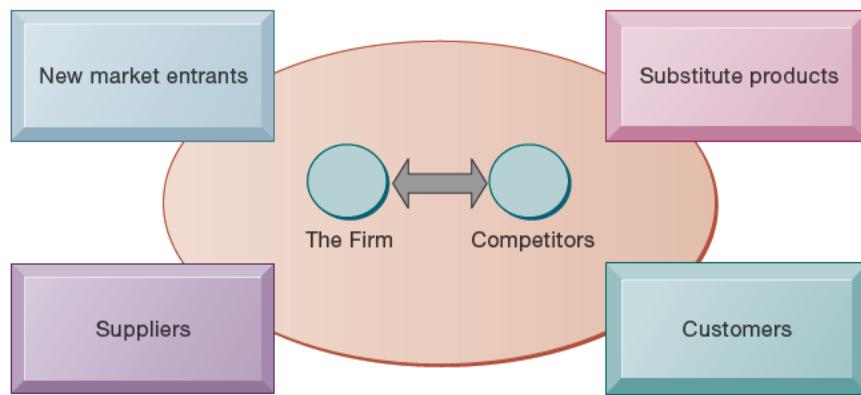
All firms share market space with other competitors who are continuously devising new, more-efficient ways to produce by introducing new products and services, and attempting to attract customers by developing their brands and imposing switching costs on their customers.

New Market Entrants

In a free economy with mobile labor and financial resources, new companies are always entering the marketplace. In some industries, there are very low barriers to entry, whereas in other industries, entry is very difficult. For instance, it is fairly easy to start a pizza business or just about any small retail business, but it is much more expensive and difficult to enter the computer chip business, which has very high capital costs and requires significant expertise and knowledge that are hard to obtain. New companies have several possible

FIGURE 3.8 PORTER'S COMPETITIVE FORCES MODEL

In Porter's competitive forces model, the strategic position of the firm and its strategies are determined not only by competition with its traditional direct competitors but also by four other forces in the industry's environment: new market entrants, substitute products, customers, and suppliers.



advantages: They are not locked into old plants and equipment, they often hire younger workers who are less expensive and perhaps more innovative, they are not encumbered by old worn-out brand names, and they are “more hungry” (more highly motivated) than traditional occupants of an industry. These advantages are also their weaknesses: They depend on outside financing for new plants and equipment, which can be expensive; they have a less-experienced workforce; and they have little brand recognition.

Substitute Products and Services

In just about every industry, there are substitutes that your customers might use if your prices become too high. New technologies create new substitutes all the time. Ethanol can substitute for gasoline in cars; vegetable oil for diesel fuel in trucks; and wind, solar, and hydro power for industrial electricity generation. Likewise, Internet and wireless telephone service can substitute for traditional telephone service. And, of course, an Internet music service that allows you to stream music tracks to an iPad or smartphone has become a substitute for CD-based music stores. The more substitute products and services in your industry, the less you can control pricing and the lower your profit margins.

Customers

A profitable company depends in large measure on its ability to attract and retain customers (while denying them to competitors) and charge high prices. The power of customers grows if they can easily switch to a competitor's products and services or if they can force a business and its competitors to compete on price alone in a transparent marketplace where there is little **product differentiation** and all prices are known instantly (such as on the Internet). For instance, in the used college textbook market on the Internet, students (customers) can find multiple suppliers of just about any current college textbook. In this case, online customers have extraordinary power over used-book firms.

Suppliers

The market power of suppliers can have a significant impact on firm profits, especially when the firm cannot raise prices as fast as can suppliers. The more different suppliers a firm has, the greater control it can exercise over suppliers



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Supermarkets and large retail stores such as Walmart use sales data captured at the checkout counter to determine which items have sold and need to be reordered. Walmart's continuous replenishment system transmits orders to restock directly to its suppliers. The system enables Walmart to keep costs low while fine-tuning its merchandise to meet customer demands.

in terms of price, quality, and delivery schedules. For instance, manufacturers of laptop PCs almost always have multiple competing suppliers of key components, such as keyboards, hard drives, and display screens.

Information System Strategies for Dealing with Competitive Forces

What is a firm to do when it is faced with all these competitive forces? And how can the firm use information systems to counteract some of these forces? How do you prevent substitutes and inhibit new market entrants? There are four generic strategies, each of which often is enabled by using information technology and systems: low-cost leadership, product differentiation, focus on market niche, and strengthening customer and supplier intimacy.

Low-Cost Leadership

Use information systems to achieve the lowest operational costs and the lowest prices. The classic example is Walmart. By keeping prices low and shelves well stocked using a legendary inventory replenishment system, Walmart became the leading retail business in the United States. Walmart's continuous replenishment system sends orders for new merchandise directly to suppliers as soon as consumers pay for their purchases at the cash register. Point-of-sale terminals record the bar code of each item passing the checkout counter and send a purchase transaction directly to a central computer at Walmart headquarters. The computer collects the orders from all Walmart stores and transmits them to suppliers. Suppliers can also access Walmart's sales and inventory data using web technology.

Because the system replenishes inventory with lightning speed, Walmart does not need to spend much money on maintaining large inventories of goods in its own warehouses. The system also enables Walmart to adjust purchases of store items to meet customer demands. Competitors, such as Sears, have been spending 24.9 percent of sales on overhead. But by using systems to keep operating costs low, Walmart pays only 16.6 percent of sales revenue for overhead. (Operating costs average 20.7 percent of sales in the retail industry.)

Walmart's continuous replenishment system is also an example of an **efficient customer response system**. An efficient customer response system directly links consumer behavior to distribution and production and supply chains. Walmart's continuous replenishment system provides such an efficient customer response.

INTERACTIVE SESSION ORGANIZATIONS

Shipping Wars

Shipping and delivery have been vital to the success of e-commerce, both for retailers and for the shipping companies themselves. FedEx, UPS, and the United States Postal Service (USPS) have earned many billions of dollars handling the massive amount of products ordered from Amazon and other e-commerce sites. Convenient and seamless online ordering and shipping processes, along with free or low-cost delivery or two-day delivery, are a source of competitive advantage for online merchants over traditional brick-and-mortar retailers.

Especially important in logistics is the “last mile,” which refers to the last step in a delivery that takes the package to the customer’s doorstep. Instead of using the USPS, FedEx, or UPS for the last mile, Amazon is building a fleet of delivery vans and expanding its fleet of Boeing 737 and 767 airplanes for this purpose. Amazon Air is a cargo airline operating exclusively to transport Amazon packages. By 2021, Amazon Air will have at least 70 cargo aircraft operating out of over 20 air gateways in the United States. Amazon additionally expanded its airport hub operations, building a \$1.5 billion hub at Cincinnati/Northern Kentucky International Airport. Amazon also has operations at Fort Worth Alliance Airport and Chicago Rockford International Airport.

Amazon taking over the “last mile” will drain billions of dollars of business away from the US Post Office (which handles 62 percent of Amazon’s packages), UPS (handling 21 percent), and FedEx (handling 8 percent). Amazon is not trying to replace these shippers but does want to gain some control over logistics in order to guarantee that Amazon Prime members get their two-day shipping on time and that it has capability to handle very large sales volumes during the holidays or bad weather periods. Amazon will also save on costs. According to Morgan Stanley, Amazon saves \$2 to \$4 per package, amounting to \$2 billion annually, when it uses its own fleet. Additionally, having total control over the entire shipping process makes it possible for Amazon to provide a better customer experience. It is easier to track lost packages and respond immediately to customer inquiries if Amazon does not have to work through another shipper. Amazon’s shipping policies have been a principal driver of its rapid retail growth.

When Amazon announced one-day shipping for Prime members in April 2019, FedEx canceled its express delivery contract with Amazon, redefining its business strategy. Management believes FedEx doesn’t really need Amazon to flourish, since Amazon accounted for less than 1.3 percent of FedEx’s \$70 billion in consolidated annual revenues and had been one of FedEx’s least profitable customers on a margin basis. Management also believed that working with Amazon was cannibalizing FedEx’s own business. The direction FedEx has chosen calls for focusing on its ground delivery service and establishing new partnerships with other retailers and brands to serve the broader e-commerce market.

For example, in June 2019 FedEx and Dollar General announced a strategic alliance to offer new, convenient access to FedEx drop-off and pickup services at thousands of Dollar General stores. The effort is designed to increase access to FedEx for all customers, particularly those living in rural communities where Dollar General has a large footprint. FedEx and Dollar General began rolling out the service in more than 1,500 Dollar General stores in late summer 2019, and will be in more than 8,000 stores by the end of 2020. The Dollar General alliance will expand the FedEx Retail Convenience Network to more than 62,000 retail locations. That move will put more than 90 percent of Americans within 5 miles of a FedEx hold retail location. Customers will be able to drop off prepackaged and prelabeled FedEx Express or FedEx Ground shipments at Dollar General stores and pick up packages sent to their neighborhood Dollar General stores.

FedEx thinks it can overtake Amazon and become the fastest, most cost-efficient e-commerce delivery service. In December 2018 FedEx announced its Extra Hours’ Delivery Options for Retail Customers, which will provide next-day and overnight shipping to e-commerce customers. FedEx is also initiating package delivery seven days a week to further compete with Amazon.

How does United Parcel Service (UPS) stack up in this competitive arena? Unlike FedEx, UPS is deepening its ties to Amazon. It wants to stay neutral, whereas FedEx has broken away from Amazon in favor of courting the brick-and-mortar retailers. UPS is

also relying more on the U.S. Postal Service, especially for Sunday deliveries. FedEx is now delivering on its own about 2 million packages per day that it had formerly handed to the U.S. Postal Service for last-mile delivery. By handling an increased volume of packages on its own, FedEx believes it can make better use of its more than 600 sorting and delivery facilities around the United States to help retailers with shipments from stores to residences. However, analysts such as Morgan Stanley's Ravi Shanker are not sure

that increasing the volume of short-haul deliveries will generate the kind of returns FedEx is seeking.

Which company will win the retail shipping wars? The outcome could determine the future direction of the entire e-commerce retail industry.

Sources: Bloomberg, "FedEx Has a Plan to Battle Amazon Shipping, CEO Says," January 30, 2020; Greg Petro, "Amazon Versus FedEx: The Retail Shipping Wars," *Forbes*, June 28, 2019; and Shep Hyken, "Look Out FedEx and UPS—Is Amazon Going to Disrupt the Shipping Industry? *Forbes*, January 17, 2019.

CASE STUDY QUESTIONS

1. Why is shipping so important for e-commerce? Explain your answer.
2. Compare the shipping strategies of Amazon, FedEx, and UPS? How are they related to each company's business model?
3. Will FedEx succeed in its push into ground shipping? Why or why not?

The Interactive Session on Organizations provides another example of low-cost leadership strategy—the struggle among the major shipping companies such as FedEx, UPS, and now Amazon, for dominance of the e-commerce package shipping and delivery business.

Product Differentiation

Use information systems to enable new products and services or greatly change the customer convenience in using your existing products and services (see Table 3.3). Big Tech firms like Google, Facebook, Amazon, Apple, and others are pouring billions of dollars into research and deployment of new services, and enhancements to their most valuable services and products in order to differentiate them from potential competitors. For instance, Google has updated its Google Assistant to enable more natural continuous conversations and smart displays that can display the output of Assistant to screens. Google added Assistant support to its core Google Maps service to make interaction with Maps more natural, and released a Machine Language Kit for developers that supports text recognition, face detection, image labeling, and landmark recognition. The continual stream of innovations flowing from Big Tech companies ensures their products are unique and difficult to copy.

Manufacturers and retailers are using information systems to create products and services that are customized and personalized to fit the precise specifications of individual customers. For example, Nike sells customized sneakers through its NIKE BY YOU program on its website. Customers are able to select the type of shoe, colors, material, and personalized text. Nike transmits the orders via computers to specially equipped plants in China and Korea. The sneakers take about three weeks to reach the customer. This ability to offer individually tailored products or services using the same production resources as mass production is called **mass customization**.

More and more companies are differentiating their products not just by the features of the products themselves but also by the entire experience of

TABLE 3.3 IT-ENABLED NEW PRODUCTS AND SERVICES PROVIDING COMPETITIVE ADVANTAGE

Amazon: One-click shopping	Amazon holds a patent on one-click shopping that it licenses to other online retailers.
Online music: Apple iTunes	Apple sells music from an online library of more than 50 million songs.
Golf club customization: Ping	Customers can have clubs custom-fit and built to their individual specifications.
Online person-to-person payment: PayPal	PayPal enables the transfer of money between individual bank accounts and between bank accounts and credit card accounts.

buying and using the product. This is called the “customer experience,” and **customer experience management** (management of interactions with customers throughout the entire business relationship) has become an important competitive strategy.

Focus on Market Niche

Use information systems to enable a specific market focus and serve this narrow target market better than competitors. Information systems support this strategy by producing and analyzing data for finely tuned sales and marketing techniques. Information systems enable companies to analyze customer buying patterns, tastes, and preferences closely so that they efficiently pitch advertising and marketing campaigns to smaller and smaller target markets.

The data come from a range of sources—credit card transactions, demographic data, purchase data from checkout counter scanners at supermarkets and retail stores, and data collected when people access and interact with websites. Sophisticated software tools find patterns in these large pools of data and infer rules from them to guide decision making. Analysis of such data drives one-to-one marketing that creates personal messages based on individualized preferences. For example, Hilton Hotels' OnQ system analyzes detailed data collected on active guests in all of its properties to determine the preferences of each guest and each guest's profitability. Hilton uses this information to give its most profitable customers additional privileges, such as late checkouts. Contemporary customer relationship management (CRM) systems feature analytical capabilities for this type of intensive data analysis (see Chapters 2 and 9).

Credit card companies are able to use this strategy to predict their most profitable cardholders. The companies gather vast quantities of data about consumer purchases and other behaviors and mine these data to construct detailed profiles that identify cardholders who might be good or bad credit risks. We discuss the tools and technologies for data analysis in Chapters 6 and 12.

Strengthen Customer and Supplier Intimacy

Use information systems to tighten linkages with suppliers and develop intimacy with customers. Toyota, Ford, and other automobile manufacturers use information systems to facilitate direct access by suppliers to production schedules and even permit suppliers to decide how and when to ship supplies to their factories. This allows suppliers more lead time in producing goods. On the customer side, Amazon keeps track of user preferences for book purchases and can recommend titles purchased by others to its customers. Strong linkages to customers and suppliers increase **switching costs** (the cost of switching from one product to a competing product) and loyalty to your firm.

Table 3.4 summarizes the competitive strategies we have just described. Some companies focus on one of these strategies, but you will often see companies pursuing several of them simultaneously. For example, Walmart has traditionally pursued a low-cost leadership strategy, but it also offers unique new services through its supercenters and more targeted marketing.

The Internet's Impact on Competitive Advantage

Because of the Internet, the traditional competitive forces are still at work, but competitive rivalry has become much more intense (Porter, 2001). Internet technology is based on universal standards that any company can use, making it easy for rivals to compete on price alone and for new competitors to enter the market. Because information is available to everyone, the Internet raises the bargaining power of customers, who can quickly find the lowest-cost provider on the web. Profits have been damped. Table 3.5 summarizes some of the potentially negative impacts of the Internet on business firms identified by Porter.

The Internet has nearly destroyed some industries and has severely threatened more. For instance, the printed encyclopedia industry and the travel agency industry have been nearly decimated by the availability of substitutes over the Internet. Likewise, the Internet has had a significant impact on the retail, music, book, retail brokerage, software, telecommunications, and newspaper industries.

However, the Internet has also created entirely new markets; formed the basis for thousands of new products, services, and business models; and provided new opportunities for building brands with very large and loyal customer bases. Amazon, eBay, YouTube, Facebook, Travelocity, and Google are examples. In this sense, the Internet is “transforming” entire industries, forcing firms to change how they do business.

Smart Products and the Internet of Things

The growing use of sensors in industrial and consumer products, often called the Internet of Things (IoT), is an excellent example of how the Internet is changing competition within industries and creating new products and services. Under Armour and other sports and fitness companies are pouring money into wearable health trackers and fitness equipment that use sensors to report users' activities to remote corporate computing centers where the data can be analyzed. Farm tractors from John Deere, Kubota, and Mahindra are loaded with field radar, GPS transceivers, and hundreds of sensors keeping track of the equipment. GE is creating a new business helping its aircraft and wind turbine clients improve operations by examining the data generated from the many thousands of sensors in the equipment. The result is what are referred to as “smart products”—products that are a part of a larger set of information-intensive services sold by firms (Gandhi and Gervet, 2016; Porter and Heppelmann, 2014; Iansiti and Lakhani, 2014).

Smart products offer new functionality, greater reliability, and more intense use of products while providing detailed information that can be used to improve both the products and the customer experience. They expand

TABLE 3.4 FOUR BASIC COMPETITIVE STRATEGIES

STRATEGY	DESCRIPTION	EXAMPLE
Low-cost leadership	Use information systems to produce products and services at a lower price than competitors while enhancing quality and level of service	Walmart
Product differentiation	Use information systems to differentiate products, and enable new services and products	Uber, Nike, Apple
Focus on market niche	Use information systems to enable a focused strategy on a single market niche; specialize	Hilton Hotels
Customer and supplier intimacy	Use information systems to develop strong ties and loyalty with customers and suppliers	Toyota Corporation, Amazon

TABLE 3.5 IMPACT OF THE INTERNET ON COMPETITIVE FORCES AND INDUSTRY STRUCTURE

COMPETITIVE FORCE	IMPACT OF THE INTERNET
Substitute products or services	Enables substitutes to emerge with new approaches to meeting needs and performing functions
Customers' bargaining power	Availability of global price and product information shifts bargaining power to customers
Suppliers' bargaining power	Procurement over the Internet tends to raise bargaining power over suppliers; suppliers can also benefit from reduced barriers to entry and from the elimination of distributors and other intermediaries standing between them and their users
Threat of new entrants	Reduces barriers to entry, such as the need for a sales force, access to channels, and physical assets; provides a technology for driving business processes that makes other things easier to do
Positioning and rivalry among existing competitors	Widens the geographic market, increasing the number of competitors and reducing differences among competitors; makes it more difficult to sustain operational advantages; puts pressure to compete on price

opportunities for product and service differentiation. When you buy a wearable digital health product, you not only get the product itself, you also get a host of services. Smart products increase rivalry among firms that will either innovate or lose customers to competitors. Smart products generally raise switching costs and inhibit new entrants to a market because existing customers are trapped in the dominant firm's software environment. Finally, smart products may decrease the power of suppliers of physical components if, as many believe, the physical product becomes less important than the software and hardware that make it run. The Interactive Session on Technology case explores the use of sensors and other smart products to create a "smart nation".

The Business Value Chain Model

Although the Porter model is very helpful for identifying competitive forces and suggesting generic strategies, it is not very specific about what exactly to do, and it does not provide a methodology to follow for achieving competitive advantages. If your goal is to achieve operational excellence, where do you start? Here's where the business value chain model is helpful.

The **value chain model** highlights specific activities in the business where competitive strategies can best be applied (Porter, 1985) and where information systems are most likely to have a strategic impact. This model identifies specific, critical leverage points where a firm can use information technology most effectively to enhance its competitive position. The value chain model views the firm as a series or chain of basic activities that add a margin of value to a firm's products or services. These activities can be categorized as either primary activities or support activities (see Figure 3.9).

Primary activities are most directly related to the production and distribution of the firm's products and services, which create value for the customer. Primary activities include inbound logistics, operations, outbound logistics, sales and marketing, and service. Inbound logistics includes receiving and storing materials for distribution to production. Operations transforms inputs into finished products. Outbound logistics entails storing and distributing finished products. Sales and marketing includes promoting and selling the firm's products. The service activity includes maintenance and repair of the firm's goods and services.

Support activities make the delivery of the primary activities possible and consist of organization infrastructure (administration and management), human resources (employee recruiting, hiring, and training), technology

INTERACTIVE SESSION TECHNOLOGY

Singapore as a Smart Nation

Singapore is a small island at the southern tip of the Malay Peninsula with a population of about 5.8 million. Over the second half of the last century, this tiny dot on the map has become well-known for its astonishing economic development—it is now one of the countries with the highest GDP per capita in the world.

The next step in Singapore's evolution is its plan to use information technology to transform itself into a "smart nation." A smart nation or city uses electronic data collection sensors, large scale data centers, and analytic software for initiatives that address a variety of urban challenges. Singapore's Smart Nation initiative aims to make Singapore a sustainable modern city, countering the pressures of increasing urban density and an aging population. Recently, Singapore has also launched a national artificial intelligence strategy, which its government has identified as a key step in the development of its Smart Nation program.

As one of the smallest countries in the world, Singapore does not have much room to expand its transport infrastructure. The Singapore government announces traffic-related indexes, traffic alerts, and traffic snapshots in national and regional views by consolidating data provided by the weather and the transport departments, collected by surveillance cameras on traffic hotspots, sensors on vehicles, commuters' fare cards, and the Electronic Road Pricing System (Singapore's electronic toll collection scheme for alleviating traffic jams). Before travelers hit the road, they now can consult the Realtime Singapore Traffic Watch website or third-party mobile apps for traffic conditions and commute details such as bus arrival timings. Singapore is also testing on-demand driverless vehicles.

Housing planning in Singapore must consider its sunny, hot, and humid climate. Virtual Singapore creates simulations to design a comfortable green living environment that balances the needs of a large population in a limited space. It offers a dynamic 3D city model and data hub, available for the general public, government bureaus, businesses, and research institutes to conduct long-term planning and virtual experiments. Smart Towns are equipped with solar energy panels and smart lights, which light up or dim depending on whether they detect passers-by, thus saving energy. This smart lighting system won first place at the IDC Smart City Asia Pacific Awards 2020 in the category of smart building/smart tech parks. The Automated Meter Reading scheme will allow residents

to access water usage data with just a few taps on their smartphones. The Pneumatic Waste Conveyance System aims to deliver household waste to sealed containers through underground vacuum tunnels and use sensors to adjust the service cycle of trash-collection trucks. The authority uses drones to survey mosquito breeding hotspots to prevent outbreaks of dengue fever.

Patients in Singapore can obtain medical advice from healthcare professionals without leaving home through the Smart Health Video Consultation system, which is made possible by the wide coverage of stable, high-speed household Internet connections and the high level of smartphone penetration. Patients in Singapore may perform rehabilitation exercises anytime and anywhere using a TeleRehab kit. It has been designed to be easy to operate—a patient just needs to access the app in the tablet PC provided in the kit, put the limb and neck sensors on correctly, and perform the rehab exercises (by following the video demos on the tablet) using the appropriate exercise bands with different levels of resistance. If necessary, they can consult their therapist in real time during office hours using video-conferencing. To keep its senior citizens healthy and active, Singapore has introduced RoboCoach, a robot fitness trainer that replicates human movements using motion-sensor technology and gives instructions in one of four languages or dialects.

There are other infrastructural projects in progress, such as CODEX (a data exchange platform for internal data-sharing among government agencies), NDI (a digital identification program of citizens and businesses that allows pre-filled form information to be shared with authorized public or private parties), Moments of Life (a one-stop portal for parents to fill out and submit applications for their newborns), and the Smart Nation Sensor Platform (a scheme to collect different types of data, such as air quality, on a territory-wide scale). The private sector, research institutions, and individuals contribute ideas and launch projects.

Singapore was named the Smart City of 2018 at the Smart City Expo World Congress for its outstanding performance and for setting a model for the world by involving its people, the private sector, and government agencies in implementing its blueprints for a smart nation. Its projects have demonstrated the city's willingness to improve the quality of life of its residents, and all signs indicate that its tech strategies will continue to enrich their lives in the future.

However, smart cities and smart nations are not without their issues. Critics point out that in the last ten years smart city and smart nation projects have failed to deliver on many of their objectives, such as reducing urban automobile congestion and pollution despite grand promises with budgets to match. They also take many years to implement the technology, let alone the solutions. The initiatives are often ignored by citizens who fail to see the benefits in their daily lives, especially for poor, elderly, and less tech-savvy citizens, and they pose extraordinary privacy and security issues as well.

Sources: IDC Smart City Asia Pacific Awards, "2020 Winners," www.idc.com, May 20, 2020; Integrated Health Information Systems, Ihis.com.sg, accessed January 8, 2020; Smart Nation Singapore, "Smart Nation Initiatives/Strategic National Projects," Smartnation.sg, accessed January 8, 2020; Eileen Yu, "Singapore Wants Widespread AI Use in Smart Nation Drive," Zdnet.com, November 14, 2019; Tham Yuen-C, "What Is Codex? The Tech Behind Singapore's Smart Nation," Govinsider.asia, April 24, 2019; Kevin McSpadden, "Critics of SG Smart City and All Smart Cities Worldwide—5 Critiques of the Smart City Push," Yahoo News, September 2018; "Finance and Policy AP: Can Investment of \$100m in AI Get Singapore's 'Smart Nation' Vision Back on Track?" Smartcitiesworldforums.com, May 8, 2017; Kevin Kwang, "Commentary: Singapore's Smart Nation Vision Blurry Without a Success Story," Channel News Asia, August 15, 2017; Maros Krivý, "Towards a Critique of Cybernetic Urbanism: The Smart City and the Society of Control," Journal of Planning Theory, April 27, 2016; Boyd Cohen, "The Smartest Cities in the World 2015: Methodology," www.fastcompany.com, November 20, 2014.

CASE STUDY QUESTIONS

1. What are the factors driving the Smart Nation initiative?
2. Describe the smart city initiatives of an urban center in your country or region.
3. What are the possible downsides to the Smart Nation project?

Case contributed by Joyce Chan, City University of Hong Kong

(improving products and the production process), and procurement (purchasing input).

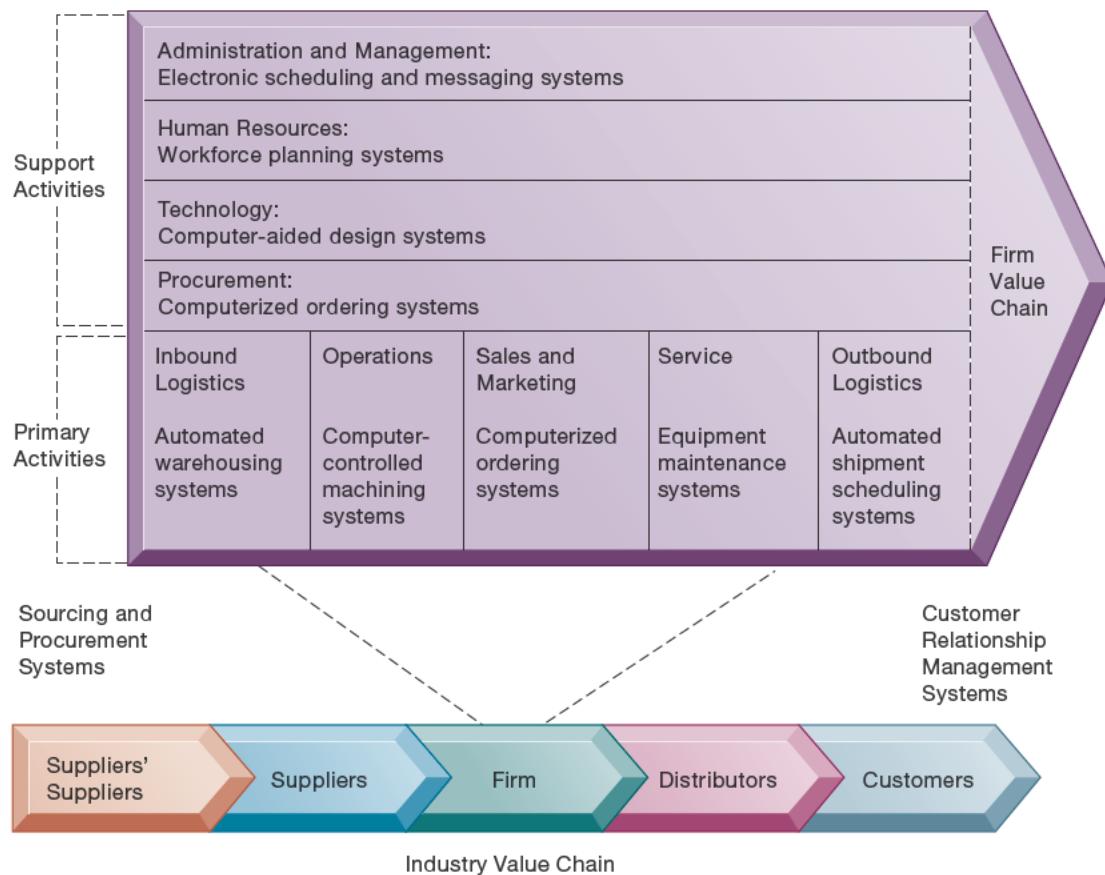
Now you can ask at each stage of the value chain, "How can we use information systems to improve operational efficiency and improve customer and supplier intimacy?" This will force you to critically examine how you perform value-adding activities at each stage and how the business processes might be improved. You can also begin to ask how information systems can be used to improve the relationship with customers and with suppliers who lie outside the firm's value chain but belong to the firm's extended value chain where they are absolutely critical to your success. Here, supply chain management systems that coordinate the flow of resources into your firm and customer relationship management systems that coordinate your sales and support employees with customers are two of the most common system applications that result from a business value chain analysis. We discuss these enterprise applications in detail later in Chapter 9.

Using the business value chain model will also cause you to consider benchmarking your business processes against your competitors or others in related industries and identifying industry best practices. **Benchmarking** involves comparing the efficiency and effectiveness of your business processes against strict standards and then measuring performance against those standards. Industry **best practices** are usually identified by consulting companies, research organizations, government agencies, and industry associations as the most successful solutions or problem-solving methods for consistently and effectively achieving a business objective.

Once you have analyzed the various stages in the value chain at your business, you can come up with candidate applications of information systems. Then, once you have a list of candidate applications, you can decide which to develop first. By making improvements in your own business value chain

FIGURE 3.9 THE VALUE CHAIN MODEL

This figure provides examples of systems for both primary and support activities of a firm and of its value partners that can add a margin of value to a firm's products or services.



that your competitors might miss, you can achieve competitive advantage by attaining operational excellence, lowering costs, improving profit margins, and forging a closer relationship with customers and suppliers. If your competitors are making similar improvements, then at least you will not be at a competitive disadvantage—the worst of all cases!

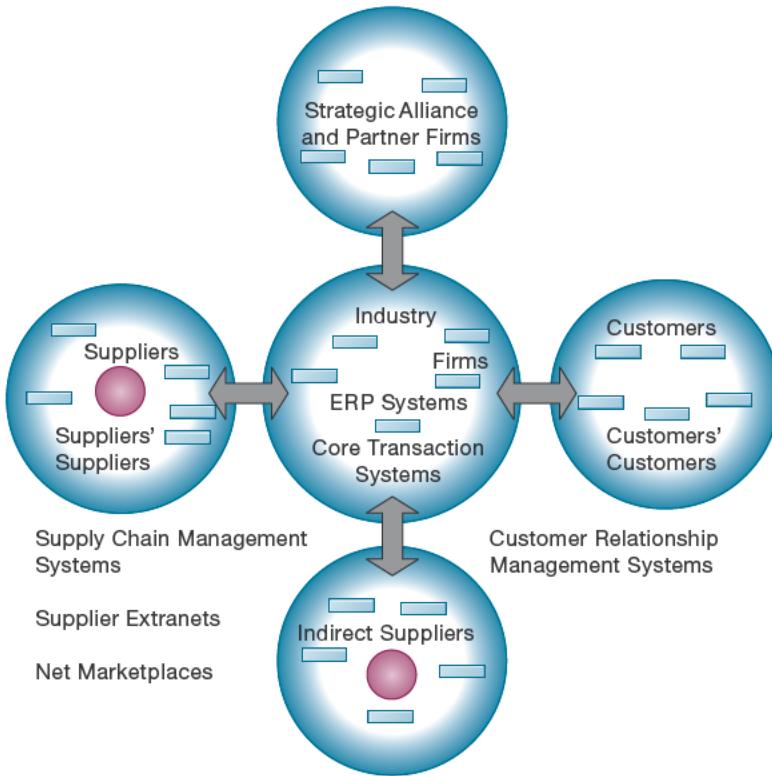
Extending the Value Chain: The Value Web

Figure 3.9 shows that a firm's value chain is linked to the value chains of its suppliers, distributors, and customers. After all, the performance of most firms depends not only on what goes on inside a firm but also on how well the firm coordinates with direct and indirect suppliers, delivery firms (logistics partners, such as FedEx or UPS), and, of course, customers.

How can information systems be used to achieve strategic advantage at the industry level? By working with other firms, industry participants can use information technology to develop industrywide standards for exchanging information or business transactions electronically, which force all market participants to subscribe to similar standards. Such efforts increase efficiency, making product substitution less likely and perhaps raising entry costs—thus discouraging new entrants. Also, industry members can build industrywide, IT-supported consortia, symposia, and communications networks to coordinate activities concerning government agencies, foreign competition, and competing industries.

FIGURE 3.10 THE VALUE WEB

The value web is a networked system that can synchronize the value chains of business partners within an industry to respond rapidly to changes in supply and demand.



Looking at the industry value chain encourages you to think about how to use information systems to link up more efficiently with your suppliers, strategic partners, and customers. Strategic advantage derives from your ability to relate your value chain to the value chains of other partners in the process. For instance, if you are Amazon.com, you want to build systems that:

- Make it easy for suppliers to display goods and open stores on the Amazon site.
- Make it easy for customers to pay for goods.
- Develop systems that coordinate the shipment of goods to customers.
- Develop shipment tracking systems for customers.

Internet technology has made it possible to create highly synchronized industry value chains called value webs. A **value web** is a collection of independent firms that use information technology to coordinate their value chains to produce a product or service for a market collectively. It is more customer driven and operates in a less linear fashion than the traditional value chain.

Figure 3.10 shows that this value web synchronizes the business processes of customers, suppliers, and trading partners among different companies in an industry or in related industries. These value webs are flexible and adaptive to changes in supply and demand. Relationships can be bundled or unbundled in response to changing market conditions. Firms will accelerate time to market and to customers by optimizing their value web relationships to make quick decisions on who can deliver the required products or services at the right price and location.

Synergies, Core Competencies, and Network-Based Strategies

A large corporation is typically a collection of businesses. Often, the firm is organized financially as a collection of strategic business units and the returns to the firm are directly tied to the performance of all the strategic business units. Information systems can improve the overall performance of these business units by promoting synergies and core competencies.

Synergies

The idea of synergies is that when the output of some units can be used as inputs to other units or two organizations pool markets and expertise, these relationships lower costs and generate profits. Bank and financial firm mergers such as the merger of Bank of America and Countrywide Financial Corporation occurred precisely for this purpose.

One use of information technology in these synergy situations is to tie together the operations of disparate business units so that they can act as a whole. For example, acquiring Countrywide Financial enabled Bank of America to extend its mortgage lending business and to tap into a large pool of new customers who might be interested in its credit card, consumer banking, and other financial products. Information systems would help the merged companies consolidate operations, lower retailing costs, and increase cross-marketing of financial products.

Enhancing Core Competencies

Yet another way to use information systems for competitive advantage is to think about ways that systems can enhance core competencies. The argument is that the performance of all business units will increase insofar as these business units develop, or create, a central core of competencies. A **core competency** is an activity for which a firm is a world-class leader. Core competencies may involve being the world's best miniature parts designer, the best package delivery service, or the best thin-film manufacturer. In general, a core competency relies on knowledge that is gained over many years of practical field experience with a technology. This practical knowledge is typically supplemented with a long-term research effort and committed employees.

Any information system that encourages the sharing of knowledge across business units enhances competency. Such systems might encourage or enhance existing competencies and help employees become aware of new external knowledge; such systems might also help a business leverage existing competencies to related markets. For example, Procter & Gamble, a world leader in brand management and consumer product innovation, uses a series of systems to enhance its core competencies by helping people working on similar problems share ideas and expertise. Employees working in research and development (R&D), engineering, purchasing, marketing, legal affairs, and business information systems around the world can share documents, reports, charts, videos, and other data from various sources online and locate employees with special expertise. P&G systems also can link to research scientists and entrepreneurs outside the company who are searching for new, innovative products worldwide.

Network-Based Strategies

Internet and networking technology have inspired strategies that take advantage of firms' abilities to create networks or network with each other. Network-based strategies include the use of network economics, a virtual company model, and business ecosystems.

Network Economics **Network economics** refers to market situations where the economic value being produced depends on the number of people using a product. For certain products and markets, the real economic value comes from the fact that other people use the product. In these situations, "network effects" are at work. For instance, what's the value of a telephone if it is not connected to millions of others? Email has value because it allows us to communicate with millions of others. Business models that are based on network effects have been highly successful on the Internet, including social networks, software, messaging apps, and on-demand companies like Uber and Airbnb.

In traditional economics—the economics of factories and agriculture production experiences diminishing returns. The more any given resource is applied to production, the lower the marginal gain in output, until a point is reached where the additional inputs produce no additional outputs. This is the law of diminishing returns, and it is the foundation for most of modern economics.

In some situations, the law of diminishing returns does not work. For instance, in a network, the marginal costs of adding another participant are about zero, whereas the marginal gain is much larger. The larger the number of subscribers in a telephone system or the Internet, the greater the value to all participants because each user can interact with more people. It is not much more expensive to operate a television station with 1,000 subscribers than with 10 million subscribers. The value of a community of people grows with size, whereas the cost of adding new members is inconsequential. The value of Facebook to users increases greatly as more people use the social network.

From this network economics perspective, information technology can be strategically useful. Internet sites can be used by firms to build communities of users—like-minded customers who want to share their experiences. This builds customer loyalty and enjoyment and builds unique ties to customers. eBay, the giant online auction site, is an example. This business is based on a network of millions of users, and has built an online community by using the Internet. The more people offering products on eBay, the more valuable the eBay site is to everyone because more products are listed, and more competition among suppliers lowers prices. Network economics also provides strategic benefits to commercial software vendors. The value of their software and complementary software products increases as more people use them, and there is a larger installed base to justify continued use of the product and vendor support.

Virtual Company Model Another network-based strategy uses the model of a virtual company to create a competitive business. A **virtual company**, also known as a virtual organization, uses networks to link people, assets, and ideas, enabling it to ally with other companies to create and distribute products and services without being limited by traditional organizational boundaries or physical locations. One company can use the capabilities of another company without being organizationally tied to that company. The virtual company model is useful when a company finds it cheaper to acquire products, services, or capabilities from an external vendor or when it needs to move quickly to exploit new market opportunities and lacks the time and resources to respond on its own.

Fashion companies, such as GUESS, Ann Taylor, Levi Strauss, and Reebok, enlist Hong Kong-based Li & Fung to manage production and shipment of their garments. Li & Fung handles product development, raw material sourcing,

production planning, quality assurance, and shipping. Li & Fung does not own any fabric, factories, or machines, outsourcing all of its work to a network of more than 15,000 suppliers in 40 countries all over the world. Customers place orders with Li & Fung over its private extranet. Li & Fung then sends instructions to appropriate raw material suppliers and factories where the clothing is produced. The Li & Fung extranet tracks the entire production process for each order. Working as a virtual company keeps Li & Fung flexible and adaptable so that it can design and produce the products ordered by its clients in short order to keep pace with rapidly changing fashion trends.

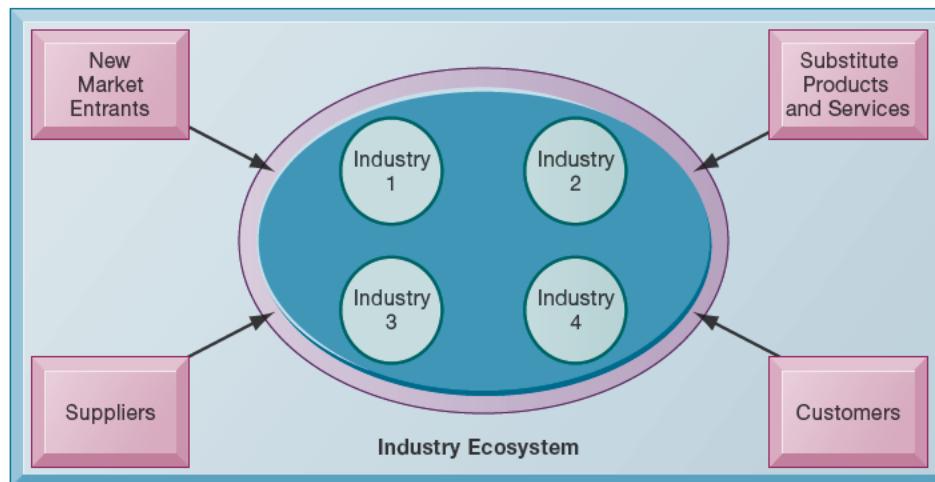
Business Ecosystems and Platforms The Internet and the emergence of digital firms call for some modification of the industry competitive forces model. The traditional Porter model assumes a relatively static industry environment; relatively clear-cut industry boundaries; and a relatively stable set of suppliers, substitutes, and customers. Instead of participating in a single industry, some of today's firms participate in industry sets—collections of industries that provide related services and products that deliver value to the customer (see Figure 3.11). **Business ecosystem** is another term for these loosely coupled but interdependent networks of suppliers, distributors, outsourcing firms, transportation service firms, and technology manufacturers (Iansiti and Levien, 2004).

An example of a business ecosystem is the mobile Internet platform. In this ecosystem there are four industries: device makers (Apple iPhone, Samsung, LG, and others), wireless telecommunication firms (AT&T, Verizon, T-Mobile, Sprint, and others), independent software applications providers (generally small firms selling games, applications, and ring tones), and Internet service providers (who participate as providers of Internet service to the mobile platform). Each of these industries has its own history, interests, and driving forces. But these elements come together in a sometimes cooperative and sometimes competitive new mobile digital platform ecosystem, creating value for consumers that none of them could achieve acting alone.

Business ecosystems typically have one or only a few keystone firms that dominate the ecosystem and create the **platforms** used by other niche firms.

FIGURE 3.11 AN ECOSYSTEM STRATEGIC MODEL

The digital firm era requires a more dynamic view of the boundaries among industries, firms, customers, and suppliers, with competition occurring among industry sets in a business ecosystem. In the ecosystem model, multiple industries work together to deliver value to the customer. IT plays an important role in enabling a dense network of interactions among the participating firms.



For instance, both Microsoft and Facebook provide platforms composed of information systems, technologies, and services that thousands of other firms in different industries use to enhance their own capabilities (Van Alstyne et al., 2016). Facebook is a platform used by billions of people and millions of businesses to interact and share information as well as to buy, market, and sell numerous products and services. More firms are trying to use information systems to develop into keystone firms by building IT-based platforms that other firms can use. Alternatively, firms should consider how their information systems will enable them to become profitable niche players in the larger ecosystems created by keystone firms.

3-4 What are the challenges posed by strategic information systems, and how should they be addressed?

Strategic information systems often change the organization as well as its products, services, and operating procedures, driving the organization into new behavioral patterns. Successfully using information systems to achieve a competitive advantage is challenging and requires precise coordination of technology, organizations, and management.

Sustaining Competitive Advantage

The competitive advantages that strategic systems confer do not necessarily last long enough to ensure long-term profitability. Because competitors can retaliate and copy strategic systems, competitive advantage is not always sustainable. Markets, customer expectations, and technology change; globalization has made these changes even more rapid and unpredictable. The Internet can make competitive advantages disappear very quickly because virtually all companies can use this technology. Classic strategic systems, such as American Airlines's SABRE computerized reservation system, Barclays' ATM system, and FedEx's package tracking system, benefited by being the first in their industries. Then rival systems emerged. Amazon was an e-commerce leader but now faces competition from eBay, Walmart, and Google. Information systems alone cannot provide an enduring business advantage. Systems originally intended to be strategic frequently become tools for survival, required by every firm to stay in business, or they may inhibit organizations from making the strategic changes essential for future success.

Aligning IT with Business Objectives

The research on IT and business performance has found that (a) the more successfully a firm can align information technology with its business goals, the more profitable it will be, and (b) only one-quarter of firms achieve alignment of IT with the business. About half of a business firm's profits can be explained by alignment of IT with business (Luftman, 2003).

Most businesses get it wrong: Information technology takes on a life of its own and does not serve management and shareholder interests very well. Instead of businesspeople taking an active role in shaping IT to the enterprise, they ignore it, claim not to understand IT, and tolerate failure in the IT area as just a nuisance to work around. Such firms pay a hefty price in poor performance. Successful firms and managers understand what IT can do and how it works, take an active role in shaping its use, and measure its impact on revenues and profits.

Management Checklist: Performing a Strategic Systems Analysis

To align IT with the business and use information systems effectively for competitive advantage, managers need to perform a strategic systems analysis. To identify the types of systems that provide a strategic advantage to their firms, managers should ask the following questions:

1. What is the structure of the industry in which the firm is located?
 - What are some of the competitive forces at work in the industry? Are there new entrants to the industry? What is the relative power of suppliers, customers, and substitute products and services over prices?
 - Is the basis of competition quality, price, or brand?
 - What are the direction and nature of change within the industry? From where are the momentum and change coming?
 - How is the industry currently using information technology? Is the organization behind or ahead of the industry in its application of information systems?
2. What are the business, firm, and industry value chains for this particular firm?
 - How is the company creating value for the customer—through lower prices and transaction costs or higher quality? Are there any places in the value chain where the business could create more value for the customer and additional profit for the company?
 - Does the firm understand and manage its business processes using the best practices available? Is it taking maximum advantage of supply chain management, customer relationship management, and enterprise systems?
 - Does the firm leverage its core competencies?
 - Is the industry supply chain and customer base changing in ways that benefit or harm the firm?
 - Can the firm benefit from strategic partnerships, value webs, ecosystems, or platforms?
 - Where in the value chain will information systems provide the greatest value to the firm?
3. Have we aligned IT with our business strategy and goals?
 - Have we correctly articulated our business strategy and goals?
 - Is IT improving the right business processes and activities to promote this strategy?
 - Are we using the right metrics to measure progress toward those goals?

3-5 | How will MIS help my career?

Here is how Chapter 3 and this book can help you find a job as an entry-level business development representative.



The Company

Superior Data Quality, a fast-growing Australia-based company providing software and services to help large companies manage their data and data quality, is looking for an entry-level business development representative. The company's data quality and data management tools and services help firms correct, standardize, and enhance customer data by capturing accurate address, email, and phone information; removing duplicate data in corporate systems; analyzing data to discover relationships; restructuring and standardizing data; and monitoring data to ensure ongoing quality control and standardization. The company has 12,000 clients worldwide, 450 employees, and offices throughout the United States, Europe, and Asia.

Position Description

The business development representative will help the company's sales team meet aggressive growth targets. The company provides classroom and on-the-job training on how to communicate with prospects and customers, how to identify appropriate markets for its solutions, how to write a sales plan, and how to use tools such as Salesforce.com. Job responsibilities include:

- Researching targeted accounts to generate potential business opportunities.
- Supporting customer acquisition and sales strategies.
- Implementing tactics for successful execution of marketing campaigns.
- Building and managing a pipeline of sales leads through prospecting and qualifying marketing-generated leads.
- Reporting on the success of campaigns and lead generation activities.

Job Requirements

- Bachelor's degree
- Strong interest in a sales career
- Exceptional communication, interpersonal, analytical, and problem-solving skills
- Ability to multitask in fast-paced environment

Interview Questions

1. What do you know about data quality and data management? Have you any work experience in these areas? Have you ever encountered a data quality problem? If so, can you describe how the problem was solved?
2. Have you ever worked with Salesforce.com? What do you know about it? How have you used the software?
3. Can you give us an example of a marketing or sales-related problem or other business problem that you helped solve? Do you have any examples of your writing and analysis work?
4. Have you had much face-to-face contact with customers? Can you describe what work you did with customers?

Author Tips

1. Review the discussion of IT and business strategy in Chapter 3 and also the section on data management, including data quality, in Chapter 6.
2. Use the web to find out more about tools and services for promoting data quality and data management and research the company's specific offerings in this area.
3. Review the company's LinkedIn profile and posts in addition to other social media channels. Are there consistent themes across these channels on which the company seems to focus? Be prepared to show that you understand the kinds of business challenges facing this company.
4. Learn what you can about Salesforce.com related to the responsibilities outlined for this job. Inquire about exactly how you would be using Salesforce.com in your work.
5. Consider inquiring what kinds of problems with customers' data quality you would be most likely to encounter on the job.

REVIEW SUMMARY

3-1 Which features of organizations do managers need to know about to build and use information systems successfully?

All modern organizations are hierarchical, specialized, and impartial, using explicit routines to maximize efficiency. All organizations have their own cultures and politics arising from differences in interest groups, and they are affected by their surrounding environment. Organizations differ in goals, groups served, social roles, leadership styles, incentives, types of tasks performed, and type of structure. These features help explain differences in organizations' use of information systems. Information systems and the organizations in which they are used interact with and influence each other.

3-2 What is the impact of information systems on organizations?

The introduction of a new information system will affect organizational structure, goals, work design, values, competition between interest groups, decision making, and day-to-day behavior. At the same time, information systems must be designed to serve the needs of important organizational groups and will be shaped by the organization's structure, business processes, goals, culture, politics, and management. Information technology can reduce transaction and agency costs, and such changes have been accentuated in organizations using the Internet. New systems disrupt established patterns of work and power relationships, so there is often considerable resistance to them when they are introduced.

3-3 How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network economics help companies develop competitive strategies using information systems?

In Porter's competitive forces model, the strategic position of the firm and its strategies are determined by competition with its traditional direct competitors, but they are also greatly affected by new market entrants, substitute products and services, suppliers, and customers. Information systems help companies compete by maintaining low costs, differentiating products or services, focusing on market niche, strengthening ties with customers and suppliers, and increasing barriers to market entry with high levels of operational excellence.

The value chain model highlights specific activities in the business where competitive strategies and information systems will have the greatest impact. The model views the firm as a series of primary and support activities that add value to a firm's products or services. Primary activities are directly related to production and distribution, whereas support activities make the delivery of primary activities possible. A firm's value chain can be linked to the value chains of its suppliers, distributors, and customers. A value web consists of information systems that enhance competitiveness at the industry level by promoting the use of standards and industrywide consortia and by enabling businesses to work more efficiently with their value partners.

Because firms consist of multiple business units, information systems achieve additional efficiencies or enhance services by tying together the operations of disparate business units. Information systems help businesses leverage their core competencies by promoting the sharing of knowledge across business units. Information systems facilitate business models based on large networks of users or subscribers that take advantage of network economics. A virtual company strategy uses networks to link to other firms so that a company can use the capabilities of other companies to build, market, and distribute products and services. In business ecosystems, multiple industries work together to deliver value to the customer. Information systems support a dense network of interactions among the participating firms.

3-4 What are the challenges posed by strategic information systems, and how should they be addressed?

Implementing strategic systems often requires extensive organizational change and a transition from one sociotechnical level to another. Such changes are often difficult and painful to achieve. Moreover, not all strategic systems are profitable, and they can be expensive to build. Many strategic information systems are easily copied by other firms, so that strategic advantage is not always sustainable.

Key Terms

Agency theory, 119
Benchmarking, 132
Best practices, 132
Business ecosystem, 137
Competitive forces model, 123
Core competency, 135
Customer experience management, 128
Disruptive technologies, 116
Efficient customer response system, 125
Mass customization, 127
Network economics, 136

Organization, 111
Platforms, 137
Primary activities, 130
Product differentiation, 124
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Support activities, 130
Switching costs, 128
Transaction cost theory, 119
Value chain model, 130
Value web, 134
Virtual company, 136

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

3-1 Which features of organizations do managers need to know about to build and use information systems successfully?

- How is interaction between information technology and organizations influenced by mediating factors?
- How do the definitions of organizations relate to their use of information systems technology?

3-2 What is the impact of information systems on organizations?

- Describe how information technology can help an organization contract in size.
- List the four most common factors underpinning organizational resistance to innovation.
- Explain how the Internet is radically changing key business practices.
- Identify three key organizational factors to consider when planning a new system.

3-3 How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network economics help companies develop competitive strategies using information systems?

- Define Porter's competitive forces model and explain how it works.
- Describe what the competitive forces model explains about competitive advantage.
- List and describe four competitive strategies enabled by information systems that firms can pursue.

- Describe how information systems can support each of these competitive strategies and give examples.

- Explain why aligning IT with business objectives is essential for strategic use of systems.
- Define and describe the value chain model.
- Explain how the value chain model can be used to identify opportunities for information systems.
- Define the value web and show how it is related to the value chain.
- Explain how the value web helps businesses identify opportunities for strategic information systems.
- Describe how the Internet has changed competitive forces and competitive advantage.
- Explain how information systems promote synergies and core competencies.
- Describe how promoting synergies and core competencies enhances competitive advantage.
- Explain how businesses benefit by using network economics and ecosystems.
- Define and describe a virtual company and the benefits of pursuing a virtual company strategy.

3-4 What are the challenges posed by strategic information systems, and how should they be addressed?

- List and describe the management challenges posed by strategic information systems.
- Explain how to perform a strategic systems analysis.

Discussion Questions

- 3-5** MyLab MIS It has been said that there is no such thing as a sustainable strategic advantage. Do you agree? Why or why not?
- 3-6** MyLab MIS It has been said that the advantage that leading-edge retailers such as Dell and Walmart have over their competition isn't
- 3-7** MyLab MIS technology; it's their management. Do you agree? Why or why not?
- What are some of the issues to consider in determining whether the Internet would provide your business with a competitive advantage?

Hands-On MIS Projects

The projects in this section give you hands-on experience identifying information systems to support a business strategy and to solve a customer retention problem, using a database to improve decision making about business strategy, and using web tools to configure and price an automobile. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 3-8** Dolce is an Italian company selling high-end turnkey kitchen designs—designer stoves, refrigerators, microwave ovens, and other appliances as well as worktops and kitchen cabinets. To compete better globally, Dolce has decided to let customers design their own kitchens through a web-based interface. The client needs to insert the exact measurements and make requests for appliances and furniture materials, and then the order will go to the Italian factory, where the kitchen's parts will be assembled, packaged, and sent to the client. How can Dolce take advantage of information systems to succeed with this concept?
- 3-9** Habibi Watches sells trendy watches and other apparel online in the United Arab Emirates. As a purchase requires registration, the company has been able to acquire a lot of customer data. Information regarding a customer's previous purchases and email and home addresses is therefore easily obtainable. How can information systems help Habibi Watches attract more attention from existing customers? How can management decisions be made regarding quality of customer service, product quality, etc. using information systems?

Improving Decision Making: Using a Database to Clarify Business Strategy

Software skills: Database querying and reporting; database design

Business skills: Reservation systems; customer analysis

- 3-10** In this exercise, you will use database software to analyze the reservation transactions for a hotel and use that information to fine-tune the hotel's business strategy and marketing activities.

In MyLab MIS, you will find a database for hotel reservation transactions developed in Microsoft Access with information about the President's Inn in Cape May, New Jersey. At the Inn, 10 rooms overlook side streets, 10 rooms have bay windows that offer limited views of the ocean, and the remaining 10 rooms in the front of the hotel face the ocean. Room rates are based on room choice, length of stay, and number of guests per room. Room rates are the same for one to four guests. Fifth and sixth guests must pay an additional \$20 charge each per person per day. Guests staying for seven days or more receive a 10 percent discount on their daily room rates. The owners currently use a manual reservation and bookkeeping system, which has caused many problems. Use the database to develop reports on average length of stay, average visitors per room, base revenue per room (i.e., length of visit multiplied by the daily rate), and strongest customer base. After answering these questions, write a brief report about the Inn's current business situation and suggest future strategies.

Improving Decision Making: Using Web Tools to Configure and Price an Automobile

Software skills: Internet-based software

Business skills: Researching product information and pricing

- 3-11** In this exercise, you will use software at car websites to find product information about a car of your choice and use that information to make an important purchase decision. You will also evaluate two of these sites as selling tools.

You are interested in purchasing a new Ford Escape (or some other car of your choice). Go to the website of CarsDirect (www.carsdirect.com) and begin your investigation. Locate the Ford Escape. Research the various Escape models, and choose one you prefer in terms of price, features, and safety ratings. Locate and read at least two reviews. Surf the website of the manufacturer, in this case Ford (www.ford.com). Compare the information available on Ford's website with that of CarsDirect for the Ford Escape. Try to locate the lowest price for the car you want in a local dealer's inventory. Suggest improvements for CarsDirect.com and Ford.com.

Collaboration and Teamwork Project

Identifying Opportunities for Strategic Information Systems

- 3-12** With your team of three or four other students, select a company described in the *The Financial Times*, *Fortune*, *Forbes*, or another business publication or do your research on the web. Visit the company's website to find additional information about that company and to see how the firm is using the web. On the basis of this information, analyze the business. Include a description of the organization's features, such as important business processes, culture, structure, and environment as well as its business strategy. Suggest strategic information systems appropriate for that particular business, including those based on Internet technology, if appropriate. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Offline, Online, and Back: The Evolution of the UK Grocery Market

CASE STUDY

The UK grocery market is predicted to grow by 12.5 percent through 2024, and according to the food and grocery research organization IGD, it is expected to reach a value of £217.7 billion. The main grocery stores operating in Great Britain are Tesco, which, as of December 2020, had a market share of 27 percent; Sainsbury, 15.7 percent; ASDA, 14.1 percent; and Morrisons, 10.3 percent. Together, they cover over 65 percent of the grocery market and are considered the “Big Four” in the United Kingdom. Tesco reached its peak in 2007, when it held 31.1 percent of the UK grocery market share. Worldwide, the company operates around 7,000 stores across Europe and Asia.

In the United Kingdom, Tesco focused on implementing a strategy that enabled the company to offer the lowest costs and achieve cost leadership. This drew price-sensitive customers away from its competitors and increased its market share. Tesco adopted the following strategies to maintain this cost leadership: (1) high utilization of assets through production of large outputs and spreading fixed costs over large quantities, (2) minimal direct and indirect costs in the production and distribution stages, and (3) strict control over the supply chain to ensure low costs. This strategy was viable for Tesco; as a big company, it could take advantage of economies of scale in the market.

However, due to the popularity of discount supermarkets such as Aldi and Lidl, Tesco has recently been struggling to maintain its cost leadership. Consumer behavior has changed in the United Kingdom due to economic recession and inflation, leading customers to shift to budget supermarkets for their grocery purchases. Over the last several years, Tesco's market share has fallen slightly; by contrast, Aldi and Lidl have continuously been increasing their market share over the last few years. In December 2020, Aldi was the fifth largest grocery chain in the United Kingdom with a market share of 7.7 percent.

Besides the physical supermarkets, Tesco initially operated two online platforms: Tesco.com for grocery home deliveries and Tesco Direct for household goods and clothing. However, in May 2018, Tesco

announced Tesco Direct's closure in an unexpected move. Tesco Direct had been launched in 2006, and it had cost the company £25–£30 million. According to Charles Wilson, the then CEO of Tesco's UK chain, closing one of the websites would help them to focus their investment in one platform to offer better service and more products to customers. Although the closure cost 500 jobs, it was not a huge surprise, considering that Tesco had, by its own admission, faced challenges in making it profitable. Tesco's attempt to compete with huge online retailers such as Amazon and Argos had failed because it had been unable to make profits after covering the costs of marketing and order fulfillment.

Besides this setback, Tesco must also contend with the threat from discount supermarkets. By June 2019, Aldi had opened 830 stores in the United Kingdom since 1990, when its first store was launched. Aldi reported £11.3 billion in revenue for 2018, an 11 percent increase over the previous year. Similarly, Lidl reached a total of 760 stores by June 2019 and also plans to continue to grow over the next five years. Customers were skeptical at the beginning, but once they saw the low-price products, they switched their buying preferences to these discount supermarkets.

The COVID-19 crisis served as a further boost to the discount sector. According to some estimates, customers who switched from the Big Four supermarkets save over £2.2 billion annually by shopping at Aldi. Aldi UK's most successful year was 2017, when it generated £10 billion in annual sales for the first time.

Experts argue that the main reasons these discount supermarkets have been successful is rising inflation and the stagnation in wages, and the atmosphere of uncertainty brought about by the COVID-19 crisis. The services offered by Aldi are similar to those that the “Big Four” provide their customers, but Aldi has the advantage of lower prices and is still considered a discounter, which is especially attractive for customers during inflation. Surveys show that Aldi also gets very good ratings in customer satisfaction. During the COVID-19 crisis, Aldi announced the opening of 100 new stores and

further investment in a new online ordering service. Aldi is trying out new formats of home delivery; for example, “click-and-collect” enables shoppers to order groceries and pick them up at a nearby store. Furthermore, a partnership with the courier firm Deliveroo allows for rapid grocery delivery service within half an hour.

Ever since the two discount supermarkets came to the United Kingdom from Germany, they have forced the big grocery stores to rethink their approach. Thanks to their low-price grocery strategy, Aldi and Lidl have changed the UK supermarket industry for some time to come. Big supermarkets like Tesco and Sainsbury already offer online grocery shopping, but they faced difficulties making a profit from their e-commerce operations. With Aldi and Lidl's entry into this market, these challenges will only increase.

In the beginning of 2016, Aldi opened its first online store for the UK market. The discount retailer made its opening move by investing £35 million to launch an online website for selling wine, which was followed by non-food “special buys.” According to Kantar Retail analyst Bryan Roberts, this move is a smart way of reaching customers who don't have access to an Aldi.

Lidl founded the Lidl Digital Logistics, and experts expect this supermarket to enter the grocery delivery market too. So far, Lidl has sold wine and some non-food items online in parts of Europe, but not groceries. Lidl's approach to entering the digital market is quite innovative: recently, they launched a chatbot designed to help customers in their choice of wine based on what they are eating.

The public love for the discounters signifies a major threat for big supermarkets looking to keep their market share, both on- and offline. To take the fight to Aldi and Lidl, and having seen Aldi and Lidl's success in gaining market share, Tesco announced plans in 2018 to open a discount chain of 60 stores all over the United Kingdom, thus entering the fast-growing discount market. History has shown that attempts by big supermarkets to launch discount brands have largely failed. Tesco was no exception, and it has since scaled back those plans and even closed some of those stores.

With Aldi and Lidl trying to enter the e-commerce industry and Tesco trying to defeat them by entering the discount market, the war between the big and budget supermarkets has taken some interesting

turns, especially since food shopping has undergone changes too: more people prefer to buy food on a daily basis and more locally, and a high number of them prefer to buy their food online. A number of European retailers have responded to this by opening smaller stores in nearby locations, launching online stores, and testing other new models for shopping.

Tesco has been in the business of selling on the Internet for a long time now; in 1996, it became the first supermarket to launch online shopping. There are several ways Tesco is using information technology to its advantage. For instance, in 2011, while Tesco's domestic United Kingdom sales were dropping, it was a huge success in South Korea, its largest market outside the United Kingdom, as a result of its ability to adapt to local customer needs. As South Koreans are among the people with the longest working hours worldwide, Tesco introduced “virtual stores” with its Homeplus brand in the country. It displayed these virtual stores in subways and bus stations, where people could scan products' barcodes using their smartphones and purchase them online. These products were then delivered to them right after they returned home, thus saving time and effort for the consumers.

History has shown that the grocery industry needs to adapt to consumer demands and lifestyles continuously. The United Kingdom and South Korea are a study in contrasts. While people in the United Kingdom switched from domestic big supermarkets to budget supermarkets, the opposite happened in South Korea thanks to Homeplus, which turned Tesco into the country's second largest grocery retailer. Customers in the United Kingdom are price-sensitive due to economic recession and inflation, whereas customers in South Korea have embraced the technology made available to them to suit their time-sensitive lifestyle.

E-commerce is a huge opportunity for discounters, but what will happen to the grocery sector if Aldi and Lidl decide to offer their full range of products online? Perhaps more importantly, can they gain a bigger share of the grocery market at the expense of the Big Four in United Kingdom? Some experts believe that this strategy is untenable. According to retail consultant Graham Soult, the discount supermarkets' initiative of entering the online shopping market runs the same risks and problems that other supermarkets have faced. He believes that the uniqueness of these supermarkets lies in their simplicity and low

cost, which they might be putting at risk when they start to sell food and groceries online. Simply put, the complexity of the e-commerce industry might not fit their low-cost business model.

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CASE STUDY QUESTIONS

- 3-13** Analyze the cost leadership strategy of Tesco based on Porter's Competitive Forces Model. Why would it be a smart move to close one of its online shopping sites?
- 3-14** Do you think Aldi and Lidl's strategy of venturing into e-commerce is a good idea?
- 3-15** Comment on Tesco's strategy of opening a discount chain. Do you think it could recover Tesco's former market position? Explain your answer.
- 3-16** How much potential do you see for virtual stores (like the ones Tesco introduced in South Korea) in the United Kingdom?

Case contributed by Bernd Schenk, University of Liechtenstein

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4

Ethical and Social Issues in Information Systems

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 4-1** What ethical, social, and political issues are raised by information systems?
- 4-2** What specific principles for conduct can be used to guide ethical decisions?
- 4-3** Why do contemporary information systems technology and the Internet pose challenges to the protection of individual privacy and intellectual property?
- 4-4** How have information systems affected laws for establishing accountability and liability and the quality of everyday life?
- 4-5** How will MIS help my career?

CHAPTER CASES

Your Smartphone: Big Brother's Best Friend
The Boeing 737 MAX Crashes: What Happened and Why?
Do Smartphones Harm Children? Maybe, Maybe Not
Facebook Privacy: Your Life for Sale

VIDEO CASES

What Net Neutrality Means for You
Facebook and Google Privacy: What Privacy?
United States v. Terrorism: Data Mining for Terrorists and Innocents

Instructional Video:
Viktor Mayer-Schönberger on the Right to Be Forgotten

MyLab MIS

Discussion Questions: 4-5, 4-6, 4-7; Hands-On MIS Projects: 4-8, 4-9, 4-10, 4-11;
eText with Conceptual Animations

Your Smartphone: Big Brother's Best Friend

Every minute of every day, all over the world, dozens of companies are tracking the precise locations of tens of millions of people with mobile phones and storing the data in gigantic data repositories. One of those being tracked could be you. Anyone who has accessed these data can see whom you've met, where you spent the night, where you pray, or whether you visited a psychiatrist's office or massage parlor.

Google Maps, with over one billion users, is perhaps the most popular location-based app in the world. Most of its users are having their locations tracked. Google, Facebook, and other large tech companies are more likely to keep the location data they collect for internal use. But many smaller companies, such as Reveal Mobile, operating behind the scenes in mobile apps, also collect location data from your phone's sensors, with your knowing or unknowing consent.

The location data have many uses, such as providing maps and driving directions, facilitating payments, analyzing urban traffic patterns, and identifying where Americans have—and haven't—been practicing social distancing during the coronavirus pandemic. However, location data are often sent to marketing companies to create targeted advertising. Once companies have legally obtained location data, there are few legal restrictions on what they can do with them, including selling the data for profit. Every app is potentially transmitting data to five or ten other apps. Your data are being combined with other data to learn more about you. It's difficult to know which apps are sharing and profiting from peoples' location data.

How is this allowed to go on? When downloading an app, a mobile phone user "consented," by clicking on an "I agree" screen to the terms of service in order to use the app. Downloading the app and agreeing to terms of service are potentially allowing the user's sensitive information to be exposed to ad networks, data brokers, and other technology companies. There are some location-using apps that do so with clear disclosures, but many don't. Some companies even collect the data for one purpose while using it for another.

By law, location-tracking companies are only required to describe their practices in their privacy policies, which tend to be dense legal documents that are very difficult for the average person to understand. If a private company is legally collecting location data, it is free to distribute or share the



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data however it wants. Location-tracking companies assert that the location data they work with are anonymous, but comprehensive records of time and place are still able to identify real people.

It is often nearly impossible to know which companies receive your location information and what they do with it. Since collection of location data is largely unregulated, some of these companies can legally obtain access to phone location sensors and then buy and sell the information. Smaller location-tracking companies are able to insert their tracking programs into established apps from larger app developers using software development kits (SDKs), small programs that can be used to build features within an app, including location-tracking capabilities. SDKs are embedded in thousands of apps. The categories of app most commonly working with SDKs include travel, entertainment, maps and navigation, social networking, shopping, games, and sports.

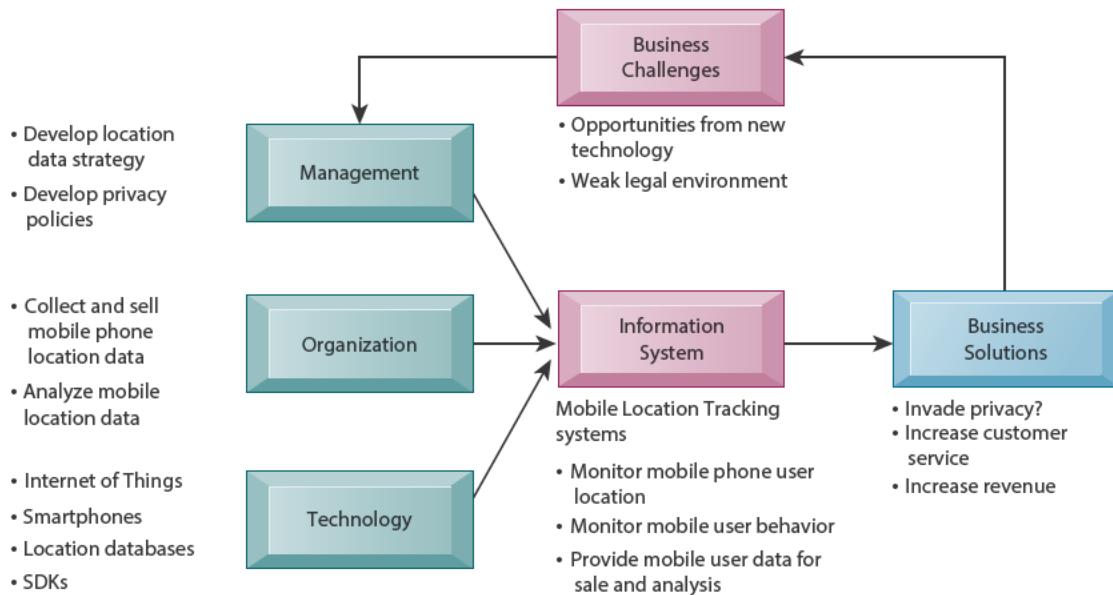
In a New York Times Opinion test, the music app iHeartRadio asked users to allow location services “to get your favorite DJ.” The iHeart app then sent the precise geolocation of the user’s phone to the data company Cuebiq for analysis such as measuring whether people visited a store after seeing an online ad. iHeartRadio stated its use of location data complies with “all applicable laws” and that its privacy policy includes “fulsome disclosure around location use.” iHeartRadio revised the consent screen for a later version of the app that includes more details.

Sources: New York Times Editorial Board, “The Government Uses ‘Near Perfect Surveillance Data’ on Americans,” *New York Times*, February 7, 2020; Stuart A. Thompson and Charlie Warzel, “Smartphones Are Spies. Here’s Whom They Report To,” *New York Times*, December 20, 2019 and “Twelve Million Phones, One Dataset, Zero Privacy,” *New York Times*, December 19, 2019.

The challenges that mobile phone location tracking poses to privacy, described in the chapter-opening case, show that technology can be a double-edged sword. It can be the source of many benefits, including the ability to use smartphones to access online maps and driving directions or local weather and business news. At the same time, digital technology creates new opportunities for invading privacy and using information that could cause harm.

The chapter-opening diagram calls attention to important points this case and this chapter raise. Advances in data management and analytics, mobile communications, and the Internet of Things (IoT) have created opportunities for organizations to track the locations of many individuals using smartphones at any given time. The organizations described here are benefiting from collecting and using location-based data to monitor mobile phone user behavior so that this information can be sold for marketing and other purposes. The use of location data from mobile phone users is also taking benefits away from individuals because it can invade their privacy. Individuals might be subject to job discrimination or special scrutiny based on behavior patterns revealed by location tracking. There are very few privacy protections for mobile location tracking.

This case illustrates an ethical dilemma because it shows two sets of interests at work, the interests of organizations that have raised profits or even helped many people with mobile location tracking and those who fervently believe that businesses and public organizations should not use personal data to invade



privacy or harm individuals. As a manager, you will need to be sensitive to both the positive and negative impacts of information systems for your firm, employees, and customers. You will need to learn how to resolve ethical dilemmas involving information systems.

Here are some questions to think about: Does analyzing mobile phone location data create an ethical dilemma? Why or why not? Should there be new privacy laws to protect personal data collected from mobile phone users? Why or why not?

4-1 What ethical, social, and political issues are raised by information systems?

In the past 20 years, we have witnessed, arguably, one of the most ethically challenging periods for U.S. and global business. Table 4.1 provides a small sample of recent cases demonstrating failed ethical judgment by senior and middle managers. These lapses in ethical and business judgment occurred across a broad spectrum of industries.

In today's global legal environment, managers who violate the law and are convicted will most likely spend time in prison. International treaties and Interpol, enabled by global information systems, have made it possible to extradite, prosecute, arrest, and imprison business managers suspected of criminal activity on a global basis.

Although business firms would, in the past, often pay for the legal defense of their employees enmeshed in civil charges and criminal investigations, firms are now encouraged to cooperate with prosecutors to reduce charges against the entire firm for obstructing investigations. More than ever, as a manager or an employee, you will have to decide for yourself what constitutes proper legal and ethical conduct.

These major instances of failed ethical and legal judgment were not masterminded by information systems departments, but information systems were

TABLE 4.1 RECENT EXAMPLES OF FAILED ETHICAL JUDGMENT BY SENIOR MANAGERS

Volkswagen AG	Installed “defeat-device” emissions software on over 500,000 diesel cars in the United States and roughly 10.5 million more worldwide that allowed them to meet U.S. emissions standards during regulatory testing while actually spewing unlawful levels of pollutants into the air in real-world driving. Criminal charges were brought against six ranking VW executives, including Oliver Schmidt, who was sentenced to seven years in prison and a \$400,000 fine.
Wells Fargo (2018)	Wells Fargo bank admitted to opening millions of false accounts, manipulating terms of mortgages, and forcing auto loan customers to purchase unneeded insurance. The bank was fined \$2.5 billion by the federal government.
Takata Corporation (2015)	Takata executives admitted they covered up faulty airbags used in millions of cars over many years. Three executives were indicted on criminal charges and Takata was fined \$1 billion. Takata filed for bankruptcy in June 2017.
Barclays Bank PLC (2012)	One of the world’s largest banks admitted to manipulating its submissions for the LIBOR benchmark interest rates in order to benefit its trading positions and the media’s perception of the banks’ financial health. Fined \$160 million.

instrumental in many of these frauds. In many cases, the perpetrators of these crimes artfully used financial reporting information systems to bury their decisions from public scrutiny.

We deal with the issue of control in information systems in Chapter 8. In this chapter, we will talk about the ethical dimensions of these and other actions based on the use of information systems.

Ethics refers to the principles of right and wrong that individuals, acting as free moral agents, use to make choices to guide their behavior. Information systems raise new ethical questions for both individuals and societies because they create opportunities for intense social change and, thus, threaten existing distributions of power, money, rights, and obligations. Like other technologies, such as steam engines, electricity, and the telephone, information technology can be used to achieve social progress, but it can also be used to commit crimes and threaten cherished social values. The development of information technology will produce benefits for many and costs for others.

Ethical issues in information systems have been given new urgency by the rise of the Internet and e-commerce. Internet and digital technologies make it easier than ever to assemble, integrate, and distribute information, unleashing new concerns about the appropriate use of customer information, the protection of personal privacy, and the protection of intellectual property.

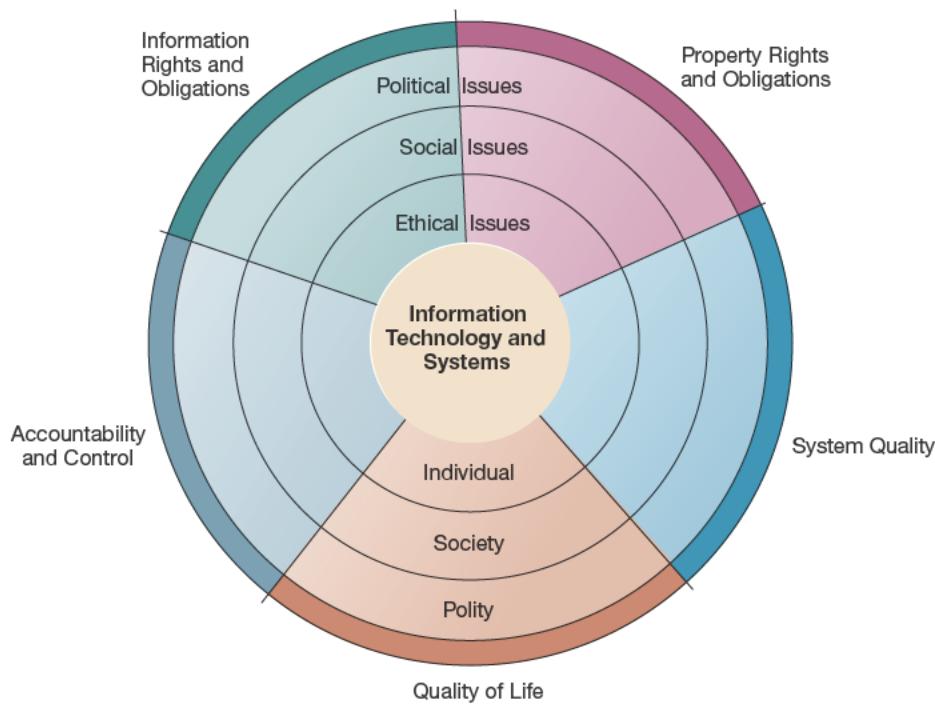
Other pressing ethical issues that information systems raise include establishing accountability for the consequences of information systems, setting standards to safeguard system quality that protects the safety of the individual and society, and preserving values and institutions considered essential to the quality of life in an information society. When using information systems, it is essential to ask, “What is the ethical and socially responsible course of action?”

A Model for Thinking about Ethical, Social, and Political Issues

Ethical, social, and political issues are closely linked. The ethical dilemma you may face as a manager of information systems typically is reflected in social and political debate. One way to think about these relationships is shown in Figure 4.1. Imagine society as a more or less calm pond on a summer day,

FIGURE 4.1 THE RELATIONSHIP BETWEEN ETHICAL, SOCIAL, AND POLITICAL ISSUES IN AN INFORMATION SOCIETY

The introduction of new information technology has a ripple effect, raising new ethical, social, and political issues that must be dealt with on the individual, social, and political levels. These issues have five moral dimensions: information rights and obligations, property rights and obligations, system quality, quality of life, and accountability and control.



a delicate ecosystem in partial equilibrium with individuals and with social and political institutions. Individuals know how to act in this pond because social institutions (family, education, organizations) have developed well-honed rules of behavior, and these are supported by laws developed in the political sector that prescribe behavior and promise sanctions for violations. Now toss a rock into the center of the pond. What happens? Ripples, of course.

Imagine instead that the disturbing force is a powerful shock of new information technology and systems hitting a society more or less at rest. Suddenly, individual actors are confronted with new situations often not covered by the old rules. Social institutions cannot respond overnight to these ripples—it may take years to develop etiquette, expectations, social responsibility, politically correct attitudes, or approved rules. Political institutions also require time before developing new laws and often require the demonstration of real harm before they act. In the meantime, you may have to act. You may be forced to act in a legal gray area.

We can use this model to illustrate the dynamics that connect ethical, social, and political issues. This model is also useful for identifying the main moral dimensions of the information society, which cut across various levels of action—individual, social, and political.

Five Moral Dimensions of the Information Age

The major ethical, social, and political issues that information systems raise include the following moral dimensions.

- *Information rights and obligations* What **information rights** do individuals and organizations possess with respect to themselves? What can they protect?
- *Property rights and obligations* How will traditional intellectual property rights be protected in a digital society in which tracing and accounting for ownership are difficult, and ignoring such property rights is so easy?
- *Accountability and control* Who can and will be held accountable and liable for the harm done to individual and collective information and property rights?
- *System quality* What standards of data and system quality should we demand to protect individual rights and the safety of society?
- *Quality of life* What values should be preserved in an information- and knowledge-based society? Which institutions should we protect from violation? Which cultural values and practices does the new information technology support?

We explore these moral dimensions in detail in Sections 4-3 and 4-4.

Key Technology Trends that Raise Ethical Issues

Ethical issues long preceded information technology. Nevertheless, information technology has heightened ethical concerns, taxed existing social arrangements, and made some laws obsolete or severely crippled. Five key technological trends are responsible for these ethical stresses, summarized in Table 4.2.

The doubling of computing power every 18 months has made it possible for most organizations to use information systems for their core production processes. As a result, our dependence on systems and our vulnerability to system errors and poor data quality have increased. Social rules and laws have not yet adjusted to this dependence. Standards for ensuring the accuracy and reliability of information systems (see Chapter 8) are not universally accepted or enforced.

Advances in data storage techniques and rapidly declining storage costs have been responsible for the proliferation of databases on individuals—employees, customers, and potential customers—maintained by private and public organizations. These advances in data storage have made the routine

TABLE 4.2 TECHNOLOGY TRENDS THAT RAISE ETHICAL ISSUES

TREND	IMPACT
Computing power doubles every 18 months	More organizations depend on computer systems for critical operations and become more vulnerable to system failures.
Data storage costs rapidly decline	Organizations can easily maintain detailed databases on individuals. There are no limits on the data collected about you.
Data analysis advances	Companies can analyze vast quantities of data gathered on individuals to develop detailed profiles of individual behavior. Large-scale population surveillance is enabled.
Networking advances	The cost of moving data and making data accessible from anywhere falls exponentially. Access to data becomes more difficult to control.
Mobile device growth impact	Individual cell phones may be tracked without user consent or knowledge. The always-on device becomes a tether.



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Credit card purchases can make personal information available to market researchers, telemarketers, and direct mail companies. Advances in information technology facilitate the invasion of privacy.

violation of individual privacy both inexpensive and effective. Enormous data storage systems for terabytes and petabytes of data are now available on-site or as online services for firms of all sizes to use in identifying customers.

Advances in data analysis techniques for large pools of data are another technological trend that heightens ethical concerns because companies and government agencies can find out highly detailed personal information about individuals. With contemporary data management tools (see Chapter 6), companies can assemble and combine myriad pieces of information about you stored on computers much more easily than in the past.

Think of all the ways you generate digital information about yourself—credit card purchases; telephone calls; magazine subscriptions; video rentals; mail-order purchases; banking records; local, state, and federal government records (including court and police records); and visits to websites. Put together and mined properly, this information could reveal not only your credit information but also your driving habits, your tastes, your associations, what you read and watch, and your political interests.

Companies purchase relevant personal information from these sources to help them more finely target their marketing campaigns. Chapters 6 and 12 describe how companies can analyze large pools of data from multiple sources to identify buying patterns of customers rapidly and make individualized recommendations. The use of computers to combine data from multiple sources and create digital dossiers of detailed information on individuals is called **profiling**.

For example, several thousand of the most popular websites allow Google Marketing Platform (formerly DoubleClick), an Internet advertising broker, to track the activities of their visitors in exchange for revenue from advertisements based on visitor information Google Marketing Platform gathers. Google Marketing Platform uses this information to create a profile of each online visitor, adding more detail to the profile as the visitor accesses an associated Google Marketing Platform site. Over time, Google Marketing Platform can create a detailed dossier of a person's spending and computing habits on the web that is sold to companies to help them target their web ads more precisely. Advertisers can combine online consumer information with offline information, such as credit card purchases at stores.

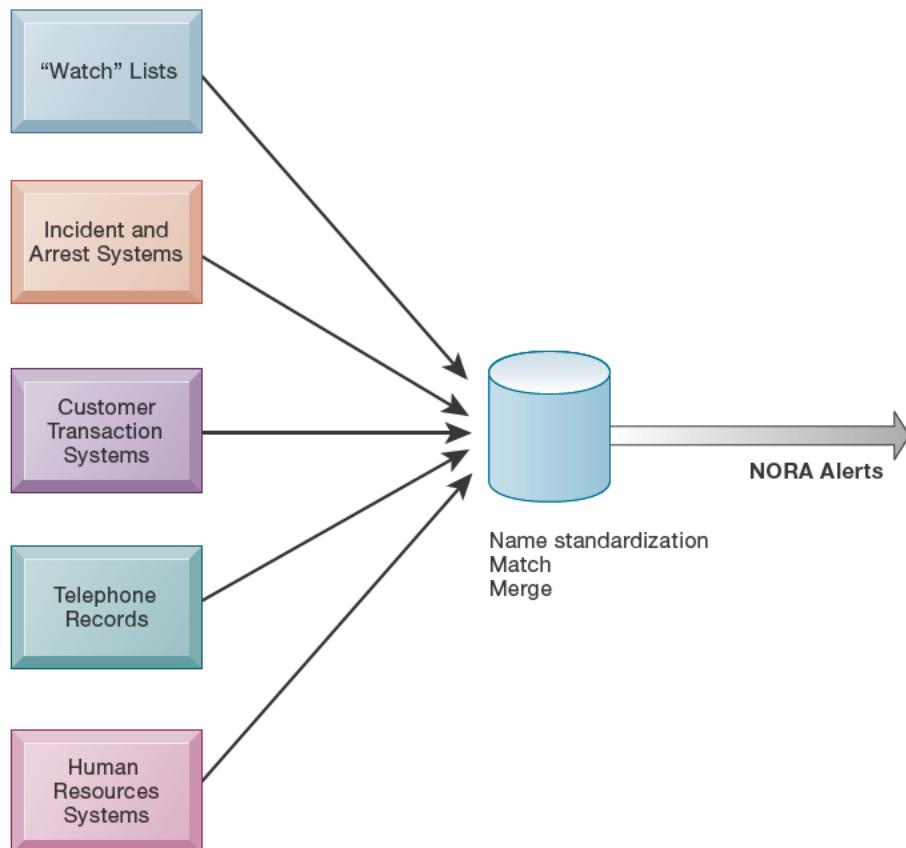
LexisNexis Risk Solutions (formerly ChoicePoint) gathers data from police, criminal, and motor vehicle records, credit and employment histories, current and previous addresses, professional licenses, and insurance claims to assemble and maintain dossiers on almost every adult in the United States. The company sells this personal information to businesses and government agencies. Demand for personal data is so enormous that data broker businesses, such as Risk Solutions, Acxiom, Nielsen, Experian, Equifax, and CoreLogic, are flourishing. The two largest credit card networks, Visa Inc. and Mastercard Inc., have agreed to link credit card purchase information with consumer social network and other information to create customer profiles that could be sold to advertising firms.

A data analysis technology called **nonobvious relationship awareness (NORA)** has given both the government and the private sector even more powerful profiling capabilities. NORA can take information about people from many disparate sources, such as employment applications, telephone records, customer listings, and wanted lists, and correlate relationships to find obscure connections that might help identify criminals or terrorists (see Figure 4.2).

NORA technology scans data and extracts information as the data are being generated so that it could, for example, instantly discover a man at an airline ticket counter who shares a phone number with a known terrorist before that person boards an airplane. The technology is considered a valuable tool for homeland security but does have privacy implications because it can provide such a detailed picture of the activities and associations of a single individual.

FIGURE 4.2 NONOBVIOUS RELATIONSHIP AWARENESS (NORA)

NORA technology can take information about people from disparate sources and find obscure, nonobvious relationships. It might discover, for example, that an applicant for a job at a casino shares a telephone number with a known criminal and issue an alert to the hiring manager.



Finally, advances in networking, including the Internet, promise to reduce greatly the costs of moving and accessing large quantities of data and open the possibility of mining large pools of data remotely by using small desktop machines, mobile devices, and cloud servers, permitting an invasion of privacy on a scale and with a precision heretofore unimaginable.

4-2 What specific principles for conduct can be used to guide ethical decisions?

Ethics is a concern of humans who have freedom of choice. Ethics is about individual choice: When faced with alternative courses of action, what is the correct moral choice? What are the main features of ethical choice?

Basic Concepts: Responsibility, Accountability, and Liability

Ethical choices are decisions made by individuals who are responsible for the consequences of their actions. **Responsibility** is a key element of ethical action. Responsibility means that you accept the potential costs, duties, and obligations for the decisions you make. **Accountability** is a feature of systems and social institutions; it means that mechanisms are in place to determine who took action and who is responsible. Systems and institutions in which it is impossible to find out who took what action are inherently incapable of ethical analysis or ethical action. **Liability** extends the concept of responsibility further to the area of laws. Liability is a feature of political systems in which a body of laws is in place that permits individuals to recover the damages done to them by other actors, systems, or organizations. **Due process** is a related feature of law-governed societies and is a process in which laws are known and understood, and ability exists to appeal to higher authorities to ensure that the laws are applied correctly.

These basic concepts form the underpinning of an ethical analysis of information systems and those who manage them. First, information technologies are filtered through social institutions, organizations, and individuals. Systems do not have impacts by themselves. Whatever information system effects exist are products of institutional, organizational, and individual actions and behaviors. Second, responsibility for the consequences of technology falls clearly on the institutions, organizations, and individual managers who choose to use the technology. Using information technology in a socially responsible manner means that you can and will be held accountable for the consequences of your actions. Third, in an ethical, political society, individuals and others can recover damages done to them through a set of laws characterized by due process.

Ethical Analysis

When confronted with a situation that seems to present ethical issues, how should you analyze it? The following five-step process should help:

1. *Identify and describe the facts clearly* Find out who did what to whom and where, when, and how. In many instances, you will be surprised at the errors in the initially reported facts, and often you will find that simply getting the facts straight helps define the solution. It also helps to get the opposing parties involved in an ethical dilemma to agree on the facts.

2. *Define the conflict or dilemma and identify the higher-order values involved*
Ethical, social, and political issues always reference higher values. The parties to a dispute all claim to be pursuing higher values (e.g., freedom, privacy, protection of property, or the free enterprise system). Typically, an ethical issue involves a dilemma: two diametrically opposed courses of action that support worthwhile values. For example, the chapter-opening case study illustrates two competing values: the need to make organizations more efficient and cost-effective and the need to respect individual privacy.
3. *Identify the stakeholders* Every ethical, social, and political issue has stakeholders: players in the game who have an interest in the outcome, who have invested in the situation, and usually who have vocal opinions. Find out the identity of these groups and what they want. This will be useful later when designing a solution.
4. *Identify the options that you can reasonably take* You may find that none of the options satisfy all the interests involved but that some options do a better job than others. Sometimes arriving at a good or ethical solution may not always be a balancing of consequences to stakeholders.
5. *Identify the potential consequences of your options* Some options may be ethically correct but disastrous from other points of view. Other options may work in one instance but not in similar instances. Always ask yourself, “What if I choose this option consistently over time?”

Candidate Ethical Principles

Once your analysis is complete, what ethical principles or rules should you use to make a decision? What higher-order values should inform your judgment? Although you are the only one who can decide which among many ethical principles you will follow, and how you will prioritize them, it is helpful to consider some ethical principles with deep roots in many cultures that have survived throughout recorded history:

1. Do unto others as you would have them do unto you (the **Golden Rule**). Putting yourself in the place of others, and thinking of yourself as the object of the decision, can help you think about fairness in decision making.
2. If an action is not right for everyone to take, it is not right for anyone (**Immanuel Kant's categorical imperative**). Ask yourself, “If everyone did this, could the organization, or society, survive?”
3. If an action cannot be taken repeatedly, it is not right to take at all. This is the **slippery slope rule**: An action may bring about a small change now that is acceptable, but if it is repeated, it would bring unacceptable changes in the long run. In the vernacular, it might be stated as “once started down a slippery path, you may not be able to stop.”
4. Take the action that achieves the higher or greater value (**utilitarian principle**). This rule assumes you can prioritize values in a rank order and understand the consequences of various courses of action.
5. Take the action that produces the least harm or the least potential cost (**risk aversion principle**). Some actions have extremely high failure costs of very low probability (e.g., building a nuclear generating facility in an urban area) or extremely high failure costs of moderate probability (speeding and automobile accidents). Avoid actions that have extremely high failure costs; focus on reducing the probability of accidents occurring.
6. Assume that virtually all tangible and intangible objects are owned by someone else unless there is a specific declaration otherwise. (This is the **ethical no-free-lunch rule**.) If something someone else has created is useful to you, it has value, and you should assume the creator wants compensation for this work.

Actions that do not easily pass these rules deserve close attention and a great deal of caution. The appearance of unethical behavior may do as much harm to you and your company as actual unethical behavior.

Professional Codes of Conduct

When groups of people claim to be professionals, they take on special rights and obligations because of their special claims to knowledge, wisdom, and respect. Professional codes of conduct are promulgated by associations of professionals such as the General Council of the Bar for England and Wales, the UK's General Medical Council, the Association of Information Technology Professionals (AITP), and the Association for Computing Machinery (ACM). These professional groups take responsibility for the partial regulation of their professions by determining entrance qualifications and competence. Codes of ethics are promises by professions to regulate themselves in the general interest of society. For example, avoiding harm to others, honoring property rights (including intellectual property), and respecting privacy are among the General Moral Imperatives of the ACM's Code of Ethics and Professional Conduct.

Some Real-World Ethical Dilemmas

Information systems have created new ethical dilemmas in which one set of interests is pitted against another. For example, many companies use voice recognition software to reduce the size of their customer support staff by enabling computers to recognize a customer's responses to a series of computerized questions. Many companies monitor what their employees are doing on the Internet to prevent them from wasting company resources on nonbusiness activities (see the Chapter 7 Interactive Session on Management).

In each instance, you can find competing values at work, with groups lined up on either side of a debate. A company may argue, for example, that it has a right to use information systems to increase productivity and reduce the size of its workforce to lower costs and stay in business. Employees displaced by information systems may argue that employers have some responsibility for their welfare. Business owners might feel obligated to monitor employee email and Internet use to minimize drains on productivity. Employees might believe they should be able to use the Internet for short personal tasks in place of the telephone. A close analysis of the facts can sometimes produce compromised solutions that give each side half a loaf. Try to apply some of the principles of ethical analysis described to each of these cases. What is the right thing to do?

4-3 Why do contemporary information systems technology and the Internet pose challenges to the protection of individual privacy and intellectual property?

In this section, we take a closer look at the five moral dimensions of information systems first described in Figure 4.1. In each dimension, we identify the ethical, social, and political levels of analysis and use real-world examples to illustrate the values involved, the stakeholders, and the options chosen.

Information Rights: Privacy and Freedom in the Internet Age

Privacy is the claim of individuals to be left alone, free from surveillance or interference from other individuals or organizations, including the state. Claims to privacy are also involved at the workplace. Millions of employees are subject to digital and other forms of high-tech surveillance. Information technology and systems threaten individual claims to privacy by making the invasion of privacy cheap, profitable, and effective.

The claim to privacy is protected in the United States, Canadian, and German constitutions in a variety of ways and in other countries through various statutes. In the United States, the claim to privacy is protected primarily by the First Amendment guarantees of freedom of speech and association, the Fourth Amendment protections against unreasonable search and seizure of one's personal documents or home, and the guarantee of due process. The Privacy Act of 1974 has been the most important of U.S. privacy laws, regulating the federal government's collection, use, and disclosure of information. At present, most U.S. federal privacy laws apply only to the federal government and regulate very few areas of the private sector.

Most American and European privacy law is based on a regime called **Fair Information Practices (FIP)**, first set forth in a report written in 1973 by a federal government advisory committee and updated in 2010 to take into account new privacy-invading technology (U.S. Department of Health, Education, and Welfare, 1973). FIP is a set of principles governing the collection and use of information about individuals. FIP principles are based on the notion of a mutuality of interest between the record holder and the individual. The individual has an interest in engaging in a transaction, and the record keeper—usually a business or government agency—requires information about the individual to support the transaction. After information is gathered, the individual maintains an interest in the record, and the record may not be used to support other activities without the individual's consent. In 1998, the Federal Trade Commission (FTC) restated and extended the original FIP to provide guidelines for protecting online privacy. Table 4.3 describes the FTC's FIP principles.

The FTC's FIP principles are being used as guidelines to drive changes in privacy legislation. The FTC has added three practices to its framework for privacy. Firms should adopt privacy by design, building products and services that protect privacy; firms should increase the transparency of their data practices; and firms should require consumer consent and provide

TABLE 4.3 FEDERAL TRADE COMMISSION FAIR INFORMATION PRACTICE PRINCIPLES

Notice/awareness (core principle). Websites must disclose their information practices before collecting data. Includes identification of collector; uses of data; other recipients of data; nature of collection (active/inactive); voluntary or required status; consequences of refusal; and steps taken to protect confidentiality, integrity, and quality of the data.
Choice/consent (core principle). A choice regime must be in place allowing consumers to choose how their information will be used for secondary purposes other than supporting the transaction, including internal use and transfer to third parties.
Access/participation. Consumers should be able to review and contest the accuracy and completeness of data collected about them in a timely, inexpensive process.
Security. Data collectors must take responsible steps to ensure that consumer information is accurate and secure from unauthorized use.
Enforcement. A mechanism must be in place to enforce FIP principles. This can involve self-regulation, legislation giving consumers legal remedies for violations, or federal statutes and regulations.

clear options to opt out of data-collection schemes. The FTC has extended its privacy policies to address behavioral targeting, smartphone tracking, the Internet of Things (IoT), and mobile health apps (Federal Trade Commission, 2019; 2015). In 2018 the FTC reached settlements with Venmo, the P2P payment app, Uber, and RealPage to resolve privacy and data security issues in systems operated by these firms.

Public opinion polls show an ongoing distrust of online marketers. Although there are many studies of privacy issues at the federal level, there has been no significant legislation in recent years. A 2016 survey by the Pew Research Center found that 91 percent of Americans feel consumers have lost control of their personal information online and 86 percent have taken steps to protect their information online.

Privacy protections have also been added to U.S. federal laws deregulating financial services and safeguarding the maintenance and transmission of health information about individuals. For instance, the U.S. Gramm-Leach-Bliley Act of 1999 includes some privacy protection for consumers of financial services. All financial institutions are required to disclose their policies and practices for protecting the privacy of nonpublic personal information and to allow customers to opt out of information-sharing arrangements with nonaffiliated third parties.

The U.S. Health Insurance Portability and Accountability Act (HIPAA) of 1996, which took effect in 2003, includes privacy protection for medical records. The law gives patients access to their personal medical records that healthcare providers, hospitals, and health insurers maintain and the right to authorize how protected information about themselves can be used or disclosed.

The European Directive on Data Protection

In 2018 the European Commission implemented the EU **General Data Protection Regulation (GDPR)**, which is arguably the most important privacy legislation in the last 20 years since the FTC's Fair Information Practices Principles. It applies to all firms and organizations that collect, store, or process personal information of EU citizens, and these protections apply worldwide regardless of where the processing takes place (European Commission, 2018; Satariano, 2018).

The GDPR is an updated framework for protecting PII (personally identifiable information), and replaces an earlier Data Protection Directive of 1998. In Europe, privacy protection is historically much stronger than it is in the United States. In the United States, there is no federal agency charged with enforcing privacy laws, and there is no single privacy statute governing private corporation use of PII. Instead, privacy laws are piecemeal, sector by sector (e.g., medical privacy, educational privacy, and financial privacy laws). These are enforced by the FTC, through self-regulation by businesses, and by individuals who must sue agencies or companies in court to recover damages. This is expensive and rarely done.

In the EU data protection laws are comprehensive, applying to all organizations, and enforced by data protection agencies in each country to pursue complaints brought by citizens and actively enforce privacy laws. The GDPR protects a wide variety of PII: basic identity information such as name, address, and ID numbers; web data such as location, IP address, cookie data, and RFID tags; health and genetic data; mobile phone number; driver's license and passport number; biometric and facial data; racial and ethnic data; political opinions; and sexual orientation.

The main objective of this new framework is to strengthen the rights of citizens to their own personal information and to strengthen oversight of firms to ensure they implement these individual rights. A second thrust was to harmonize conflicting data protection standards among the 28 European bloc nations and create a single EU agency to implement and enforce the regulation. And third, to enforce these conditions worldwide for all organizations that operate in the EU, or process data pertaining to EU citizens, regardless of where the organization is located.

For individuals, the GDPR requires organizations to allow consumers to access all their personal information without charge within one month; delete personal data (right to be forgotten); ensure data portability so consumers are not locked into a particular service; and guarantee the right to sue providers for damages or abuse of PII, including class action law suits.

Organizational requirements have been strengthened to include requiring organizations to have a data protection officer that reports to senior management; requiring explicit consent before collecting data (positive opt-in), and eliminating default opt-in processes; publishing the rationale for data collection and the length of retention; reporting of breaches and hacks within 72 hours; liability for data they share with partners or other firms, and a listing of all firms they share data with; building privacy protections into all new systems (privacy by design); limiting targeting and retargeting of individuals to audience-level, anonymized data, rather than targeting based on intimate, personal profiles; limiting the collection of personal data to only that which is needed to support a task, or a transaction, and then deleting it shortly thereafter. Abuse of PII can be fined up to \$20 million or 4 percent of the organization's global revenue, whichever is greater. Finally, the EU will enforce the GDPR requirements with non-EU countries like the United States using intergovernmental privacy shield agreements that ensure that EU data processed in non-EU nations meets GDPR standards. Privacy shield agreements are a more enforceable version of earlier **safe harbor** agreements. A safe harbor is a private self-regulating policy and enforcement mechanism that meets the objectives of government regulators and legislation but does not involve government regulation or enforcement (Lomas, 2018).

The GDPR is clearly aimed at Facebook, Google, Twitter, and other ad-based web businesses that build collections of personal data by tracking individuals across the web, merging that data with other data from firms and data brokers, in order to build comprehensive digital images (profiles) and to target these persons with ads. Google and Facebook are both extremely popular in Europe and dominate their markets, but at the same time they are widely criticized for invading privacy and not protecting PII.

Privacy laws have been enacted in over 80 nations around the world. Table 4.4 provides some examples.

Internet Challenges to Privacy

Internet technology has posed new challenges for the protection of individual privacy. Websites track searches that have been conducted, the websites and web pages visited, the online content a person has accessed, and what items that person has inspected or purchased over the web. This monitoring and tracking of website visitors occurs in the background without the visitor's knowledge. It is conducted not just by individual websites but by advertising networks such as Microsoft Advertising, Yahoo, and Google's Marketing Platform that are capable of tracking personal browsing behavior across thousands of websites. Both website publishers and the advertising industry defend tracking of individuals

TABLE 4.4**EXAMPLES OF PRIVACY LAWS IN VARIOUS NATIONS**

NATION	PRIVACY LAW
Australia	Australia Privacy Principles (APP) establish the privacy protection framework in the Privacy Act of 1988. APP consists of 13 principles guiding the handling of personal information in an open and clear manner. Privacy Policies detail why and how personal information is collected, how individuals can access and correct their own information, and how individuals can complain about a breach of the principles. APP apply to most Australian Government agencies and some private sector organizations. APP are principles-based law, which gives an organization flexibility in tailoring their personal information handling practices to their business models and the diverse needs of individuals. A breach of an APP can lead to regulatory action and penalties.
Iceland	Iceland is not a member of the EU but has close ties as a party to the European Economic Area Agreement. Iceland is obligated to incorporate specific EU acts into Icelandic national legislation, and has implemented the EU GDPR through its Data Protection Act. Iceland's Data Protection Authority (DPA) is authorized to impose administrative fines for breaches of GDPR and Data Protection Act provisions. A significant breach of the Data Protection Act (such as when the PII of a large number of data subjects that should have remained confidential is deliberately transferred to a third party or published publicly) can result in up to a three-year prison sentence.
Singapore	The Personal Data Protection Act (DPA) of 2012 provides various rules governing the collection, use, disclosure, and care of personal data. DPA stipulates that personal information may only be collected for reasonable purposes and with the consent of the individual, who must also be informed of the purpose for the data collection. There are some exceptions. (For example, DPA exempts personal data processed by an individual for the purposes of their personal, family or household affairs. Police or taxation authorities do not have to disclose information held or processed to prevent crime or taxation fraud.)
South Africa	Protection of personal data is addressed by the Electronic Communications and Transactions Act of 2002, which provides for the facilitation and regulation of electronic communications and transactions, including protection of personal information. Subscription to the ECT Act's regime for protecting PII is voluntary. Collectors of PII may subscribe to a set of universally accepted data protection principles. It is envisaged that individuals will prefer to deal only with the data collectors that have subscribed to ECT Act data protection principles. Sanctions for breaching ECT Act provisions are left to the participating parties themselves to agree on.

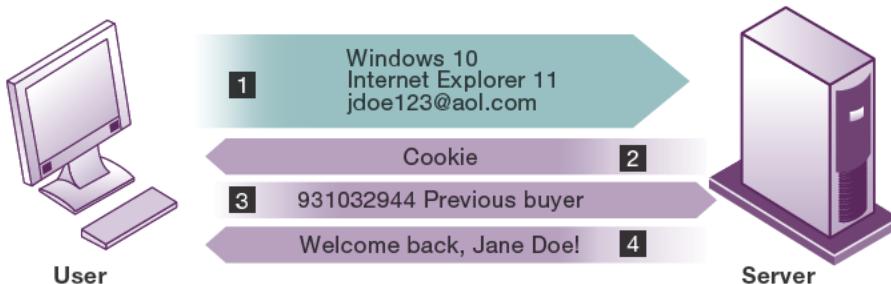
across the web because doing so allows more relevant ads to be targeted to users, and this pays for the cost of publishing websites. The commercial demand for this personal information is virtually insatiable. However, these practices also impinge on individual privacy.

Cookies are small text files deposited on a computer hard drive when a user visits websites. Cookies identify the visitor's web browser software and track visits to the website. When the visitor returns to a site that has stored a cookie, the website software searches the visitor's computer, finds the cookie, and knows what that person has done in the past. It may also update the cookie, depending on the activity during the visit. In this way, the site can customize its content for each visitor's interests. For example, if you purchase a book on Amazon.com and return later from the same browser, the site will welcome you by name and recommend other books of interest based on your past purchases. Google Marketing Platform, described earlier in this chapter, uses cookies to build its dossiers with details of online purchases and examine the behavior of website visitors. Figure 4.3 illustrates how cookies work.

Websites using cookie technology cannot directly obtain visitors' names and addresses. However, if a person has registered at a site, that information can be combined with cookie data to identify the visitor. Website owners can also combine the data they have gathered from cookies and other website monitoring tools with personal data from other sources, such as offline data collected from surveys or paper catalog purchases, to develop very detailed profiles of their visitors.

FIGURE 4.3 HOW COOKIES IDENTIFY WEB VISITORS

Cookies are written by a website on a visitor's computer. When the visitor returns to that website, the web server requests the ID number from the cookie and uses it to access the data stored by that server on that visitor. The website can then use these data to display personalized information.



1. The web server reads the user's web browser and determines the operating system, browser name, version number, Internet address, and other information.
2. The server transmits a tiny text file with user identification information called a cookie, which the user's browser receives and stores on the user's computer hard drive.
3. When the user returns to the website, the server requests the contents of any cookie it deposited previously in the user's computer.
4. The web server reads the cookie, identifies the visitor, and calls up data on the user.

There are now even more subtle and surreptitious tools for surveillance of Internet users. **Web beacons**, also called *web bugs* (or simply tracking files), are tiny software programs that keep a record of users' online clickstreams. They report this data back to whoever owns the tracking file, which is invisibly embedded in email messages and web pages to monitor the behavior of the user visiting a website or sending email. Web beacons are placed on popular websites by third-party firms who pay the websites a fee for access to their audience. So how common is web tracking? In a path-breaking series of articles in the *Wall Street Journal*, researchers examined the tracking files on 50 of the most popular U.S. websites. What they found revealed a very widespread surveillance system. On the 50 sites, they discovered 3,180 tracking files installed on visitor computers. Only one site, Wikipedia, had no tracking files. Two-thirds of the tracking files came from 131 companies whose primary business is identifying and tracking Internet users to create consumer profiles that can be sold to advertising firms looking for specific types of customers. The biggest trackers were Google, Microsoft, and Quantcast, all of whom are in the business of selling ads to advertising firms and marketers. A follow-up study found tracking on the 50 most popular sites had risen nearly fivefold due to the growth of online ad auctions where advertisers buy the data about users' web-browsing behavior.

Other **spyware** can secretly install itself on an Internet user's computer by piggybacking on larger applications. Once installed, the spyware calls out to websites to send banner ads and other unsolicited material to the user, and it can report the user's movements on the Internet to other computers. More information is available about intrusive software in Chapter 8.

About 80 percent of global Internet users use Google Search and other Google services, making Google the world's largest collector of online user data. Whatever Google does with its data has an enormous impact on online privacy. Most experts believe that Google possesses the largest collection of personal information in the world—more data on more people than any government agency. The nearest competitor is Facebook.

After Google acquired the advertising network DoubleClick (now Google Marketing Platform) in 2007, it began using behavioral targeting to help display more relevant ads based on users' search activities and to target individuals as they move from one site to another to show them display or banner ads. Google allows tracking software on its search pages, and using Marketing Platform, it can track users across the Internet. One of its programs enables advertisers to target ads based on the search histories of Google users, along with any other information the user submits to Google such as age, demographics, region, and web activities (such as blogging). Google's AdSense program enables Google to help advertisers select keywords and design ads for various market segments based on search histories such as helping a clothing website create and test ads targeted at teenage females. Google now displays targeted ads on YouTube and Google mobile applications, and its Marketing Platform ad network serves up targeted banner ads.

The United States has allowed businesses to gather transaction information generated in the marketplace and then use that information for other marketing purposes without obtaining the **informed consent** of the individual whose information is being used. These firms argue that when users agree to the sites' terms of service, they are also agreeing to allow the site to collect information about their online activities. An **opt-out** model of informed consent permits the collection of personal information until the consumer specifically requests the data not to be collected. Privacy advocates would like to see wider use of an **opt-in** model of informed consent in which a business is prohibited from collecting any personal information unless the consumer specifically takes action to approve information collection and use. Here, the default option is no collection of user information.

The online industry has preferred self-regulation to privacy legislation for protecting consumers. Members of the advertising network industry, including Google's Marketing Platform, have created an industry association called the Network Advertising Initiative (NAI) to develop its own privacy policies to help consumers opt out of advertising network programs and provide consumers redress from abuses.

Individual firms such as Microsoft, Mozilla Foundation, Yahoo, and Google have recently adopted policies on their own in an effort to address public concern about tracking people online. Microsoft's Internet Explorer 11 web browser was released in 2015 with the opt-out option as the default, but this was changed to opt-in by default because most websites ignored the request to opt out. Other browsers have opt-out options, but users need to turn them on, and most users fail to do this. AOL established an opt-out policy that allows users of its site to choose not to be tracked. Yahoo follows NAI guidelines and allows opt-out for tracking and web beacons (web bugs). Google has reduced retention time for tracking data.

In general, most Internet businesses do little to protect the privacy of their customers, and consumers do not do as much as they should to protect themselves. For commercial websites that depend on advertising to support themselves, most revenue derives from selling access to customer information. Of the companies that do post privacy policies on their websites, about half do not monitor their sites to ensure that they adhere to these policies. The vast majority of online customers claim they are concerned about online privacy, but fewer than half read the privacy statements on websites. In general, website privacy policies require a law degree to understand and are ambiguous about key terms (Laudon and Traver, 2020). Today, what firms such as Facebook and Google call a privacy policy is in fact a data use policy. The concept of privacy is associated with consumer rights, which firms do not wish to recognize. A data

use policy simply tells customers how the information will be used without any mention of rights.

Technical Solutions

In addition to legislation, there are a few technologies that can protect user privacy during interactions with websites. Many of these tools are used for encrypting email, for making email or surfing activities appear anonymous, for preventing client computers from accepting cookies, or for detecting and eliminating spyware. Apple iOS devices have settings for limiting ad tracking. For the most part, however, technical solutions have failed to protect users from being tracked as they move from one site to another.

Many browsers have Do Not Track options. For users who have selected the Do Not Track browser option, their browser will send a request to websites that the user's behavior not be tracked, but websites are not obligated to honor these requests. There is no online advertising industry agreement on how to respond to Do Not Track requests nor, currently, any legislation requiring websites to stop tracking. Private browser encryption software or apps on mobile devices provide consumers a powerful opportunity to at least keep their messages private.

Property Rights: Intellectual Property

Contemporary information systems have severely challenged existing laws and social practices that protect **intellectual property**. Intellectual property is defined as tangible and intangible products of the mind created by individuals or corporations. Information technology has made it difficult to protect intellectual property because computerized information can be so easily copied or distributed on networks. Intellectual property is subject to a variety of protections under four legal traditions: copyright, patents, trademarks, and trade secrets.

Copyright

Copyright is a statutory grant that protects creators of intellectual property from having their work copied by others for any purpose during the life of the author plus an additional 70 years after the author's death. For corporate-owned works, copyright protection lasts for 95 years after their initial creation. Congress has extended copyright protection to books, periodicals, lectures, dramas, musical compositions, maps, drawings, artwork of any kind, and motion pictures. The intent behind copyright laws has been to encourage creativity and authorship by ensuring that creative people receive the financial and other benefits of their work. Most industrial nations have their own copyright laws, and there are several international conventions and bilateral agreements through which nations coordinate and enforce their laws.

In the mid-1960s, the Copyright Office began registering software programs, and in 1980, Congress passed the Computer Software Copyright Act, which clearly provides protection for software program code and copies of the original sold in commerce; it sets forth the rights of the purchaser to use the software while the creator retains legal title.

Copyright protects against copying entire programs or their parts. Damages and relief are readily obtained for infringement. The drawback to copyright protection is that the underlying ideas behind a work are not protected, only their manifestation in a work. A competitor can use your software, understand

how it works, and build new software that follows the same concepts without infringing on a copyright.

Look-and-feel copyright infringement lawsuits are precisely about the distinction between an idea and its expression. For instance, in the early 1990s, Apple Computer sued Microsoft Corporation and Hewlett-Packard for infringement of the expression of Apple's Macintosh interface, claiming that the defendants copied the expression of overlapping windows. The defendants countered that the idea of overlapping windows can be expressed only in a single way and, therefore, was not protectable under the merger doctrine of copyright law. When ideas and their expression merge, the expression cannot be copyrighted.

In general, courts appear to be following the reasoning of a 1989 case—*Brown Bag Software v. Symantec Corp.*—in which the court dissected the elements of software alleged to be infringing. The court found that similar concept, function, general functional features (e.g., drop-down menus), and colors are not protectable by copyright law (*Brown Bag Software v. Symantec Corp.*, 1992).

Patents

In the United States, A **patent** grants the owner an exclusive monopoly on the ideas behind an invention for 20 years. The intent behind U.S. patent law was to ensure that inventors of new machines, devices, or methods receive the full financial and other rewards of their labor and yet make widespread use of the invention possible by providing detailed diagrams for those wishing to use the idea under license from the patent's owner. The granting of a patent is determined by the United States Patent and Trademark Office and relies on court rulings.

The key concepts in patent law are originality, novelty, and invention. The Patent Office did not accept applications for software patents routinely until a 1981 Supreme Court decision held that computer programs could be part of a patentable process. Since that time, hundreds of patents have been granted, and thousands await consideration.

The strength of patent protection is that it grants a monopoly on the underlying concepts and ideas of software. The difficulty is passing stringent criteria of nonobviousness (e.g., the work must reflect some special understanding and contribution), originality, and novelty as well as years of waiting to receive protection.

The danger of patents is that they may stifle competition by raising barriers to entry into an industry. Patents force new entrants to pay licensing fees to patent owners and therefore can slow down the development of technical applications of new ideas.

In Europe, patents can be obtained directly from particular countries under the terms of specific national laws or via a central process enabled by the European Patent Convention, which harmonized many of the national laws to a certain extent, at the European Patent Office.

Trademarks

Trademarks are the marks, symbols, and images used to distinguish products in the marketplace. Trademark laws protect consumers by ensuring they receive what they paid for. These laws also protect the investments that firms have made to bring products to market. Typical trademark infringement violations occur when one firm appropriates or pirates the marks of a competing firm. Infringement also occurs when firms dilute the value of another firm's

marks by weakening the connection between a mark and the product. For instance, if a firm copies the trademarked Google icon, colors, and images, it would be infringing on Google's trademarks. It would also be diluting the connection between the Google search service and its trademarks, potentially creating confusion in the marketplace.

In the e-commerce arena, the U.S. Anticybersquatting Consumer Protection Act creates civil liabilities for anyone who attempts in bad faith to profit from an existing famous or distinctive trademark by registering an Internet domain name that is identical or confusingly similar to, or "dilutive" of, that trademark. In addition, ICANN has a set of procedures to rapidly resolve trademark disputes regarding domain names called the Uniform Rapid Suspension (URS) system. These include a procedure that allows a trademark owner to seek suspension of an infringing domain name and a Trademark Clearing house repository of data on registered, court-validated, or statute-protected trademarks.

Trade Secrets

Any intellectual work product—a formula, device, pattern, methods of manufacture, or compilation of data—used for a business purpose can be classified as a **trade secret**, provided it is not based on information in the public domain. Protections for trade secrets vary from state to state. In general, trade secret laws grant a monopoly on the ideas behind a work product, but it can be a very tenuous monopoly.

Software that contains novel or unique elements, procedures, or compilations can be considered a trade secret. Trade secret law protects the actual ideas in a work product, not only their manifestation. To make this claim, the creator or owner must take care to bind employees and customers with nondisclosure agreements and prevent the secret from falling into the public domain.

The limitation of trade secret protection is that, although virtually all software programs of any complexity contain unique elements of some sort, it is difficult to prevent the ideas in the work from falling into the public domain when the software is widely distributed.

In 2016, the U.S. Defend Trade Secrets Act (DTSA), which creates a federal private right of action for trade secret protection, was enacted to prevent large-scale theft of trade secrets by hackers and foreign nations. The European Union has a similar Trade Secrets Directive to protect European firms and nations (Winston & Strawn, 2019).

Challenges to Intellectual Property Rights

Contemporary information technologies, especially software, pose severe challenges to existing intellectual property regimes and, therefore, create significant ethical, social, and political issues. Digital media differ from books, periodicals, and other media in terms of ease of replication; ease of transmission; ease of alteration; compactness, making theft easy; and difficulties in establishing uniqueness.

The proliferation of digital networks, including the Internet, has made it even more difficult to protect intellectual property. Before widespread use of networks, copies of software, books, magazine articles, or films had to be stored on physical media, such as paper, computer disks, or videotape, creating some hurdles to distribution. Using networks, information can be more widely reproduced and distributed. The BSA Global Software Survey conducted by International Data Corporation and The Software Alliance (also known as BSA) reported that 37 percent of the software installed on personal computers was unlicensed in 2018 (The Software Alliance, 2018).

The Internet was designed to transmit information freely around the world, including copyrighted information. You can easily copy and distribute virtually anything to millions of people worldwide, even if they are using different types of computer systems. Information can be illicitly copied from one place and distributed through other systems and networks even though these parties do not willingly participate in the infringement.

Individuals have been illegally copying and distributing digitized music files on the Internet for several decades. File-sharing services such as Napster and, later, Grokster, Kazaa, Morpheus, Megaupload, and The Pirate Bay sprang up to help users locate and swap digital music and video files, including those protected by copyright. Illegal file sharing became so widespread that it threatened the viability of the music recording industry and, at one point, consumed 20 percent of Internet bandwidth. The recording industry won several legal battles for shutting these services down, but it has not been able to halt illegal file sharing entirely. The motion picture and cable television industries are waging similar battles. Several European nations have worked with U.S. authorities to shut down illegal sharing sites, with mixed results.

As legitimate online music stores such as iTunes and streaming services such as Spotify expanded, illegal file sharing significantly declined. The Apple iTunes Store legitimized paying for music and entertainment and created a closed environment from which music and videos could not be easily copied and widely distributed unless played on Apple devices. Amazon's Kindle also protects the rights of publishers and writers because its books cannot be copied to the Internet and distributed. Streaming of Internet radio, on services such as Pandora and Spotify, and Hollywood movies (at sites such as Hulu and Netflix) also inhibit piracy because the streams cannot be easily recorded on separate devices and videos cannot be downloaded so easily. Despite these gains in legitimate online music platforms, artists and record labels have experienced a 50 percent decline in revenues and the loss of thousands of jobs since 2000.

The U.S. **Digital Millennium Copyright Act (DMCA)** of 1998 also provides some copyright protection. The DMCA implemented a World Intellectual Property Organization Treaty that makes it illegal to circumvent technology-based protections of copyrighted materials. Internet service providers (ISPs) are required to take down sites of copyright infringers they are hosting when the ISPs are notified of the problem. The EU takes a more proactive view of copyright protection on the Internet than does the United States. When fully implemented, its 2019 Directive on Copyright in the Digital Single Market will require that firms such as Facebook and Google pay creators and publishers for content such as music, news, and art, which such firms have previously often used without fair compensation.

4-4 How have information systems affected laws for establishing accountability and liability and the quality of everyday life?

Along with privacy and property laws, new information technologies are challenging existing liability laws and social practices for holding individuals and institutions accountable. If a person is injured by a machine controlled, in part, by software, who should be held accountable and, therefore, held liable? Should

a social network site like Facebook or Twitter be held liable and accountable for the posting of pornographic material or racial insults, or should it be held harmless against any liability for what users post (as is true of common carriers, such as the telephone system)? What about the Internet? If you outsource your information processing to the cloud, and the cloud provider fails to provide adequate service, what can you do? Cloud providers often claim the software you are using is the problem, not the cloud servers.

Computer-Related Liability Problems

In 2018, Under Armour, maker of athletic clothing, disclosed that hackers had breached its fitness app called MyFitnessPal and had stolen data from over 150 million user accounts. The data included email addresses, passwords, and usernames, along with other information not disclosed. The firm's stock took a hit of 2 percent following the announcement, likely causing MyFitnessPal users to lose confidence in the app (Shaban, 2018). Credit card information was not involved, but the app's 2 million users also enter into the app their detailed exercise and diet information. Who is liable for any economic or personal harm caused to individuals or businesses whose personal and business data is stolen from firms with whom they interact, often on a daily basis? Are information system managers responsible for the harm that corporate systems can do? Beyond IT managers, insofar as computer software is part of a machine, and the machine injures someone physically or economically, the producer of the software and the operator can be held liable for damages. Insofar as the software acts like a book, storing and displaying information, courts have been reluctant to hold authors, publishers, and booksellers liable for contents (the exception being instances of fraud or defamation); hence, courts have been wary of holding software authors liable.

In general, it is very difficult (if not impossible) to hold software producers liable for their software products that are considered to be like books, regardless of the physical or economic harm that results. Historically, print publishers of books and periodicals have not been held liable because of fears that liability claims would interfere with First Amendment rights guaranteeing freedom of expression. However, if the software controls a machine that involves people, the manufacturer of the machine can be held liable for damages, as in the case of the Boeing 737 MAX plane where software and sensors malfunctioned, or were poorly designed. (see the Interactive Session on Management).

What about software as a service? ATMs are a service provided to bank customers. If this service fails, customers will be inconvenienced and perhaps harmed economically if they cannot access their funds in a timely manner. Should liability protections be extended to software publishers and operators of defective financial, accounting, simulation, or marketing systems?

Software is very different from books. Software users may develop expectations of infallibility about software; software is less easily inspected than a book, and it is more difficult to compare with other software products for quality; software claims to perform a task rather than describe a task, as a book does; and people come to depend on services essentially based on software. Given the centrality of software to everyday life, the chances are excellent that

INTERACTIVE SESSION MANAGEMENT

The Boeing 737 Max Crashes: What Happened and Why?

Shortly after takeoff from Jakarta, Indonesia, on October 29, 2018, Lion Air Flight 610 slammed nose-first into the Java Sea. All of the flight's 189 passengers and crew perished. On March 10, 2019 Ethiopian Airlines Flight 302 crashed under similar circumstances, killing all 157 on board. Both flights had used the same aircraft, a Boeing 737 MAX 8, and both accidents had been caused by the same automated system in the 737 MAX designed to prevent the plane from stalling.

Although there are many models of Boeing 737 aircraft, the Maneuvering Characteristics Augmentation System (MCAS) appears only on the Boeing 737 MAX, which was created a decade ago and first took to the air in 2017. MCAS was designed to correct a design flaw in the 737 MAX. Boeing wanted to add a more fuel-efficient airplane to its narrow-body fleet to compete with the Airbus A320neo. This would have taken Boeing years.

Instead of designing a completely new plane, Boeing opted to make its existing 737s more fuel-efficient and competitive by adding a more economical but larger engine to the 737 airframe. The new engine was too large to be located midwing as it was on the standard 737, so Boeing positioned the engine higher up the wing. This new engine position could make the plane's nose point upward in midflight, causing the plane to stall and then crash. MCAS was intended to prevent the plane's nose from getting too high.

A sensor outside the airplane automatically activated the MCAS and straightened the airplane whenever it detected the airplane's nose going up. MCAS could activate even when the airplane was not on autopilot—and it could repeat this as many times as it wanted even if pilots overrode it. In the Lion Air crash, the sensor had miscalculated the airplane's nose as pointing upward when it was actually straight. These false readings were passed to the MCAS, which repeatedly tried to straighten the plane by pointing it nose to the ground. Eventually MCAS aimed the airplane's nose to the ground so severely that the pilots could not bring it back up and the plane crashed nose-down into the ocean.

Boeing was so intent on saving time and money with the 737 MAX that safety took a back seat. The company pressured the Federal Aviation

Administration (FAA) to allow it to self-certify a large portion of the 737 MAX's development. With little oversight, Boeing focused on improving fuel efficiency as much as possible in record time. According to an FAA official, by 2018 Boeing was allowed to certify 96 percent of its own work.

The FAA does allow every U.S. airplane manufacturer to self-certify a portion of a new airplane's development. This is because the agency would require an additional 10,000 staff and over \$1.8 billion to take on all this work. Boeing was allowed to self-certify the new MCAS software, and Boeing certified that MCAS was safe. The FAA turned nearly complete control over to Boeing, assigning two relatively inexperienced FAA engineers to oversee Boeing's early work on the system. When FAA engineers started looking into the first Boeing 737 MAX crash, they had very little information on the MCAS system and didn't fully understand it. Their files on the aircraft did not contain a complete safety review.

The original version of MCAS relied on data from at least two types of sensors, but Boeing's final version used just one. In both the Lion Air and Ethiopian Air crashes, it was a single damaged sensor that sent the planes into irrecoverable nose-dives. According to three FAA officials, Boeing never disclosed this change to MCAS to FAA staff involved in determining pilot training needs. When Boeing asked to remove the description of the system from the pilot's manual, the FAA agreed. Consequently, most MAX pilots did not know about the software until after the first crash. Boeing did not provide 737 MAX test pilots with detailed briefings about how fast or steeply MCAS could push down a plane's nose, and that the system relied on a single sensor—rather than two—to verify the accuracy of incoming data about the angle of a plane's nose.

Regulators had determined that pilots could fly the new 737 MAX airplanes without extensive retraining because they were essentially the same as previous generations, saving Boeing more money. All pilots flying 737 MAX planes were never trained using flight simulators. Instead, Boeing presented two-hour lessons about the new plane using iPads and gave pilots a 13-page handbook explaining differences between the 737 MAX and earlier 737 models. Boeing

never trained pilots on the new MCAS software, and many pilots did not know this capability existed. Boeing later claimed it did not want to overload pilots with information, but 737 MAX production was so rushed that a flight simulator was not ready by the time the 737 MAX was completed.

Boeing sold expensive add-on safety features that could have prevented both crashes. The first was two exterior sensors to inform pilots of their angle of attack (how they are flying against the wind). The second was a disagreement alert, which switches on whenever the sensor gives false readings. Both Lion Air and Ethiopian Airlines flew standard 737 MAX models that did not have these safety features because their management thought they could not afford them. (Boeing now includes one of these features in its standard 737 MAX package and recommends full flight simulator training for all pilots flying MAX jets.)

A day after the Ethiopian crash, China grounded all of its 737 MAX planes. Other nations followed suit. The FAA initially defended the 737 MAX, but finally succumbed to intense pressure to ground the plane on March 13, 2019. Boeing stopped delivery of all MAX jets to its customers, with unfilled orders worth half a trillion dollars in revenue. The 737 MAX was supposed to be a major moneymaker for Boeing,

representing an estimated two-thirds of future deliveries and 40 percent of its annual profit. As of March 2020, Boeing had lost half of its stock market value. While regulators await a series of fixes from Boeing, the 737 MAX planes remain grounded, and if the ban persists too long, Boeing may have to halt production. Families of crash victims have filed more than one hundred lawsuits against the company. The future of the 737 MAX and Boeing itself look very clouded.

Sources: Al Root, "Boeing Stock Is Down 50% Since the 737 MAX Was Grounded 1 Year Ago. Is It Cheap Enough?" *Barrons*, March 12, 2020; Niraj Chokshi, "Boeing Said to Add Another Fix to 737 MAX to Appease Regulators," *New York Times*, March 11, 2020; David Slotnick, "Nearly a Year After It Began, the Boeing 737 Max Crisis Still Drags On. Here's The Complete History of the Plane That's Been Grounded Since 2 Crashes Killed 346 People 5 Months Apart," *Business Insider*, March 5, 2020; Natalie Kitroeff, Daid Gelles, and Jack Nicas, "The Roots of Boeing's 737 MAX Crisis: A Regulator Relaxes Its Oversight," *New York Times*, July 27, 2019; Jack Nicas, Natalie Kitroeff, David Gelles, and James Glanz, "Boeing Built Deadly Assumptions into 737 Max, Blind to a Late Design Change," *New York Times*, June 1, 2019; Andrew Tangel and Andy Pasztor, "Boeing's Own Test Pilots Lacked Key Details of 737 MAX Flight-Control System," *Wall Street Journal*, May 3, 2019; Oliver Taylor, "10 Facts about the Boeing 737 MAX Air Crashes," *ListVerse*, April 8, 2019; Robert Wall and Andrew Tangel, "Safety Fears Put Boeing on the Defensive," *Wall Street Journal*, March 11, 2019; and Andrew J. Hawkins, "Everything You Need to Know About the Boeing 737 MAX Airplane Crashes," *The Verge*, March 22, 2019.

CASE STUDY QUESTIONS

1. What is the problem described in this case? Would you consider it an ethical dilemma? Why or why not?
2. Describe the role of management, organization, and technology factors in the Boeing 737 MAX

3. safety problems. To what extent was management responsible?
4. Is the solution provided by Boeing adequate? Explain your answer.
5. What steps could Boeing and the FAA have taken to prevent this problem from occurring?

liability law will extend its reach to include software even when the software merely provides an information service.

Telephone systems have not been held liable for the messages transmitted because they are regulated common carriers. In return for their right to provide telephone service, they must provide access to all, at reasonable rates, and achieve acceptable reliability. Likewise, cable networks are considered private networks not subject to regulation, but broadcasters using the public airwaves are subject to a wide variety of federal and local constraints on content and facilities. In the United States, with few exceptions, websites are not held liable for content posted on their sites regardless of whether it was placed there by the website owners or users.

System Quality: Data Quality and System Errors

In 2018, many of the largest cloud providers experienced significant outages, taking out sites and services throughout the United States and Europe. Google Cloud experienced an outage that took down entire platforms like Snapchat, Spotify, and Pokemon GO. Amazon Web Services (AWS) experienced an outage that took down Amazon's own Alexa, and several enterprise services such as Atlassian, Slack, and Twilio. Microsoft's Azure service had an outage that affected its storage and networking service in Northern Europe.

Outages at cloud computing services are still infrequent. As more and more firms rely on cloud providers and centralize their data and operations with a small group of cloud providers, these outages have called into question the reliability and quality of cloud services. Are these outages acceptable?

The debate over liability and accountability for unintentional consequences of system use raises a related but independent moral dimension: What is an acceptable, technologically feasible level of system quality? At what point should system managers say, "Stop testing, we've done all we can to perfect this software. Ship it!" Individuals and organizations may be held responsible for avoidable and foreseeable consequences, which they have a duty to perceive and correct. The gray area is that some system errors are foreseeable and correctable only at very great expense, expense so great that pursuing this level of perfection is not feasible economically—no one could afford the product.

For example, although software companies try to debug their products before releasing them to the marketplace, they knowingly ship buggy products because the time and cost of fixing all minor errors would prevent these products from ever being released. What if the product was not offered on the marketplace? Would social welfare as a whole falter and perhaps even decline? Carrying this further, just what is the responsibility of a producer of computer services—should it withdraw the product that can never be perfect, warn the user, or forget about the risk (let the buyer beware)?

Three principal sources of poor system performance are (1) software bugs and errors, (2) hardware or facility failures caused by natural or other causes, and (3) poor input data quality. The Chapter 8 Learning Track discusses why zero defects in software code of any complexity cannot be achieved and why the seriousness of remaining bugs cannot be estimated. Hence, there is a technological barrier to perfect software, and users must be aware of the potential for catastrophic failure. The software industry has not yet arrived at testing standards for producing software of acceptable but imperfect performance.

Although software bugs and facility catastrophes are likely to be widely reported in the press, by far the most common source of business system failure is data quality (see Chapter 6). Few companies routinely measure the quality of their data, but individual organizations report data error rates ranging from 0.5 to 30 percent.

Quality of Life: Equity, Access, and Boundaries

The negative social costs of introducing information technologies and systems are beginning to mount along with the power of the technology. Many of these negative social consequences are not violations of individual rights or property crimes. Nevertheless, they can be extremely harmful to individuals, societies, and political institutions. Computers and information technologies potentially can destroy valuable elements of our culture and society even while they bring us benefits. If there is a balance of good and bad consequences of using information systems, whom do we hold responsible for the bad consequences? Next,

we briefly examine some of the negative social consequences of systems, considering individual, social, and political responses.

Big Tech: Concentrating Economic and Political Power

In 2019, Amazon accounted for over half of all e-commerce retail sales, along with 75 percent of all book sales. Google accounts for 87 percent of online search. Facebook (including Instagram) accounts for over 86 percent of all social network users, and has 60 percent of the total Internet audience. Ninety percent of new online ad dollars went to Google or Facebook. Seventy-five percent of video streamers use Netflix, 53 percent use YouTube, and 33 percent use Amazon. In the office, Microsoft dominates with around 80 percent of the world's PCs using Windows software and software products. Apple accounts for 48 percent of the US market in smartphones (Google accounts for the remaining 52 percent). The millions of Apple apps run only on Apple phones, and likewise Android apps run only on Android phones. In the new world of these so-called Big Tech firms, oligopolies and monopolies dominate the Web and mobile platforms. The wealth created by these firms inevitably translates into political influence: these same firms have amassed an army of lobbyists in Washington and state capitals to ensure that legislation, or legislative inquiries, that might affect their market and tax concerns reflects their interests. Big Tech firms have increased their lobbying efforts in Washington to over \$30 billion annually, second only to financial firm lobbying (Lohr, Isaac, and Popper, 2019).

Concentrations of market power are not new in the United States or Europe. Beginning in 1890 with the Sherman Antitrust Act in the United States, and continuing through the 1960s, monopolies have been considered threats to competition and to smaller start-up businesses, generally restraining free trade. Monopolies typically achieve their size by purchasing smaller competitors, or crushing them by developing similar products, or engaging in predatory pricing by dropping prices drastically for short periods of time to force smaller firms out of business. Big Tech firms have a well-documented history of these behaviors. But antitrust thinking changed in the 1970s to a different standard of harm: consumer welfare. In this view, bigness per se was not a danger, nor was anticompetitive behavior. Instead price and consumer welfare became paramount. As long as consumers were not forced to pay higher prices, market power was not important, not a social or economic harm. In this view, because the offerings of Facebook, Google, and Amazon are either free or very low cost, there can be no harm.

Critics point out that consumer welfare is harmed in other ways than price, namely, by preventing new, innovative companies from market access, or surviving long enough to prosper as independent firms. Complaints and lawsuits originated by small start-up firms alleging anticompetitive and unfair practices, and concerns about the abuse of personal privacy by Big Tech firms, have led to a torrent of critical articles and several congressional investigations. Big Tech firms are today the targets of stinging public criticism, legislative investigations, and regulatory actions. Many commentators are calling for breaking up Big Tech firms into separate businesses much as the Sherman Antitrust act broke up Standard Oil in 1911, as well as other monopolies in photography, tobacco, steel, railroads, meat packing, telecommunications, and computers (Kang, Streitfeld, and Karni, 2019).

Rapidity of Change: Reduced Response Time to Competition

Information systems have helped to create much more efficient national and international markets. Today's rapid-moving global marketplace has reduced the normal social buffers that permitted businesses many years to adjust to



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Although some people enjoy the convenience of working at home, the do-anything-anywhere computing environment can blur the traditional boundaries between work and family time.

competition. Time-based competition has an ugly side; the business you work for may not have enough time to respond to global competitors and may be wiped out in a year along with your job. We stand the risk of developing a just-in-time society with just-in-time jobs and just-in-time workplaces, families, and vacations. One impact of Uber (see Chapter 10) and other on-demand services firms is to create just-in-time jobs with no benefits or insurance for employees.

Maintaining Boundaries: Family, Work, and Leisure

The danger of ubiquitous computing, telecommuting, nomad computing, mobile computing, and the do-anything-anywhere computing environment is that it is actually coming true. The traditional boundaries that separate work from family and just plain leisure have been weakened.

Although writers have traditionally worked just about anywhere, the advent of information systems, coupled with the growth of knowledge-work occupations, means that more and more people are working when traditionally they would have been playing or communicating with family and friends. The work umbrella now extends far beyond the eight-hour day into commuting time, vacation time, and leisure time. The explosive growth and use of smartphones have only heightened the sense of many employees that they are never away from work.

Even leisure time spent on the computer threatens these close social relationships. Extensive Internet and cell phone use, even for entertainment or recreational purposes, takes people away from their family and friends. Among middle school and teenage children, it can lead to harmful antisocial behavior, such as the recent upsurge in cyberbullying.

Weakening these institutions poses clear-cut risks. Family and friends historically have provided powerful support mechanisms for individuals, and they act as balance points in a society by preserving private life, providing a place for people to collect their thoughts, think in ways contrary to their employer, and dream.

Dependence and Vulnerability

Today, our businesses, governments, schools, and private associations, such as churches, are incredibly dependent on information systems and are, therefore, highly vulnerable if these systems fail. Think of what would happen if the nation's electric power grid shut down, with no backup structure to make up for

the loss of the system. With information systems now as ubiquitous as the telephone system, it is startling to realize that there are no regulatory or standard-setting forces in place as there are for telephone, electrical, radio, television, or other public utility technologies. The absence of standards and the criticality of some system applications may eventually call forth demands for national standards and perhaps regulatory oversight.

Computer Crime and Abuse

New technologies, including computers, create new opportunities for committing crime by creating new, valuable items to steal, new ways to steal them, and new ways to harm others. **Computer crime** is the commission of illegal acts by using a computer or against a computer system. Simply accessing a computer system without authorization or with intent to do harm, even by accident, is now a federal crime. The most frequent types of incidents comprise a greatest hits list of cybercrime: malware, phishing, network interruption, spyware, and denial of service attacks. The true cost of all computer crime is unknown, but it is estimated to be in the billions of dollars. You can find a more detailed discussion of computer crime in Chapter 8.

Computer abuse is the commission of acts involving a computer that may not be illegal but are considered unethical. The popularity of the Internet, email, and mobile phones has turned one form of computer abuse—spamming—into a serious problem for both individuals and businesses. Originally, **spam** was junk email an organization or individual sent to a mass audience of Internet users who had expressed no interest in the product or service being marketed. Spammers tend to market pornography, fraudulent deals and services, outright scams, and other products not widely approved in most civilized societies.

Spamming has mushroomed because it costs only a few cents to send thousands of messages advertising wares to Internet users. The percentage of all email that is spam was estimated at around 55 percent in 2019 (Statista, 2020). Most spam originates from bot networks, which consist of thousands of captured PCs that can initiate and relay spam messages. Spam costs for businesses are very high (estimated at more than \$50 billion per year) because of the computing and network resources and the time required to deal with billions of unwanted email messages.

Identity and financial-theft cybercriminals are targeting smartphones as users check email, do online banking, pay bills, and reveal personal information. Cell phone spam usually comes in the form of SMS text messages, but increasingly, users are receiving spam in their Facebook News feed and messaging service as well.

ISPs and individuals can combat spam by using spam filtering software to block suspicious email before it enters a recipient's email inbox. However, spam filters may block legitimate messages. Spammers know how to skirt filters by continually changing their email accounts, by incorporating spam messages in images, by embedding spam in email attachments and digital greeting cards, and by using other people's computers that have been hijacked by botnets (see Chapter 8). Many spam messages are sent from one country although another country hosts the spam website.

Spamming is more tightly regulated in Europe than in the United States. In 2002, the European Parliament passed a ban on unsolicited commercial messaging. (European Parliament, 2009). Digital marketing can be targeted only to people who have given prior consent. Australia, South Africa, and Malaysia are among other countries that also have anti-spam laws.

The U.S. CAN-SPAM Act of 2003, which went into effect in 2004, does not outlaw spamming but does ban deceptive email practices by requiring commercial email messages to display accurate subject lines, identify the true senders, and offer recipients an easy way to remove their names from email lists. It also prohibits the use of fake return addresses. A few people have been prosecuted under this law, but it has had a negligible impact on spamming, in large part because of the Internet's exceptionally poor security and the use of offshore servers and botnets. Most large-scale spamming has moved offshore to Russia and Eastern Europe, where hackers control global botnets capable of generating billions of spam messages. One of the largest spam networks in recent years was the Russian network Festi, based in St. Petersburg. Festi is best known as the spam generator behind the global Viagra-spam industry.

Employment: Trickle-Down Technology and Reengineering Job Loss

Reengineering work is typically hailed in the information systems community as a major benefit of new information technology. It is much less frequently noted that redesigning business processes has caused millions of mid-level factory managers and clerical workers to lose their jobs. Some economists have sounded new alarms about information and computer technology threatening middle-class, white-collar jobs (in addition to blue-collar factory jobs). Erik Brynjolfsson and Andrew P. McAfee argue that the pace of automation has picked up in recent years because of a combination of technologies, including robotics, numerically controlled machines, computerized inventory control, pattern recognition, voice recognition, and online commerce. One result is that machines can now do a great many jobs heretofore reserved for humans, including tech support, call center work, X-ray examination, and even legal document review (Brynjolfsson and McAfee, 2011).

These views contrast with other economists' assessments that new technologies created as many or more new jobs than they destroyed. In some cases, employment has grown or remained unchanged in industries like finance, where investment in IT capital is highest. For instance, the growth of e-commerce has led to a decline in retail sales jobs but an increase in jobs for warehouse workers, supervisors, and delivery work. These economists also believe that bright, educated workers who are displaced by technology will move to better jobs in fast-growth industries. Missing from this equation are unskilled, blue-collar workers and older, less-well-educated middle managers. It is not clear that these groups can be retrained easily for high-quality, high-paying jobs. (See the Chapter 11 Interactive Session on Organizations.)

Equity and Access: Increasing Racial and Social Class Cleavages

Does everyone have an equal opportunity to participate in the digital age? Will the social, economic, and cultural gaps that exist in the United States and other societies be reduced by information systems technology? Or will the cleavages be increased, permitting the better-off to become even more better-off relative to others?

These questions have not yet been fully answered because the impact of systems technology on various groups in society has not been thoroughly studied. What is known is that information, knowledge, computers, and access to these resources through educational institutions and public libraries are inequitably distributed along ethnic and social class lines, as are many other information resources. Several studies have found that low-income groups in advanced

industrial societies are less likely to have computers or online Internet access even though computer ownership and Internet access have soared in the past five years. Although the gap in computer access is narrowing, higher-income families in each ethnic group are still more likely to have home computers and broadband Internet access than lower-income families in the same group. Moreover, the children of higher-income families are far more likely to use their Internet access to pursue educational goals, whereas lower-income children are much more likely to spend time on entertainment and games. This is called the “time-wasting” gap.

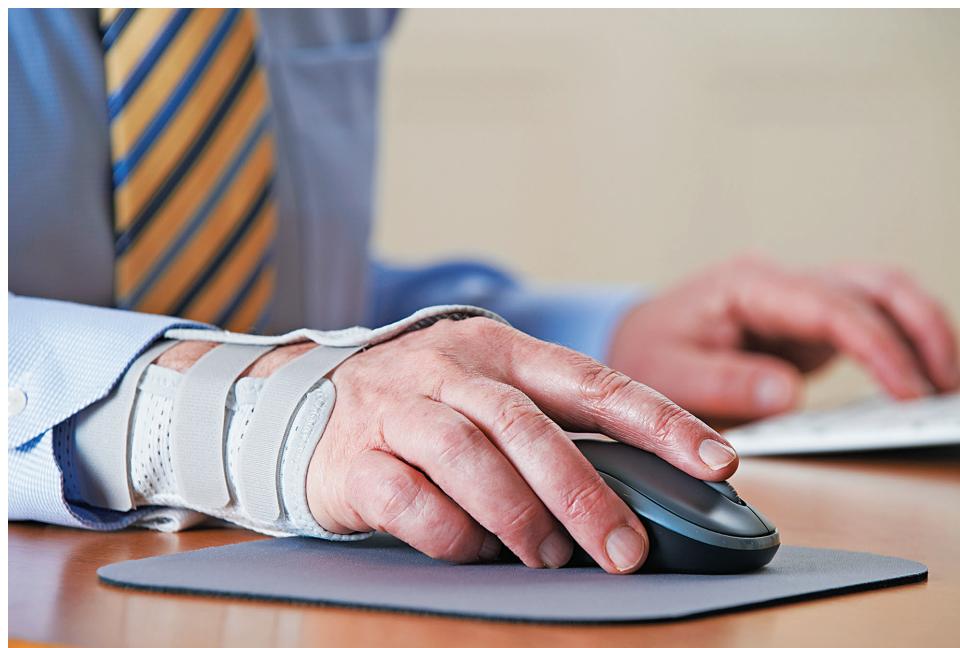
Left uncorrected, this **digital divide** could lead to a society of information haves, who are computer literate and skilled, versus a large group of information have-nots, who are computer illiterate and unskilled. Public interest groups want to narrow this digital divide by making digital information services—including the Internet—available to virtually everyone, just as basic telephone service is now.

Health Risks: RSI, CVS, and Cognitive Decline

A common occupational disease today is **repetitive stress injury (RSI)**. RSI occurs when muscle groups are forced through repetitive actions often with high-impact loads (such as tennis) or tens of thousands of repetitions under low-impact loads (such as working at a computer keyboard). The incidence of RSI is estimated to affect as much as one-third of the labor force and accounts for one-third of all disability cases.

The single largest source of RSI is computer keyboards. The most common kind of computer-related RSI is **carpal tunnel syndrome (CTS)**, in which pressure on the median nerve through the wrist's bony structure, called a carpal tunnel, produces pain. The pressure is caused by constant repetition of keystrokes: In a single shift, a word processor may perform 23,000 keystrokes. Symptoms of CTS include numbness, shooting pain, inability to grasp objects, and tingling. Millions of workers have been diagnosed with CTS. It affects an estimated 3 to 6 percent of the workforce (LeBlanc and Cestia, 2011).

Repetitive stress injury (RSI) is a leading occupational disease today. The single largest cause of RSI is computer keyboard work.



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INTERACTIVE SESSION TECHNOLOGY

Do Smartphones Harm Children? Maybe, Maybe Not

For many of us, smartphones have become indispensable, but they have also come under fire for their impact on the way we think and behave, especially among children. There is a growing wariness among parents, educators, psychologists, and even Silicon Valley luminaries that the benefits of screens are overblown, even as learning tools, and the risks for addiction and stunting development seem high.

The average American teenager who uses a smartphone receives his or her first phone at age 10 and spends over 4.5 hours a day on it (excluding texting and talking). Seventy-eight percent of teens check their phones at least hourly, and 50 percent report feeling “addicted” to their phones. There have been a number of studies on the negative effects of heavy smartphone and social media use on the mental and physical health of children whose brains are still developing. These range from distractions in the classroom to a higher risk of suicide and depression.

A recent survey of over 2,300 teachers by the Center on Media and Child Health and the University of Alberta found that 67 percent of the teachers reported that the number of students who are negatively distracted by digital technologies in the classroom is growing. Seventy-five percent of these teachers think students’ ability to focus on educational tasks has decreased. Research by psychology professor Jean Twenge of San Diego State University found that U.S. teenagers who spend 3 hours a day or more on electronic devices are 35 percent more likely, and those who spend 5 hours or more are 71 percent more likely, to have a risk factor for suicide than those who spend less than 1 hour. This research also showed that eighth-graders who are heavy users of social media have a 27 percent higher risk of depression. Those who spend more than the average time playing sports, hanging out with friends in person, or doing homework have a significantly lower risk. Additionally, teens who spend 5 or more hours a day on electronic devices are 51 percent more likely to get less than 7 hours of sleep per night (versus the recommended 9).

These findings are now being challenged by other academic researchers. A paper published in the *Journal of Child Psychology and Psychiatry* by psychology professors Candice L. Odgers of the University of California, Irvine, and Madeleine R. Jensen of the

University of North Carolina at Greensboro evaluated about 40 studies that examined the link between social media use and adolescent depression and anxiety. They found that link to be small and inconsistent. An analysis by Amy Orben at the University of Cambridge and similar work by Jeff Hancock, founder of the Stanford Social Media Lab, reached similar conclusions. Hancock’s analysis of 226 studies on the well-being of phone users concluded that if you compare the effects of your phone to sleeping, smoking, or eating properly, the net effect is essentially zero.

Twenge’s critics point out that although her work found a correlation between the appearance of smartphones and a rise in reports of mental health issues, it did not prove that phones were the cause. Are teens who are more depressed spending more time on their phones? Or are teens becoming depressed because they spend more time on their phones? It could be that the rise in depression led teenagers to excessive phone use, and that there were other potential explanations for depression and anxiety. Additionally, anxiety and suicide rates appear not to have risen in large parts of Europe where smartphones are more prevalent. The studies of smartphone use that exist do not show causal data, so there is no definitive proof that digital technology alters minds for the worse.

These researchers are not arguing that intensive use of smartphones doesn’t matter. Children who use their phones too much can miss out on other valuable activities, such as exercise. And research does show that excessive phone use can exacerbate the problems of certain vulnerable groups, such as children with mental health issues. But they do not believe that screens are responsible for broad social problems, such as teenagers’ rising anxiety rates and sleep deprivation problems. In most cases, the phone is a mirror revealing problems a child would have even without the phone.

Sources: Nathaniel Popper, “Panicking About Your Kids’ Phones? New Research Says Don’t,” *New York Times*, January 17, 2020; Brian Resnick, “Have Smartphones Really Destroyed a Generation? We Don’t Know,” *Vox*, May 16, 2019; Jack Nicas, “Apple Cracks Down on Apps That Fight iPhone Addiction,” *New York Times*, April 27, 2019; Nellie Bowles, “Human Contact Is Now a Luxury Good,” *New York Times*, March 23, 2019 and “A Dark Consensus Emerges About Screens and Kids Begins to Emerge in Silicon Valley,” *New York Times*, October 26, 2018.

CASE STUDY QUESTIONS

1. Identify the problem described in this case study. In what sense is it an ethical dilemma?
2. Compare the research findings approving or disapproving of smartphone use among children and teenagers.
3. Should restrictions be placed on children's and teenagers' smartphone use? Why or why not?

RSI is avoidable. Designing workstations for a neutral wrist position (using a wrist rest to support the wrist), proper monitor stands, and footrests all contribute to proper posture and reduced RSI. Ergonomically correct keyboards are also an option. These measures should be supported by frequent rest breaks and rotation of employees to different jobs.

RSI is not the only occupational illness computers cause. Back and neck pain, leg stress, and foot pain also result from poor ergonomic designs of workstations. **Computer vision syndrome (CVS)** refers to any eyestrain condition related to display screen use in desktop computers, laptops, e-readers, smartphones, and handheld video games. CVS affects about 90 percent of people who spend three hours or more per day at a computer. Its symptoms, which are usually temporary, include headaches, blurred vision, and dry and irritated eyes.

In addition to these maladies, computer technology may be harming our cognitive functions or at least changing how we think and solve problems. Although the Internet has made it much easier for people to access, create, and use information, some experts believe that it is also preventing people from focusing and thinking clearly on their own. They argue that excessive use of computers (and smartphones—see the Interactive Session on Technology) reduces intelligence. One MIT scholar believes exposure to computers encourages looking up answers rather than engaging in real problem solving. Students, in this view, don't learn much surfing the web or answering email when compared to listening, drawing, arguing, looking, and exploring (Henry, 2011).

The computer has become part of our lives—personally as well as socially, culturally, and politically. It is unlikely that the issues and our choices will become easier as information technology continues to transform our world. The growth of the Internet and the information economy suggests that all the ethical and social issues we have described will be heightened further as we move further into the first digital century.



4-5 How will MIS help my career?

Here is how Chapter 4 and this book can help you find a job as a junior privacy analyst.

The Company

Ordn Air Force Base in Norway has an open entry-level position for a junior privacy analyst in its human resources office. The office maintains detailed personnel records, including work history, compensation, healthcare, and retirement benefits, on more than 6,800 military members and their families and 1,250 civilian employees.

Position Description

The junior privacy analyst will assist with employee recordkeeping and help ensure compliance with all privacy regulations, including the GDPR. Job responsibilities include:

- Analyzing and developing policy and procedures related to privacy office functions.
- Logging and tracking requests, assistance with review, redaction and preparation of responsive records, and tracking all privacy office correspondence.
- Monitoring and responding to written, verbal, and electronic correspondence and inquiries directed to the government privacy office, including sensitive beneficiary/personnel correspondence.
- Coordinating privacy office meetings.
- Reviewing and analyzing data and documents and assessing options, issues, and positions for a variety of program planning, reporting, and execution activities.

Job Requirements

- Bachelor's degree in liberal arts or business
- Strong communication and organizational skills
- Experience with recordkeeping and file systems desirable

Interview Questions

1. What background or job experience do you have in the privacy protection field?
2. What do you know about the GDPR?
3. What do you know about privacy protection practices for both written and electronic correspondence?
4. If you were asked to improve privacy protection for our organization, how would you proceed?
5. Have you ever dealt with a problem involving privacy protection? What role did you play in its solution?

Author Tips

1. Review this chapter, with special attention to the sections dealing with information systems and privacy.
2. Use the web to find out more about the GDPR and privacy protection procedures and policies for personnel records.
3. Try to find out more about employee recordkeeping and privacy protection at other organizations.
4. If you do not have any hands-on experience in the privacy area, explain what you do know about privacy and why it is so important to protect sensitive personal data, and indicate you would be very interested in learning more and doing privacy-related work.

REVIEW SUMMARY

4.1 What ethical, social, and political issues are raised by information systems?

Information technology is introducing changes for which laws and rules of acceptable conduct have not yet been developed. Increasing computing power, storage, and networking capabilities—including the Internet—expand the reach of individual and organizational actions and magnify their impacts. The ease and anonymity with which information is now communicated, copied, and manipulated in online environments pose new challenges to the protection of privacy and intellectual property. The main ethical, social, and political issues information systems raise center on information rights and obligations, property rights and obligations, accountability and control, system quality, and quality of life.

4.2 What specific principles for conduct can be used to guide ethical decisions?

Six ethical principles for judging conduct include the Golden Rule, Immanuel Kant's categorical imperative, the slippery slope rule, the utilitarian principle, the risk aversion principle, and the ethical no-free-lunch rule. These principles should be used in conjunction with an ethical analysis.

4.3 Why do contemporary information systems technology and the Internet pose challenges to the protection of individual privacy and intellectual property?

Contemporary data storage and data analysis technology enable companies to gather personal data from many sources easily about individuals and analyze these data to create detailed digital profiles about individuals and their behaviors. Data flowing over the Internet can be monitored at many points. Cookies and other web monitoring tools closely track the activities of website visitors. Not all websites have strong privacy protection policies, and they do not always allow for informed consent regarding the use of personal information. Traditional copyright laws are insufficient to protect against software piracy because digital material can be copied so easily and transmitted to many locations simultaneously over the Internet.

4.4 How have information systems affected laws for establishing accountability and liability and the quality of everyday life?

New information technologies are challenging existing liability laws and social practices for holding individuals and institutions accountable for harm done to others. Although computer systems have been sources of efficiency and wealth, they have some negative impacts. Computer errors can cause serious harm to individuals and organizations. Poor data quality is also responsible for disruptions and losses for businesses. Jobs can be lost when computers replace workers or tasks become unnecessary in reengineered business processes. The ability to own and use a computer may be exacerbating socio-economic disparities among different ethnic groups and social classes. Widespread use of computers increases opportunities for computer crime and computer abuse. Computers can also create health and cognitive problems such as repetitive stress injury, computer vision syndrome, and the inability to think clearly and perform complex tasks.

Key Terms

<i>Accountability</i> , 159	<i>General Data Protection Regulation (GDPR)</i> , 163
<i>Carpal tunnel syndrome (CTS)</i> , 180	<i>Golden Rule</i> , 160
<i>Computer abuse</i> , 178	<i>Immanuel Kant's categorical imperative</i> , 160
<i>Computer crime</i> , 178	<i>Information rights</i> , 156
<i>Computer vision syndrome (CVS)</i> , 182	<i>Informed consent</i> , 167
<i>Cookies</i> , 165	<i>Intellectual property</i> , 168
<i>Copyright</i> , 168	<i>Liability</i> , 159
<i>Digital divide</i> , 180	<i>Nonobvious relationship awareness (NORA)</i> , 158
<i>Digital Millennium Copyright Act (DMCA)</i> , 171	<i>Opt-in</i> , 167
<i>Due process</i> , 159	<i>Opt-out</i> , 167
<i>Ethical no-free-lunch rule</i> , 160	<i>Patent</i> , 169
<i>Ethics</i> , 154	<i>Privacy</i> , 162
<i>Fair Information Practices (FIP)</i> , 162	<i>Profiling</i> , 157

*Repetitive stress injury (RSI), 180
Responsibility, 159
Risk aversion principle, 160
Safe harbor, 164
Slippery slope rule, 160
Spam, 178*

*Spyware, 166
Trade secret, 170
Trademarks, 169
Utilitarian principle, 160
Web beacons, 166*

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

4-1 What ethical, social, and political issues are raised by information systems?

- Explain what nonobvious relationship awareness is.
- Describe the net impact of the doubling of computer power every eighteen months.
- List some of the ethical issues in information systems that have been given new urgency by the rise of the Internet and electronic commerce.

4-2 What specific principles for conduct can be used to guide ethical decisions?

- List and describe the five steps in an ethical analysis.
- Identify and describe six ethical principles.

4-3 Why do contemporary information systems technology and the Internet pose challenges to the protection of individual privacy and intellectual property?

- Define privacy and Fair Information Practices.

- Explain how the Internet challenges the protection of individual privacy and intellectual property.
- Explain how informed consent, legislation, industry self-regulation, and technology tools help protect the individual privacy of Internet users.
- List and define the three regimes that protect intellectual property rights.

4-4 How have information systems affected laws for establishing accountability and liability and the quality of everyday life?

- Identify the most common reason for business system failure.
- Describe why all organizations have become dependent and vulnerable as a result of using information systems.
- Describe computer crime using an example.
- Explain what is meant by the term digital divide.

Discussion Questions

4-5 Should producers of software-based services, such as ATMs, be held liable for economic injuries suffered when their systems fail? MyLab MIS

4-6 Should companies be responsible for unemployment their information systems cause? Why or why not? MyLab MIS

4-7 Discuss the pros and cons of allowing companies to amass personal data for behavioral targeting. MyLab MIS

Hands-On MIS Projects

The projects in this section give you hands-on experience in analyzing the privacy implications of using online data brokers, developing a corporate policy for employee web usage, using blog creation tools to create a simple blog, and analyzing web browser privacy. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 4-8** FashionToday is an online fashion shop catering to Belgium, the Netherlands, and Luxembourg. It keeps track of each customer's email address, home address, age, gender, clothing preferences, and body-size measurements. Yara is a young woman who struggles to find things her size but is a regular shopper at FashionToday. One day, she receives a text message announcing a new line of clothes named FTXL. Clearly, she has been selected based on her submitted body size measurements. Five days later, she receives an ad for weight-loss supplements from Herbs4Life, an affiliate of FashionToday. Has FashionToday violated Yara's privacy? Is this potentially offensive to people like Yara? Explain your answer.
- 4-9** As the head of a small insurance company with six employees, you are concerned about how effectively your company is using its networking and human resources. Budgets are tight, and you are struggling to meet payrolls because employees are reporting many overtime hours. You do not believe that the employees have a sufficiently heavy workload to warrant working longer hours and are looking into the amount of time they spend on the Internet.

Each employee uses a computer with Internet access on the job. Review a sample of your company's weekly report of employee web usage, which can be found in MyLab MIS.

- Calculate the total amount of time each employee spent on the web for the week and the total amount of time that company computers were used for this purpose. Rank the employees in the order of the amount of time each spent online.
- Do your findings and the contents of the report indicate any ethical problems employees are creating? Is the company creating an ethical problem by monitoring its employees' use of the Internet?
- Use the guidelines for ethical analysis presented in this chapter to develop a solution to the problems you have identified.

Achieving Operational Excellence: Creating a Simple Blog

Software skills: Blog creation

Business skills: Blog and web page design

- 4-10** In this project, you'll learn how to build a simple blog of your own design using the online blog creation software available at Blogger.com. Pick a sport, hobby, or topic of interest as the theme for your blog. Name the blog, give it a title, and choose a template for the blog. Post at least four entries to the blog, adding a label for each posting. Edit your posts if necessary. Upload an image, such as a photo from your computer, or the web, to your blog. Add capabilities for other registered users, such as team members, to comment on your blog. Briefly describe how your blog could be useful to a company selling products or services related to the theme of your blog. List the tools available to Blogger that would make your blog more useful for business and describe the business uses of each. Save your blog and show it to your instructor.

Improving Decision Making: Analyzing Web Browser Privacy

Software Skills: Web browser software

Business Skills: Analyzing web browser privacy protection features

- 4-11** This project will help develop your Internet skills for using the privacy protection features of leading web browser software.

Examine the privacy protection features and settings for two leading web browsers such as Internet Explorer, Microsoft Edge, Mozilla Firefox, or Google Chrome. Make a table comparing the features of two of these browsers in terms of functions provided and ease of use.

- How do these privacy protection features protect individuals?
- How do these privacy protection features affect what businesses can do on the Internet?

- Which browser does the best job of protecting privacy? Why?

Collaboration and Teamwork Project

Developing a Corporate Code of Ethics

4-12 With three or four of your classmates, develop a corporate ethics code on privacy that addresses both employee privacy and the privacy of customers and users of the corporate website. Be sure to consider email privacy and employer monitoring of worksites as well as corporate use of information about employees concerning their off-the-job behavior (e.g., lifestyle, marital arrangements, and so forth). If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Facebook Privacy: Your Life for Sale

CASE STUDY

Facebook describes its corporate mission as giving people the power to build community and bring the world closer together. In 2017 and 2018 these lofty objectives took a serious blow when it became known that Facebook had lost control of the personal information users share on the site. Facebook had allowed its platform to be exploited by Russian intelligence and political consultants with the intention of intensifying existing political cleavages, driving people away from community and from one another during the U.S. presidential election of 2016.

In January 2018, a founder and former employee of a political consulting and voter profiling company called Cambridge Analytica revealed that his firm had harvested the personal information of as many as 87 million users of Facebook, and used this information in an effort to influence the U.S. presidential election of 2016. Facebook does not sell the personal information of its users, but it did allow third-party apps to obtain the personal information of Facebook users. In this case, a U.K. researcher was granted access to 50,000 Facebook users for the purpose of research. He developed an app quiz that claimed to measure users' personality traits. Facebook's design allowed this app to not only collect the personal information of people who agreed to take the survey, but also the personal information of all the people in those users' Facebook social network. The researcher sold the data to Cambridge Analytica, who in turn used it to send targeted political ads in the presidential election.

In a Senate hearing in October 2017, Facebook testified that Russian operatives had exploited Facebook's social network in an effort to influence the 2016 presidential election. More than 130,000 fake messages and stories had been sent to Facebook users in the United States using an army of automated software bots, built and operated by several thousand Russian-based hackers working for a Russian intelligence agency, the Internet Research Agency. (A bot is a software program that performs an automated task, and is often on the Internet for malicious purposes—see Chapter 8.) Using 75,000 fake Facebook accounts and 230,000 bots, Russian hackers sent messages to an estimated 146 million

people on Facebook. The messages targeted users based on their personal information collected by Facebook in the normal course of business, including religion, race, ethnicity, personal interests, and political views. The ads targeted groups who had opposing political views, with the intention of intensifying social conflict among them.

How could all this happen? As it turns out, it was quite easy and inexpensive, given the design and management of Facebook. Once Facebook grants access to advertisers, app developers, or researchers, it has a very limited capability to control how that information is used. Third-party agreements and policies are rarely reviewed by Facebook to check for compliance. Facebook executives claimed they were as shocked as others that 87 million Facebook users had their personal information harvested by Russian intelligence agencies and used by Cambridge Analytica to target political ads.

It gets worse: In early June 2018, several months after Facebook was forced to explain its privacy measures and pledge reforms in the wake of the Cambridge Analytica scandal, the *New York Times* reported that Facebook had data-sharing partnerships with at least 60 device makers, as well as selected app developers. Facebook allowed Apple, Samsung, Amazon, and other companies that sell mobile phones, tablets, TVs, and video game consoles to gain access not only to data about Facebook users but also personal data about their friends—without their explicit consent. All of these practices were in violation of a 2012 privacy settlement with the FTC (Federal Trade Commission) in which Facebook agreed to stop deceiving users about their ability to control their personal data, and to stop sharing data with third parties without informing users.

Facebook did not in fact change its behavior and instead deceived its users by claiming it could control their privacy. Senior managers at Facebook, including founder and CEO Mark Zuckerberg, were apparently aware of this deception according to company emails. In 2019 Facebook's privacy issues finally resulted in a record-breaking \$5 billion dollar fine by the FTC for obviously and intentionally violating the 2012 settlement. Facebook also agreed to new oversight by regulators in privacy matters, and

to develop new practices and policies for handling personal information. While \$5 billion is a large sum of money, for a company with \$56 billion in annual revenue, the fine may not be enough to change its actual behavior. The fine was, in the words of critics, barely a dent in Facebook's revenue. There are no specific restrictions on its mass surveillance of users, and the new privacy policies will be created by Facebook not the FTC. The settlement also provided immunity to Facebook executives and directors from any personal liability for the past violations of the 2012 settlement, and of users' privacy, and shielded the company from any claims of past violations. In other words, the past was wiped clean.

Facebook has a diverse array of compelling and useful features. It has helped families find lost pets and allows active-duty soldiers to stay in touch with their families; and it gives smaller companies a chance to further their e-commerce efforts and larger companies a chance to solidify their brands. Perhaps most obviously, Facebook makes it easier for you to keep in touch with your friends, relatives, local restaurants, and, in short, just about all the things you are interested in. These are the reasons so many people use Facebook—it provides real value to users. But at a cost. The cost of participating in the Facebook platform is that your personal information is shared with advertisers and with others you may not know.

Facebook's checkered past of privacy violations and missteps raises doubts about whether it should be trusted with the personal data of billions of people. Unlike European nations, there are no laws in the United States that give consumers the right to know what data companies like Facebook have compiled. You can challenge information in credit reports because of the Fair Credit Reporting Act, but until recently, you could not obtain what data Facebook has gathered about you.

Think you own your face? Not on Facebook, thanks to the firm's facial recognition software for photo tagging of users. This "tag suggestions" feature is automatically on when you sign up, and there is no user consent. A federal court in 2016 allowed a lawsuit to go forward contesting Facebook's right to photo tag without user consent. This feature is in violation of several state laws that seek to secure the privacy of biometric data.

A *Consumer Reports* study found that among 150 million Americans on Facebook every day, at least 4.8 million were willingly sharing information that

could be used against them in some way. That includes plans to travel on a particular day, which burglars could use to time robberies, or Liking a page about a particular health condition or treatment, which might prompt insurers to deny coverage. Credit card companies and similar organizations have begun engaging in weblining, taken from the term *redlining*, by altering their treatment of you based on the actions of other people with profiles similar to yours. Employers can assess your personality and behavior by using your Facebook Likes. Millions of Facebook users have never adjusted Facebook's privacy controls, which allow friends using Facebook applications to transfer your data unwittingly to a third party without your knowledge.

Why, then, do so many people share sensitive details of their life on Facebook? Often, it's because users do not realize that their data are being collected and transmitted in this way. A Facebook user's friends are not notified if information about them is collected by that user's applications. Many of Facebook's features and services are enabled by default when they are launched without notifying users, and a study by Siegel + Gale found that Facebook's privacy policy is more difficult to comprehend than government notices or typical bank credit card agreements, which are notoriously dense. Did you know that whenever you log into a website using Facebook, Facebook shares some personal information with that site and can track your movements on that site? Next time you visit Facebook, click Privacy Settings and see whether you can understand your options.

However, there are some signs that Facebook might become more responsible with its data collection processes, whether by its own volition or because it is forced to do so. As a publicly traded company, Facebook now invites more scrutiny from investors and regulators. In 2018, in response to a maelstrom of criticism in the United States, and Europe's new General Data Protection Regulation (GDPR), Facebook changed its privacy policy to make it easier for users to select their privacy preferences; to know exactly what they are consenting to; to download users' personal archives and the information that Facebook collects and shares, including facial images; to restrict click bait and spam in newsfeeds; to more closely monitor app developers' use of personal information; and to increase efforts to eliminate millions of fake accounts. Facebook hired 10,000 new employees and several hundred

fact-checking firms to identify and eliminate fake news. For the first time in its history, Facebook is being forced to apply editorial controls to the content posted by users and, in that sense, become more like a traditional publisher and news outlet that takes responsibility for its content. Unfortunately, as researchers have long known, and Facebook executives understand, very few users—estimated to be less than 12 percent—take the time to understand and adjust their privacy preferences. In reality, user choice is not a powerful check on Facebook's use of personal information.

Although U.S. Facebook users have little recourse to access data that Facebook has collected on them, users from other countries have done better. In Europe, over 100,000 Facebook users have already requested their data, and European law requires Facebook to respond to these requests within 40 days. Government privacy regulators from France, Spain, Italy, Germany, Belgium, and the Netherlands have been actively investigating Facebook's privacy controls as the European Union pursues more stringent privacy protection legislation.

CEO Mark Zuckerberg stated in January 2020 that one of Facebook's main goals for the next decade is to build much stronger privacy protections for everyone on Facebook. For example, Facebook made an "Off-Facebook Activity" tool available to all of its members. This tool allows people to see and control the data that other apps and websites share with Facebook. Nevertheless, although Facebook has shut down several of its more egregious privacy-invading features and enhanced its consent process, the company's data use policies make it very clear that, as a condition of using the service, users grant the company wide latitude in using their personal information in advertising. The default option for users is "opt-in"; most users do not know how to control use of their information; and they cannot "opt out" of all sharing if they want to use Facebook. This is called the "control paradox" by researchers: even when users are given controls over the use of their personal information, they typically choose not to use those controls. Although users can limit some uses of their information, extensive knowledge of Facebook data features is required. Facebook shows you ads not only on Facebook but across the web through its Facebook Audience Network, which keeps track of

what its users do on other websites and then targets ads to those users on those websites.

Critics have asked Facebook why it doesn't offer an ad-free service—like music streaming sites—for a monthly fee. Others want to know why Facebook does not allow users just to opt out of tracking. But these kinds of changes would be very difficult for Facebook because its business model depends entirely on the largely unfettered use of its users' personal private information, just as it declares in its data use policy. That policy states very openly that if you use Facebook you agree to its terms of service, which enable it to share your information with third parties of its choosing. As Apple CEO Tim Cook noted, at Facebook, the product they sell is you.

Sources: Mark Zuckerberg, "Starting the New Decade by Giving You More Control. You're Your Privacy," abut.fb.com, January 28, 2020; Geoffrey A. Fowler, "Facebook Will Now Show You Exactly How It Stalks You—Even When You're Not Using Facebook," *Washington Post*, January 28, 2020; Mike Isaac and Natasha Singer, "On Wednesday, the Federal Trade Commission Placed New Conditions on Facebook for Privacy Violations," *New York Times*, July 24, 2019; "A \$5 Billion Fine for Facebook Won't Fix Privacy," *New York Times*, July 25, 2019; Devin Coldewey and Natasha Lomas, "Facebook Settles with FTC: \$5 Billion and New Privacy Guarantees," *Techcrunch*, July 24, 2019; John D. McKinnon, Emily Glazer, Deepa Seetharaman, and Jeff Horwitz, "Facebook Worries Emails Could Show Zuckerberg Knew of Questionable Privacy Practices," *New York Times*, June 12, 2019; Federal Trade Commission, "In the Matter of Facebook, a Corporation," FTC, July 24, 2019; Deepa Seetharaman and Kirsten Grind, "Facebook Gave Some Companies Access to Additional Data About Users' Friends," *Wall Street Journal*, June 8, 2018; Cecilia Kang and Sheera Frenkel, "Facebook Says Cambridge Analytica Harvested Data of Up to 87 Million Users," *New York Times*, April 24, 2018; Eduardo Porter, "The Facebook Fallacy: Privacy Is Up to You," *New York Times*, April 24, 2018; and David Mayer, "Facebook Is Giving You New Privacy Options, But It's Clear What It Wants You to Choose," *Fortune*, March 19, 2018,

CASE STUDY QUESTIONS

- 4-13** Perform an ethical analysis of Facebook. What is the ethical dilemma presented by this case?
- 4-14** What is the relationship of privacy to Facebook's business model?
- 4-15** Describe the weaknesses of Facebook's privacy policies and features. What management, organization, and technology factors have contributed to those weaknesses?
- 4-16** Will Facebook be able to have a successful business model without invading privacy? Explain your answer. Could Facebook take any measures to make this possible?

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PART TWO

Information Technology Infrastructure

CHAPTER 5

IT Infrastructure and Emerging Technologies

CHAPTER 6

Foundations of Business Intelligence:
Databases and Information Management

CHAPTER 7

Telecommunications, the Internet,
and Wireless Technology

CHAPTER 8

Securing Information Systems

PART TWO provides the technical foundation for understanding information systems by examining hardware, software, database, and networking technologies along with tools and techniques for security and control. This part answers questions such as: What technologies do businesses today need to accomplish their work? What do I need to know about these technologies to make sure they enhance the performance of the firm? How are these technologies likely to change in the future? What technologies and procedures are required to ensure that systems are reliable and secure?

5

IT Infrastructure and Emerging Technologies

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 5-1** What is IT infrastructure, and what are the stages and drivers of IT infrastructure evolution?
- 5-2** What are the components of IT infrastructure?
- 5-3** What are the current trends in computer hardware platforms?
- 5-4** What are the current computer software platforms and trends?
- 5-5** What are the challenges of managing IT infrastructure and management solutions?
- 5-6** How will MIS help my career?

CHAPTER CASES

- Southeast Asia's Grab Leverages Information Technology to Enhance Its Services
- Open Source Innovation: The New Company Advantage
- Glory Finds Solutions in the Cloud
- Project JEDI: A Cloud of Controversy

VIDEO CASES

- Rockwell Automation Fuels the Oil and Gas Industry with the Internet of Things (IoT)
- ESPN.com: The Future of Sports Coverage in the Cloud
- Netflix: Building a Business in the Cloud

MyLab MIS

Discussion Questions: 5-6, 5-7, 5-8; Hands-On MIS Projects: 5-9, 5-10, 5-11, 5-12;
eText with Conceptual Animations

Southeast Asia's Grab Leverages Information Technology to Enhance Its Services

Grab is a Singapore-based company that offers customers a taxi-booking service, as well as food delivery and mobile payments, via a smartphone app. Initially founded and established in neighboring Malaysia in 2012, Grab has undergone rapid expansion, extending its operations to a number of other Southeast Asian countries, including Thailand, Vietnam, the Philippines, and Singapore. The company employs around 6,000 employees, with 2.8 million drivers currently registered. The Grab mobile application has been downloaded onto approximately 185 million mobile devices to date, and the app is used to book in excess of 6 million rides every day. Grab's annual revenue in 2019 was \$2.3 billion.

Grab's success is founded upon the successful leveraging of information technology to provide passengers with a safer and more reliable taxi service. Its success in Malaysia capitalized on the unpredictability and unreliability of the country's taxis, many of which opt not to use the taxi meter during peak periods. Grab has thus provided stability to an otherwise unpredictable sector, guaranteeing customers a metered taxi with transparency via the driver's rating, all through an easy-to-use smartphone app. The firm currently operates five research and development centers across Asia and one in the United States as it continues to explore how it can best utilize information technology.

Grab uses Amazon's Redshift and ElastiCache data warehousing and data storage cloud-based services to manage its millions of daily bookings in real-time as well as to allow users to track drivers and view traffic conditions. Through data analytics, the firm is better able to match demand with supply, thus increasing the app user's chances of obtaining a driver quickly. Through a technique called geohashing, cities like Singapore are divided into grids, each of which is analyzed by the system to determine the ratio of drivers to customers. Using a color-coding system, drivers in low-demand areas receive a notification on their mobile phone instructing them to drive to an appropriate low-supply area denoted by a red dot in the app's map. This allows Grab to effectively manage and adjust the distribution of drivers to ensure that resources are allocated appropriately to high-demand areas. Integrated with the firm's Android and iPhone app, the system provides real-time updates regarding the driver's current position as well as an estimated time of arrival. Such provisions help to reduce customer frustration and minimize the amount of time they have to spend just waiting around.



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In 2016, the firm allied itself with Lippo, Southeast Asia's consumer services provider, to implement an e-payment platform in Indonesia, the company's largest market. The payment platform allows Grab's users not only to pay for the rides directly via their mobile phone but also to pay for a number of Lippo's retail services. Anthony Tan, Grab's co-founder and group CEO, views the initiative as a step towards broader e-money adoption in Indonesia and the Southeast Asian region as a whole, given the large number of individuals who do not have access to a bank account but are equipped with a smartphone.

The GrabPlatform, launched in 2018, aims to integrate all of Grab's services, from rides and payment apps to food delivery services and on-demand grocery delivery. This means that Grab's over 9 million drivers, delivery partners, merchants, and agents across 339 cities in eight countries can use the same technology, localized to their own language and needs. In 2019, Grab took in \$1.4 billion in funding to further expand its services.

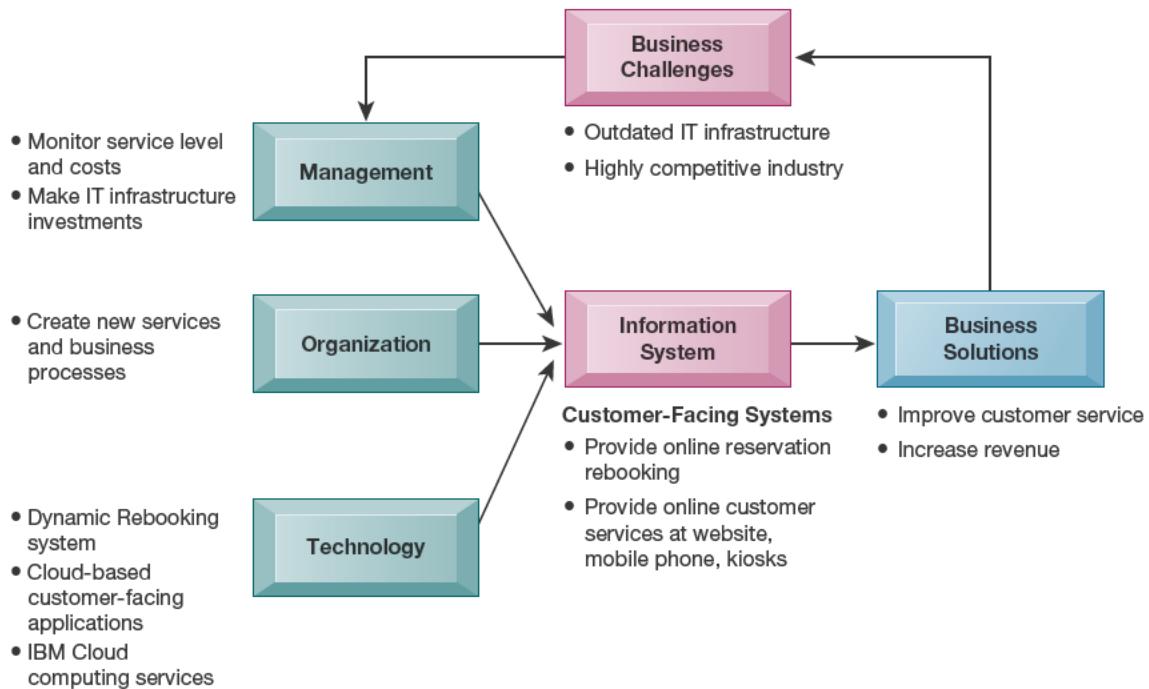
Sources: Molly Moore, "Number of Active Drivers of Grab, Go-Jek, and Ola APAC 2019," Statista.com, December 15, 2020; Yolum Lee, "Grab to Cut 5% of Employees in Another Setback for Softbank," bloomberg.com, June 16, 2020; "Grab Everything Online: Grab Releases Digital-first GrabPayCard in the Philippines Powered by Mastercard," newsroom.mastercard.com, June 3, 2020; Aw Cheng Wei, "Grab Broadens Its Financial Services Here, Offering Loans to Businesses," *Straits Times*, March 13, 2019; Claudia Chong, "Grab Takes in US\$1.46b More to Feed Super App Ambition in SEA," *Business Times*, Singapore, March 2, 2019; "Grab Unveils Open Platform Strategy to Build Southeast Asia's First Everyday Superapp," grab.com, July 10, 2018; Radhika Dhawan Puri, "Grab Pushes Digital Innovation to Stay Ahead of the Game," futurereadysingapore.com, accessed October 21, 2017; "Grab and Lippo Group Strike Payments Partnership," grab.com, July 22, 2016; "Grab Case Study," aws.amazon.com, 2016; Vincent Chang, "GrabTaxi's Edge Lies in Real-Time Data Analytics," *Straits Times*, December 23, 2015.

Case contributed by Imran Medi, Asia Pacific University of Technology and Innovation

Grab's use of information systems illustrates how technology can improve an organization's performance and support its core business processes. Effectively managing resources and ensuring that there is sufficient and timely supply to meet demand lies at the heart of improving an organization's performance. Through its real-time monitoring of ride requests, Grab is able to effectively position its finite resources, provide its customers with a timely service, and ensure that it maximizes capacity, enabling its drivers to earn more fares. This is important, as failure to provide each driver with an adequate number of customers will inevitably result in those drivers deserting the company.

The chapter-opening case diagram illustrates the important points raised by the case. Grab is competing with many other forms of transportation, especially in a city like Singapore, in which the public mass rail transport system is highly efficient and reliable. Grab must at the very least match this level of service by ensuring not only that customers are able to get a driver and car to their desired destination but that their waiting time is minimized as much as possible. This is where the use of Amazon's cloud-based services come in: a dedicated cloud services provider allows the firm to concentrate its energy on the enhancement of its app while benefiting from the capabilities provided by Amazon.

Here are some questions to think about: How has Grab's use of hardware and software facilitated its growth in Southeast Asia? How important is cloud computing to Grab's operations?



5-1 What is IT infrastructure, and what are the stages and drivers of IT infrastructure evolution?

In Chapter 1, we defined *information technology (IT) infrastructure* as the shared technology resources that provide the platform for the firm's specific information system applications. An IT infrastructure includes investment in hardware, software, and services—such as consulting, education, and training—that are shared across the entire firm or across entire business units in the firm. A firm's IT infrastructure provides the foundation for serving customers, working with vendors, and managing internal firm business processes (see Figure 5.1).

Supplying firms worldwide with IT infrastructure (hardware, software, networking, and IT services) in 2020 was estimated to be a \$3.9 trillion industry (Gartner, 2020). Investments in infrastructure account for between 25 and 50 percent of information technology expenditures in large firms, led by financial services firms where IT investment is well over half of all capital investment.

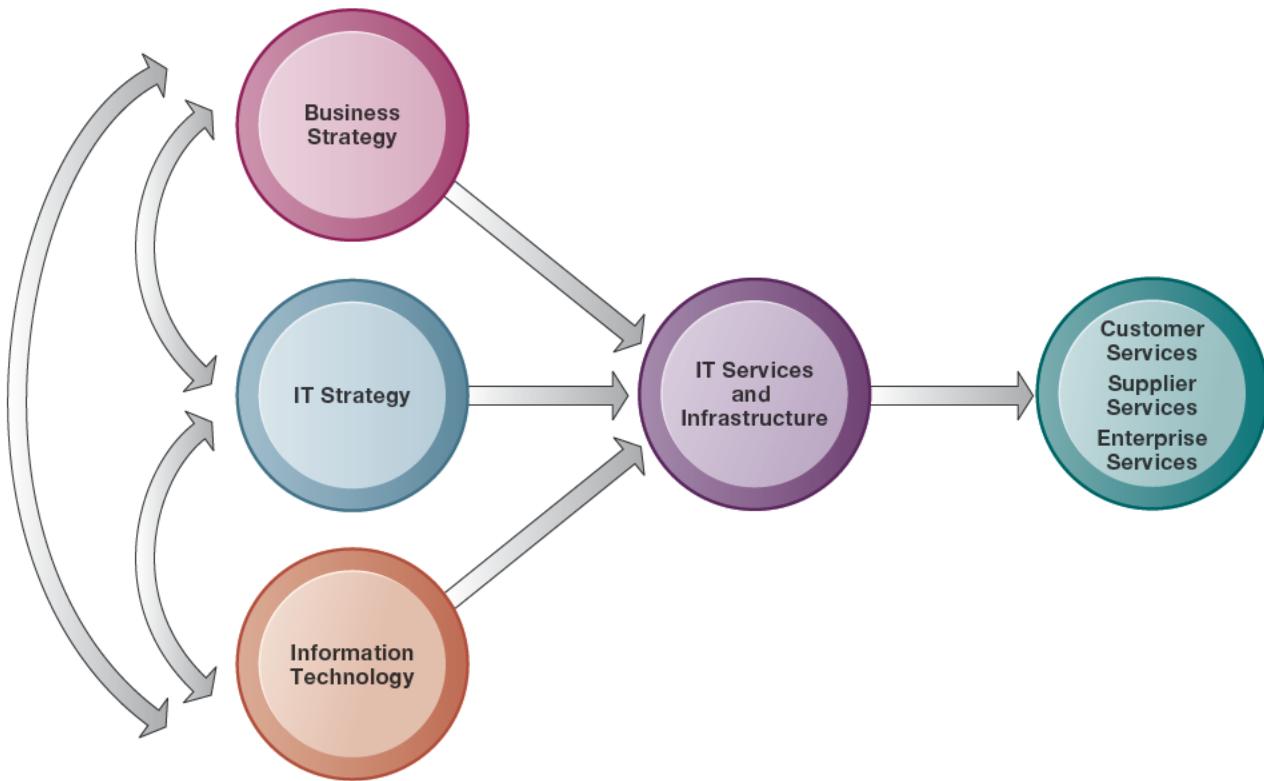
Defining IT Infrastructure

An IT infrastructure consists of a set of physical devices and software applications that are required to operate the entire enterprise. But IT infrastructure also includes a set of firmwide services budgeted by management and composed of both human and technical capabilities. These services include the following:

- Computing platforms used to provide computing services that connect employees, customers, and suppliers into a coherent digital environment, including large mainframes, midrange computers, desktop and laptop computers, and mobile handheld and remote cloud computing services

FIGURE 5.1 CONNECTION BETWEEN THE FIRM, IT INFRASTRUCTURE, AND BUSINESS CAPABILITIES

The services a firm is capable of providing to its customers, suppliers, and employees are a direct function of its IT infrastructure. Ideally, this infrastructure should support the firm's business and information systems strategy. New information technologies have a powerful impact on business and IT strategies as well as the services that can be provided to customers.



- Telecommunications services that provide data, voice, and video connectivity to employees, customers, and suppliers
- Data management services that store and manage corporate data and provide capabilities for analyzing the data
- Application software services, including online software services, that provide enterprise-wide capabilities such as enterprise resource planning, customer relationship management, supply chain management, and knowledge management systems that are shared by all business units
- Physical facilities management services that develop and manage the physical installations required for computing, telecommunications, and data management services
- IT management services that plan and develop the infrastructure, coordinate with the business units for IT services, manage accounting for the IT expenditure, and provide project management services
- IT standards services that provide the firm and its business units with policies that determine which information technology will be used, when, and how
- IT education services that provide training in system use to employees and offer managers training in how to plan for and manage IT investments

- IT research and development services that provide the firm with research on potential future IT projects and investments that could help the firm differentiate itself in the marketplace

This “service platform” perspective makes it easier to understand the business value provided by infrastructure investments. For instance, the real business value of a fully loaded personal computer operating at 3.5 gigahertz that costs about \$1,000 and a high-speed Internet connection is hard to understand without knowing who will use it and how it will be used. When we look at the services provided by these tools, however, their value becomes more apparent: The new PC makes it possible for a high-cost employee making \$100,000 a year to connect to all the company's major systems and the public Internet. The high-speed Internet service saves this employee about an hour per day in reduced wait time for Internet information. Without this PC and Internet connection, the value of this one employee to the firm might be cut in half.

Evolution of IT Infrastructure

The IT infrastructure in organizations today is an outgrowth of more than 50 years of evolution in computing platforms. There have been five stages in this evolution, each representing a different configuration of computing power and infrastructure elements (see Figure 5.2). The five eras are general-purpose mainframe and minicomputer computing, personal computers, client/server networks, enterprise computing, and cloud and mobile computing.

Technologies that characterize one era may also be used in another time period for other purposes. For example, some companies still run traditional mainframe systems or use mainframe computers as servers supporting large websites and corporate enterprise applications.

General-Purpose Mainframe and Minicomputer Era (1959 to Present)

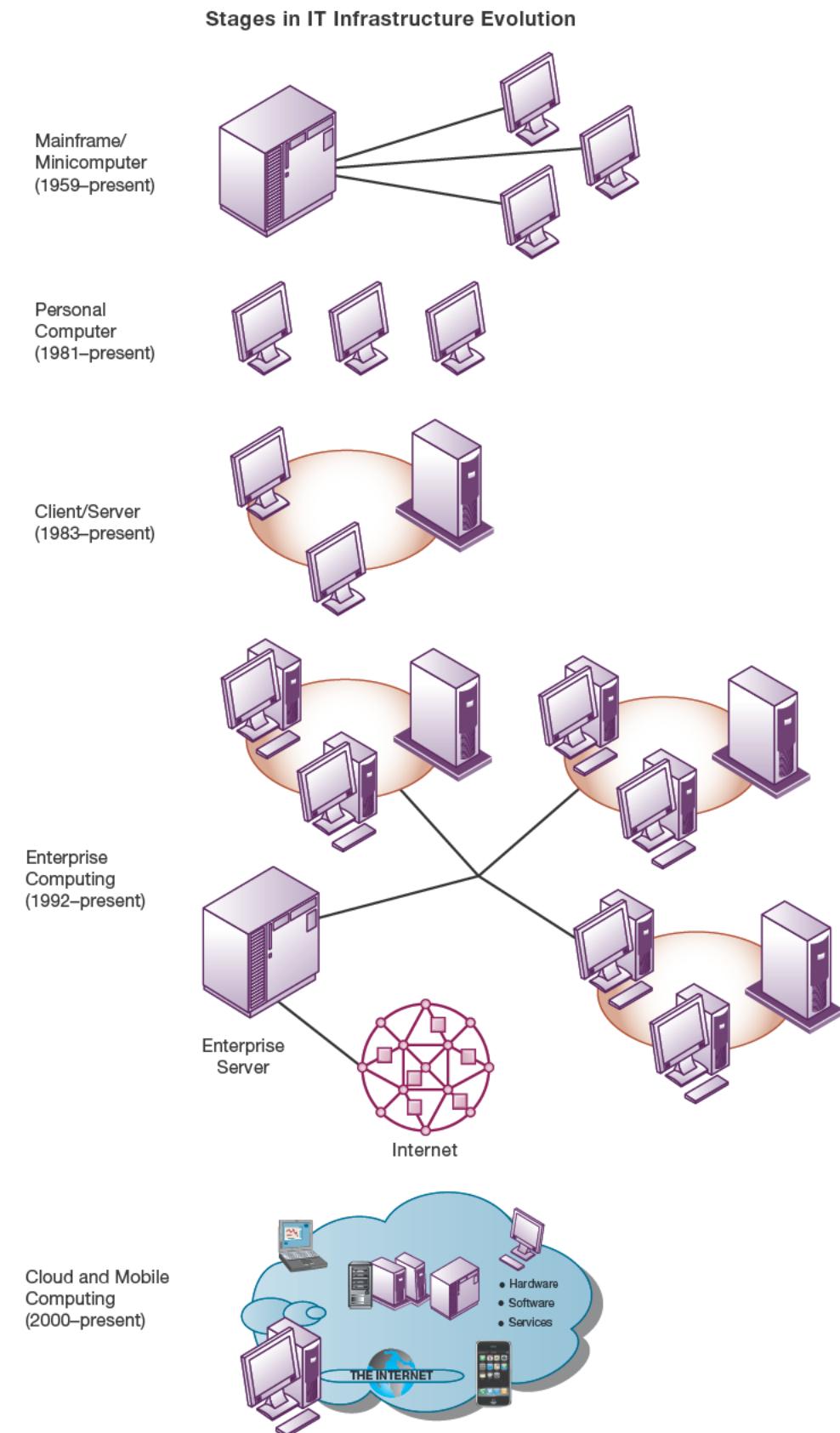
The introduction of the IBM 1401 and 7090 transistorized machines in 1959 marked the beginning of widespread commercial use of **mainframe** computers. In 1965, the mainframe computer truly came into its own with the introduction of the IBM 360 series. The 360 was the first commercial computer that could provide time sharing, multitasking, and virtual memory in more advanced models. IBM has dominated mainframe computing from this point on. Mainframe computers became powerful enough to support thousands of online remote terminals connected to the centralized mainframe using proprietary communication protocols and proprietary data lines.

The mainframe era was a period of highly centralized computing under the control of professional programmers and systems operators (usually in a corporate data center), with most elements of infrastructure provided by a single vendor, the manufacturer of the hardware and the software.

This pattern began to change with the introduction of **minicomputers**, produced by Digital Equipment Corporation (DEC) in 1965. DEC minicomputers (PDP-11 and later the VAX machines) offered powerful machines at far lower prices than IBM mainframes, making possible decentralized computing, customized to the specific needs of individual departments or business units rather than time sharing on a single huge mainframe. In recent years, the minicomputer has evolved into a midrange computer or midrange server and is part of a network.

FIGURE 5.2 ERAS IN IT INFRASTRUCTURE EVOLUTION

Illustrated here are the typical computing configurations characterizing each of the five eras of IT infrastructure evolution.



Personal Computer Era (1981 to Present)

Although the first truly personal computers (PCs) appeared in the 1970s (the Xerox Alto, the MITS Altair 8800, and the Apple I and II, to name a few), these machines had only limited distribution to computer enthusiasts. The appearance of the IBM PC in 1981 is usually considered the beginning of the PC era because this machine was the first to be widely adopted by businesses. At first using the DOS operating system, a text-based command language, and later the Microsoft Windows operating system, the **Wintel PC** computer (Windows operating system software on a computer with an Intel microprocessor) became the standard desktop personal computer. Worldwide PC sales have declined because of the popularity of tablets and smartphones, but the PC is still a popular tool for business. Approximately 88 percent of desktop PCs are thought to run a version of Windows, and about 8 percent run a version of MacOS. Wintel dominance as a computing platform is receding as iPhone and Android device sales increase.

Proliferation of PCs in the 1980s and early 1990s launched a spate of personal desktop productivity software tools—word processors, spreadsheets, electronic presentation software, and small data management programs—that were very valuable to both home and corporate users. These PCs were stand-alone systems until PC operating system software in the 1990s made it possible to link them into networks.

Client/Server Era (1983 to Present)

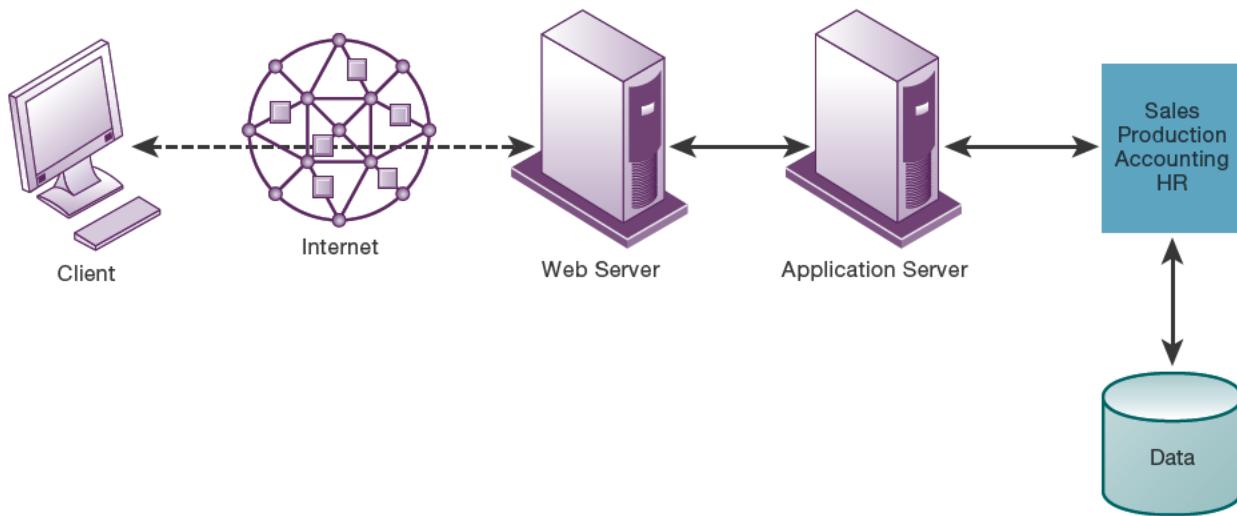
In **client/server computing**, desktop or laptop computers called **clients** are networked to powerful **server** computers that provide the client computers with a variety of services and capabilities. Computer processing work is split between these two types of machines. The client is the user point of entry, whereas the server typically processes and stores shared data, serves up web pages, or manages network activities. The term *server* refers to both the software application and the physical computer on which the network software runs. The server could be a mainframe, but today, server computers typically are more powerful versions of personal computers, based on inexpensive chips and often using multiple processors in a single computer box or in server racks.

The simplest client/server network consists of a client computer networked to a server computer, with processing split between the two types of machines. This is called a *two-tiered client/server architecture*. Whereas simple client/server networks can be found in small businesses, most corporations have more complex, **multitiered client/server architectures** (often called *N-tier client/server architectures*) in which the work of the entire network is balanced over several different levels of servers, depending on the kind of service being requested (see Figure 5.3).

For instance, at the first level, a **web server** will serve a web page to a client in response to a request for service. Web server software is responsible for locating and managing stored web pages. If the client requests access to a corporate system (a product list or price information, for instance), the request is passed along to an **application server**. Application server software handles all application operations between a user and an organization's back-end business systems. The application server may reside on the same computer as the web server or on its own dedicated computer. Chapters 6 and 7 provide more detail on other pieces of software that are used in multitiered client/server architectures for e-commerce and e-business.

FIGURE 5.3 A MULTITIERED (N-TIER) CLIENT/SERVER NETWORK

In a multitiered client/server network, client requests for service are handled by different levels of servers.



Client/server computing enables businesses to distribute computing work across a series of smaller, inexpensive machines that cost much less than centralized mainframe systems. The result is an explosion in computing power and applications throughout the firm.

Novell NetWare was the leading technology for client/server networking at the beginning of the client/server era. Today, Microsoft is the market leader with its **Windows** operating systems (Windows Server and Windows 10).

Enterprise Computing Era (1992 to Present)

In the early 1990s, firms turned to networking standards and software tools that could integrate disparate networks and applications throughout the firm into an enterprise-wide infrastructure. As the Internet developed into a trusted communications environment after 1995, business firms began seriously using the *Transmission Control Protocol/Internet Protocol (TCP/IP)* networking standard to tie their disparate networks together. We discuss TCP/IP in detail in Chapter 7.

The resulting IT infrastructure links different pieces of computer hardware and smaller networks into an enterprise-wide network so that information can flow freely across the organization and between the firm and other organizations. It can link different types of computer hardware, including mainframes, servers, PCs, and mobile devices, and it includes public infrastructures such as the telephone system, the Internet, and public network services. The enterprise infrastructure also requires software to link disparate applications and enable data to flow freely among different parts of the business, such as enterprise applications (see Chapters 2 and 9) and web services (discussed in Section 5-4).

Cloud and Mobile Computing Era (2000 to Present)

The growing bandwidth power of the Internet has pushed the client/server model one step further, toward what is called the “cloud computing model.” **Cloud computing** refers to a model of computing that provides access to a shared pool of computing resources (computers, storage, applications, and

services) over the network, often the Internet. These “clouds” of computing resources can be accessed on an as-needed basis from any connected device and location.

Cloud computing has become the fastest-growing form of computing, with worldwide public cloud spending to reach \$350 billion by 2022 (Gartner 2019). Thousands or even hundreds of thousands of servers are located in cloud data centers, where they can be accessed by desktop computers, laptop computers, tablets, entertainment centers, smartphones, and other client machines linked to the Internet. Amazon, Google, IBM, Oracle, and Microsoft operate huge, scalable cloud computing centers that provide computing power, data storage, application development tools, and high-speed Internet connections to firms that want to maintain their IT infrastructures remotely. Firms such as Google, Microsoft, SAP, Oracle, and Salesforce.com sell software applications as services delivered over the Internet.

We discuss cloud and mobile computing in more detail in Section 5-3. The Learning Tracks include a table titled “Comparing Stages in IT Infrastructure Evolution,” which compares each era on the infrastructure dimensions introduced.

Technology Drivers of Infrastructure Evolution

The changes in IT infrastructure we have just described have resulted from developments in computer processing, memory chips, storage devices, networking hardware and software, and software design that have exponentially increased computing power while exponentially reducing costs. Let's look at the most important developments.

Moore's Law and Microprocessing Power

In 1965, Gordon Moore, the director of Fairchild Semiconductor's Research and Development Laboratories, wrote in *Electronics* magazine that since the first microprocessor chip was introduced in 1959, the number of components on a chip with the smallest manufacturing costs per component (generally transistors) had doubled each year. This assertion became the foundation of **Moore's Law**. Moore later reduced the rate of growth to a doubling every two years.

There are at least three variations of Moore's Law, none of which Moore ever stated: (1) the power of microprocessors doubles every 18 months, (2) computing power doubles every 18 months, and (3) the price of computing falls by half every 18 months.

Figure 5.4 illustrates the relationship between number of transistors on a microprocessor and millions of instructions per second (MIPS), a common measure of processor power. Figure 5.5 shows the exponential decline in the cost of transistors and rise in computing power. For instance, in 2018, you could buy an Intel i7 processor chip with 2.5 billion transistors for about one ten-millionth of a dollar per transistor.

Exponential growth in the number of transistors and the power of processors coupled with an exponential decline in computing costs may not be able to continue much longer. In the last five years, the cost improvement rate has fallen to single digits from 30 percent annual reductions. Chip manufacturers continue to miniaturize components. Today's transistors are 14 nanometers (billions of a meter) in size. Within the next five years or so, chip makers may reach the physical limits of semiconductor size. At that point they may need

FIGURE 5.4 MOORE'S LAW AND MICROPROCESSOR PERFORMANCE

Packing 5 billion transistors into a tiny microprocessor has exponentially increased processing power. Processing power has increased to more than 250,000 MIPS (about 2.6 billion instructions per second).

Source: Authors' estimate.

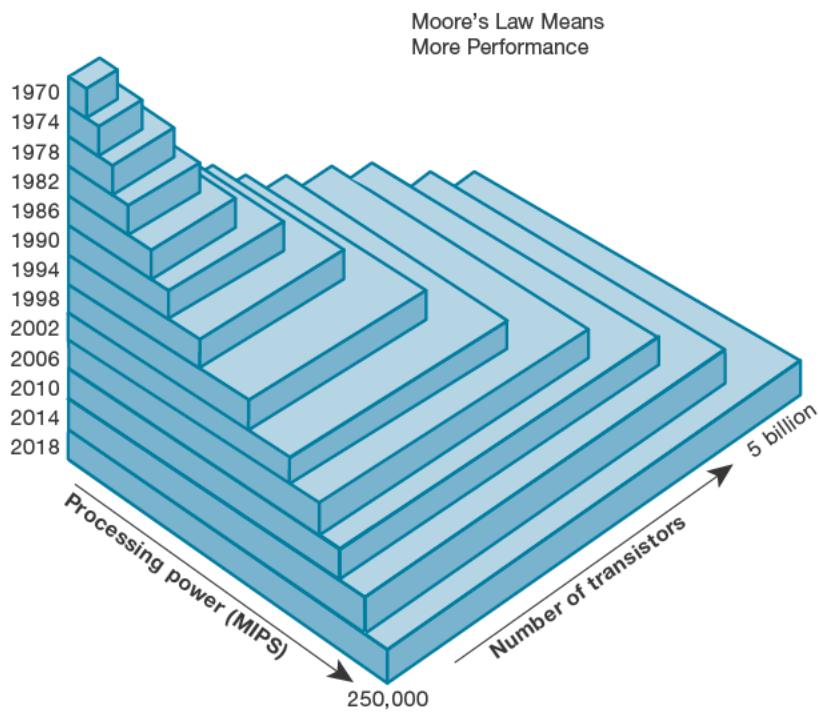
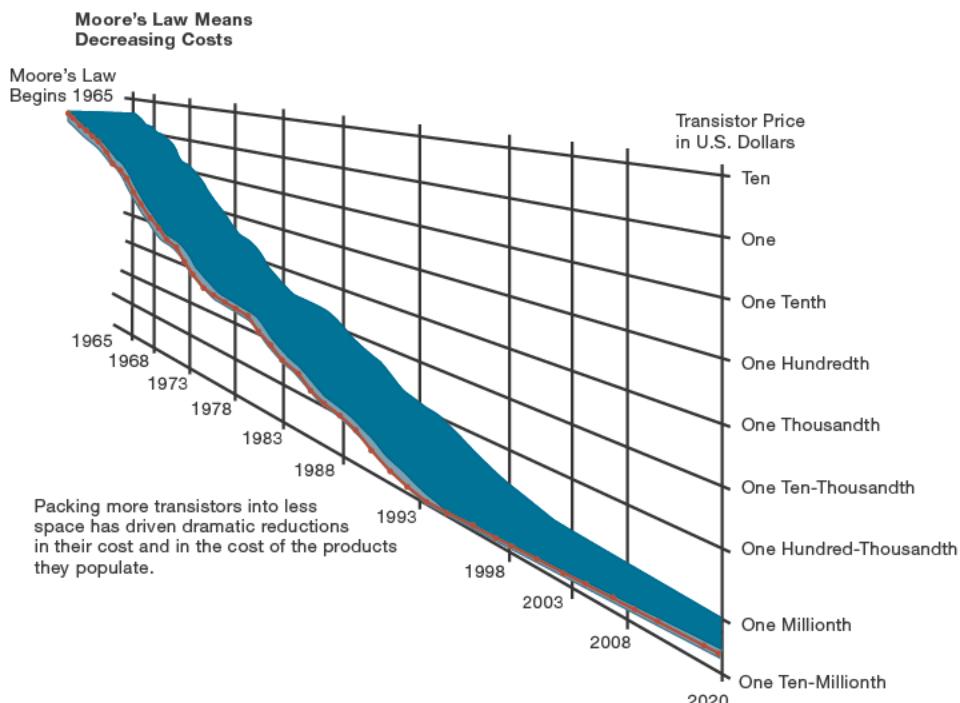
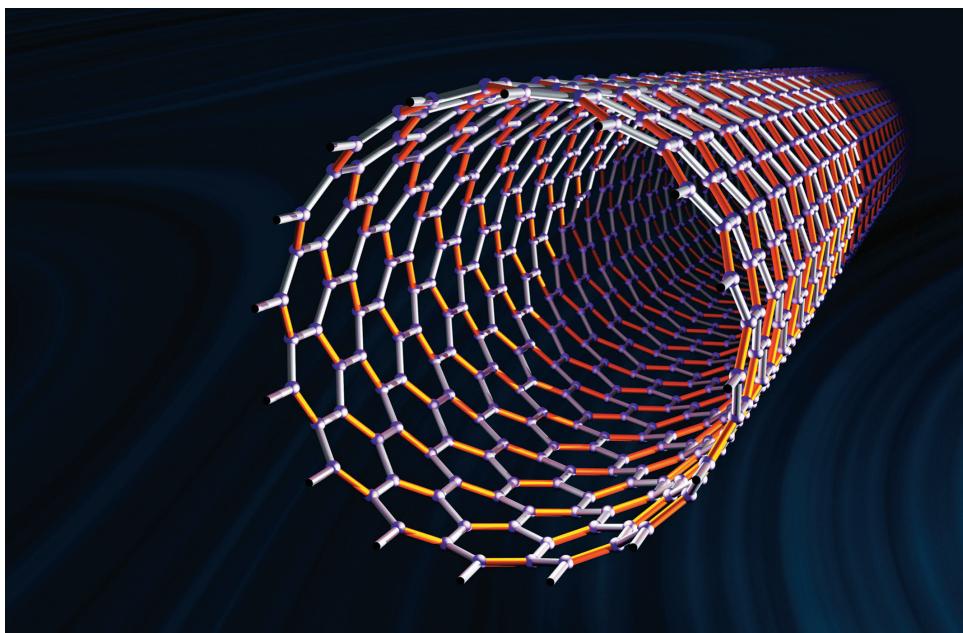


FIGURE 5.5 FALLING COST OF CHIPS

Changes in production technology, and very-large-scale production runs, have driven dramatic declines in the cost of chips, and the products that use them.

Source: Authors' estimate.





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Nanotubes are tiny tubes about 10,000 times thinner than a human hair. They consist of rolled-up sheets of carbon hexagons, have potential use as minuscule wires or in ultrasmall electronic devices, and are very powerful conductors of electrical current.

to use alternatives to fashioning chips from silicon or find other ways to make computers more powerful.

Chip manufacturers can shrink the size of transistors down to the width of several atoms by using nanotechnology. **Nanotechnology** uses individual atoms and molecules to create computer chips and other devices that are thousands of times smaller than current technologies permit. Chip manufacturers are trying to develop a manufacturing process to produce nanotube processors economically. Stanford University scientists have built a nanotube computer.

The Law of Mass Digital Storage

A second technology driver of IT infrastructure change is the Law of Mass Digital Storage. The amount of digital information is roughly doubling every year (Lyman and Varian, 2003). Fortunately, the cost of storing digital information is falling at an exponential rate of 100 percent a year. Figure 5.6 shows that the number of megabytes that can be stored on magnetic media for \$1 from 1950 to the present roughly doubled every 15 months. In 2020, a 1 terabyte hard disk drive sells at retail for about \$50.

Metcalfe's Law and Network Economics

Moore's Law and the Law of Mass Digital Storage help us understand why computing resources are now so readily available. But why do people want more computing and storage power? The economics of networks and the growth of the Internet provide some answers.

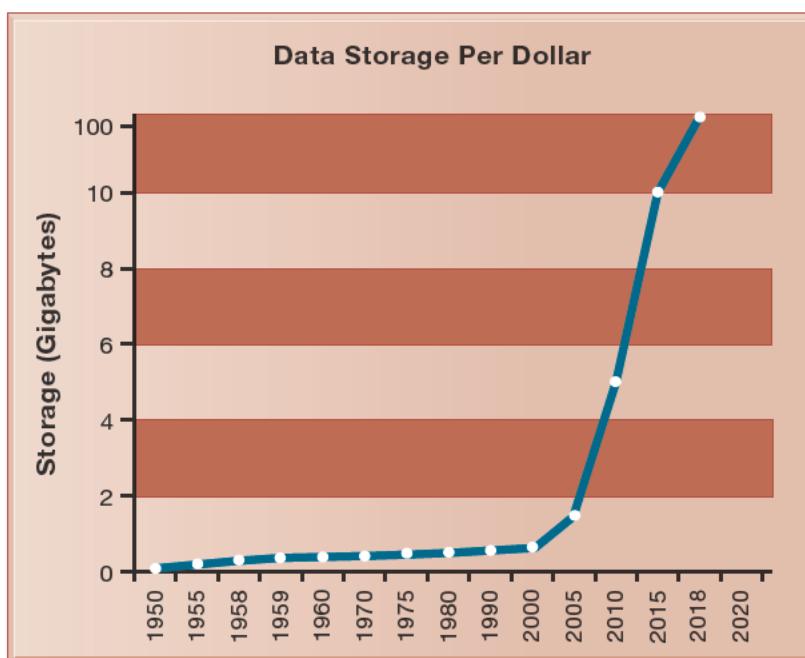
Robert Metcalfe—*inventor of Ethernet local area network technology*—claimed in 1970 that the value or power of a network grows exponentially as a function of the number of network members. Metcalfe and others point to the *increasing returns to scale* that network members receive as more and more people join the network. As the number of members in a network grows linearly, the value of the entire system grows exponentially and continues to grow as members increase. Demand for information technology has been driven by

FIGURE 5.6

THE AMOUNT OF STORAGE PER DOLLAR RISES EXPONENTIALLY, 1950–2018

Cloud storage services like Google Drive provide 100 gigabytes of storage for \$1.99 per month.

Source: Authors' estimates.



the social and business value of digital networks, which rapidly multiply the number of actual and potential links among network members.

Declining Communications Costs and the Internet

A fourth technology driver transforming IT infrastructure is the rapid decline in the costs of communication and the exponential growth in the size of the Internet. Today there are over 4.5 billion Internet users worldwide (Internetworldstats.com, 2020). Figure 5.7 illustrates the exponentially declining cost of communication both over the Internet and over telephone networks (which increasingly are based on the Internet). As communication costs fall toward a very small number and approach zero, utilization of communication and computing facilities explode. In 2008, consumers paid about \$9.01 per Mbps for Internet access. Ten years later, in 2018, that price had shrunk to \$0.76 per Mbps (NCTA, 2019).

To take advantage of the business value associated with the Internet, firms must greatly expand their Internet connections, including wireless connectivity, and greatly expand the power of their client/server networks, desktop clients, and mobile computing devices. There is every reason to believe these trends will continue.

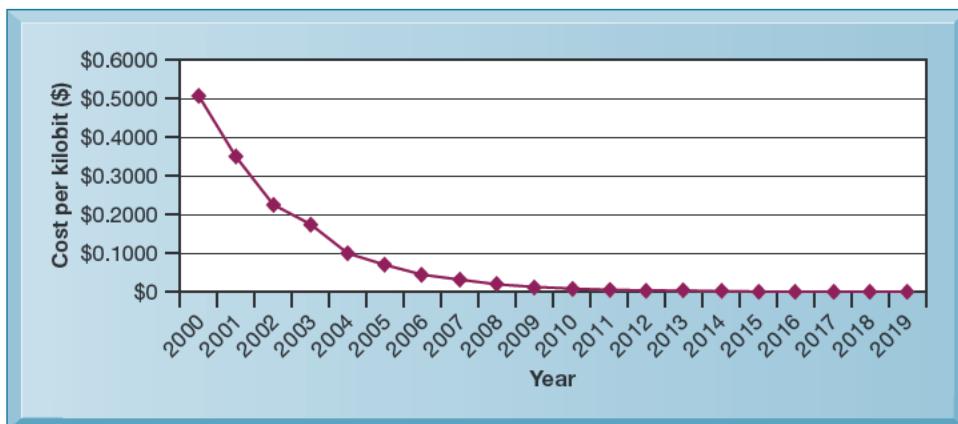
Standards and Network Effects

Today's enterprise infrastructure and Internet computing would be impossible—both now and in the future—without agreements among manufacturers and widespread consumer acceptance of **technology standards**. Technology standards are specifications that establish the compatibility of products and the ability to communicate in a network.

FIGURE 5.7**EXPONENTIAL DECLINES IN INTERNET COMMUNICATIONS COSTS (\$/MBPS)**

The cost of communication over the Internet and over telephone networks has declined exponentially, fueling the explosive growth of communication and computing worldwide.

Sources: "Average Internet Connection Speed in the United States from 2007 to 2017 (in Mbps), by Quarter," Statista, 2018; "Home Broadband Adoption 2006," by John B. Horrigan, Pew Research, 2007; "Internet Speeds: How Fast Does Internet Speed Grow?" by Xah Lee. Date: December 30, 2006. Last updated: January 22, 2017, <http://xahlee.info/comp/bandwidth.html>



Technology standards unleash powerful economies of scale and result in price declines as manufacturers focus on the products built to a single standard. Without these economies of scale, computing of any sort would be far more expensive than is currently the case. Table 5.1 describes important standards that have shaped IT infrastructure.

In the 1990s, corporations started moving toward standard computing and communications platforms. The Wintel PC with the Windows operating system and Microsoft Office desktop productivity applications became the standard desktop and mobile client computing platform. (It now shares the spotlight with other standards, such as Apple's iOS and Macintosh operating systems and the Android operating system.) Widespread adoption of Unix-Linux as the enterprise server operating system of choice made possible the replacement of proprietary and expensive mainframe infrastructures. In networking, the Ethernet standard enabled PCs to connect together in small local area networks (LANs; see Chapter 7), and the TCP/IP standard enabled these LANs to be connected into firmwide networks, and ultimately, to the Internet.

5-2**What are the components of IT infrastructure?**

IT infrastructure today is composed of seven major components. Figure 5.8 illustrates these infrastructure components and the major vendors within each component category. These components constitute investments that must be coordinated with one another to provide the firm with a coherent infrastructure.

TABLE 5.1 SOME IMPORTANT STANDARDS IN COMPUTING

STANDARD	SIGNIFICANCE
American Standard Code for Information Interchange (ASCII) (1958)	Made it possible for computer machines from different manufacturers to exchange data; later used as the universal language linking input and output devices such as keyboards and mice to computers. Adopted by the American National Standards Institute in 1963.
Common Business Oriented Language (COBOL) (1959)	An easy-to-use software language that greatly expanded the ability of programmers to write business-related programs and reduced the cost of software. Sponsored by the Defense Department in 1959.
Unix (1969–1975)	A powerful multitasking, multiuser, portable operating system initially developed at Bell Labs (1969) and later released for use by others (1975). It operates on a wide variety of computers from different manufacturers. Adopted by Sun, IBM, HP, and others in the 1980s, it became the most widely used enterprise-level operating system.
Ethernet (1973)	A network standard for connecting desktop computers into local area networks that enabled the widespread adoption of client/server computing and local area networks and further stimulated the adoption of personal computers.
Transmission Control Protocol/Internet Protocol (TCP/IP) (1974)	Suite of communications protocols and a common addressing scheme that enables millions of computers to connect together in one giant global network (the Internet). Later, it was used as the default networking protocol suite for local area networks and intranets. Developed in the early 1970s for the U.S. Department of Defense.
IBM/Microsoft/Intel Personal Computer (1981)	The standard Wintel design for personal desktop computing based on standard Intel processors and other standard devices, Microsoft DOS, and later Windows software. The emergence of this standard, low-cost product laid the foundation for a 25-year period of explosive growth in computing throughout all organizations around the globe. Today, more than 1 billion PCs power business and government activities every day.
World Wide Web (1989–1993)	Standards for storing, retrieving, formatting, and displaying information as a worldwide web of electronic pages incorporating text, graphics, audio, and video enable creation of a global repository of billions of web pages.

In the past, technology vendors supplying these components offered purchasing firms a mixture of incompatible, proprietary, partial solutions that could not work with other vendor products. Increasingly, vendor firms have been forced to cooperate in strategic partnerships with one another in order to keep their customers. For instance, a hardware and services provider such as IBM cooperates with all the major enterprise software providers, has strategic relationships with system integrators, and promises to work with whichever data management products its client firms wish to use (even though it sells its own database management software called DB2).

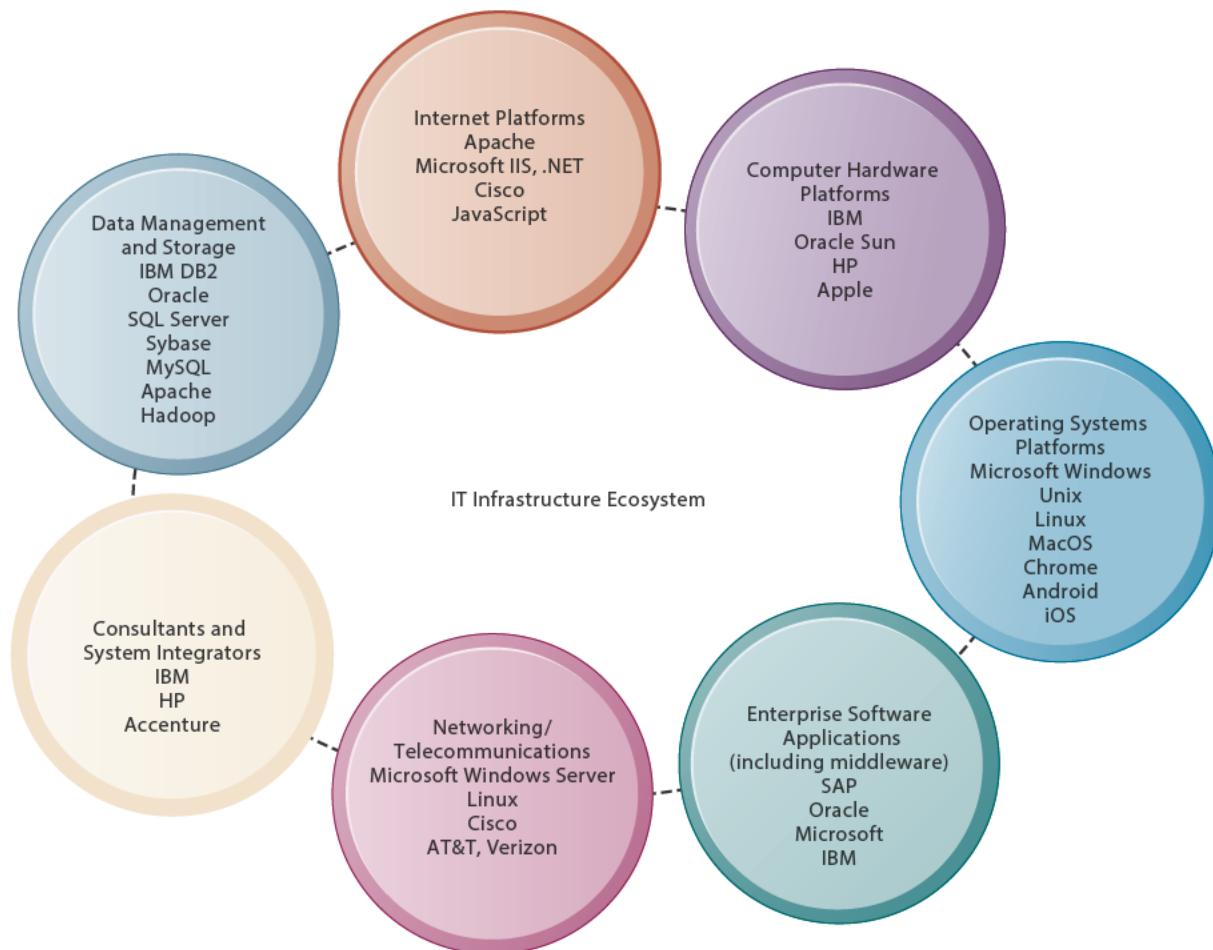
Another big change is that companies are moving more of their IT infrastructure to the cloud or to outside services, owning and managing much less on their premises. Firms' IT infrastructure will increasingly be an amalgam of components and services that are partially owned, partially rented or licensed, partially located on site, and partially supplied by external vendors or cloud services.

Computer Hardware Platforms

Firms worldwide are expected to spend \$688 billion on computer hardware devices in 2020, including mainframes, servers, PCs, tablets, and smartphones. All these devices constitute the computer hardware platform for corporate (and personal) computing worldwide.

FIGURE 5.8 THE IT INFRASTRUCTURE ECOSYSTEM

There are seven major components that must be coordinated to provide the firm with a coherent IT infrastructure. Listed here are major technologies and suppliers for each component.



Most business computing has taken place using microprocessor chips manufactured or designed by Intel Corporation and, to a lesser extent, AMD Corporation. Intel and AMD processors are often referred to as “i86” processors because the original IBM PCs used an Intel 8086 processor, and all the Intel (and AMD) chips that followed are downward compatible with this processor. (For instance, you should be able to run a software application designed 10 years ago on a new PC you bought yesterday.)

The computer platform changed dramatically with the introduction of mobile computing devices, from the iPod in 2001 to the iPhone in 2007 and the iPad in 2010. Worldwide, over 3.5 billion people use smartphones. You can think of these devices as a second computer hardware platform, one that is consumer device-driven.

Mobile devices are not required to perform as many tasks as computers in the first computer hardware platform, so they consume less power, and generate less heat. Processors for mobile devices are manufactured by a wide range of firms, including Apple, Samsung, and Qualcomm, using an architecture designed by ARM Holdings.

Mainframes have not disappeared. They continue to be used to reliably and securely handle huge volumes of transactions, for analyzing very large

quantities of data, and for handling large workloads in cloud computing centers. The mainframe is still the digital workhorse for banking and telecommunications networks that are often running software programs that are older and require a specific hardware platform. However, the number of providers has dwindled to one: IBM. IBM has also repurposed its mainframe systems so they can be used as giant servers for enterprise networks and corporate websites. A single IBM mainframe can run thousands of instances of Linux or Windows Server software and is capable of replacing thousands of smaller servers (see the discussion of virtualization in Section 5-3).

Operating System Platforms

The leading operating systems for corporate servers are Microsoft Windows Server, **Unix**, and **Linux**, an inexpensive and robust open source relative of Unix. Microsoft Windows Server is capable of providing enterprise-wide operating system and network services and appeals to organizations seeking Windows-based IT infrastructures. Unix and Linux are scalable, reliable, and much less expensive than mainframe operating systems. They can also run on many different types of processors. The major providers of Unix operating systems are IBM, HP, and Oracle-Sun, each with slightly different and partially incompatible versions.

Over 80 percent of PCs use some form of the Microsoft Windows **operating system** for managing the resources and activities of the computer. However, there is now a much greater variety of client operating systems than in the past, with new operating systems for computing on handheld mobile digital devices or cloud-connected computers.

Google's **Chrome OS** provides a lightweight operating system for cloud computing using a web-connected computer. Programs are not stored on the user's computer but are used over the Internet and accessed through the Chrome web browser. User data reside on servers across the Internet. **Android** is an open source operating system for mobile devices such as smartphones and tablet computers, developed by the Open Handset Alliance led by Google. It has become the most popular smartphone platform worldwide, competing with iOS, Apple's mobile operating system for the iPhone, iPad, and iPod Touch. Conventional client operating system software is designed around the mouse and keyboard but increasingly is becoming more natural and intuitive by using touch technology. **iOS**, the operating system for the phenomenally popular Apple iPad and iPhone, features a **multitouch** interface, where users employ one or more fingers to manipulate objects on a screen without a mouse or keyboard. Microsoft's **Windows 10** and Windows 8, which run on tablets as well as PCs, have multitouch capabilities, as do many Android devices.

Enterprise Software Applications

Firms worldwide are expected to spend about \$503 billion in 2020 on software for enterprise applications that are treated as components of IT infrastructure. We introduced the various types of enterprise applications in Chapter 2, and Chapter 9 provides a more detailed discussion of each.

The largest providers of enterprise application software are SAP and Oracle. Also included in this category is middleware software supplied by vendors such as IBM and Oracle for achieving firmwide integration by

linking the firm's existing application systems. Microsoft is attempting to move into the lower ends of this market by focusing on small and medium-sized businesses.

Data Management and Storage

Enterprise database management software is responsible for organizing and managing the firm's data so that they can be efficiently accessed and used. Chapter 6 describes this software in detail. The leading database software providers are IBM (DB2), Oracle, Microsoft (SQL Server), and SAP Sybase (Adaptive Server Enterprise). MySQL is a Linux open source relational database product now owned by Oracle Corporation, and Apache Hadoop is an open source software framework for managing very large data sets (see Chapter 6).

Networking/Telecommunications Platforms

Companies worldwide are expected to spend \$1.5 trillion for telecommunications services in 2020 (Gartner, Inc., 2020). Windows Server is predominantly used as a local area network operating system, followed by Linux and Unix. Large, enterprise-wide area networks use some variant of Unix. Most local area networks, as well as wide area enterprise networks, use the TCP/IP protocol suite as a standard (see Chapter 7).

Cisco and Juniper Networks are leading networking hardware providers. Telecommunications platforms are typically provided by telecommunications/telephone services companies that offer voice and data connectivity, wide area networking, wireless services, and Internet access. Leading telecommunications service vendors include AT&T and Verizon. This market is exploding with new providers of cellular wireless, high-speed Internet, and Internet telephone services.

Internet Platforms

Internet platforms include hardware, software, and management services to support a firm's website, including web hosting services, routers, and cabling or wireless equipment. A **web hosting service** maintains a large web server, or series of servers, and provides fee-paying subscribers with space to maintain their websites.

The Internet revolution created a veritable explosion in server computers, with many firms collecting thousands of small servers to run their Internet operations. There has been a steady push to reduce the number of server computers by increasing the size and power of each and by using software tools that make it possible to run more applications on a single server. Use of stand-alone server computers is decreasing as organizations transition to cloud computing services. The Internet hardware server market has become increasingly concentrated in the hands of IBM, Dell, Oracle, and HP, as prices have fallen dramatically.

The major web software application development tools and suites are supplied by Microsoft (Microsoft Visual Studio and the Microsoft .NET development platform), Oracle-Sun, and a host of independent software developers, including Adobe. Chapter 7 describes the components of the firm's Internet platform in greater detail.

Consulting and System Integration Services

Today, even a large firm does not have the staff, the skills, the budget, or the necessary experience to deploy and maintain its entire IT infrastructure. Implementing a new infrastructure requires (as noted in Chapters 13 and 14) significant changes in business processes and procedures, training and education, and software integration. Leading consulting firms providing this expertise include Accenture, IBM Services, HP, Infosys, and Wipro.

Software integration means ensuring the new infrastructure works with the firm's older, so-called legacy systems and ensuring the new elements of the infrastructure work with one another. **Legacy systems** are generally older transaction processing systems created for mainframe computers that continue to be used to avoid the high cost of replacing or redesigning them. Replacing these systems is cost prohibitive and generally not necessary if these older systems can be integrated into a contemporary infrastructure.

5-3 What are the current trends in computer hardware platforms?

The exploding power of computer hardware and networking technology has dramatically changed how businesses organize their computing power, putting more of this power on networks and mobile handheld devices and obtaining more of their computing capabilities in the form of services. We look at eight hardware trends: the mobile digital platform, consumerization of IT and BYOD, quantum computing, virtualization, cloud computing, edge computing, green computing, and high-performance/power-saving processors.

The Mobile Digital Platform

New mobile digital computing platforms have emerged as alternatives to PCs and larger computers. The iPhone and Android smartphones have taken on many functions of PCs, including transmitting data, surfing the web, transmitting email and instant messages, displaying digital content, and exchanging data with internal corporate systems. The mobile platform also includes small, lightweight netbooks optimized for wireless communication and Internet access, **tablet computers** such as the iPad, and digital e-book readers such as Amazon's Kindle with some web access capabilities.

Smartphones and tablets are becoming the primary means of accessing the Internet and are increasingly used for business computing as well as for consumer applications. For example, service agents at British Airways use iPads and custom apps to engage with customers, share important flight updates and airport information, rebook travel, and track luggage.

Wearable computing devices are a recent addition to the mobile digital platform. These include smartwatches, smart glasses, smart ID badges, and activity trackers. Wearable computing technology has many business uses, especially for delivering information to workers in warehouses or in the field without requiring them to interrupt their tasks.

Consumerization of IT and BYOD

The popularity, ease of use, and rich array of useful applications for smartphones and tablet computers have created a groundswell of interest in allowing employees to use their personal mobile devices in the workplace, a

phenomenon popularly called “*bring your own device*” (BYOD). **BYOD** is one aspect of the **consumerization of IT**, in which new information technology that first emerges in the consumer market spreads into business organizations. Consumerization of IT includes not only mobile personal devices but also business uses of software services that originated in the consumer marketplace as well, such as Google and Yahoo search, Gmail, Google Maps, Dropbox, and even Facebook and Twitter.

Consumerization of IT is forcing businesses to rethink the way they obtain and manage information technology equipment and services. Historically, at least in large firms, the IT department was responsible for selecting and managing the information technology and applications used by the firm and its employees. It furnished employees with desktops or laptops that were able to access corporate systems securely. The IT department maintained control over the firm’s hardware and software to ensure that the business was being protected and that information systems served the purposes of the firm and its management. Today, employees and business departments are playing a much larger role in technology selection, in many cases demanding that employees be able to use their own personal computers, smartphones, and tablets to access the corporate network. It is more difficult for the firm to manage and control these consumer technologies and make sure they serve the needs of the business.

Quantum Computing

Quantum computing uses the principles of quantum physics to represent data and perform operations on these data. While conventional computers handle bits of data as either 0 or 1 but not both, quantum computing can process units of data as 0, 1, or both simultaneously. A quantum computer would gain enormous processing power through this ability to be in multiple states at once, allowing it to solve some scientific and business problems millions of times faster than can be done today. IBM has made quantum computing available to the general public through IBM Cloud. Google’s Alphabet, Microsoft, Intel, and NASA are also working on quantum computing platforms. Quantum computing is still an emerging technology, but its real-world applications are growing.

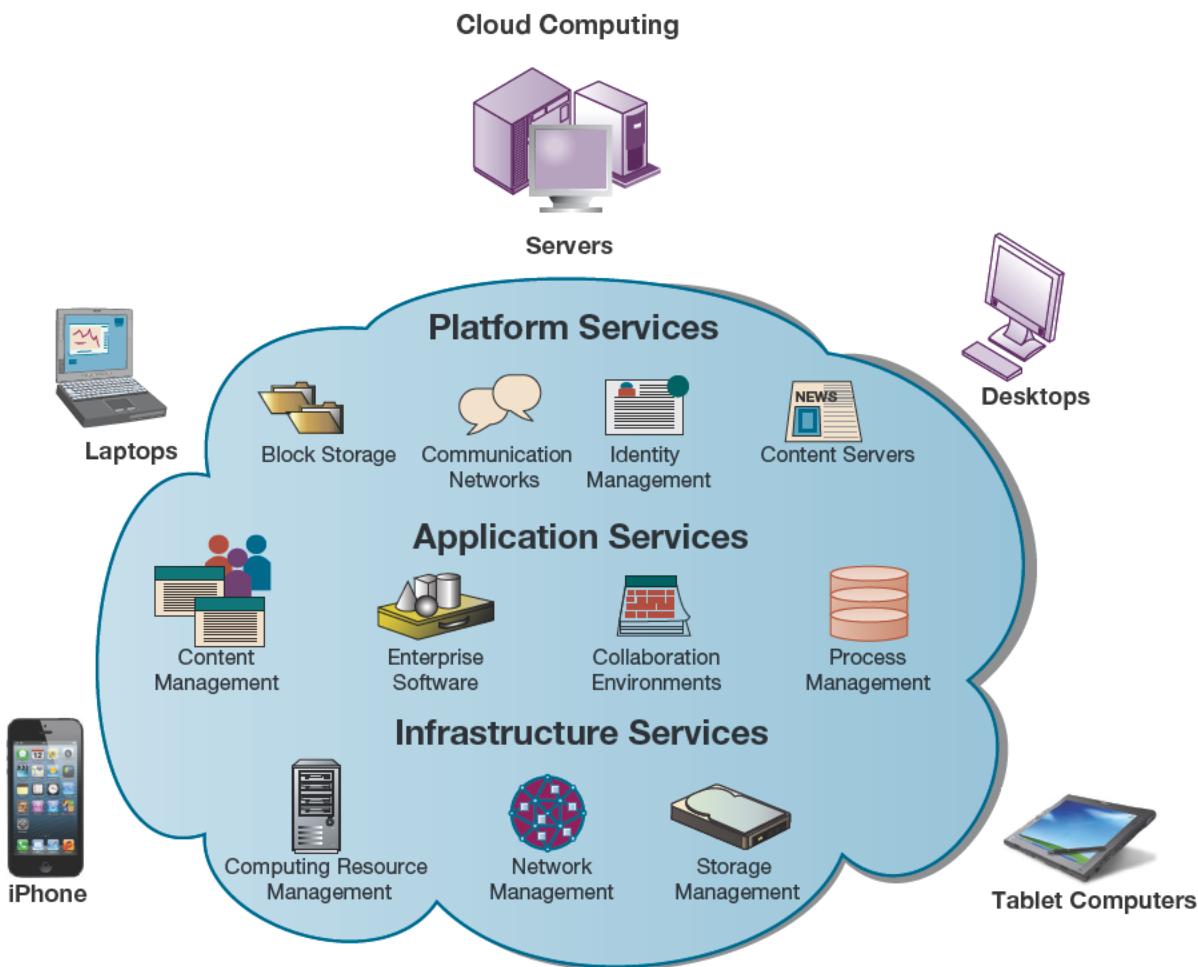
Virtualization

Virtualization is the process of presenting a set of computing resources (such as computing power or data storage) so that they can all be accessed in ways that are not restricted by physical configuration or geographic location. Virtualization enables a single physical resource (such as a server or a storage device) to appear to the user as multiple logical resources. For example, a server or mainframe can be configured to run many instances of an operating system (or different operating systems) so that it acts like many different machines. Each virtual server “looks” like a real physical server to software programs, and multiple virtual servers can run in parallel on a single machine. VMware is the leading virtualization software vendor for Windows and Linux servers.

Server virtualization is a common method of reducing technology costs by providing the ability to host multiple systems on a single physical machine. Most servers run at just 15 to 20 percent of capacity, and virtualization can boost server utilization rates to 70 percent or higher. Higher utilization rates translate into fewer computers required to process the same amount of work, reduced

FIGURE 5.9 CLOUD COMPUTING PLATFORM

In cloud computing, hardware and software capabilities are a pool of virtualized resources provided over a network, often the Internet. Businesses and employees have access to applications and IT infrastructure anywhere, at any time, and on any device.



data center space to house machines, and lower energy usage. Virtualization also facilitates centralization and consolidation of hardware administration.

Virtualization also enables multiple physical resources (such as storage devices or servers) to appear as a single logical resource, as in **software-defined storage (SDS)**, which separates the software for managing data storage from storage hardware. Using software, firms can pool and arrange multiple storage infrastructure resources and efficiently allocate them to meet specific application needs. SDS enables firms to replace expensive storage hardware with lower-cost commodity hardware and cloud storage hardware. There is less under- or over-utilization of storage resources.

Cloud Computing

Cloud computing is a model of computing in which computer processing, storage, software, and other services are provided as a shared pool of virtualized resources over a network, primarily the Internet. These “clouds” of computing resources can be accessed on an as-needed basis from any connected device and location. Figure 5.9 illustrates the cloud computing concept. Cloud

computing enables companies and individuals to perform all of their computing work using a virtualized IT infrastructure in a remote location.

The U.S. National Institute of Standards and Technology (NIST) defines cloud computing as having the following essential characteristics (Mell and Grance, 2009):

- **On-demand self-service:** Consumers can obtain computing capabilities such as server time or network storage as needed automatically on their own.
- **Ubiquitous network access:** Cloud resources can be accessed using standard network and Internet devices, including mobile platforms.
- **Location-independent resource pooling:** Computing resources are pooled to serve multiple users, with different virtual resources dynamically assigned according to user demand. The user generally does not know where the computing resources are located.
- **Rapid elasticity:** Computing resources can be rapidly provisioned, increased, or decreased to meet changing user demand.
- **Measured service:** Charges for cloud resources are based on amount of resources actually used.

Cloud computing consists of three different types of services:

- **Infrastructure as a service (IaaS):** Customers use processing, storage, networking, and other computing resources from cloud service providers to run their information systems. For example, Amazon uses the spare capacity of its IT infrastructure to provide a broadly based cloud environment selling IT infrastructure services. These include its Simple Storage Service (S3) for storing customers' data and its Elastic Compute Cloud (EC2) service for running their applications. Users pay only for the amount of computing and storage capacity they actually use. (See the Interactive Session on Organizations.) Figure 5.10 shows the range of services Amazon Web Services offers.

FIGURE 5.10 AMAZON WEB SERVICES

Amazon Web Services (AWS) is a collection of web services that Amazon provides to users of its cloud platform. AWS is the largest provider of cloud computing services in the United States.



INTERACTIVE SESSION ORGANIZATIONS

Glory Finds Solutions in the Cloud

Ever wonder who keeps track of all your ATM transactions? If you use ATMs anywhere in the globe—and who doesn't—chances are good that specialist firms like Glory Global Solutions Ltd. are managing the process of dispensing and depositing cash ATM transactions. It's called the cash management business, and it's at the heart of banking activity in thousands of bank branches and global banking systems, and an important part of the retail vending, automated self-service venues, and gaming industries (such as the gambling industry, which runs on cash). There are over 3 million ATMs worldwide. Given the ubiquity of ATMs, cash transactions require global scale systems to manage the flow of value.

Glory Global was founded in 1918 as Kokuei Machinery in Himeji, Japan. Originally a light bulb manufacturing firm, it expanded on its manufacturing strengths by building the first coin and cash counters in Japan. By the 1970s it had moved into the manufacture of ATMs worldwide and changed its name to The Glory Group. Through a series of acquisitions, Glory expanded rapidly. In 2013 Glory acquired Talaris (a UK-based cash management firm) to create Glory Global Solutions Ltd., with headquarters in Basingstoke, England. Today Glory Global Solutions is one of the world's largest cash management solutions providers. Glory Global Solutions has over 3,000 employees, has a direct presence in over 20 countries, and services customers in over 100 countries around the world. Glory Solutions is a subsidiary of The Glory Group, which remains a Japanese-owned firm that trades on the Tokyo stock exchange.

Growing over the years through more than 25 acquisitions, Glory Group inherited a collection of legacy systems developed in different countries, by multiple firms and developers, for different lines of business. The company also inherited a collection of data centers from the firms it acquired. The various systems could not communicate with one another, and management was unable to "see" all of its businesses or to understand the business processes of their various business segments and operating companies. Management decided the firm could not achieve its strategic goals of growing the business without being able to streamline and standardize its

business processes worldwide. The inefficiency of operating so many disparate data centers and the absence of a single global system operating on a modern technology platform suggested the need for a global enterprise database approach and for operating on a cloud platform provided by a single vendor. Moving to a cloud solution would greatly reduce its data management and IT infrastructure costs.

Glory had already begun the move toward a cloud-based business by deploying Microsoft Office 365 and other cloud solutions a few years before. For the first time, the firm was able to share documents, data, and presentations across all its business segments. The firm's managers believed they could obtain a positive return on their investment within four years by moving other processes to a single database and a single cloud service.

The next challenge was determining which vendor would be the best choice. There are multiple vendors of cloud-based computing, from very large firms like Oracle, SAP, IBM, and HP to smaller, regional providers. Ultimately, Glory narrowed the choice down to two global vendors and then decided that Oracle best fit their needs. The firm had already adopted in its European operations several elements of Oracle's traditional enterprise suite installed on Glory's own servers. In the last five years, along with most global cloud providers, Oracle has moved rapidly toward offering "computing on demand" as a business model, where customers do not purchase software but instead rent the computing power they need and pay for only as much as they use the service. Having a single vendor for licensing software and processing power rather than dealing with multiple vendors was also seen as a positive factor.

Few firms have the expertise to move rapidly from a legacy system to a contemporary cloud platform. Glory reviewed ten vendors of systems integration services and chose a firm called TCS to help them with the transition and fill gaps in the firm's own knowledge. TCS had considerable experience with Oracle enterprise systems and had a number of pre-built modules that could be used by Glory. System integrators are consulting firms that have expertise in the hardware and software of business systems and bring with them knowledge and background in

best business practices learned over many years in different industries. They help firms redesign their business processes and merge them into the enterprise software and IT infrastructure. After twelve months of work, the new platform was ready to deploy.

A key challenge facing management was how to implement these platform changes in 24 countries with multiple languages and multiple regulations in each country. This turned out to be a massive cultural change. Each of the firm's business units required training in the new business processes and the software used to implement the processes. Over 2,000 of the firm's employees would be using the new systems, some daily, to perform their jobs. A direct cutover to the new system was considered too risky. A parallel system cutover where both the old and new platforms operate in parallel was considered too expensive, and too difficult technically.

Management decided instead on a regional rollout strategy starting with the UK headquarters location. The company implemented the new system in the remaining countries over an 18-month period. Overall, the transition required four years to completion. Management believes the new system will reduce annual IT costs by 50 percent compared to the older legacy systems, but the real benefit will come from being able to operate and grow as a single global firm.

Sources: Glory-Global Group, "Fact Book 2020," accessed December 21, 2020; Glory-Global Group, "Glory Cash Recycling System, CI-5 Awarded the Design Prize "Red Dot Design Award 2019," Press Release, March 25, 2019; Glory-Global Group, "Declining ATMs, Growing Cashback—Are We Entering a New Cash Cycle?," February 14, 2019; Federal Reserve Board, "The Federal Reserve Payments Study 2018," federalreserve.gov, 2018; Accenture, "ATM Benchmarking Study 2018 and Industry Report," accenture.com, 2018; Ariella Brown, "Public Cloud Helps Global Firm Grow Its Business," CIO Insight, December 13, 2016.

CASE STUDY QUESTIONS

1. Why did Glory choose a cloud solution as opposed to modernizing the systems it had?
2. Why was it necessary to hire a systems integrator firm?
3. What were the main organizational change requirements for implementing the new cloud platform?
4. Why did management choose a regional rollout strategy? Why in the United Kingdom?

- **Software as a service (SaaS):** Customers use software hosted by the vendor on the vendor's cloud infrastructure and delivered as a service over a network. Leading software as a service (SaaS) examples are Google's G Suite, which provides common business applications online, and Salesforce.com, which leases customer relationship management and related software services over the Internet. Both charge users an annual subscription fee, although Google has a pared-down free version. Users access these applications from a web browser, and the data and software are maintained on the providers' remote servers.
- **Platform as a service (PaaS):** Customers use infrastructure and programming tools supported by the cloud service provider to develop their own applications. For example, Microsoft offers PaaS tools and services for software development and testing among its Azure cloud services. Another example is Salesforce.com's Salesforce Platform.

Chapter 2 discussed Google Docs, Microsoft Office 365, and related software services for desktop productivity and collaboration. These are among the most popular software services for consumers, although they are increasingly used in business. Salesforce.com is a leading software service for business. Salesforce.com provides customer relationship management (CRM) and other application software solutions as software services leased over the Internet. Its sales and service clouds offer applications for improving sales and customer service. A

marketing cloud enables companies to engage in digital marketing interactions with customers through email, mobile, social, web, and connected products. Salesforce.com also provides a community cloud platform for online collaboration and engagement and an analytics cloud platform to deploy sales, service, marketing, and custom analytics apps.

Salesforce.com is also a leading example of platform as a service (PaaS). Its Salesforce Platform gives users the ability to develop, launch, and manage applications without having to deal with the infrastructure required for creating new software. The Salesforce Platform provides a set of development tools and IT services that enable users to build new applications and run them in the cloud on Salesforce.com's data center infrastructure. Salesforce.com also lists software from other independent developers on its AppExchange, an online marketplace for third-party applications that run on the Salesforce Platform.

A cloud can be private or public. A **public cloud** is owned and maintained by a cloud service provider, such as Amazon Web Services, and made available to the general public or industry group. Public cloud services are often used for websites with public information and product descriptions, one-time large computing projects, developing and testing new applications, and consumer services such as online storage of data, music, and photos. Google Drive, Dropbox, and Apple iCloud are leading examples of these consumer public cloud services.

A **private cloud** is operated solely for an organization. It may be managed by the organization or a third party and may be hosted either internally or externally. Like public clouds, private clouds are able to allocate storage, computing power, or other resources seamlessly to provide computing resources on an as-needed basis. Companies that want flexible IT resources and a cloud service model while retaining control over their own IT infrastructure are gravitating toward these private clouds.

Because organizations using public clouds do not own the infrastructure, they do not have to make large investments in their own hardware and software. Instead, they purchase their computing services from remote providers and pay only for the amount of computing power they actually use (utility computing) or are billed on a monthly or annual subscription basis. The term **on-demand computing** has also been used to describe such services.

Cloud computing has some drawbacks. Unless users make provisions for storing their data locally, the responsibility for data storage and control is in the hands of the provider. Some companies worry about the security risks related to entrusting their critical data and systems to an outside vendor that also works with other companies. Companies expect their systems to be available 24/7 and do not want to suffer any loss of business capability if cloud infrastructures malfunction. Nevertheless, the trend is for companies to shift more of their computer processing and storage to some form of cloud infrastructure. Startups and small companies with limited IT resources and budgets will find public cloud services especially helpful.

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TABLE 5.2 CLOUD COMPUTING MODELS COMPARED

TYPE OF CLOUD	DESCRIPTION	MANAGED BY	USES
Public cloud	Third-party service offering computing, storage, and software services to multiple providers customers and that is available to the public	Third-party service	Companies without major privacy concerns Companies seeking pay-as-you-go IT services Companies lacking IT resources and expertise
Private cloud	Cloud infrastructure operated solely for a single organization and hosted either internally or externally	In-house IT or private third-party host	Companies with stringent privacy and security requirements Companies that must have control over data sovereignty
Hybrid cloud	Combination of private and public cloud services that remain separate entities	In-house IT, private host, third-party providers	Companies requiring some in-house control of IT that are also willing to assign part of their IT infrastructures to a public cloud

Large firms are most likely to adopt a **hybrid cloud** computing model where they use their own infrastructure for their most essential core activities and adopt public cloud computing for less critical systems or for additional processing capacity during peak business periods. Table 5.2 compares the three cloud computing models. Cloud computing will gradually shift firms from having a fixed infrastructure capacity toward a more flexible infrastructure, some of it owned by the firm and some of it rented from giant computer centers owned by computer hardware vendors. You can find out more about cloud computing in the Learning Tracks for this chapter.

Edge Computing

Having all the laptops, smartphones, tablets, wireless sensor networks, and local on-premise servers used in cloud computing systems interacting with a single central public cloud data center to process all their data can be inefficient and costly. **Edge computing** is a method of optimizing cloud computing systems by performing some data processing on a set of linked servers at the edge of the network, near the source of the data. This reduces the amount of data flowing back and forth between local computers and other devices and the central cloud data center.

Edge computing deployments are useful when sensors or other IoT devices do not need to be constantly connected to a central cloud. For example, an oil rig in the ocean might have thousands of sensors producing large amounts of data, perhaps to confirm that systems are working properly. The data do not necessarily need to be sent over a network as soon as they are produced, so the local edge computing system could compile the data and send daily reports to a central data center or cloud for long-term storage. By only sending important data over the network, the edge computing system reduces the amount of data traversing the network.

Edge computing also reduces delays in the transmitting and processing of data because data does not have to travel over a network to a remote data center or cloud for processing. This is ideal for situations where delays of milliseconds can be untenable, such as in financial services, manufacturing, or autonomous vehicles.

Green Computing

By curbing hardware proliferation and power consumption, virtualization has become one of the principal technologies for promoting green computing. **Green computing, or green IT**, refers to practices and technologies for

designing, manufacturing, using, and disposing of computers, servers, and associated devices such as monitors, printers, storage devices, and networking and communications systems to minimize impact on the environment.

According to Green House Data, the world's data centers use as much energy as the output of 30 nuclear power plants, which amounts to 1.5 percent of all energy use in the world. A corporate data center can easily consume over 100 times more power than a standard office building. All this additional power consumption has a negative impact on the environment and corporate operating costs. Data centers are now being designed with energy efficiency in mind, using state-of-the art air-cooling techniques, energy-efficient equipment, virtualization, and other energy-saving practices. Large companies like Microsoft, Google, Facebook, and Apple are starting to reduce their carbon footprint with clean energy-powered data centers with power-conserving equipment and extensive use of wind and hydropower.

High-Performance and Power-Saving Processors

Another way to reduce power requirements and hardware sprawl is to use more efficient and power-saving processors. Contemporary microprocessors now feature multiple processor cores (which perform the reading and execution of computer instructions) on a single chip. A **multicore processor** is an integrated circuit to which two or more processor cores have been attached for enhanced performance, reduced power consumption, and more efficient simultaneous processing of multiple tasks. This technology enables two or more processing engines with reduced power requirements and heat dissipation to perform tasks faster than a resource-hungry chip with a single processing core. Today you'll find PCs with dual-core, quad-core, six-core, and eight-core processors and servers with 16- and 32-core processors.

Intel and other chip manufacturers are working on microprocessors that minimize power consumption, which is essential for prolonging battery life in small mobile digital devices. Highly power-efficient microprocessors, such as A10, A11 Bionic, and A12 Bionic processors used in Apple's iPhone and iPad and Intel's Atom processor, are used in lightweight smartphones and tablets, intelligent cars, and healthcare devices.

5-4 What are the current computer software platforms and trends?

There are four major themes in contemporary software platform evolution:

- Linux and open source software
- Software for the Web: Java, JavaScript, HTML, and HTML5
- Web services and service-oriented architecture
- Software outsourcing and cloud services

Linux and Open Source Software

Open source software is software produced by a community of several hundred thousand programmers around the world. Open source software is free and can be modified by users. Works derived from the original code must also be free.

Popular open source software tools include the Linux operating system, the Apache HTTP web server, the Mozilla Firefox web browser, and the Apache OpenOffice desktop productivity suite. Google's Android mobile operating system and Chrome web browser are based on open source tools. You can find out more about the Open Source Definition from the Open Source Initiative and the history of open source software in the Learning Tracks for this chapter. The Interactive Session on Technology case also provides more information on the open source movement.

Linux

Perhaps the most well-known open source software is Linux, an operating system related to Unix. Linux was created by Finnish programmer Linus Torvalds and first posted on the Internet in August 1991. Linux applications are embedded in cell phones, smartphones, tablet computers, and consumer electronics. Linux is available in free versions downloadable from the Internet or in low-cost commercial versions that include tools and support from vendors such as Red Hat.

Although Linux is not used in many desktop systems, it is a leading operating system for servers, mainframe computers, and supercomputers. IBM, HP, Intel, Dell, and Oracle have made Linux a central part of their offerings to corporations. Linux has profound implications for corporate software platforms—cost reduction, reliability, and resilience—because Linux can work on all the major hardware platforms.

Software for the Web: Java, JavaScript, HTML, and HTML5

Java is an operating system-independent, processor-independent, object-oriented programming language created by Sun Microsystems that has been a popular interactive programming environment for the web. The Java platform has also migrated into mobile phones, tablets, and consumer electronic devices. Java software is designed to run on any computer or computing device, regardless of the specific microprocessor or operating system the device uses. For each of the computing environments in which Java is used, a Java Virtual Machine interprets Java programming code for that machine. In this manner, the code is written once and can be used on any machine for which there exists a Java Virtual Machine.

Java developers can create small applet programs that can be embedded in web pages and downloaded to run on a web browser. A **web browser** is an easy-to-use software tool with a graphical user interface for displaying web pages and for accessing the web and other Internet resources. Microsoft's Internet Explorer, Microsoft Edge, Mozilla Firefox, Google Chrome, and Apple Safari browsers are examples. At the enterprise level, Java is being used for more complex e-commerce and e-business applications.

HTML and HTML5

Hypertext Markup Language (HTML) is a page description language for specifying how text, graphics, video, and sound are placed on a web page and for creating dynamic links to other web pages and objects. Using these links, a user need only point at a highlighted keyword or graphic, click on it, and immediately be transported to another document.

INTERACTIVE SESSION TECHNOLOGY

Open Source Innovation: The New Competitive Advantage

Open source software is computer software whose source code is distributed freely and can be modified by anyone. The open source movement started as a response to the high cost of, and restrictions on, proprietary software. Initially, open source software was created and maintained by communities of users. Famous examples include Linux, Apache, and Firefox.

In the late 2010s, a new trend arose: companies began to release their proprietary software as open source. This phenomenon, known as open innovation, aimed to increase the pace of innovation by relying on users for new ideas and features instead of just relying on a small, internal group doing R&D. This marked a dramatic shift in mindset, from competing based on proprietary intellectual property (such as patents or copyrights) to competing through opening up and sharing. Two prominent examples of open innovation are Baidu and Fujitsu.

Based in China, Baidu is the leading search engine company in China and the fourth-most visited site in the world. It is often dubbed the “Google of China.” Besides its core search services, Baidu offers community cloud services, an online video platform, maps, takeout delivery, online and mobile payments, and more. To power these services, Baidu was relying more and more on AI. In 2016, in a move that took the IT world by surprise, Baidu released the source code and documentation for its AI software, PaddlePaddle (PArallel Distributed Deep LEarning), which had taken three years to develop, on the open source development platform GitHub.

PaddlePaddle is a framework based on deep learning, a promising field in machine learning and AI. It develops algorithms from huge amounts of data inputs by inferring patterns and using sophisticated classifying and predictive capabilities. It also supports neural network architectures, such as convolutional and recurrent neural networks. Today, PaddlePaddle powers more than 30 of Baidu’s offline and online products and services, used across a variety of industries, including finance and healthcare. For Baidu’s takeout business, for example, it calculates the time for food to reach customers. It is also the brains behind speech transcription in Chinese, translating speech-to-text for broadcast transcription and for smartphone speech interfaces. Other examples of functionality supported by it are search ranking,

advertising, image classification, machine translation, and optical character recognition. PaddlePaddle’s core libraries are written in C++ for speed, and it is scalable to a large number of CPUs or GPUs on multiple machines.

In 2020, Baidu made a new toolkit for quantum machine learning, known as Paddle Quantum, available on GitHub. Paddle Quantum is designed to be used to build and train quantum neural networks. Baidu also open-sourced tools for a variety of enhanced features for the PaddlePaddle framework, which is now being used by more than 1.9 million developers at 84,000 businesses.

A similar example comes from tech giant Fujitsu, a leading Japanese multinational information and communication technology company employing 130,000 employees in more than 100 countries. The company recognized that it was critical for it to move from its traditional products and services to the Internet and the cloud, and this drove it toward open source.

One of the opportunities identified by Fujitsu was multi-cloud environments. Cloud services offered by providers such as Amazon and IBM have different access methods and billing systems, and they lack a set of standardized technologies to link the different clouds together. To address this gap, Fujitsu created the Open Service Catalog Manager (OSCM), open source software based on Fujitsu’s Systemwalker Service Catalogue Manager. OSCM allows different cloud service providers to list and manage their services and also enables customers to get integrated billing from different providers. OSCM has been certified by OpenStack and can be integrated with various service providers such as Amazon Web Services and Microsoft Azure. Fujitsu thus created an industry-wide, vendor-neutral open source platform for delivering cloud services.

Both Baidu and Fujitsu used a non-traditional approach to enhance innovation and product development in their companies. Baidu wanted to keep up with other global tech giants who were already releasing their AI code, such as Facebook’s Torch toolkit and Google’s TensorFlow. Besides a competitive necessity, this was also an attempt to access and attract deep learning expertise to enable Baidu to counter the trend of AI professionals increasingly concentrating in a few global companies that are becoming

intellectual monopolies. Fujitsu meanwhile adopted an open source strategy because keeping its software proprietary was no longer very profitable. In addition, it realized that there was much greater scope for innovation and expansion with the participation of the community. Finally, it was an opportunity for Fujitsu to pioneer a platform and develop new competencies without a lot of investment.

In addition to the many expected benefits, such as lower cost and faster pace of innovation, both Baidu and Fujitsu enjoyed many unexpected benefits. Baidu's undertaking became the springboard for AI innovation in China, opening the door to a variety of deep-learning applications in all facets of society, such as business, healthcare, and transportation. Fujitsu became the partner of choice for vendors using OCSM and companies such as ImageWare

Systems, which builds cloud-based identity-management solutions.

Sources: "Baidu: Investors: Company Overview," ir.baidu.com; accessed December 17, 2020; The Linux Foundation, "Lightning Talk: Making Business by Contributing to Open Source-Gu Jinxiang, Fujitsu (FNST)," www.youtube.com, December 15, 2020; Mike Wheatley, "Baidu Open-Sources Its Paddle Quantum Learning Toolkit on Github," www.siliconangle.com, May 28, 2020; Libby Clark, "Fujitsu Open Source Project Aims to Be Front End for Cloud Foundry Service-Broker API," www.linux.com, October 11, 2016; John Ribeiro, "Baidu Open Sources Its Deep Learning Platform PaddlePaddle," www.pc-world.com, September 1, 2016; James Vincent, "Baidu Follows U.S. Tech Giants and Open Sources Its Deep Learning Tools," www.theverge.com, September 1, 2016; Serdar Yegulalp, "Baidu Open-Sources Python-Driven Machine Learning Framework," www.infoworld.com, September 1, 2016; "Fujitsu Upgrades Biometrics-as-a-Service with Latest Catalog Manager Marketplace and ImageWare's GoVerifyID," www.fujitsu.com, July 14, 2016; Swapnil Bhartiya, "Fujitsu Releases Its First Open Source Project: Open Service Catalog Manager," linux.com, December 7, 2015.

CASE STUDY QUESTIONS

1. What is open source software? How is it different from proprietary software?
2. What motivated Baidu to make its AI software open source? How did Baidu benefit from open sourcing?
3. Why did Fujitsu adopt an open source strategy? How did Fujitsu benefit from it?

Case contributed by Neerja Sethi and Vijay Sethi, Nanyang Technological University

HTML was originally designed to create and link static documents composed largely of text. Today, however, the web is much more social and interactive, and many web pages have multimedia elements—images, audio, and video. Additional programming was required to integrate these rich media with web pages, putting strains on computer processing. The next evolution of HTML, called **HTML5**, solves this problem by making it possible to embed images, audio, video, and other elements directly into a document without processor-intensive add-ons. HTML5 makes it easier for web pages to function across different display devices, including mobile devices as well as desktops, and it supports the storage of data offline for apps that run over the web.

JavaScript is another core technology for making web pages more interactive. The vast majority of websites use JavaScript for client-side page behavior, and all major web browsers have a built-in JavaScript engine to execute it very quickly. JavaScript runs very fast and is able to instruct the computer on how to interact with the user upon receiving user input.

Other popular programming tools for web applications include Python and Ruby on Rails. Python is known for its flexibility in scaling web applications, its ability to run on most platforms, and its ease of use. Ruby on Rails provides a framework with tools for building feature-rich websites.

Web Services and Service-Oriented Architecture

Web services refer to a set of loosely coupled software components that exchange information with each other using universal web communication standards and languages. They can exchange information between two different systems regardless of the operating systems or programming languages on which the systems are based. They can be used to build open standard web-based applications linking systems of two different organizations, and they can also be used to create applications that link disparate systems within a single company. Different applications can use web services to communicate with each other in a standard way without time-consuming custom coding.

The foundation technology for web services is **XML**, which stands for Extensible Markup Language. This language was developed in 1996 by the World Wide Web Consortium (W3C, the international body that oversees the development of the web) as a more powerful and flexible markup language than hypertext markup language (HTML) for web pages. Whereas HTML is limited to describing how data should be presented in the form of web pages, XML can perform presentation, communication, and storage of data. In XML, a number is not simply a number; the XML tag specifies whether the number represents a price, a date, or a ZIP code. Table 5.3 illustrates some sample XML statements.

By tagging selected elements of the content of documents for their meanings, XML makes it possible for computers to manipulate and interpret their data automatically and perform operations on the data without human intervention. Web browsers and computer programs, such as order processing or enterprise resource planning (ERP) software, can follow programmed rules for applying and displaying the data. XML provides a standard format for data exchange, enabling web services to pass data from one process to another.

Web services communicate through XML messages over standard web protocols. Companies discover and locate web services through a directory. Using web protocols, a software application can connect freely to other applications without custom programming for each different application with which it wants to communicate. Everyone shares the same standards.

The collection of web services that are used to build a firm's software systems constitutes what is known as a service-oriented architecture. A **service-oriented architecture (SOA)** is a set of self-contained services that communicate with each other to create a working software application. Business tasks are accomplished by executing a series of these services. Software developers reuse these services in other combinations to assemble other applications as needed.

Virtually all major software vendors provide tools and entire platforms for building and integrating software applications using web services. Microsoft has incorporated web services tools in its Microsoft .NET platform.

Dollar Rent A Car's systems use web services for its online booking system with Southwest Airlines' website. Although both companies' systems are based on different technology platforms, a person booking a flight on Southwest.com can reserve a car from Dollar without leaving the airline's website. Instead of

TABLE 5.3 EXAMPLES OF XML

PLAIN ENGLISH	XML
Subcompact	<AUTOMOBILETYPE="Subcompact">
4 passenger	<PASSENGERUNIT="PASS">4</PASSENGER>
\$16,800	<PRICE CURRENCY="USD">\$16,800</PRICE>

struggling to get Dollar's reservation system to share data with Southwest's information systems, Dollar used Microsoft .NET web services technology as an intermediary. Reservations from Southwest are translated into web services protocols, which are then translated into formats that can be understood by Dollar's computers.

Other car rental companies have linked their information systems to airline companies' websites before. But without web services, these connections had to be built one at a time. Web services provide a standard way for Dollar's computers to "talk" to other companies' information systems without having to build special links to each one. Dollar is now expanding its use of web services to link directly to the systems of a small tour operator and a large travel reservation system as well as a wireless website for cell phones and smartphones. It does not have to write new software code for each new partner's information systems or each new wireless device (see Figure 5.11).

Software Outsourcing and Cloud Services

Today, many business firms continue to operate legacy systems that continue to meet a business need and that would be extremely costly to replace. But they will purchase or rent most of their new software applications from external sources. Figure 5.12 illustrates the rapid growth in external sources of software for U.S. firms.

FIGURE 5.11 HOW DOLLAR RENT A CAR USES WEB SERVICES

Dollar Rent A Car uses web services to provide a standard intermediate layer of software to "talk" to other companies' information systems. Dollar Rent A Car can use this set of web services to link to other companies' information systems without having to build a separate link to each firm's systems.

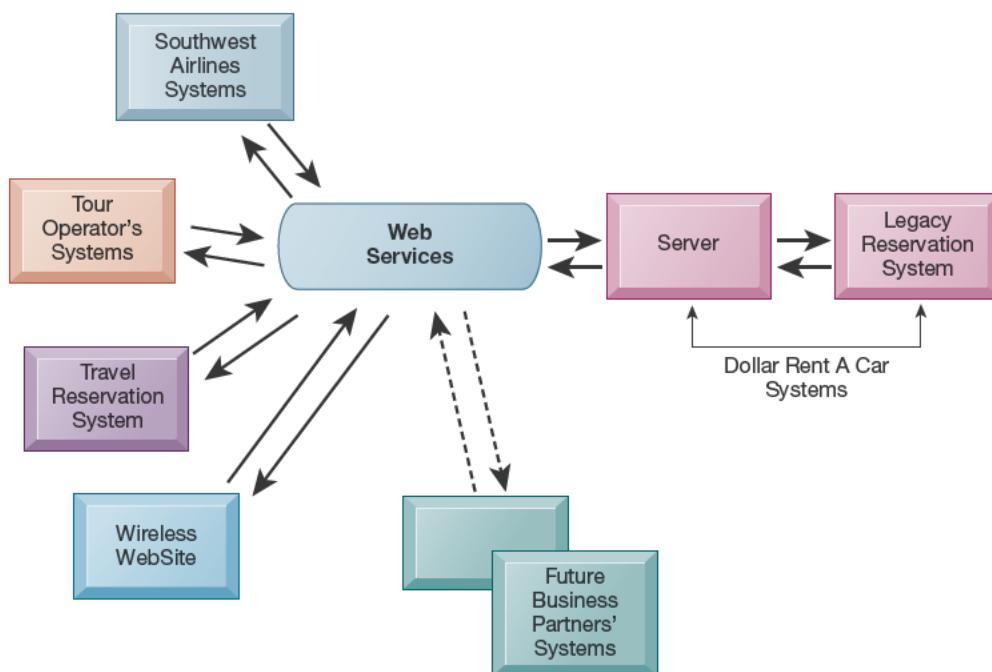
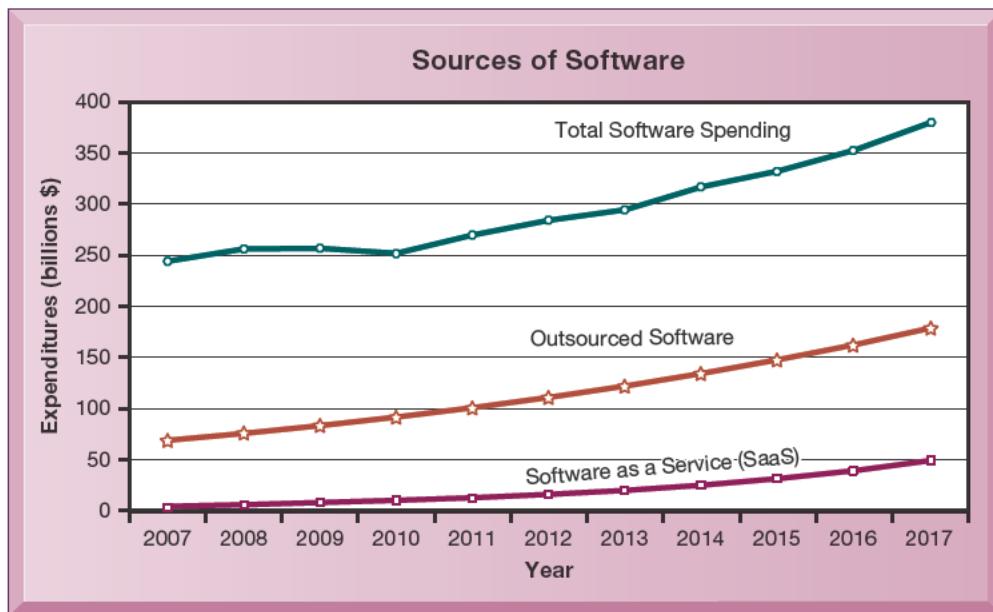


FIGURE 5.12 CHANGING SOURCES OF FIRM SOFTWARE

Spending for software that originated outside the firm, provided by a variety of vendors, has been growing steadily.

Source: BEA National Income and Product Accounts, 2018.



There are three external sources for software: software packages from a commercial software vendor (most ERP systems), outsourcing custom application development to an external vendor (which may or may not be offshore), and cloud-based software services and tools (SaaS/PaaS).

Software Packages and Enterprise Software

We have already described software packages for enterprise applications as one of the major types of software components in contemporary IT infrastructures. A **software package** is a prewritten commercially available set of software programs that eliminates the need for a firm to write its own software programs for certain functions, such as payroll processing or order handling.

Enterprise application software vendors such as SAP and Oracle have developed powerful software packages that can support the primary business processes of a firm worldwide from warehousing, customer relationship management, and supply chain management to finance and human resources. These large-scale enterprise software systems provide a single, integrated, worldwide software system for firms at a cost much less than they would pay if they developed it themselves. Chapter 9 discusses enterprise systems in detail.

Software Outsourcing

Software **outsourcing** enables a firm to contract custom software development or maintenance of existing legacy programs to outside firms, which often operate offshore in low-wage areas of the world. For example, in 2013, IKEA announced a six-year offshore IT outsourcing deal with German infrastructure solutions firm Wincor Nixdorf. Wincor Nixdorf set up 12,000 point-of-sale (POS) systems in 300 IKEA stores in 25 countries. Wincor Nixdorf provides IKEA with services that include operation and customization of the systems, as well as updating the software and applications running on

them. Having a single software provider offshore helped IKEA reduce the work to run the stores (Existek, 2017). Offshore software outsourcing firms have primarily provided lower-level maintenance, data entry, and call center operations, although more sophisticated and experienced offshore firms, particularly in India, have been hired for new-program development. However, as wages offshore rise and the costs of managing offshore projects are factored in (see Chapter 13), some work that would have been sent offshore is returning to domestic companies.

Cloud-Based Software Services and Tools

In the past, software such as Microsoft Word or Adobe Illustrator came in a box and was designed to operate on a single machine. Today, you're more likely to download the software from the vendor's website or to use the software as a cloud service delivered over the Internet and pay a subscription fee.

Cloud-based software and the data it uses are hosted on powerful servers in data centers and can be accessed with an Internet connection and standard web browser. In addition to free or low-cost tools for individuals and small businesses provided by Google or Yahoo, enterprise software and other complex business functions are available as services from the major commercial software vendors. Instead of buying and installing software programs, subscribing companies rent the same functions from these services, with users paying either on a subscription or per-transaction basis. A leading example of software as a service (SaaS) is Salesforce.com, described earlier in this chapter, which provides on-demand software services for customer relationship management.

In order to manage their relationship with an outsourcer or technology service provider, firms need a contract that includes a **service level agreement (SLA)**. The SLA is a formal contract between customers and their service providers that defines the specific responsibilities of the service provider and the level of service expected by the customer. SLAs typically specify the nature and level of services provided, criteria for performance measurement, support options, provisions for security and disaster recovery, hardware and software ownership and upgrades, customer support, billing, and conditions for terminating the agreement. We provide a Learning Track on this topic.

Mashups and Apps

The software you use for both personal and business tasks today may be composed of interchangeable components that integrate freely with other applications on the Internet. Individual users and entire companies mix and match these software components to create their own customized applications and to share information with others. The resulting software applications are called **mashups**. The idea is to take different sources and produce a new work that is greater than the sum of its parts. You have performed a mashup if you've ever personalized your Facebook profile or your blog with a capability to display videos or slide shows.

Web mashups combine the capabilities of two or more online applications to create a kind of hybrid that provides more customer value than the original sources alone. For instance, ZipRealty uses Google Maps and data provided by an online real estate database. **Apps** are small, specialized software programs that run on the Internet, on your computer, or on your mobile phone or tablet and are generally delivered over the Internet. Google refers to its online services as apps. But when we talk about apps today, most of the attention goes to the apps that have been developed for the mobile digital platform. It is these

apps that turn smartphones and tablets into general-purpose computing tools. There are now millions of apps for the iOS and Android operating systems.

Some downloaded apps do not access the web, but many do, providing faster access to web content than traditional web browsers. Apps provide a streamlined nonbrowser pathway for users to perform a number of tasks, ranging from reading the newspaper to shopping, searching, personal health monitoring, playing games, and buying. They increasingly are used by managers as gateways to their firm's enterprise systems. Because so many people are now accessing the Internet from their mobile devices, some say that apps are "the new browsers." Apps are also starting to influence the design and function of traditional websites as consumers are attracted to the look and feel of apps and their speed of operation.

Many apps are free or purchased for a small charge, much less than conventional software, which further adds to their appeal. The success of these mobile platforms depends in large part on the quantity and the quality of the apps they provide. Apps tie the customer to a specific hardware platform: As the user adds more and more apps to his or her mobile phone, the cost of switching to a competing mobile platform rises.

At the moment, the most commonly downloaded apps are games, news and weather, maps/navigation, social networking, music, and video/movies. But there are also serious apps for business users that make it possible to create and edit documents, connect to corporate systems, schedule and participate in meetings, track shipments, and dictate voice messages. Most large online retailers have apps for consumers for researching and buying goods and services online.

5-5 What are the challenges of managing IT infrastructure and management solutions?

Creating and managing a coherent IT infrastructure raises multiple challenges: dealing with platform and technology change (including cloud and mobile computing), management and governance, and making wise infrastructure investments.

Dealing with Platform and Infrastructure Change

As firms grow, they often quickly outgrow their infrastructure. As firms shrink, they can get stuck with excessive infrastructure purchased in better times. How can a firm remain flexible if investments in IT infrastructure are fixed-cost purchases and licenses? How well does the infrastructure scale? **Scalability** refers to the ability of a computer, product, or system to expand to serve a large number of users without breaking down. New applications, mergers and acquisitions, and changes in business volume all affect computer workload and must be considered when planning hardware capacity.

Firms using mobile computing and cloud computing platforms will require new policies, procedures, and tools for managing these platforms. They will need to inventory all of their mobile devices in business use and develop policies and tools for tracking, updating, and securing them, and for controlling the data and applications that run on them. Firms often turn to **mobile device management (MDM)** software, which monitors, manages, and secures mobile devices that are deployed across multiple mobile service providers and across

multiple mobile operating systems being used in the organization. MDM tools enable the IT department to monitor mobile usage, install or update mobile software, back up and restore mobile devices, and remove software and data from devices that are stolen or lost.

Firms using cloud computing and SaaS will need to fashion new contractual arrangements with remote vendors to make sure that the hardware and software for critical applications are always available when needed and that they meet corporate standards for information security. It is up to business management to determine acceptable levels of computer response time and availability for the firm's mission-critical systems to maintain the level of business performance that is expected.

Management and Governance

A long-standing issue among information system managers and CEOs has been the question of who will control and manage the firm's IT infrastructure. Chapter 2 introduced the concept of IT governance and described some issues it addresses. Other important questions about IT governance are: Should departments and divisions have the responsibility of making their own information technology decisions, or should IT infrastructure be centrally controlled and managed? What is the relationship between central information systems management and business unit information systems management? How will infrastructure costs be allocated among business units? Each organization will need to arrive at answers based on its own needs.

Making Wise Infrastructure Investments

IT infrastructure is a major investment for the firm. If too much is spent on infrastructure, it lies idle and constitutes a drag on the firm's financial performance. If too little is spent, important business services cannot be delivered and the firm's competitors (who spent the right amount) will outperform the underinvesting firm. How much should the firm spend on infrastructure? This question is not easy to answer.

A related question is whether a firm should purchase and maintain its own IT infrastructure components or rent them from external suppliers, including those offering cloud services. The decision either to purchase your own IT assets or to rent them from external providers is typically called the *rent-versus-buy* decision.

Cloud computing is a low-cost way to increase scalability and flexibility, but firms should evaluate this option carefully in light of security requirements and impact on business processes and workflows. In some instances, the cost of renting software adds up to more than purchasing and maintaining an application in-house, or firms can overspend on cloud services (Loten, 2018). Yet there are many benefits to using cloud services including significant reductions in hardware, software, human resources, and maintenance costs. Moving to cloud computing allows firms to focus on their core businesses rather than technology issues.

Total Cost of Ownership of Technology Assets

The actual cost of owning technology resources includes the original cost of acquiring and installing hardware and software as well as ongoing administration costs for hardware and software upgrades, maintenance, technical support, training, and even utility and real estate costs for running and housing the

TABLE 5.4 TOTAL COST OF OWNERSHIP (TCO) COST COMPONENTS

INFRASTRUCTURE COMPONENT	COST COMPONENTS
Hardware acquisition	Purchase price of computer hardware equipment, including computers, terminals, storage, and printers
Software acquisition	Purchase or license of software for each user
Installation	Cost to install computers and software
Training	Cost to provide training for information systems specialists and end users
Support	Cost to provide ongoing technical support, help desks, and so forth
Maintenance	Cost to upgrade the hardware and software
Infrastructure	Cost to acquire, maintain, and support related infrastructure, such as networks and specialized equipment (including storage backup units)
Downtime	Cost of lost productivity if hardware or software failures cause the system to be unavailable for processing and user tasks
Space and energy	Real estate and utility costs for housing and providing power for the technology

technology. The **total cost of ownership (TCO)** model can be used to analyze these direct and indirect costs to help firms determine the actual cost of specific technology implementations. Table 5.4 describes the most important components to consider in a TCO analysis.

When all these cost components are considered, the TCO for a PC might run up to three times the original purchase price of the equipment. Gains in productivity and efficiency from equipping employees with mobile computing devices must be balanced against increased costs from integrating these devices into the firm's IT infrastructure and from providing technical support. Other cost components include fees for wireless airtime, end-user training, help desk support, and software for special applications. Costs are higher if the mobile devices run many different applications or need to be integrated into back-end systems such as enterprise applications.

Hardware and software acquisition costs account for only about 20 percent of TCO, so managers must pay close attention to administration costs to understand the full cost of the firm's hardware and software. It is possible to reduce some of these administration costs through better management. Many large firms are saddled with redundant, incompatible hardware and software because their departments and divisions have been allowed to make their own technology purchases.

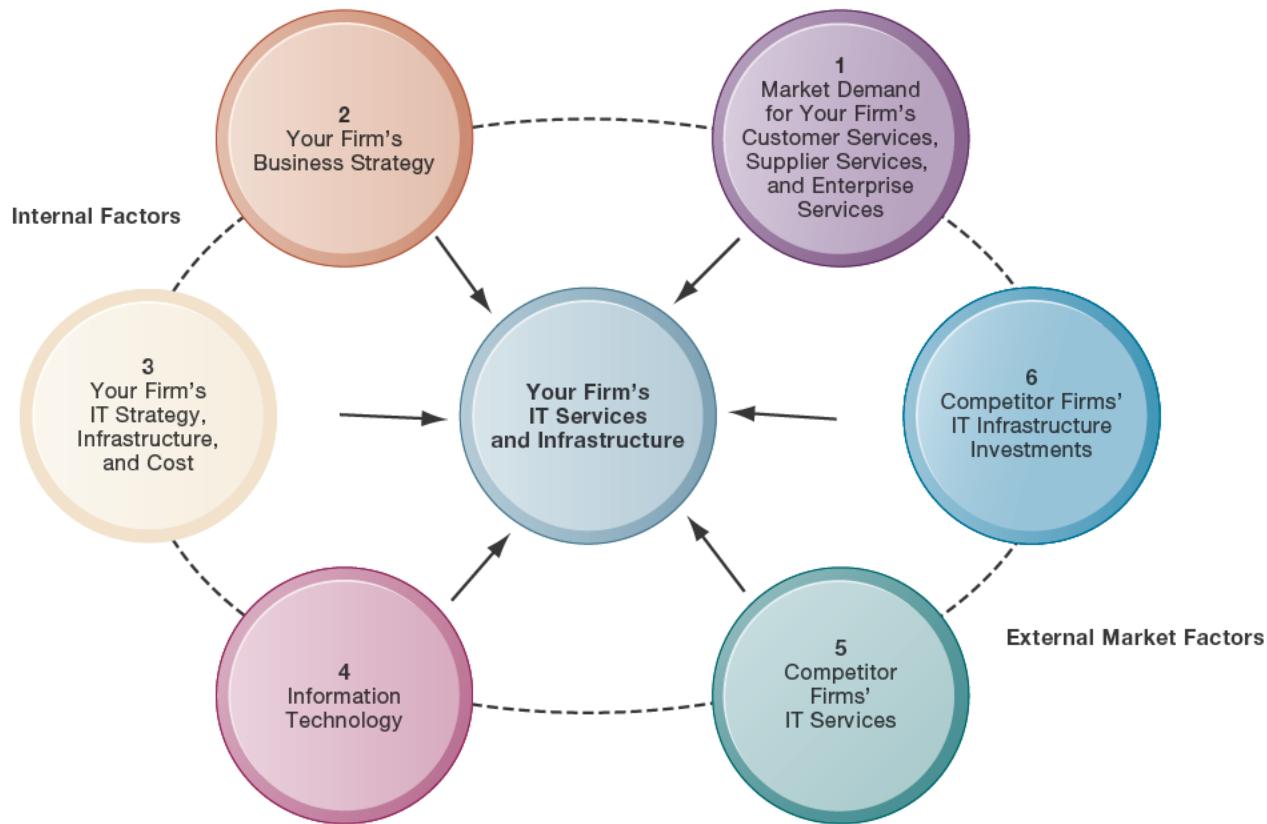
In addition to switching to cloud services, these firms could reduce their TCO through greater centralization and standardization of their hardware and software resources. Companies could reduce the size of the information systems staff required to support their infrastructure if the firm minimizes the number of different computer models and pieces of software that employees are allowed to use. In a centralized infrastructure, systems can be administered from a central location and troubleshooting can be performed from that location.

Competitive Forces Model for IT Infrastructure Investment

Figure 5.13 illustrates a competitive forces model you can use to address the question of how much your firm should spend on IT infrastructure.

FIGURE 5.13 COMPETITIVE FORCES MODEL FOR IT INFRASTRUCTURE

There are six factors you can use to answer the question "How much should our firm spend on IT infrastructure?"



Market demand for your firm's services. Make an inventory of the services you currently provide to customers, suppliers, and employees. Survey each group, or hold focus groups to find out if the services you currently offer are meeting the needs of each group. For example, are customers complaining of slow responses to their queries about price and availability? Are employees complaining about the difficulty of finding the right information for their jobs? Are suppliers complaining about the difficulties of discovering your production requirements?

Your firm's business strategy. Analyze your firm's five-year business strategy and try to assess what new services and capabilities will be required to achieve strategic goals.

Your firm's IT strategy, infrastructure, and cost. Examine your firm's information technology plans for the next five years and assess its alignment with the firm's business plans. Determine the total IT infrastructure costs. You will want to perform a TCO analysis. If your firm has no IT strategy, you will need to devise one that takes into account the firm's five-year strategic plan.

Information technology assessment. Is your firm behind the technology curve or at the bleeding edge of information technology? Both situations are to be avoided. It is usually not desirable to spend resources on advanced technologies that are still experimental, often expensive, and sometimes unreliable. You want to spend on technologies for which standards have been established; IT vendors are competing on cost, not design; and where there are multiple suppliers. However, you do not want to put off investment in new technologies or allow competitors to develop new business models and capabilities based on the new technologies.

Competitor firm services. Try to assess what technology services competitors offer to customers, suppliers, and employees. Establish quantitative and qualitative measures to compare them to those of your firm. If your firm's service levels fall short, your company is at a competitive disadvantage. Look for ways your firm can excel at service levels.

Competitor firm IT infrastructure investments. Benchmark your expenditures for IT infrastructure against your competitors. Many companies are quite public about their innovative expenditures on IT. If competing firms try to keep IT expenditures secret, you may be able to find IT investment information in public companies' SEC Form 10-K annual reports to the federal government when those expenditures affect a firm's financial results.

Your firm does not necessarily need to spend as much as or more than your competitors. Perhaps it has discovered much less expensive ways of providing services, and this can lead to a cost advantage. Alternatively, your firm may be spending far less than competitors, and experiencing commensurate poor performance and losing market share.



5-6 How will MIS help my career?

Here is how Chapter 5 and this book can help you find a job as an entry-level IT consultant.

The Company

A1 Tech IT Consulting, a national technology consulting firm headquartered in Brussels, is looking for an entry-level IT consultant. The company partners with technology vendors to create and sell leading-edge technology solutions based on cloud, network, and managed IT services to small, medium-sized, and enterprise-sized companies. The company has 65 employees and is noted for outstanding customer service.

Position Description

The entry-level IT consultant will work with the firm's account managers to maintain good relationships with existing clients and help its technology consultants create solutions and proposals for prospective customers. The company will provide on-the-job training about the technology industry and its technology consulting process. Job responsibilities include:

- Providing research on potential and existing clients and the competitive landscape.
- Managing digital marketing campaigns.
- Assisting in identifying potential business opportunities.
- Preparing periodic reports on screening, tracking, and monitoring clients and prospects.

Job Requirements

- Bachelor's degree or equivalent
- Ability to communicate well with clients by phone, by email, and face-to-face

- Ability to work in a fast-paced environment and collaborate effectively as a team member
- Proficiency in Microsoft Office (Word, Excel, and PowerPoint)
- Strong organizational, presentation, and writing skills and willingness to learn

Interview Questions

1. What do you know about cloud computing and managed IT services? Are you familiar with common operating systems, security, and data management platforms? Have you ever used these services on the job? What did you do with them?
2. Have you had much face-to-face contact with customers? Can you describe what work you did with customers? Have you ever helped customers with a technology problem?
3. Do you have any digital marketing experience?
4. Can you give us an example of a sales-related problem or other business problem that you helped solve? Do you do any writing and analysis? Can you provide examples?
5. What is your level of proficiency with Microsoft Office? What work have you done with Excel spreadsheets?

Author Tips

1. Review this chapter and also Chapters 6 through 8 of this text, paying special attention to cloud computing, networking technology, and managed technology services.
2. Use the web to research the company and how it works with other technology companies to provide its IT services. Learn what you can about these partner companies as well and the tools and services they offer.
3. Inquire exactly how you would be using Microsoft Office, and if possible provide examples of how you used these tools to solve problems in the classroom or for a job assignment. Bring examples of your writing demonstrating your analytical skills and project experience.
4. Indicate that you are very interested in learning more about the technology industry and technologies and services used by the company.
5. Review the company's LinkedIn page, Facebook, and Twitter to learn about strategic trends and important issues for this company.

REVIEW SUMMARY

5-1 What is IT infrastructure, and what are the stages and drivers of IT infrastructure evolution?

IT infrastructure is the shared technology resources that provide the platform for the firm's specific information system applications. IT infrastructure includes hardware, software, and services that are shared across the entire firm.

The five stages of IT infrastructure evolution are the mainframe era, the personal computer era, the client/server era, the enterprise computing era, and the cloud and mobile computing era. Moore's Law deals with the exponential increase in processing power and decline in the cost of computer technology, stating that every 18 months the power of microprocessors doubles and the price of computing falls in half. The Law of Mass Digital Storage deals with the exponential decrease in the cost of storing data, stating that the number of kilobytes of data that can be stored on magnetic media for \$1 roughly doubles every 15 months. Metcalfe's Law states that a network's value to participants grows exponentially as the network takes on more members. The rapid decline in costs of communication and growing agreement in the technology industry to use computing and communications standards are also driving an explosion of computer use.

5-2 What are the components of IT infrastructure?

Major IT infrastructure components include computer hardware platforms, operating system platforms, enterprise software platforms, networking and telecommunications platforms, data management software, Internet platforms, and consulting services and systems integrators.

5-3 What are the current trends in computer hardware platforms?

Increasingly, computing is taking place on a mobile digital platform. Quantum computing is an emerging technology that could dramatically boost processing power through the ability to be in more than one state at the same time. Consumerization of IT is the business use of information technology that originated in the consumer market. Virtualization organizes computing resources so that their use is not restricted by physical configuration or geographic location. In cloud computing, firms and individuals obtain computing power and software as services over a network, including the Internet, rather than purchasing and installing the hardware and software on their own computers. Edge computing helps optimize cloud computing by performing some data processing on a set of linked servers at the edge of the network, near the source of the data. A multicore processor is a microprocessor to which two or more processing cores have been attached for enhanced performance. Green computing includes practices and technologies for producing, using, and disposing of information technology hardware to minimize negative impact on the environment.

5-4 What are the current computer software platforms and trends?

Open source software is produced and maintained by a global community of programmers and is often downloadable for free. Linux is a powerful, resilient open source operating system that can run on multiple hardware platforms and is used widely to run web servers. Java and JavaScript provide software for making web applications more interactive. HTML5 makes it possible to embed images, audio, and video directly into a web document without add-on programs. Web services are loosely coupled software components based on open web standards that work with any application software and operating system. They can be used as components of web-based applications linking the systems of two different organizations or to link disparate systems of a single company. Companies are purchasing their new software applications from outside sources, including software packages, by outsourcing custom application development to an external vendor (that may be offshore), or by renting online software services (SaaS). Mashups combine two different software services to create new software applications and services. Apps are software applications that run on mobile devices and are delivered over the Internet.

5-5 What are the challenges of managing IT infrastructure and management solutions?

Major challenges include dealing with platform and infrastructure change, infrastructure management and governance, and making wise infrastructure investments. Solution guidelines include using a competitive forces model to determine how much to spend on IT infrastructure and where to make

strategic infrastructure investments, and establishing the total cost of ownership (TCO) of information technology assets. The total cost of owning technology resources includes not only the original cost of computer hardware and software but also costs for hardware and software upgrades, maintenance, technical support, and training. Many firms are turning to cloud computing in an effort to reduce their IT platform costs. Firms use tools for mobile device management (MDM) to monitor, manage, and secure mobile devices that are deployed across the enterprise.

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MyLab MIS

To complete the problems with MyLab MIS, go to EOC Discussion Questions in MyLab MIS.

Review Questions

- 5-1 What is IT infrastructure, and what are the stages and drivers of IT infrastructure evolution?**
- Define IT infrastructure from both a technology and a services perspective.
 - List each of the eras in IT infrastructure evolution and describe its distinguishing characteristics.
 - Define and describe the following: web server, application server, multitiered client/server architecture.
- 5-2 What are the components of IT infrastructure?**
- Describe Moore's Law and the Law of Mass Digital Storage.
 - Describe how network economics, declining communications costs, and technology standards affect IT infrastructure.
 - List and describe the components of IT infrastructure that firms need to manage.

5-3 What are the current trends in computer hardware platforms?

- Describe the evolving mobile platform, consumerization of IT, and cloud computing.
- Explain how businesses can benefit from virtualization, green computing, and multicore processors.

5-4 What are the current computer software platforms and trends?

- Define and describe open source software and Linux and explain their business benefits.
- Define Java, JavaScript, HTML, and HTML5 and explain why they are important.

- Define and describe web services and the role played by XML.
- Name and describe the three external sources for software.
- Define and describe software mashups and apps.

5-5 What are the challenges of managing IT infrastructure and management solutions?

- Describe what is meant by the term scalability.
- Explain why the level of IT infrastructure investment is a crucial decision for an organization.

Discussion Questions

5-6 Why is selecting computer hardware and software for the organization an important management decision? What management, organization, and technology issues should be considered when selecting computer hardware and software?

5-7 Should organizations use software service providers for all their software needs?

Why or why not? What management, organization, and technology factors should be considered when making this decision?

5-8 What are the advantages and disadvantages of cloud computing?

Hands-On MIS Projects

The projects in this section give you hands-on experience in developing solutions for managing IT infrastructures and IT outsourcing, using spreadsheet software to evaluate alternative desktop systems, and using web research to budget for a sales conference. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

5-9 The University of Pittsburgh Medical Center (UPMC) relies on information systems to operate 19 hospitals, a network of other care sites, and international and commercial ventures. Demand for additional servers and storage technology was growing by 20 percent each year. UPMC was setting up a separate server for every application, and its servers and other computers were running a number of different operating systems, including several versions of Unix and Windows. UPMC had to manage technologies from many different vendors, including Hewlett-Packard (HP), Sun Microsystems, Microsoft, and IBM. Assess the impact of this situation on business performance. What factors and management decisions must be considered when developing a solution to this problem?

5-10 Qantas Airways, Australia's leading airline, faces cost pressures from high fuel prices and lower levels of global airline traffic. To remain competitive, the airline must find ways to keep costs low while providing a high level of customer service. Qantas had a 30-year-old data center. Management had to decide whether to replace its IT infrastructure with newer technology or outsource it. What factors should be considered by Qantas management when deciding whether to outsource? If Qantas decides to outsource, list and describe points that should be addressed in a service level agreement.

Improving Decision Making: Using a Spreadsheet to Evaluate Hardware and Software Options

Software skills: Spreadsheet formulas

Business skills: Technology pricing

- 5-11** In this exercise, you will use spreadsheet software to calculate the cost of desktop systems, printers, and software.

Use the Internet to obtain pricing information on hardware and software for an office of 30 people. You will need to price 30 PC desktop systems (monitors, computers, and keyboards) manufactured by Lenovo, Dell, and HP. (For the purposes of this exercise, ignore the fact that desktop systems usually come with preloaded software packages.) Also obtain pricing on 15 desktop printers manufactured by HP, Canon, and Brother. Each desktop system must satisfy the minimum specifications shown in tables that you can find in MyLab MIS.

Also obtain pricing on 30 licenses or copies of the most recent versions of Microsoft Office 365 Business and Apache Open Office (formerly Oracle Open Office) and on 30 copies of Microsoft Windows 10 Pro. Each desktop productivity solution should contain software for word processing, spreadsheets, database, and presentations. Prepare a spreadsheet showing your research results for the desktop system, printer, and software combination offering the best performance and pricing per worker over a two-year period. Because every two workers share one printer (15 printers/30 systems), your calculations should assume only half a printer cost per worker.

Improving Decision Making: Using Web Research to Budget for a Sales Conference

Software skills: Internet-based software

Business skills: Researching transportation and lodging costs

- 5-12** The Foremost Composite Materials Company is planning a two-day sales conference for October 19–20, starting with a reception on the evening of October 18. The conference consists of all-day meetings that the entire sales force, numbering 120 sales representatives and their 16 managers, must attend. Each sales representative requires his or her own room, and the company needs two common meeting rooms, one large enough to hold the entire sales force plus a few visitors (200) and the other able to hold half the force. Management has set a budget of \$215,000 for the representatives' room rentals. The company would like to hold the conference in either Miami or Marco Island, Florida, at a Hilton- or Marriott-owned hotel.

Use the Hilton and Marriott websites to select a hotel in whichever of these cities would enable the company to hold its sales conference within its budget and meet its sales conference requirements. Then locate flights arriving the afternoon prior to the conference. Your attendees will be coming from Los Angeles (51), San Francisco (30), Seattle (22), Chicago (19), and Pittsburgh (14). Determine costs of each airline ticket from these cities. When you are finished, create a budget for the conference. The budget will include the cost of each airline ticket, the room cost, and \$70 per attendee per day for food.

Collaboration and Teamwork Project

Evaluating Server and Mobile Operating Systems

- 5-13** Form a group with three or four of your classmates. Choose server or mobile operating systems to evaluate. You might research and compare the capabilities and costs of Linux versus Unix or the most recent version of the Windows operating system for servers. Alternatively, you could compare the capabilities of the Android mobile operating system with iOS for the iPhone. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Project JEDI: A Cloud of Controversy

CASE STUDY

Most major companies have moved some of their computing operations to the cloud, and now the U.S. military wants to follow suit. Unifying information in the cloud is more necessary than ever as the armed services deploy large numbers of remote sensors, semiautonomous weapons, and artificial intelligence applications. All of these capabilities require immediate and instantaneous access to very large quantities of data gathered from many different locations. This is even more crucial now that the United States Cyber Command has been elevated to the equivalent of Central Command, which runs operations in the Middle East, or the Northern Command, which defends the continental United States.

Project JEDI is the U.S. Department of Defense's plan to modernize its IT infrastructure so that employees, officers, and soldiers on the front line can access and manipulate data at the speed of modern enterprises. Project JEDI aims to create a unified cloud infrastructure across the entire Department of Defense (DOD) that will speed the flow of data and analysis to combat troops. The new plan is part of a larger move toward replacing the military's branch-specific systems and networks with a more efficient and manageable enterprise model.

On July 26, 2018 the DOD issued a Request for Proposal (RFP) for a Joint Enterprise Defense Infrastructure (JEDI) Cloud Program, which calls for a cloud services solution that can support Unclassified, Secret, and Top Secret requirements with a focus on using commercially available services. The JEDI program calls for a ten-year \$10 billion government contract to go to a single cloud computing vendor, which will serve as the exclusive cloud computing provider for the U.S. Department of Defense. The U.S. Department of Defense maintains more than 500 public and private cloud infrastructures that support Unclassified and Secret requirements. The DOD's current cloud services are decentralized, creating an additional level of complexity for managing data and services at

an enterprise-wide level. Current DOD systems are fragmented, slowing the decision-making process within the DOD both at home and abroad. Much of the U.S. military operates on outdated computer systems built during the 1980s and 1990s. The Defense Department has spent billions of dollars trying to make these systems talk to one another. What the DOD wants and needs is an enterprise-wide cloud that supports rapid data-driven decision making and provides worldwide support for DOD operations. The JEDI contract is central to the Pentagon's efforts to modernize its technology.

The 10-year JEDI contract set off a showdown among Amazon, Microsoft, Oracle, IBM, and Google for the work to transform the military's cloud computing systems. (Google dropped out in October 2018 without submitting a formal bid, claiming the military work conflicted with corporate principles prohibiting the use of artificial intelligence in weaponry.)

Oracle, IBM, and Microsoft stated that the DoD shouldn't use a single cloud vendor for JEDI. Some experts have backed them up. Justin Cappos, associate professor of computer science and engineering at New York University, said a single cloud solution is out of the norm. Many companies use multiple cloud vendors because it's safer. Leigh Madden, Microsoft's general manager for national security, stated that his company wants to win the contract, but 80 percent of businesses use multiple cloud vendors. Other experts have pointed out that deployment of a single cloud conflicts with established best practices and industry trends in the commercial marketplace. They believe that such a large contract should not be awarded to a single company. Those favoring a single JEDI vendor note that using one provider would reduce complexity in military IT systems and streamline communications.

Oracle America and IBM both filed pre-award bid protests against the JEDI Cloud solicitation, claiming it favored Amazon and Microsoft. These were dismissed by the General Accounting Office (GAO)

in late 2018. In the end, Amazon and Microsoft, which have numerous data centers around the globe, became the two finalists, and Microsoft was awarded the contract in October 2019.

The Pentagon's Cloud Executive Steering Group described the acquisition process for the massive cloud migration that will stretch across the entire DOD IT infrastructure, focusing primarily on infrastructure-as-a-service (IaaS) and platform-as-a-service (PaaS). Instead of building and maintaining its own data centers and systems, the DOD wants to take advantage of the existing strengths of commercially available cloud technologies and not limit them with extensive customizations. The DOD wants to remain in pace with industry and be able to take advantage of new commercial software solutions. The Pentagon's acquisition regulations have in the past served as barriers to innovation. Internal acquisition policies need to be revised to take full advantage of the commercial cloud platform.

The envisioned IaaS must be more than a data center. Other requirements include vendor monitoring, identity, failover, scalability, even artificial intelligence (AI). The DOD wants to be able to immediately take advantage of commercial innovations in these areas. If the DOD uses commercially available cloud solutions, it will have the foundational technology in place to deliver better software to fighters, with better security, lower cost, and easier maintainability.

On February 13, 2020 a federal judge ordered the Pentagon to halt work on the JEDI contract, which had been awarded to Microsoft. Amazon had been long considered the favorite to win the JEDI contract, because of its dominance of cloud computing (it has 45 percent of the market) and its experience building cloud services for the Central Intelligence Agency. However, its bid was overshadowed by conflict-of-interest allegations. Amazon had filed suit in December 2019 to block the contract award to Microsoft, contending that the selection of Microsoft had been improperly influenced by President Trump's

public complaints about Amazon. Amazon's CEO, Jeff Bezos, owns *The Washington Post*, which is a frequent critic of Trump and his policies.

Oracle, a leading government contractor noted for the software to handle large databases, lobbied heavily in Congress to find opponents of Amazon with influence in the Pentagon and the White House. Oracle went to court to challenge what it felt were Amazon's conflicts of interest, but it did not prevail. Industry experts point out that Oracle is playing catch-up in cloud computing and holds many federal contracts that could be displaced by a shift to the cloud. Obstructing the implementation of JEDI could help Oracle preserve its current business longer. Although Oracle probably did not have a chance of winning the JEDI contract, it might have been able to get part of the business if the JEDI contract had been broken into smaller parts.

Microsoft, with 25 percent of the cloud computing market, had only recently opened enough classified server facilities capable of handling data on a scale required by the JEDI contract. Experts initially thought Microsoft would only get a part of the JEDI business and that the Pentagon would use multiple vendors of cloud services, as do many private companies. Microsoft had been considered the favorite for other government cloud programs, including an intelligence contract.

Despite the controversy, the JEDI project will have a huge ripple effect as a cloud innovation driver within the US government and across the private sector. Today, cloud computing has matured into the cornerstone of digital transformation across public and private sectors and as an engine for emerging technologies such as artificial intelligence, big data, and the Internet of Things (IoT).

In 2010, then-U.S. CIO Vivek Kundra announced a Cloud First policy for federal agencies. Since then, federal cloud spending has increased 500 percent. However, a 2019 survey by the Center for Digital Government found that cloud migration for government agencies continues to face obstacles, including data mobility, security, compliance, and

ensuring the right training and skills. Project JEDI is expected to have an enormous impact on all of these fronts.

Although all federal agencies must be sure not to compromise security as they shift to the cloud, the bar is even higher for the Pentagon, for the obvious reason that national security is at stake. JEDI should be a catalyst for the development of cutting-edge security advances and best practices whose benefits will eventually spill over to all cloud users across the government and in the private sector. A better enterprise cloud will also support the Pentagon's plans to expand the use of AI systems throughout the military. Huge government projects may have positive consequences beyond their original scope.

Sources: Sydney J. Freedberg Jr. "Experts Debate: Should JEDI Cloud Be Saved?" *Breaking Defense*, May 4, 2020; Joao-Pierre

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CASE STUDY QUESTIONS

- 5-14** Describe the JEDI Project. Why is it so important? What problems was it meant to solve?
- 5-15** What management, organization, and technology issues are raised by this project?
- 5-16** Should the JEDI contract be awarded to a single vendor? Why or why not?

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6

Foundations of Business Intelligence: Databases and Information Management

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 6-1** What are the problems of managing data resources in a traditional file environment?
- 6-2** What are the major capabilities of database management systems (DBMS), and why is a relational DBMS so powerful?
- 6-3** What are the principal tools and technologies for accessing information from databases to improve business performance and decision making?
- 6-4** Why are data governance and data quality assurance essential for managing the firm's data resources?
- 6-5** How will MIS help my career?

CHAPTER CASES

- Astro: Leveraging Data for Customer-Driven Service
- New Cloud Database Tools Help Vodafone Fiji Make Better Decisions
- Big Data Baseball
- Big Data in the Asia-Pacific Takes On the COVID-19 Pandemic

VIDEO CASES

- Brooks Brothers Closes In on Omnichannel Retail
- Maruti Suzuki Business Intelligence and Enterprise Databases

MyLab MIS

Discussion Questions: 6-5, 6-6, 6-7; Hands-On MIS Projects: 6-8, 6-9, 6-10, 6-11;
eText with Conceptual Animations

Astro: Leveraging Data for Customer-Driven Service

Astro is the leading Malaysian satellite television broadcaster. The growth and success of the company has been based on satisfying its customers' taste for Western, Indian, and Korean programming across a wide portfolio of services, including IPTV, broadband, and other streaming services.

However, a number of local and international firms are beginning to pose a threat to Astro's market share. The line between infrastructure and service providers has blurred as Astro ventures into the broadband market, while major telecommunications providers such as Maxis and Telekom Malaysia have expanded their own portfolios to include television and on-demand services. Astro is also increasingly under pressure from regional and international media service providers such as iFlix and, more recently, the U.S.-based Netflix.

To address these challenges, Astro turned to its data to better know and understand its customers. The firm has multiple touchpoints from which it obtains customer data and can secure continuous feedback. These include customer interactions via self-service platforms, on-demand services and libraries, and pay-per-view content, all of which provide data that Astro can use to develop insights into customer behavior.

The challenge for Astro lay in its existing infrastructure and legacy practices. The organization's data were housed at multiple locations, across various sites and on the cloud. Structured data from its PayTV services were stored on a centralized enterprise data warehouse, while unstructured data from other digital products were spread across multiple cloud-based systems. This practice reduced the visibility of data across the organization, necessitating a change in its operational model.

As part of a RM237-million investment in technology infrastructure, Astro chose to shed the traditional enterprise data warehouse paradigm and fully adopt a cloud-based data lake. The Astro Data Lake was built using Amazon Web Services (AWS) and aggregates several sources of data, including viewing information, transactions, and interactions across all touchpoints and platforms. This includes data from the firm's extensive library of over 23,000 on-demand titles hosted using Amazon Simple Storage Service (S3), with the processing and computation facilitated through Amazon Elastic Compute Cloud (EC2), delivering 2 petabytes of content every month. Amazon's AWS cloud services provides a scalable solution for data-intensive firms like Astro with a number of features: relatively easy deployment of a data lake, with little to no backend server administration through AWS Lambda; robust search functionality and user authentication



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via Amazon Elasticsearch and Amazon Cognito, respectively; and data transformation and analytics through the use of AWS Glue and Amazon Athena. These services are powered by Amazon's DynamoDB document database, which provides Astro with real-time performance with minimal latency.

The creation of the Astro Data Lake has enabled the organization to integrate the silos of analytics across the various divisions of the organization, thereby introducing enterprise-wide best practices and standards on data quality. In particular, the data lake architecture is helping to facilitate precise multi-channel advertising, individual-curated recommendations, and an in-depth understanding of individual media consumption preferences, behavior, and sentiment.

Today, Astro has an active subscriber list of nearly 5.7 million, or about 75 percent of Malaysian households. It delivers content to around 24 million people and in 2019, it launched a 4K Ultra High Definition set-top box that offers cloud recording, a broader choice of content, and broadband bundles. Astro has since introduced three streaming services, Astro GO, HBO GO, and iQIYI, attracting over 2.6 million subscribers.

Sources: P. Prem Kumar, "Malaysia's Astro Targets Netflix and Amazon with Streaming Launch," Nikkei Asia, October 8, 2020; Astro, "Transforming Our Technology Landscape to Deliver Exceptional Customer Experiences," astro.com, July 7, 2017; Digital News Asia, "Astro Accelerates Digital Business Transformation with Amazon Web Services," April 19, 2017; "Astro Inks Deal with Amazon Web Services as Part of Its Digital Strategy," Marketing-Interactive.com, April 18, 2017.

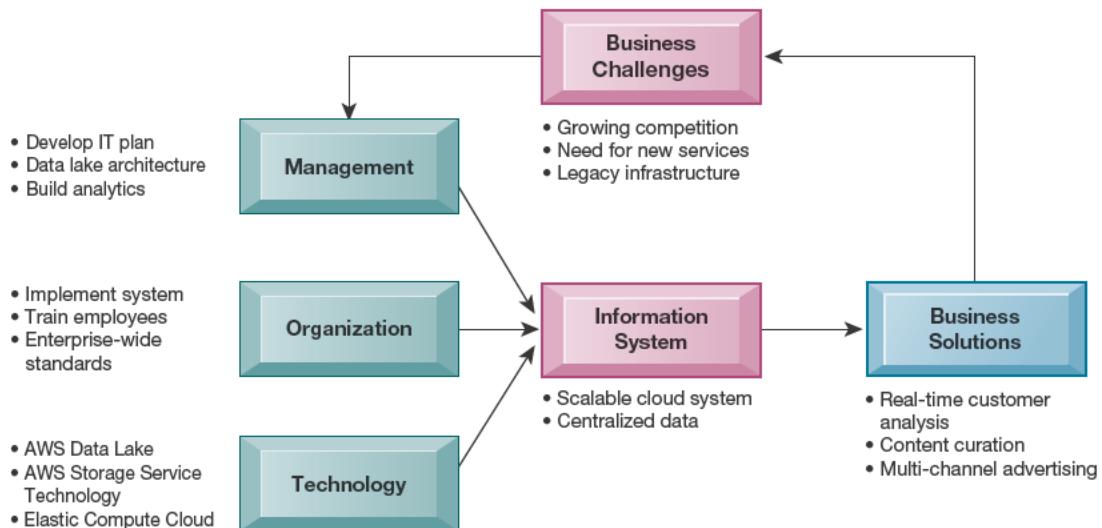
Case contributed by Imran Medi, Asia Pacific University of Technology and Innovation

Astro's centralization of its data illustrates the importance of data management, particularly when an organization is faced with multiple sources of data across several platforms. For most organizations, one of the key operating challenges of the twenty-first century is effectively leveraging information technology to capture, process, and analyze multivariate data in the wake of increased competition. This is exactly the situation Astro found itself in as a digital data-driven organization.

The chapter-opening diagram highlights the important considerations touched upon in the case and in particular draws attention to the socio-technical considerations involved in refactoring the technological infrastructure of Astro. This has involved integrating existing data from multiple sources and repositories with the continuous streams of data acquired across a variety of platforms into a single cloud-based data lake accessible to all the organization's divisions.

Part of this change involves training and upskilling of employees as well as reengineering business processes to align with the capabilities of a centralized repository. Employees need to be educated about cloud security and agile operations to fully exploit the automation potential of the cloud environment. This has required extensive organization-wide training in the use of various AWS provisions, data analytics, and security operations.

The ultimate aim of the organization is improved decision-making predicated upon a complete understanding of the customers. While various divisions had previously been engaged in some form of data analytics, this had been based upon siloed data separated from other organizational repositories.



Here are some questions to reflect upon: What considerations should a firm have when moving to a cloud-based infrastructure such as Astro's? Why is it necessary to review current business processes? How will data analytics benefit Astro, and how will AI services such as Amazon's Athena facilitate this?

6-1 What are the problems of managing data resources in a traditional file environment?

An effective information system provides users with accurate, timely, and relevant information. Accurate information is free of errors. Information is timely when it is available to decision makers when it is needed. Information is relevant when it is useful and appropriate for the types of work and decisions that require it.

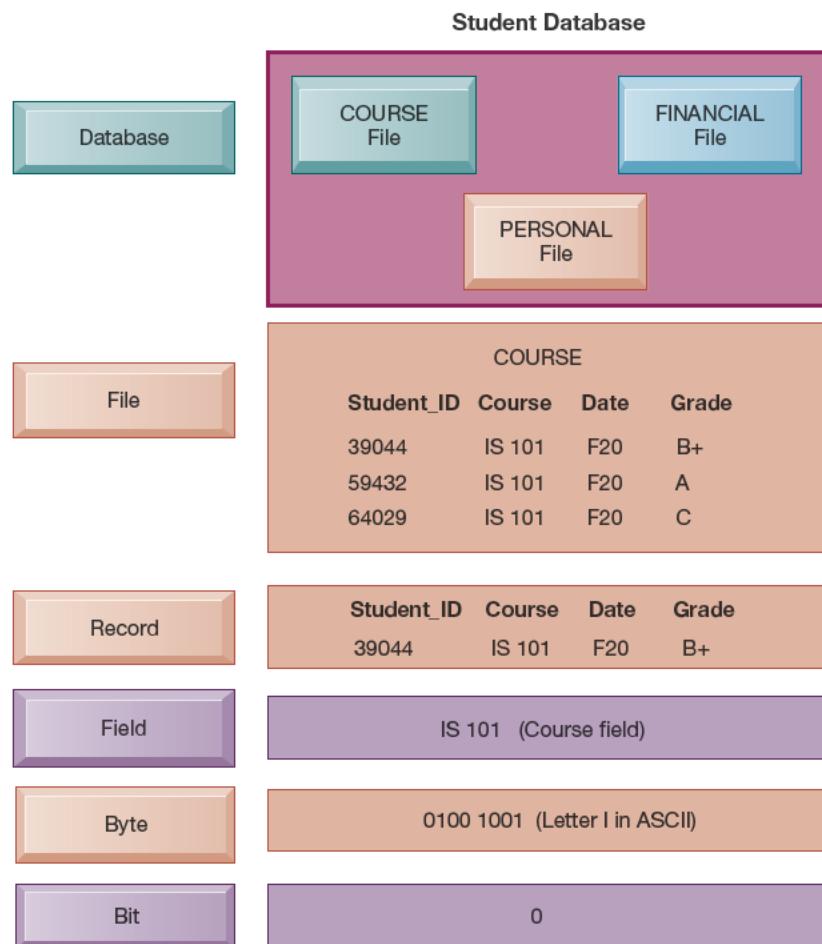
You might be surprised to learn that many businesses don't have timely, accurate, or relevant information because the data in their information systems have been poorly organized and maintained. That's why data management is so essential. To understand the problem, let's look at how information systems arrange data in computer files and traditional methods of file management.

File Organization Terms and Concepts

A computer system organizes data in a hierarchy that starts with bits and bytes and progresses to fields, records, files, and databases (see Figure 6.1). A **bit** represents the smallest unit of data a computer can handle. A group of bits, called a **byte**, represents a single character, which can be a letter, a number, or another symbol. A grouping of characters into a word, a group of words, or a complete number (such as a person's name or age) is called a **field**. A group of related fields, such as the student's name, the course taken, the date, and the grade, comprises a **record**; a group of records of the same type is called a **file**.

FIGURE 6.1 THE DATA HIERARCHY

A computer system organizes data in a hierarchy that starts with the bit, which represents either a 0 or a 1. Bits can be grouped to form a byte to represent one character, number, or symbol. Bytes can be grouped to form a field, and related fields can be grouped to form a record. Related records can be collected to form a file, and related files can be organized into a database.



For example, the records in Figure 6.1 could constitute a student course file. A group of related files makes up a database. The student course file illustrated in Figure 6.1 could be grouped with files on students' personal histories and financial backgrounds to create a student database.

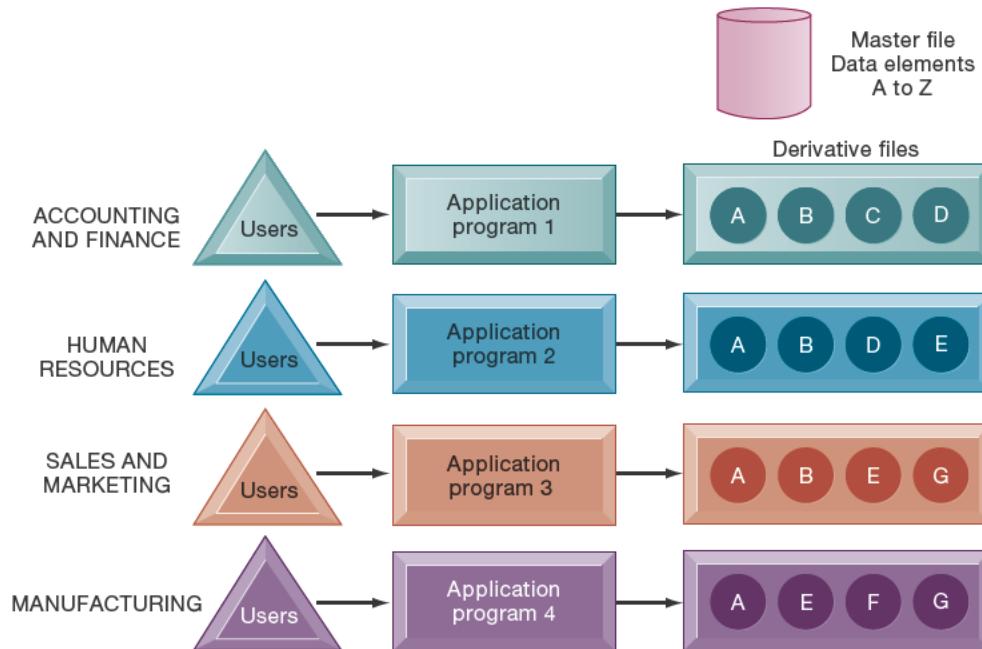
A record describes an entity. An **entity** is a person, place, thing, or event on which we store and maintain information. Each characteristic or quality describing a particular entity is called an **attribute**. For example, Student_ID, Course, Date, and Grade are attributes of the entity COURSE. The specific values that these attributes can have are found in the fields of the record describing the entity COURSE.

Problems With the Traditional File Environment

In most organizations, systems tended to grow independently without a companywide plan. Accounting, finance, manufacturing, human resources, and sales and marketing all developed their own systems and data files. Figure 6.2 illustrates the traditional approach to information processing.

FIGURE 6.2 TRADITIONAL FILE PROCESSING

The use of a traditional approach to file processing encourages each functional area in a corporation to develop specialized applications. Each application requires a unique data file that is likely to be a subset of the master file. These subsets of the master file lead to data redundancy and inconsistency, processing inflexibility, and wasted storage resources.



Each application, of course, required its own files and its own computer program to operate. For example, the human resources functional area might have a personnel master file, a payroll file, a medical insurance file, a pension file, a mailing list file, and so forth, until tens, perhaps hundreds, of files and programs existed. In the company as a whole, this process led to multiple master files created, maintained, and operated by separate divisions or departments. As this process goes on for 5 or 10 years, the organization is saddled with hundreds of programs and applications that are very difficult to maintain and manage. The resulting problems are data redundancy and inconsistency, program-data dependence, inflexibility, poor data security, and an inability to share data among applications.

Data Redundancy and Inconsistency

Data redundancy is the presence of duplicate data in multiple data files so that the same data are stored in more than one place or location. Data redundancy occurs when different groups in an organization independently collect the same piece of data and store it independently of each other. Data redundancy wastes storage resources and also leads to **data inconsistency**, where the same attribute may have different values. For example, in instances of the entity COURSE illustrated in Figure 6.1, the Date may be updated in some systems but not in others. The same attribute, Student_ID, might also have different names in different systems throughout the organization. Some systems might use Student_ID and others might use ID, for example.

Additional confusion can result from using different coding systems to represent values for an attribute. For instance, the sales, inventory, and manufacturing systems of a clothing retailer might use different codes to represent clothing size. One system might represent clothing size as "extra-large," whereas another might

use the code “XL” for the same purpose. The resulting confusion would make it difficult for companies to create customer relationship management, supply chain management, or enterprise systems that integrate data from different sources.

Program-Data Dependence

Program-data dependence refers to the coupling of data stored in files and the specific programs required to update and maintain those files such that changes in programs require changes to the data. Every traditional computer program has to describe the location and nature of the data with which it works. In a traditional file environment, any change in a software program could require a change in the data accessed by that program. One program might be modified from a five-digit to a nine-digit ZIP code. If the original data file were changed from five-digit to nine-digit ZIP codes, then other programs that required the five-digit ZIP code would no longer work properly. Such changes could cost millions of dollars to implement properly.

Lack of Flexibility

A traditional file system can deliver routine scheduled reports after extensive programming efforts, but it cannot deliver ad hoc reports or respond to unanticipated information requirements in a timely fashion. The information required by ad hoc requests is somewhere in the system but may be too expensive to retrieve. Several programmers might have to work for weeks to put together the required data items in a new file.

Poor Security

Because there is little control or management of data, access to and dissemination of information may be out of control. Management might have no way of knowing who is accessing or even making changes to the organization's data.

Lack of Data Sharing and Availability

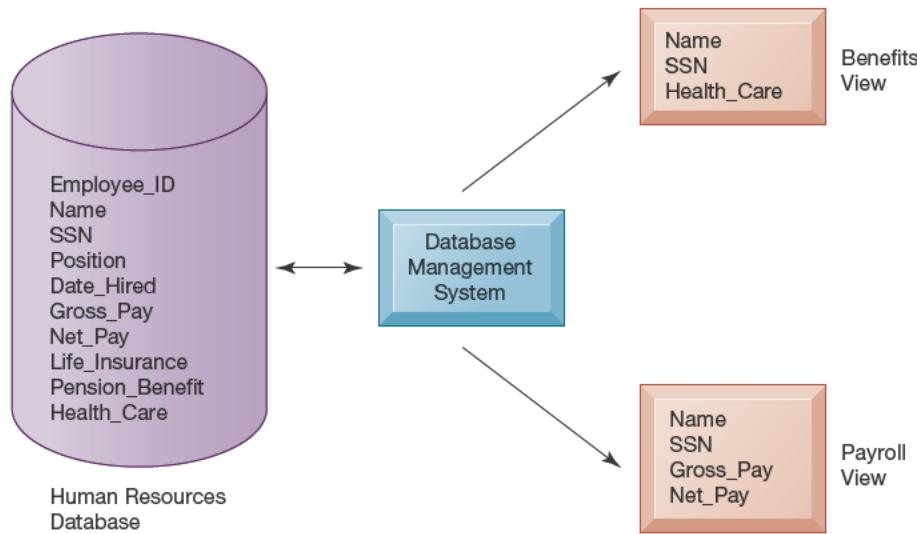
Because pieces of information in different files and different parts of the organization cannot be related to one another, it is virtually impossible for information to be shared or accessed in a timely manner. Information cannot flow freely across different functional areas or different parts of the organization. If users find different values for the same piece of information in two different systems, they may not want to use these systems because they cannot trust the accuracy of their data.

6-2 What are the major capabilities of database management systems (DBMS), and why is a relational DBMS so powerful?

Database technology cuts through many of the problems of traditional file organization. A more rigorous definition of a **database** is a collection of data organized to serve many applications efficiently by centralizing the data and controlling redundant data. Rather than storing data in separate files for each application, data appear to users as being stored in only one location. A single database services multiple applications. For example, instead of a corporation storing employee data in separate information systems and separate files for personnel, payroll, and benefits, the corporation could create a single common human resources database (see Figure 6.3).

FIGURE 6.3 HUMAN RESOURCES DATABASE WITH MULTIPLE VIEWS

A single human resources database provides many different views of data, depending on the information requirements of the user. Illustrated here are two possible views, one of interest to a benefits specialist and one of interest to a member of the company's payroll department.



Database Management Systems

A **database management system (DBMS)** is software that enables an organization to centralize data, manage them efficiently, and provide access to the stored data by application programs. The DBMS acts as an interface between application programs and the physical data files. When the application program calls for a data item, such as gross pay, the DBMS finds this item in the database and presents it to the application program. Using traditional data files, the programmer would have to specify the size and format of each data element used in the program and then tell the computer where they were located.

The DBMS relieves the programmer or end user from the task of understanding where and how the data are actually stored by separating the logical and physical views of the data. The *logical view* presents data, as they would be perceived by end users or business specialists, whereas the *physical view* shows how data are actually organized and structured on physical storage media.

The database management software makes the physical database available for different logical views required by users. For example, for the human resources database illustrated in Figure 6.3, a benefits specialist might require a view consisting of the employee's name, social security number, and health insurance coverage. A payroll department member might need data such as the employee's name, social security number, gross pay, and net pay. The data for all these views are stored in a single database, where they can be more easily managed by the organization.

How a DBMS Solves the Problems of the Traditional File Environment

A DBMS reduces data redundancy and inconsistency by minimizing isolated files in which the same data are repeated. The DBMS may not enable the organization to eliminate data redundancy entirely, but it can help control redundancy. Even if the organization maintains some redundant data, using a DBMS eliminates data

inconsistency because the DBMS can help the organization ensure that every occurrence of redundant data has the same values. The DBMS uncouples programs and data, enabling data to stand on their own. The description of the data used by the program does not have to be specified in detail each time a different program is written. Access and availability of information will be increased and program development and maintenance costs reduced because users and programmers can perform ad hoc queries of the database for many simple applications without having to write complicated programs. The DBMS enables the organization to centrally manage data, their use, and security. Data sharing throughout the organization is easier because the data are presented to users as being in a single location rather than fragmented in many different systems and files.

Relational DBMS

Contemporary DBMS use different database models to keep track of entities, attributes, and relationships. The most popular type of DBMS today for PCs as well as for larger computers and mainframes is the **relational DBMS**. Relational databases represent data as two-dimensional tables (called relations). Tables may be referred to as files. Each table contains data on an entity and its attributes. Microsoft Access is a relational DBMS for desktop systems, whereas DB2, Oracle Database, and Microsoft SQL Server are relational DBMS for large mainframes and midrange computers. MySQL is a popular open source DBMS.

Let's look at how a relational database organizes data about suppliers and parts (see Figure 6.4). The database has a separate table for the entity SUPPLIER and a table for the entity PART. Each table consists of a grid of columns and rows of data. Each individual element of data for each entity is stored as a separate field, and each field represents an attribute for that entity. Fields in a relational database are also called columns. For the entity SUPPLIER, the supplier identification number, name, street, city, state, and ZIP code are stored as separate fields within the SUPPLIER table and each field represents an attribute for the entity SUPPLIER.

The actual information about a single supplier that resides in a table is called a row. Rows are commonly referred to as records, or in very technical terms, as **tuples**. Data for the entity PART have their own separate table.

The field for Supplier_Number in the SUPPLIER table uniquely identifies each record so that the record can be retrieved, updated, or sorted. It is called a **key field**. Each table in a relational database has one field that is designated as its **primary key**. This key field is the unique identifier for all the information in any row of the table and this primary key cannot be duplicated. Supplier_Number is the primary key for the SUPPLIER table and Part_Number is the primary key for the PART table. Note that Supplier_Number appears in both the SUPPLIER and PART tables. In the SUPPLIER table, Supplier_Number is the primary key. When the field Supplier_Number appears in the PART table, it is called a **foreign key** and is essentially a lookup field to look up data about the supplier of a specific part.

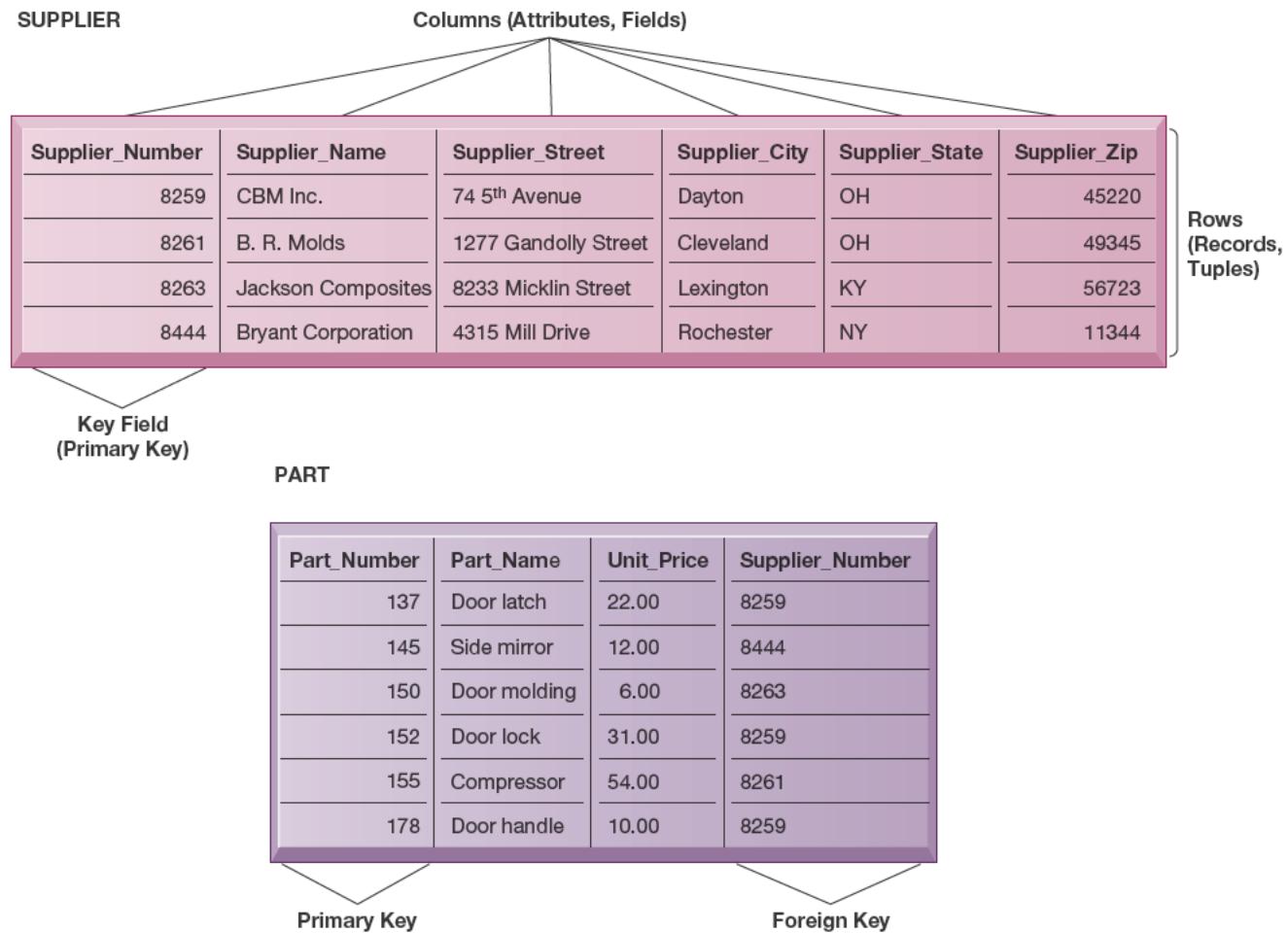
Operations of a Relational DBMS

Relational database tables can be combined easily to deliver data required by users, provided that any two tables share a common data element. Suppose we wanted to find in this database the names of suppliers who could provide us with part number 137 or part number 150. We would need information from two tables: the SUPPLIER table and the PART table. Note that these two files have a shared data element: Supplier_Number.

In a relational database, three basic operations, as shown in Figure 6.5, are used to develop useful sets of data: select, join, and project. The *select*

FIGURE 6.4 RELATIONAL DATABASE TABLES

A relational database organizes data in the form of two-dimensional tables. Illustrated here are tables for the entities SUPPLIER and PART showing how they represent each entity and its attributes. Supplier_Number is a primary key for the SUPPLIER table and a foreign key for the PART table.



operation creates a subset consisting of all records in the file that meet stated criteria. Select creates, in other words, a subset of rows that meet certain criteria. In our example, we want to select records (rows) from the PART table where the Part_Number equals 137 or 150. The *join* operation combines relational tables to provide the user with more information than is available in individual tables. In our example, we want to join the now-shortened PART table (only parts 137 or 150 will be presented) and the SUPPLIER table into a single new table.

The *project* operation creates a subset consisting of columns in a table, permitting the user to create new tables that contain only the information required. In our example, we want to extract from the new table only the following columns: Part_Number, Part_Name, Supplier_Number, and Supplier_Name.

Capabilities of Database Management Systems

A DBMS includes capabilities and tools for organizing, managing, and accessing the data in the database. The most important are its data definition language, data dictionary, and data manipulation language.

FIGURE 6.5 THE THREE BASIC OPERATIONS OF A RELATIONAL DBMS

The select, join, and project operations enable data from two different tables to be combined and only selected attributes to be displayed.

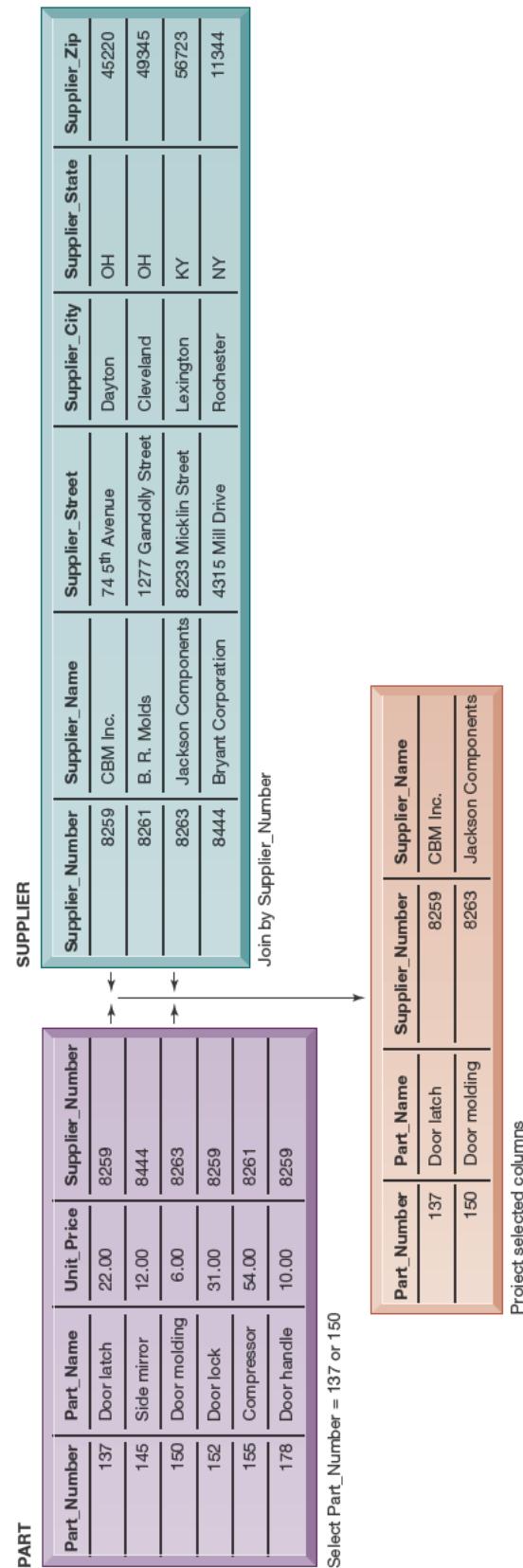


FIGURE 6.6 ACCESS DATA DICTIONARY FEATURES

Microsoft Access has a rudimentary data dictionary capability that displays information about the size, format, and other characteristics of each field in a database. Displayed here is the information maintained in the SUPPLIER table. The small key icon to the left of Supplier_Number indicates that it is a key field.

Courtesy of Microsoft Corporation

Field Name	Data Type	Description
Supplier_Number	Number	Supplier Identification Number
Supplier_Name	Text	Supplier Name
Supplier_Street	Text	Supplier Street
Supplier_City	Text	Supplier City
Supplier_State	Text	Supplier State
Supplier_Zip	Text	Supplier Zip

Field Properties:

- General: Field Size (Long Integer), Format (Auto), Decimal Places (Auto), Input Mask (None), Capital (None), Default Value (None), Validation Rule (None), Validation Text (None), Required (Yes), Indexed (Yes (No Duplicates)), Smart Tags (General), TextAlign (General).
- Lookup: A note states "A field name can be up to 64 characters long, including spaces. Press F1 for help on field names."

DBMS have a **data definition** capability to specify the structure of the content of the database. It would be used to create database tables and to define the characteristics of the fields in each table. This information about the database would be documented in a data dictionary. A **data dictionary** is an automated or manual file that stores definitions of data elements and their characteristics.

Microsoft Access has a rudimentary data dictionary capability that displays information about the name, description, size, type, format, and other properties of each field in a table (see Figure 6.6). Data dictionaries for large corporate databases may capture additional information, such as usage, ownership (who in the organization is responsible for maintaining the data), authorization, security, and the individuals, business functions, programs, and reports that use each data element.

Querying and Reporting

DBMS includes tools for accessing and manipulating information in databases. Most DBMS have a specialized language called a **data manipulation language** that is used to add, change, delete, and retrieve the data in the database. This language contains commands that permit end users and programming specialists to extract data from the database to satisfy information requests and develop applications. The most prominent data manipulation language today is **Structured Query Language**, or **SQL**. A **query** is a request for data from a database. Figure 6.7 illustrates the SQL query that would produce the new

FIGURE 6.7 EXAMPLE OF AN SQL QUERY

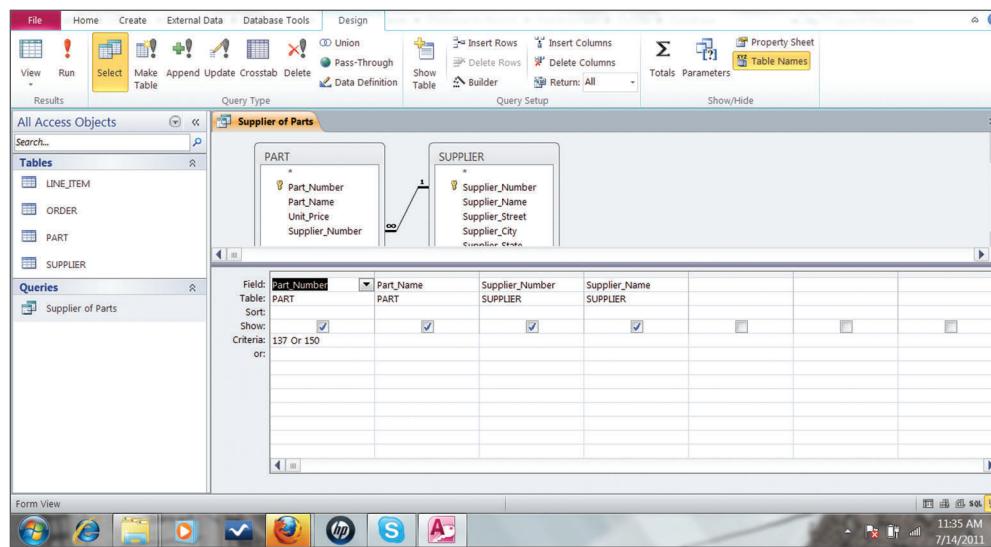
Illustrated here are the SQL statements for a query to select suppliers for parts 137 or 150. They produce a list with the same results as Figure 6.5.

```
SELECT PART.Part_Number, PART.Part_Name, SUPPLIER.Supplier_Number,
SUPPLIER.Supplier_Name
FROM PART, SUPPLIER
WHERE PART.Supplier_Number = SUPPLIER.Supplier_Number AND
Part_Number = 137 OR Part_Number = 150;
```

FIGURE 6.8 AN ACCESS QUERY

Illustrated here is how the query in Figure 6.7 would be constructed using Microsoft Access query-building tools. It shows the tables, fields, and selection criteria used for the query.

Courtesy of Microsoft Corporation



resultant table in Figure 6.5. You can find out more about how to perform SQL queries in our Learning Tracks for this chapter.

Users of DBMS for large and midrange computers, such as DB2, Oracle, or SQL Server, would employ SQL to retrieve information they needed from the database. Microsoft Access also uses SQL, but it provides its own set of user-friendly tools for querying databases and for organizing data from databases into more polished reports.

In Microsoft Access, you will find features that enable users to create queries by identifying the tables and fields they want and the results and then selecting the rows from the database that meet particular criteria. These actions in turn are translated into SQL commands. Figure 6.8 illustrates how the same query as the SQL query to select parts and suppliers would be constructed using the Microsoft Access query-building tools.

Microsoft Access and other DBMS include capabilities for report generation so that the data of interest can be displayed in a more structured and polished format than would be possible just by querying. Crystal Reports is a popular report generator for large corporate DBMS, although it can also be used with Access. Access also has capabilities for developing desktop system applications. These include tools for creating data entry screens, reports, and developing the logic for processing transactions.

Designing Databases

To create a database, you must understand the relationships among the data, the type of data that will be maintained in the database, how the data will be used, and how the organization will need to change to manage data from a companywide perspective. The database requires both a conceptual design and a physical design. The conceptual, or logical, design of a database is an abstract model of the database from a business perspective, whereas the physical design shows how the database is actually arranged on direct-access storage devices.

FIGURE 6.9 AN UNNORMALIZED RELATION FOR ORDER

An unnormalized relation contains repeating groups. For example, there can be many parts for each order. There is only a one-to-one correspondence between Order_Number and Order_Date.



Normalization and Entity-Relationship Diagrams

The conceptual database design describes how the data elements in the database are to be grouped. The design process identifies relationships among data elements and the most efficient way of grouping data elements together to meet business information requirements. The process also identifies redundant data elements and the groupings of data elements required for specific application programs. Groups of data are organized, refined, and streamlined until an overall logical view of the relationships among all the data in the database emerges.

To use a relational database model effectively, complex groupings of data must be streamlined to minimize redundant data elements and awkward many-to-many relationships. The process of creating small, stable, yet flexible and adaptive data structures from complex groups of data is called **normalization**. Figures 6.9 and 6.10 illustrate this process.

In the particular business modeled here, an order can have more than one part, but each part is provided by only one supplier. If we build a relation called ORDER with all the fields included here, we would have to repeat the name and address of the supplier for every part on the order, even though the order is for parts from a single supplier. This relationship contains what are called repeating data groups because there can be many parts on a single order to a given supplier. A more efficient way to arrange the data is to break down ORDER into smaller relations, each of which describes a single entity. If we go step by step and normalize the relation ORDER, we emerge with the relations illustrated in Figure 6.10. You can find out more about normalization, entity-relationship diagramming, and database design in the Learning Tracks for this chapter.

FIGURE 6.10 NORMALIZED TABLES CREATED FROM ORDER

After normalization, the original relation ORDER has been broken down into four smaller relations. The relation ORDER is left with only two attributes, and the relation LINE_ITEM has a combined, or concatenated, key consisting of Order_Number and Part_Number.

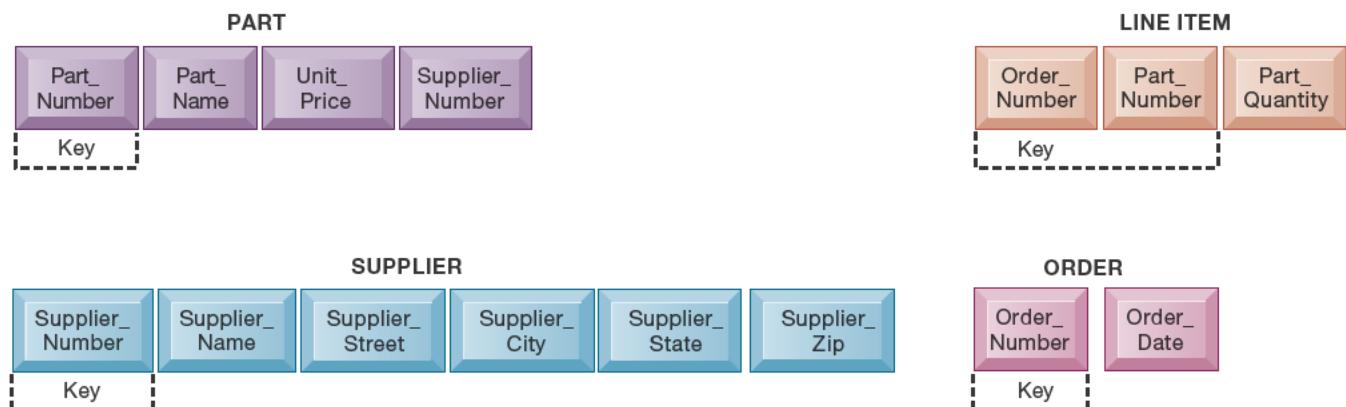
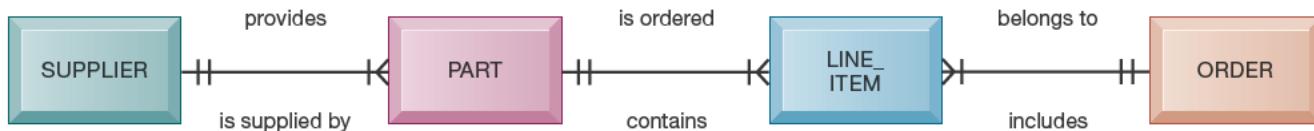


FIGURE 6.11 AN ENTITY-RELATIONSHIP DIAGRAM

This diagram shows the relationships between the entities SUPPLIER, PART, LINE_ITEM, and ORDER that might be used to model the database in Figure 6.10.



Relational database systems try to enforce **referential integrity** rules to ensure that relationships between coupled tables remain consistent. When one table has a foreign key that points to another table, you may not add a record to the table with the foreign key unless there is a corresponding record in the linked table. In the database we examined earlier in this chapter, the foreign key Supplier_Number links the PART table to the SUPPLIER table. We may not add a new record to the PART table for a part with Supplier_Number 8266 unless there is a corresponding record in the SUPPLIER table for Supplier_Number 8266. We must also delete the corresponding record in the PART table if we delete the record in the SUPPLIER table for Supplier_Number 8266. In other words, we shouldn't have parts from nonexistent suppliers!

Database designers document their data model with an **entity-relationship diagram**, illustrated in Figure 6.11. This diagram illustrates the relationship between the entities SUPPLIER, PART, LINE_ITEM, and ORDER. The boxes represent entities. The lines connecting the boxes represent relationships. A line connecting two entities that ends in two short marks designates a one-to-one relationship. A line connecting two entities that ends with a crow's foot topped by a short mark indicates a one-to-many relationship. Figure 6.11 shows that one ORDER can contain many LINE_ITEMS. (A PART can be ordered many times and appear many times as a line item in a single order.) Each PART can have only one SUPPLIER, but many PARTs can be provided by the same SUPPLIER.

It can't be emphasized enough: If the business doesn't get its data model right, the system won't be able to serve the business well. The company's systems will not be as effective as they could be because they'll have to work with data that may be inaccurate, incomplete, or difficult to retrieve. Understanding the organization's data and how they should be represented in a database is an important lesson you can learn from this course.

For example, Famous Footwear, a shoe store chain with more than 800 locations in 49 states, could not achieve its goal of having “the right style of shoe in the right store for sale at the right price” because its database was not properly designed for rapidly adjusting store inventory. The company had an Oracle relational database running on a midrange computer, but the database was designed primarily for producing standard reports for management rather than for reacting to marketplace changes. Management could not obtain precise data on specific items in inventory in each of its stores. The company had to work around this problem by building a new database where the sales and inventory data could be better organized for analysis and inventory management.

Nonrelational Databases, Cloud Databases, and Blockchain

For more than 30 years, relational database technology has been the gold standard. Cloud computing, unprecedented data volumes, massive workloads for web services, and the need to store new types of data require database

alternatives to the traditional relational model of organizing data in the form of tables, columns, and rows. Companies are turning to “NoSQL” non-relational database technologies for this purpose. **Nonrelational database management systems** use a more flexible data model and are designed for managing large data sets across many distributed machines and for easily scaling up or down. They are useful for accelerating simple queries against large volumes of structured and unstructured data, including web, social media, graphics, and other forms of data that are difficult to analyze with traditional SQL-based tools.

There are several different kinds of NoSQL databases, each with its own technical features and behavior. Oracle NoSQL Database is one example, as is Amazon’s SimpleDB, one of the Amazon Web Services that run in the cloud. SimpleDB provides a simple web services interface to create and store multiple data sets, query data easily, and return the results. There is no need to predefine a formal database structure or change that definition if new data are added later.

Pharmaceutical giant AstraZeneca employed MongoDB NoSQL database in next-generation genome sequencing to develop drugs to fight disease. The technology creates a synthetic version of messenger RNA, which helps create proteins that can fight cancer and other diseases. Analyzing a single human genome can take four days. MongoDB’s cross-platform document-oriented database can work with unstructured data pulled from disparate database systems to crunch numbers on a grand scale. With a greater command of the data, AstraZeneca can pursue links and patterns that it never noticed before.

Cloud Databases and Distributed Databases

Among the services Amazon and other cloud computing vendors provide are relational database engines. Amazon Relational Database Service (Amazon RDS) offers MySQL, Microsoft SQL Server, Oracle Database, PostgreSQL, MariaDB, or Amazon Aurora as database engines. Pricing is based on usage. Oracle has its own Database Cloud Services using its relational Oracle Database, and Microsoft Azure SQL Database is a cloud-based relational database service based on the Microsoft SQL Server DBMS. Cloud-based data management services have special appeal for businesses seeking database capabilities at a lower cost than in-house database products. (See the Interactive Session on Technology.)

Google now offers its Spanner distributed database technology as a cloud service. A **distributed database** is one that is stored in multiple physical locations. Parts or copies of the database are physically stored in one location and other parts or copies are maintained in other locations. Spanner makes it possible to store information across millions of machines in hundreds of data centers around the globe, and to synchronize the data precisely in all of its locations and ensure the data are always consistent. Google uses Spanner to support its various cloud services, and is now making the technology available to other companies that might need such capabilities to run a global business.

Blockchain

Blockchain is a distributed database technology that enables firms and organizations to create and verify transactions on a network nearly instantaneously without a central authority. The system stores transactions as a distributed ledger among a network of computers. The information held in the database is continually reconciled by the computers in the network.

INTERACTIVE SESSION TECHNOLOGY

New Cloud Database Tools Help Vodafone Fiji Make Better Decisions

Vodafone Fiji Limited is a 100 percent locally owned wireless telecommunications services provider, with more than 760,000 subscribers on its network, 260 employees, and revenue of U.S. \$185 million. Vodafone Fiji works closely with the Vodafone Group, a British multinational telecommunications conglomerate, which predominantly services Asia, Africa, Europe, and Oceania, and other operating companies to deliver cutting-edge technology to the people of Fiji. It has 85 percent of that country's market share in telecommunications services.

Prepaid customers account for 96 percent of Fiji's mobile communications market. (Less than 25 percent of U.S. mobile customers use prepaid services.) Prepaid customers are not bound by mobile service contracts, and thus are always looking for better ways to save. Consequently, Vodafone Fiji has to come up with better deals for its customers to persuade them to continue with its services. Unfortunately Vodafone Fiji's systems were not able to deliver the information for the task.

The company lacked the computing power, storage, and data management tools to analyze data quickly to make informed decisions about which deals to offer to which customers and the right times to do so. The data were stored on premises in multiple databases. Making matters worse, Amalgamated Telecom Holdings (Vodafone Fiji's major shareholder) had recently acquired several other telecommunications companies serving nearby markets in Samoa, American Samoa, Vanuatu, Cook Islands, and Kiribati. The data to be managed and mined for insights increased threefold. All those businesses had different types of data in different systems and different formats.

Vodafone Fiji's chief commercial officer Ronald Prasad and his team calculated that it would cost the company about U.S. \$2.5 million to upgrade the company's on-premises systems. They chose Oracle Autonomous Data Warehouse and Oracle Analytics Cloud services as a much more suitable and cost-effective solution. Oracle Autonomous Data Warehouse Cloud (ADWC) is a fully managed, high-performance elastic cloud service providing analytical capability over data stored in an Oracle database. The environment is optimized for data warehouse workloads and supports all standard SQL and business intelligence (BI) tools. The Oracle Autonomous

Data Warehouse provides an easy-to-use, fully autonomous database that scales elastically as workloads increase, delivers fast query performance, and requires no database administration. Vodafone Fiji would be able to extract, move, and transform data from disparate sources in the cloud, where it could be analyzed much more rapidly.

By automating many of the routine tasks required to manage Oracle databases, Oracle Autonomous Database can free up database administrators (DBAs) to do higher-level and more strategic work. The warehouse system handles a great deal of tedious technical work on its own. Vodafone Fiji would not need to hire people with specialized database management skills, which would be challenging in a small job market such as Fiji's. An on-premises data warehouse would have taken the company two months to implement, whereas it set up Oracle Autonomous Data Warehouse Cloud within 30 minutes and reporting functionality within one week. Vodafone Fiji pays only for computing resources consumed.

Oracle Analytics Cloud is a cloud-based platform that can take data in almost any form or size from almost any source (desktop, enterprise, data center), with capabilities for collecting, consolidating, and transforming data, and creating transactional and analytical reports and dashboards. Oracle Analytics Cloud provides self-service capabilities for users to perform what-if modeling and analysis. Users are empowered to visualize and discover data, including working with Big Data.

Vodafone Fiji can now easily obtain insights from the data collected and adjust its promotions to changing market dynamics. It is able to target customers who are at risk of cancelling Vodafone services as well as those most likely to respond to a special offer. The warehouse system can produce reports on call patterns to make sure customers are signed up for the optimal set of services, or target customers with 4G plans with free trials to entice them into subscribing to a data plan. Promotional campaigns customized to specific cell sites can encourage customers to get online during low utilization periods.

More than 50 rich reports are available to decision makers within minutes. Queries can be completed 5 times faster than before. A data mining procedure that used to take 125 minutes takes only 25 minutes

with Oracle Autonomous Data Warehouse; an aggregation query that used to take 294 seconds with the old on-premises system takes only 5 seconds with Oracle Autonomous Data Warehouse. Examining customer service call data, warehouse analytic tools have been able to identify trivial, repetitive inquiries where automated responses are possible, reducing inbound calls by 8 to 10 percent and freeing up

customer service agents to focus on up-selling and cross-selling based on specific customer profiles. Prasad's same three-member team has been able to handle quadruple the preacquisition workload very effectively.

Sources: www.vodafone.com.fj, accessed January 12, 2020; Tara Swords, "Call to Action," *Profit Magazine*, Fall 2019; and www.oracle.com, accessed January 12, 2020.

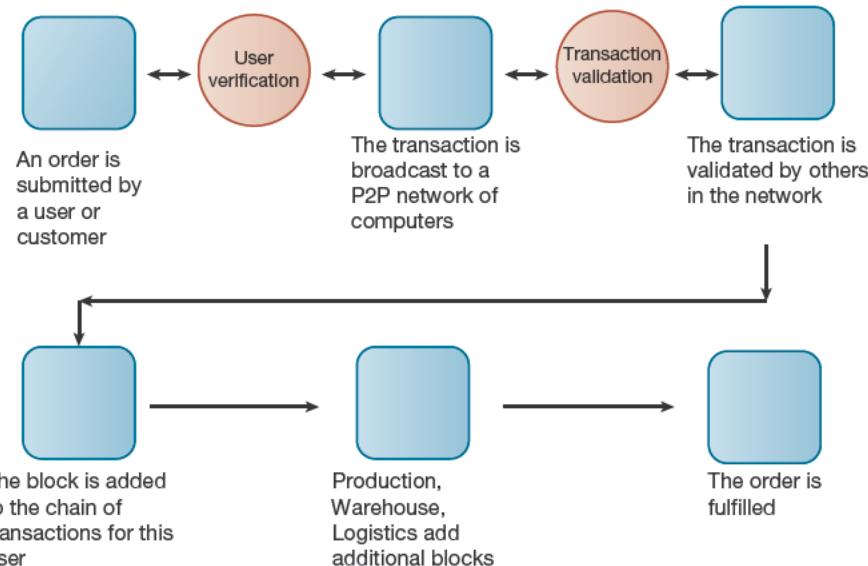
CASE STUDY QUESTIONS

1. Define the problem faced by Vodafone Fiji. What management, organization, and technology factors contributed to the problem?
2. Evaluate Oracle Autonomous Data Warehouse and Oracle Analytics Cloud as a solution for Vodafone Fiji.
3. How did the new Oracle tools change decision making at Vodafone Fiji?
4. Was using cloud services advantageous for Vodafone Fiji? Explain your answer.

The blockchain maintains a continuously growing list of records called blocks. Each block contains a timestamp and a link to a previous block. Once a block of data is recorded on the blockchain ledger, it cannot be altered retroactively. When someone wants to add a transaction, participants in the network (all of whom have copies of the existing blockchain) run algorithms to evaluate and verify the proposed transaction. Legitimate changes to the ledger are recorded across the blockchain in a matter of seconds or minutes and records are protected through cryptography. What makes a blockchain system possible and attractive to business firms is encryption and authentication of the actors and participating firms, which ensures that only legitimate actors can enter

FIGURE 6.12 HOW BLOCKCHAIN WORKS

A blockchain system is a distributed database that records transactions in a peer-to-peer network of computers



information, and only validated transactions are accepted. Once recorded, the transaction cannot be changed. Figure 6.12 illustrates how blockchain works for fulfilling an order.

There are many benefits to firms using blockchain databases. Blockchain networks radically reduce the cost of verifying users, validating transactions, and the risks of storing and processing transaction information across thousands of firms. Instead of thousands of firms building their own private transaction systems, then integrating them with suppliers, shippers, and financial institution systems, blockchain can provide a single, simple, low-cost transaction system for participating firms. Standardization of recording transactions is aided through the use of *smart contracts*. Smart contracts are computer programs that implement the rules governing transactions between firms, for example, what is the price of products, how will they be shipped, when will the transaction be completed, who will finance the transaction, what are financing terms, and the like.

The simplicity and security that blockchain offers has made it attractive for storing and securing financial transactions, supply chain transactions, medical records, and other types of data. Blockchain is a foundation technology for Bitcoin, Ethereum, and other cryptocurrencies. Chapter 8 provides more detail on securing transactions with blockchain.

6-3 What are the principal tools and technologies for accessing information from databases to improve business performance and decision making?

Businesses use their databases to keep track of basic transactions, such as paying suppliers, processing orders, keeping track of customers, and paying employees. But they also need databases to provide information that will help the company run the business more efficiently and help managers and employees make better decisions. If a company wants to know which product is the most popular or who is its most profitable customer, the answer lies in the data.

The Challenge of Big Data

Most data collected by organizations used to be transaction data that could easily fit into rows and columns of relational database management systems. We are now witnessing an explosion of data from web traffic, email messages, and social media content (tweets, status messages), as well as machine-generated data from sensors (used in smart meters, manufacturing sensors, and electrical meters) or from electronic trading systems. These data may be unstructured or semistructured and thus not suitable for relational database products that organize data in the form of columns and rows. We now use the term **big data** to describe these data sets with volumes so huge that they are beyond the ability of typical DBMS to capture, store, and analyze.

Big data is often characterized by the “3Vs”: the extreme *volume* of data, the wide *variety* of data types and sources, and the *velocity* at which data must be processed. Big data doesn’t designate any specific quantity but usually refers to data in the petabyte and exabyte range—in other words, billions to trillions of records, many from different sources. Big data are produced in much larger quantities and much more rapidly than traditional data. For example, a single jet engine is capable of generating 10 terabytes of data in just 30 minutes, and

INTERACTIVE SESSION MANAGEMENT

Big Data Baseball

Big data and analytics are sweeping the business world, and the professional sports industry is no exception. Baseball, football, soccer, hockey, tennis, and even sailboat racing are finding ways to analyze data about players and competing teams in order to improve performance. The use of analytics and big data has revolutionized the game of baseball as we know it, including defensive shifts, swing path changes, and how teams acquire and develop players.

Given the huge disparities in Major League Baseball (MLB) team budgets, wealthier teams typically have the advantage in recruiting the best players. Michael Lewis's book *Moneyball*, published in 2003, describes how Oakland Athletics manager Billy Beane was able to turn the underdog A's into a winning team by using big data analytics to guide decisions about which players to recruit and cultivate. Rigorous statistical analysis had demonstrated that on-base percentage and slugging percentage were better indicators of offensive success (and cheaper to obtain on the open market) than more historically valued qualities such as speed and contact. These observations flew in the face of conventional baseball wisdom and the beliefs of many baseball talent scouts and coaches. Beane rebuilt the A's based on these findings, producing a consistently winning team for a number of years by using advanced analytics to gain insights into each player's value and contribution to team success that wealthier teams had overlooked.

Big data is credited with helping the Boston Red Sox win the World Series in 2004 and the St. Louis Cardinals win in 2006 and 2011. To varying degrees, every Major League Baseball team today uses big data and deep analytics to support decisions about many aspects of the game. However, some teams, such as the Pittsburgh Pirates, Chicago Cubs, and Houston Astros, were slower to do so than others, and suffered lackluster performance until they embraced big data more fully.

Findings from big data analytics have changed the importance baseball teams attach to specific skills of players. Skills that previously could not be quantified are now receiving more attention, including fielding,

base running, and stealing. Skill in fielding is especially valued today. For example, Mike Trout, center fielder for the Los Angeles Angels, is highly regarded by team owners because he's an exceptional fielder and base runner and an exceptionally intelligent baseball player, even though he lacked stellar statistics in home runs. Today the biggest challenge is not whether to use big data in baseball but how to use it effectively. It is not always possible to interpret the data and separate out what is "noise" and what is actually actionable information. The amount of data players and pitchers must deal with can be overwhelming—pitch usage, swing planes, spin rates, etc. When a player steps into the batter's box, every hitter is different in terms of how much information that person can absorb before getting bogged down in it. Some want to know what a pitcher will do in certain situations—what pitches the pitcher will use and how often that person uses them—while some want to just step in with a clear head and look for the ball. There's only so much data a person can use without dissecting too much and getting too distracted from the task at hand.

Many baseball experts still believe that traditional methods of player evaluation, along with gut instinct, money, and luck, are still key ingredients for winning teams. For example, the San Francisco Giants use big data and statistics, but also base their player recruitment decisions on the opinions of scouts and coaches. According to Giants bench coach Ron Wotus, numbers really can't tell the whole story about the quality of the player; so the Giants integrate statistical data with scouting, coaching, and player experience, especially when dealing with opponents outside the National League that the Giants do not see regularly. Being able to exploit an individual player's strengths comes more from knowing the player and his ability as opposed to the statistics, Wotus believes. Shortstops with good arms can play farther from home plate than normal at times, while fast runners can play closer to home plate than usual. There are nuances to defending the opposition that are not statistically related, but statistics help when you don't know players well enough to know what to expect from them.

Sources: www.statsperform.com, accessed January 25, 2020; www.mlb.com, accessed January 25, 2020; "Sports Analytics Market Size, Shares 2020 By Top Key Players: IBM, SAP, SAS, Tableau Software, Oracle, STATS, Prozone," *MarketWatch*, January 30, 2020; "Nick San Miguel, 'San Francisco Giants: Analytics Are Not the Answer,'" www.aroundthefoghorn.com, accessed February 4, 2020; Richard Justice,

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CASE STUDY QUESTIONS

1. How did information technology change the game of baseball? Explain.
2. How did information technology affect decision making at MLB teams? What kinds of decisions changed as the result of using big data?
3. How much should baseball rely on big data and analytics? Explain your answer.

there are more than 100,000 airline flights each day. Twitter generates more than 12 terabytes of data daily. According to the International Data Center (IDC) technology research firm, data are more than doubling every two years, so the amount of data available to organizations is skyrocketing.

Businesses are interested in big data because they can reveal more patterns and interesting relationships than smaller data sets, with the potential to provide new insights into customer behavior, weather patterns, financial market activity, or other phenomena. For example, Shutterstock, the global online image marketplace, stores 24 million images, adding 10,000 more each day. To find ways to optimize the buying experience, Shutterstock analyzes its big data to find out where its website visitors place their cursors and how long they hover over an image before making a purchase. Big data is also finding many uses in the public sector. For example, the chapter-ending case explores how big data is being used to combat the COVID-19 pandemic. The Interactive Session on Management illustrates how Major League Baseball is using big data to improve player and team performance.

However, to derive business value from these data, organizations need new technologies and tools capable of managing and analyzing nontraditional data along with their traditional enterprise data. They also need to know what questions to ask of the data and limitations of big data. Capturing, storing, and analyzing big data can be expensive, and information from big data may not necessarily help decision makers. It's important to have a clear understanding of the problem big data will solve for the business.

Business Intelligence Infrastructure

Suppose you wanted concise, reliable information about current operations, trends, and changes across the entire company. If you worked in a large company, the data you need might have to be pieced together from separate systems, such as sales, manufacturing, and accounting, and even from external sources, such as demographic or competitor data. Increasingly, you might need to use big data. A contemporary infrastructure for business intelligence has an array of tools for obtaining useful information from all the different types of data used by businesses today, including semistructured and unstructured big data in vast quantities. These capabilities include data warehouses and data marts, Hadoop, in-memory computing, and analytical platforms. Some of these capabilities are available as cloud services.

Data Warehouses and Data Marts

The traditional tool for analyzing corporate data has been the data warehouse. A **data warehouse** is a database that stores current and historical data of potential interest to decision makers throughout the company. The data originate in many core operational transaction systems, such as systems for sales, customer accounts, and manufacturing, and may include data from website transactions. The data warehouse extracts current and historical data from multiple operational systems inside the organization. These data are combined with data from external sources and transformed by correcting inaccurate and incomplete data and restructuring the data for management reporting and analysis before being loaded into the data warehouse.

The data warehouse makes the data available for anyone to access as needed, but the data cannot be altered. A data warehouse system also provides a range of ad hoc and standardized query tools, analytical tools, and graphical reporting facilities.

Companies often build enterprise-wide data warehouses, where a central data warehouse serves the entire organization, or they create smaller, decentralized warehouses called data marts. A **data mart** is a subset of a data warehouse in which a summarized or highly focused portion of the organization's data is placed in a separate database for a specific population of users. For example, a company might develop marketing and sales data marts to deal with customer information. Bookseller Barnes & Noble used to maintain a series of data marts—one for point-of-sale data in retail stores, another for college bookstore sales, and a third for online sales.

Hadoop

Relational DBMS and data warehouse products are not well suited for organizing and analyzing big data or data that do not easily fit into columns and rows used in their data models. For handling unstructured and semistructured data in vast quantities, as well as structured data, organizations are using **Hadoop**. Hadoop is an open source software framework managed by the Apache Software Foundation that enables distributed parallel processing of huge amounts of data across inexpensive computers. It breaks a big data problem down into subproblems, distributes them among up to thousands of inexpensive computer processing nodes, and then combines the result into a smaller data set that is easier to analyze. You've probably used Hadoop to find the best airfare on the Internet, get directions to a restaurant, do a search on Google, or connect with a friend on Facebook.

Hadoop consists of several key services, including the Hadoop Distributed File System (HDFS) for data storage and MapReduce for high-performance parallel data processing. HDFS links together the file systems on the numerous nodes in a Hadoop cluster to turn them into one big file system. Hadoop's MapReduce was inspired by Google's MapReduce system for breaking down processing of huge data sets and assigning work to the various nodes in a cluster. HBase, Hadoop's nonrelational database, provides rapid access to the data stored on HDFS and a transactional platform for running high-scale real-time applications.

Hadoop can process large quantities of any kind of data, including structured transactional data, loosely structured data such as Facebook and Twitter feeds, complex data such as web server log files, and unstructured audio and video data. Hadoop runs on a cluster of inexpensive servers, and processors can be added or removed as needed. Companies use Hadoop for analyzing very large volumes of data as well as for a staging area for unstructured and

semistructured data before they are loaded into a data warehouse. Yahoo uses Hadoop to track users' behavior so it can modify its home page to fit their interests. Life sciences research firm NextBio uses Hadoop and HBase to process data for pharmaceutical companies conducting genomic research. Top database vendors such as IBM, Hewlett-Packard, Oracle, and Microsoft have their own Hadoop software distributions. Other vendors offer tools for moving data into and out of Hadoop or for analyzing data within Hadoop.

In-Memory Computing

Another way of facilitating big data analysis is to use **in-memory computing**, which relies primarily on a computer's main memory (RAM) for data storage. (Conventional DBMS use disk storage systems.) Users access data stored in system primary memory, thereby eliminating bottlenecks from retrieving and reading data in a traditional, disk-based database and dramatically shortening query response times. In-memory processing makes it possible for very large sets of data, amounting to the size of a data mart or small data warehouse, to reside entirely in memory. Complex business calculations that used to take hours or days are able to be completed within seconds, and this can even be accomplished using handheld devices.

The previous chapter describes some of the advances in contemporary computer hardware technology that make in-memory processing possible, such as powerful high-speed processors, multicore processing, and falling computer memory prices. These technologies help companies optimize the use of memory and accelerate processing performance while lowering costs. Leading in-memory database products include SAP HANA, Oracle Database In-Memory, Microsoft SQL Server, and Teradata Intelligent Memory.

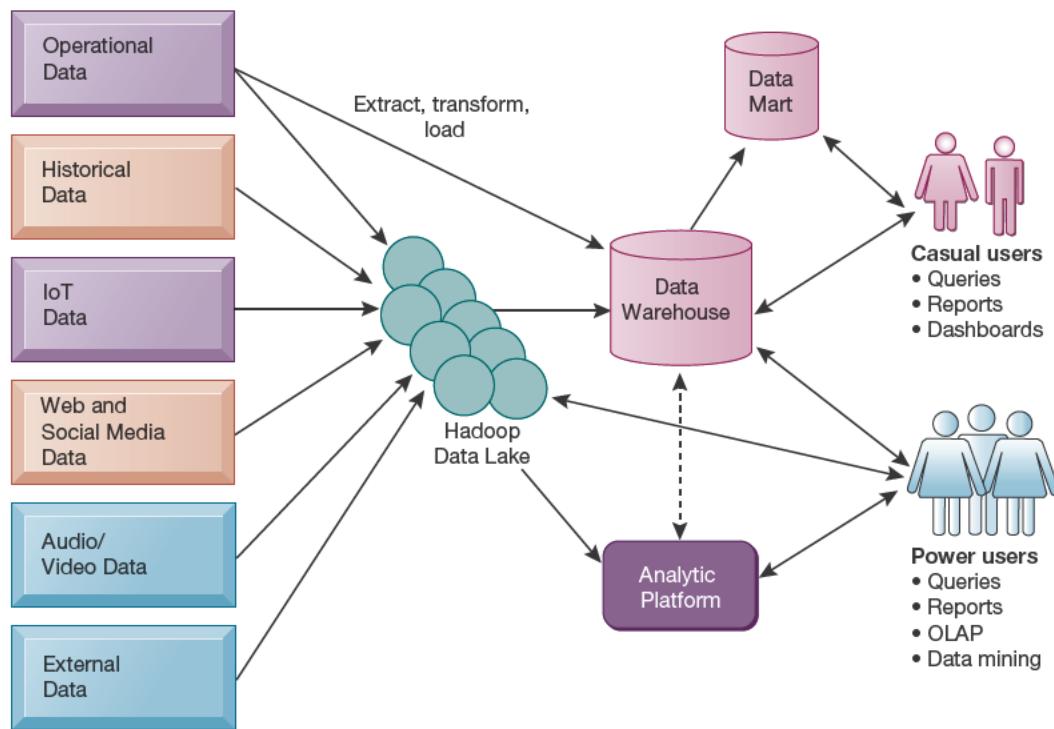
Analytic Platforms

Commercial database vendors have developed specialized high-speed **analytic platforms** using both relational and nonrelational technology that are optimized for analyzing large data sets. Analytic platforms feature pre-configured hardware-software systems that are specifically designed for query processing and analytics. For example, the IBM PureData System for Analytics features tightly integrated database, server, and storage components that handle complex analytic queries 10 to 100 times faster than traditional systems. Analytic platforms also include in-memory systems and NoSQL nonrelational database management systems and are now available as cloud services.

Figure 6.13 illustrates a contemporary business intelligence technology infrastructure using the technologies we have just described. Current and historical data are extracted from multiple operational systems along with web data, social media data, Internet of Things (IoT) machine-generated data, unstructured audio/visual data, and other data from external sources. Some companies are starting to pour all of these types of data into a data lake. A **data lake** is a repository for raw unstructured data or structured data that for the most part has not yet been analyzed, and the data can be accessed in many ways. The data lake stores these data in their native format until they are needed. The Hadoop Distributed File System (HDFS) is often used to store the data lake contents across a set of clustered computer nodes, and Hadoop clusters may be used to preprocess some of these data for use in the data warehouse, data marts, or an analytic platform, or for direct querying by power users. Outputs include reports and dashboards as well as query results. Chapter 12 discusses the various types of BI users and BI reporting in greater detail.

FIGURE 6.13 CONTEMPORARY BUSINESS INTELLIGENCE INFRASTRUCTURE

A contemporary business intelligence infrastructure features capabilities and tools to manage and analyze large quantities and different types of data from multiple sources. Easy-to-use query and reporting tools for casual business users and more sophisticated analytical toolsets for power users are included.



Analytical Tools: Relationships, Patterns, Trends

Once data have been captured and organized using the business intelligence technologies we have just described, they are available for further analysis using software for database querying and reporting, multidimensional data analysis (OLAP), and data mining. This section will introduce you to these tools, with more detail about business intelligence analytics and applications in Chapter 12.

Online Analytical Processing (OLAP)

Suppose your company sells four different products—nuts, bolts, washers, and screws—in the East, West, and Central regions. If you wanted to ask a fairly straightforward question, such as how many washers were sold during the past quarter, you could easily find the answer by querying your sales database. But what if you wanted to know how many washers were sold in each of your sales regions and compare actual results with projected sales?

To obtain the answer, you would need **online analytical processing (OLAP)**. OLAP supports multidimensional data analysis, enabling users to view the same data in different ways using multiple dimensions. Each aspect of information—product, pricing, cost, region, or time period—represents a different dimension. So, a product manager could use a multidimensional data analysis tool to learn how many washers were sold in the East in June, how that compares with the previous month and the previous June, and how it compares with the sales forecast. OLAP enables users to obtain online answers to ad hoc questions such as these in a fairly rapid amount of time, even when the data are stored in very large databases, such as sales figures for multiple years.

FIGURE 6.14 MULTIDIMENSIONAL DATA MODEL

This view shows product versus region. If you rotate the cube 90 degrees, the face that will show is product versus actual and projected sales. If you rotate the cube 90 degrees again, you will see region versus actual and projected sales. Other views are possible.

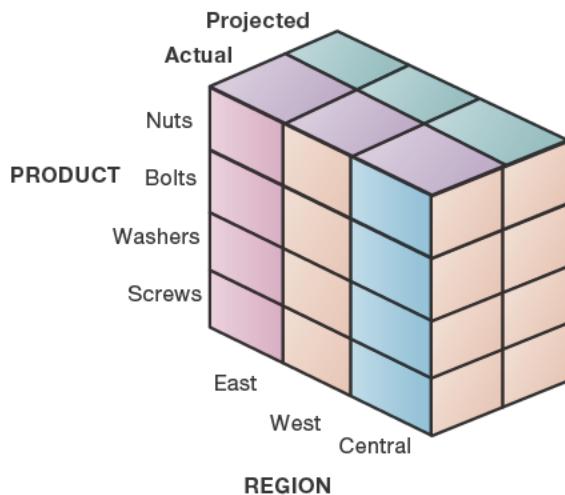


Figure 6.14 shows a multidimensional model that could be created to represent products, regions, actual sales, and projected sales. A matrix of actual sales can be stacked on top of a matrix of projected sales to form a cube with six faces. If you rotate the cube 90 degrees one way, the face showing will be product versus actual and projected sales. If you rotate the cube 90 degrees again, you will see region versus actual and projected sales. If you rotate 180 degrees from the original view, you will see projected sales and product versus region. Cubes can be nested within cubes to build complex views of data. A company would use either a specialized multidimensional database or a tool that creates multidimensional views of data in relational databases.

Data Mining

Traditional database queries answer such questions as “How many units of product number 403 were shipped in February 2020?” OLAP, or multidimensional analysis, supports much more complex requests for information, such as “Compare sales of product 403 relative to plan by quarter and sales region for the past two years.” With OLAP and query-oriented data analysis, users need to have a good idea about the information for which they are looking.

Data mining is more discovery-driven. Data mining provides insights into corporate data that cannot be obtained with OLAP by finding hidden patterns and relationships in large databases and inferring rules from them to predict future behavior. The patterns and rules are used to guide decision making and forecast the effect of those decisions. The types of information obtainable from data mining include associations, sequences, classifications, clusters, and forecasts.

- *Associations* are occurrences linked to a single event. For instance, a study of supermarket purchasing patterns might reveal that, when corn chips are purchased, a cola drink is purchased 65 percent of the time, but when there is a promotion, cola is purchased 85 percent of the time. This information helps managers make better decisions because they have learned the profitability of a promotion.
- In *sequences*, events are linked over time. We might find, for example, that if a house is purchased, a new refrigerator will be purchased within two weeks

65 percent of the time, and an oven will be bought within one month of the home purchase 45 percent of the time.

- *Classification* recognizes patterns that describe the group to which an item belongs by examining existing items that have been classified and by inferring a set of rules. For example, businesses such as credit card or telephone companies worry about the loss of steady customers. Classification helps discover the characteristics of customers who are likely to leave and can provide a model to help managers predict who those customers are so that the managers can devise special campaigns to retain such customers.
- *Clustering* works in a manner similar to classification when no groups have yet been defined. A data mining tool can discover different groupings within data, such as finding affinity groups for bank cards or partitioning a database into groups of customers based on demographics and types of personal investments.
- Although these applications involve predictions, *forecasting* uses predictions in a different way. It uses a series of existing values to forecast what other values will be. For example, forecasting might find patterns in data to help managers estimate the future value of continuous variables, such as sales figures.

These systems perform high-level analyses of patterns or trends, but they can also drill down to provide more detail when needed. There are data mining applications for all the functional areas of business and for government and scientific work. One popular use for data mining is to provide detailed analyses of patterns in customer data for one-to-one marketing campaigns or for identifying profitable customers.

Caesars Entertainment, formerly known as Harrah's Entertainment, is the largest gaming company in the world. It continually analyzes data about its customers gathered when people play its slot machines or use its casinos and hotels. The corporate marketing department uses this information to build a detailed gambling profile, based on a particular customer's ongoing value to the company. For instance, data mining lets Caesars know the favorite gaming experience of a regular customer at one of its riverboat casinos along with that person's preferences for room accommodations, restaurants, and entertainment. This information guides management decisions about how to cultivate the most profitable customers, encourage those customers to spend more, and attract more customers with high revenue-generating potential. Business intelligence improved Caesars's profits so much that it became the centerpiece of the firm's business strategy.

Text Mining and Web Mining

Unstructured data, most in the form of text files, is believed to account for more than 80 percent of useful organizational information and is one of the major sources of big data that firms want to analyze. Email, memos, call center transcripts, survey responses, legal cases, patent descriptions, and service reports are all valuable for finding patterns and trends that will help employees make better business decisions. **Text mining** tools are now available to help businesses analyze these data. These tools are able to extract key elements from unstructured natural language text, discover patterns and relationships, and summarize the information.

Businesses might turn to text mining to analyze transcripts of calls to customer service centers to identify major service and repair issues or to measure customer sentiment about their company. **Sentiment analysis** software is able to mine text comments in an email message, blog, social media conversation, or survey forms to detect favorable and unfavorable opinions about specific

subjects. For example, Kraft Foods uses a Community Intelligence Portal and sentiment analysis to tune into consumer conversations about its products across numerous social networks, blogs, and other websites. Kraft tries to make sense of relevant comments rather than just track brand mentions and can identify customers' emotions and feelings when they talk about how they barbecue and what sauces and spices they use.

The web is another rich source of unstructured big data for revealing patterns, trends, and insights into customer behavior. The discovery and analysis of useful patterns and information from the World Wide Web are called **web mining**. Businesses might turn to web mining to help them understand customer behavior, evaluate the effectiveness of a particular website, or quantify the success of a marketing campaign. For instance, marketers use the Google Trends service, which tracks the popularity of various words and phrases used in Google search queries, to learn what people are interested in and what they are interested in buying.

Web mining looks for patterns in data through content mining, structure mining, and usage mining. Web content mining is the process of extracting knowledge from the content of web pages, which may include text, image, audio, and video data. Web structure mining examines data related to the structure of a particular website. For example, links pointing to a document indicate the popularity of the document, while links coming out of a document indicate the richness or perhaps the variety of topics covered in the document. Web usage mining examines user interaction data recorded by a web server whenever requests for a website's resources are received. The usage data records the user's behavior when the user browses or makes transactions on the website and collects the data in a server log. Analyzing such data can help companies determine the value of particular customers, cross-marketing strategies across products, and the effectiveness of promotional campaigns.

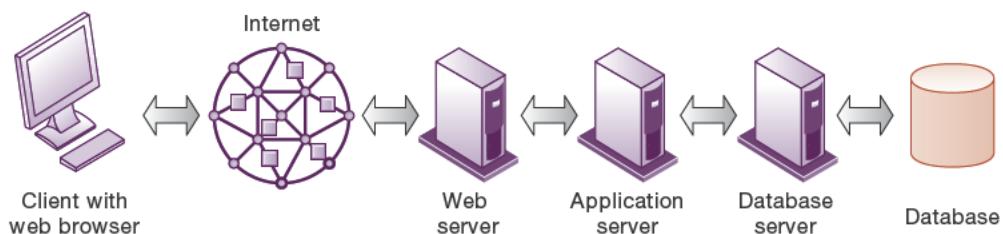
Databases and the Web

Have you ever tried to use the web to place an order or view a product catalog? If so, you were using a website linked to an internal corporate database. Many companies now use the web to make some of the information in their internal databases available to customers and business partners.

Suppose, for example, a customer with a web browser wants to search an online retailer's database for pricing information. Figure 6.15 illustrates how that customer might access the retailer's internal database over the web. The user accesses the retailer's website over the Internet using a web browser on

FIGURE 6.15 LINKING INTERNAL DATABASES TO THE WEB

Users access an organization's internal database through the web using their desktop PC browsers or mobile apps.



his or her client PC or mobile device. The user's web browser software requests data from the organization's database, using HTML commands to communicate with the web server. Apps provide even faster access to corporate databases.

Because many back-end databases cannot interpret commands written in HTML, the web server passes these requests for data to software that translates HTML commands into SQL so the commands can be processed by the DBMS working with the database. In a client/server environment, the DBMS resides on a dedicated computer called a **database server**. The DBMS receives the SQL requests and provides the required data. Middleware transfers information from the organization's internal database back to the web server for delivery in the form of a web page to the user.

Figure 6.15 shows that the middleware working between the web server and the DBMS is an application server running on its own dedicated computer (see Chapter 5). The application server software handles all application operations, including transaction processing and data access, between browser-based computers and a company's back-end business applications or databases. The application server takes requests from the web server, runs the business logic to process transactions based on those requests, and provides connectivity to the organization's back-end systems or databases. Alternatively, the software for handling these operations could be a custom program or a script.

There are a number of advantages to using the web to access an organization's internal databases. First, web browser software is much easier to use than proprietary query tools. Second, the web interface requires few or no changes to the internal database. It costs much less to add a web interface in front of a legacy system than to redesign and rebuild the system to improve user access.

Accessing corporate databases through the web is creating new efficiencies, opportunities, and business models. ThomasNet.com provides an up-to-date online directory of more than 500,000 suppliers of industrial products, such as chemicals, metals, plastics, rubber, and automotive equipment. Formerly called Thomas Register, the company used to send out huge paper catalogs with this information. Now it provides this information to users online via its website and has become a smaller, leaner company.

Other companies have created entirely new businesses based on access to large databases through the web. One is the social networking service Facebook, which helps users stay connected with each other and meet new people. Facebook features "profiles" with information on over 2.6 billion active users with information about themselves, including interests, friends, photos, and groups with which they are affiliated. Facebook maintains a very large database to house and manage all of this content. There are also many web-enabled databases in the public sector to help consumers and citizens access helpful information.

6-4 Why are data governance and data quality assurance essential for managing the firm's data resources?

Setting up a database is only a start. To make sure that the data for your business remain accurate, reliable, and readily available to those who need it, your business will need special policies and procedures for data governance. **Data governance** encompasses policies and procedures through which data can be

managed as an organizational resource. It establishes the organization's rules for sharing, disseminating, acquiring, standardizing, classifying, and inventorying information. These include identifying which users and organizational units can share information, where information can be distributed, who is responsible for updating and maintaining the information, and how data resources should be secured (see Chapter 8). A firm's information policy might specify, for example, that only selected members of the payroll and human resources department would have the right to change or view sensitive employee data, such as an employee's salary or social security number, and that these departments are responsible for making sure that such employee data are accurate.

Assuring Data Quality

With today's organizations relying so heavily on data to drive operations and decision making, data quality assurance is especially important. What would happen if a customer's telephone number or account balance were incorrect? What would be the impact if the database had the wrong price for the product you sold? Data that are inaccurate, untimely, or inconsistent with other sources of information create serious operational and financial problems for businesses, even with a well-designed database and information policy. When faulty data go unnoticed, they often lead to incorrect decisions, product recalls, and even financial losses.

Gartner Inc. reported that more than 25 percent of the critical data in large *Fortune* 1000 companies' databases is inaccurate or incomplete, including bad product codes and product descriptions, faulty inventory descriptions, erroneous financial data, incorrect supplier information, and incorrect employee data. Some of these data quality problems are caused by redundant and inconsistent data produced by multiple systems. For example, the sales ordering system and the inventory management system might both maintain data on the organization's products. However, the sales ordering system might use the term *Item Number*, and the inventory system might call the same attribute *Product Number*. The sales, inventory, or manufacturing systems of a clothing retailer might use different codes to represent values for an attribute. One system might represent clothing size as extra large, whereas the other system might use the code XL for the same purpose. During the design process for a database, data describing entities, such as a customer, product, or order, should be named and defined consistently for all business areas using the database.

Think of all the times you've received several pieces of the same direct mail advertising on the same day. This is very likely the result of having your name maintained multiple times in a database. Your name may have been misspelled or you used your middle initial on one occasion and not on another or the information was initially entered onto a paper form and not scanned properly into the system. Because of these inconsistencies, the database would treat you as different people! We often receive redundant mail addressed to Laudon, Lavdon, Lauden, or Landon.

If a database is properly designed and enterprise-wide data standards are established, duplicate or inconsistent data elements should be minimal. Most data quality problems, however, such as misspelled names, transposed numbers, or incorrect or missing codes, stem from errors during data input. The incidence of such errors is rising as companies move their businesses to the web and allow customers and suppliers to enter data into their websites that directly update internal systems.

Before a new database is in place, organizations need to identify and correct their faulty data and establish better routines for editing data once their

database is in operation. Analysis of data quality often begins with a **data quality audit**, which is a structured survey of the accuracy and level of completeness of the data in an information system. Data quality audits can be performed by surveying entire data files, surveying samples from data files, or surveying end users for their perceptions of data quality.

Data cleansing, also known as *data scrubbing*, consists of activities for detecting and correcting data in a database that are incorrect, incomplete, improperly formatted, or redundant. Data cleansing not only corrects errors but also enforces consistency among different sets of data that originated in separate information systems. Specialized data-cleansing software is available to automatically survey data files, correct errors in the data, and integrate the data in a consistent companywide format.

Data quality problems are not just business problems. They also pose serious problems for individuals, affecting their financial condition and even their jobs. For example, inaccurate or outdated data about consumers' credit histories maintained by credit bureaus can prevent creditworthy individuals from obtaining loans or lower their chances of finding or keeping a job.



6-5 How will MIS help my career?

Here is how Chapter 6 and this book can help you find a job as an entry-level data analyst.

The Company

South Africa Power, a large diversified energy company headquartered in Johannesburg, has an open position for an entry-level data analyst. The company is involved in the distribution, transmission, and generation of electricity as well as energy management and other energy-related services for 5 million customers.

Position Description

Job responsibilities include:

- Maintaining the integrity of substation equipment and related data in multiple databases, including SAP.
- Querying databases in multiple systems.
- Modifying systems for proper data management and procedural controls.
- Recommending and implementing process changes based on data problems that are identified.
- Conducting business-specific research, gathering data, and compiling reports and summaries.
- Expanding knowledge of policies, practices, and procedures.

Job Requirements

- BA/BS degree in business, finance, accounting, economics, engineering, or related discipline
- One to two years of professional work experience desirable

- Knowledge of Microsoft Office tools (Excel, PowerPoint, Access, and Word)
- Strong analytical capabilities, including attention to detail, problem solving, and decision making
- Strong oral and written communication and teamwork skills
- Familiarity with transmission substation equipment desirable

Interview Questions

1. What do you know about substation equipment? Have you ever worked with SAP for Utilities?
2. What do you know about data management and databases? Have you ever worked with data management software? If so, what exactly have you done with it?
3. Tell us what you can do with Access and Excel. What kinds of problems have you used these tools to solve? Did you take courses in Access or Excel?
4. What experience do you have analyzing problems and developing specific solutions? Can you give an example of a problem you helped solve?

Author Tips

1. Do some research on the electric utility industry equipment maintenance and software for electric utility asset management and predictive maintenance. Read blogs from IBM, Deloitte, and Intel about predictive maintenance and watch YouTube videos from GE and IBM on this topic.
2. Review Chapter 6 of this text on data management and databases, along with the Chapter 12 discussion of operational intelligence. Inquire what you would be expected to do with databases in this job position.
3. Do some research on the capabilities of SAP for Utilities and ask exactly how you would be using this software and what skills would be required. Watch SAP's YouTube video on SAP for Utilities.

REVIEW SUMMARY

6-1 What are the problems of managing data resources in a traditional file environment?

Traditional file management techniques make it difficult for organizations to keep track of all of the pieces of data they use in a systematic way and to organize these data so that they can be easily accessed. Different functional areas and groups were allowed to develop their own files independently. Over time, this traditional file management environment creates problems such as data redundancy and inconsistency, program-data dependence, inflexibility, poor security, and lack of data sharing and availability. A database management system (DBMS) solves these problems with software that permits centralization of data and data management so that businesses have a single consistent source for all their data needs. Using a DBMS minimizes redundant and inconsistent files.

6-2 What are the major capabilities of database management systems (DBMS), and why is a relational DBMS so powerful?

The principal capabilities of a DBMS include a data definition capability, a data dictionary capability, and a data manipulation language. The data definition capability specifies the structure and content of the database. The data dictionary is an automated or manual file that stores information about the data in the database, including names, definitions, formats, and descriptions of data elements. The data manipulation language, such as SQL, is a specialized language for accessing and manipulating the data in the database.

The relational database has been the primary method for organizing and maintaining data in information systems because it is so flexible and accessible. It organizes data in two-dimensional tables called relations with rows and columns. Each table contains data about an entity and its attributes. Each row represents a record, and each column represents an attribute or field. Each table also contains a key field to uniquely identify each record for retrieval or manipulation. Relational database tables can be combined easily to deliver data required by users, provided that any two tables share a common data element. Nonrelational databases are becoming popular for managing types of data that can't be handled easily by the relational data model. Both relational and nonrelational database products are available as cloud computing services. A distributed database is one that is stored in multiple physical locations, including remote cloud computing centers.

Designing a database requires both a logical design and a physical design. The logical design models the database from a business perspective. The organization's data model should reflect its key business processes and decision-making requirements. The process of creating small, stable, flexible, and adaptive data structures from complex groups of data when designing a relational database is termed normalization. A well-designed relational database will not have many-to-many relationships, and all attributes for a specific entity will only apply to that entity. It will try to enforce referential integrity rules to ensure that relationships between coupled tables remain consistent. An entity-relationship diagram graphically depicts the relationship between entities (tables) in a relational database.

6-3 What are the principal tools and technologies for accessing information from databases to improve business performance and decision making?

Contemporary data management technology has an array of tools for obtaining useful information from all the different types of data used by businesses today, including semistructured and unstructured big data in vast quantities. These capabilities include data warehouses and data marts, Hadoop, in-memory computing, and analytical platforms. OLAP represents relationships among data as a multidimensional structure, which can be visualized as cubes of data and cubes within cubes of data, enabling more sophisticated data analysis. Data mining analyzes large pools of data, including the contents of data warehouses, to find patterns and rules that can be used to predict future behavior and guide decision making. Text mining tools help businesses analyze large unstructured data sets consisting of text. Web mining tools focus on analysis of useful patterns and information from the web, examining the structure of websites and activities of website users, as well as the contents of web pages. Conventional databases can be linked via middleware to the web or a web interface to facilitate user access to an organization's internal data.

6-4 Why are data governance and data quality assurance essential for managing the firm's data resources?

Developing a database environment requires policies and procedures for managing organizational data as well as a good data model and database technology. Data governance encompasses organizational policies and procedures for the maintenance, distribution, and use of information in the organization. Data that are inaccurate, incomplete, or inconsistent create serious operational and financial problems for businesses because they may create inaccuracies in product pricing, customer accounts, and inventory data and lead to inaccurate decisions about the actions that should be taken by the firm. Firms must take special steps to make sure they have a high level of data quality. These include using enterprise-wide data standards, databases designed to minimize inconsistent and redundant data, data quality audits, and data cleansing software.

Key Terms

<i>Analytic platform</i> , 264	<i>Entity</i> , 246
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<i>Distributed database</i> , 257	<i>Web mining</i> , 268

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

- 6-1 What are the problems of managing data resources in a traditional file environment?**
 - List and describe each of the components in the data hierarchy.
 - Define and explain the significance of entities, attributes, and key fields.
 - List and describe the problems of the traditional file environment.
- 6-2 What are the major capabilities of database management systems (DBMS), and why is a relational DBMS so powerful?**
 - Define a database and a database management system.
 - Name and briefly describe the capabilities of a DBMS.
 - Define a relational DBMS and explain how it organizes data.

- List and describe the three operations of a relational DBMS.
- Explain why nonrelational databases are useful.
- Define and describe normalization and referential integrity and explain how they contribute to a well-designed relational database.
- Define and describe an entity-relationship diagram and explain its role in database design.

6-3 **What are the principal tools and technologies for accessing information from databases to improve business performance and decision making?**

- Explain why businesses may be more interested in big data than in smaller data sets.
- Describe how a business might use a data mart.

- Describe the capabilities of Hadoop Distributed File System for data storage.
- Explain how in-memory computing can be used to facilitate data analysis.
- Explain what is meant by clustering in the context of data mining.
- Describe sentiment analysis and suggest why a business might use it.

6-4 **Why are data governance and data quality assurance essential for managing the firm's data resources?**

- Define data governance and explain how it helps organizations manage their data.
- List and describe the most important data quality problems.
- List and describe the most important tools and techniques for assuring data quality.

Discussion Questions

6-5 It has been said there is no bad data, just bad management. Discuss the implications of this statement. MyLab MIS

6-6 To what extent should end users be involved in the selection of a database management system and database design? MyLab MIS

6-7 What are the consequences of an organization not having an information policy? MyLab MIS

Hands-On MIS Projects

The projects in this section give you hands-on experience in analyzing data quality problems, establishing companywide data standards, creating a database for inventory management, and using the web to search online databases for overseas business resources. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

6-8 Emerson Process Management, a global supplier of measurement, analytical, and monitoring instruments and services based in Austin, Texas, had a new data warehouse designed for analyzing customer activity to improve service and marketing. However, the data warehouse was full of inaccurate and redundant data. The data in the warehouse came from numerous transaction processing systems in Europe, Asia, and other locations around the world. The team that designed the warehouse had assumed that sales groups in all these areas would enter customer names and addresses the same way. In fact, companies in different countries were using multiple ways of entering quotes, billing, shipping, and other data. Assess the potential business impact of these data quality problems. What decisions have to be made and steps taken to reach a solution?

6-9 Your industrial supply company wants to create a data warehouse where management can obtain a single corporatewide view of critical sales information to identify bestselling products, key customers, and sales trends. Your sales and product information are stored in two different systems: a divisional sales system running on a Unix server and a corporate sales system running on an IBM mainframe. You would like to create a single standard format that consolidates these data from both systems. In MyLab MIS, you can review the proposed format along with sample files from the two systems that would supply the data for the data warehouse. Then answer the following questions:

- What business problems are created by not having these data in a single standard format?
- How easy would it be to create a database with a single standard format that could store the data from both systems? Identify the problems that would have to be addressed.

- Should the problems be solved by database specialists or general business managers? Explain.
- Who should have the authority to finalize a single companywide format for this information in the data warehouse?

Achieving Operational Excellence: Building a Relational Database for Inventory Management

Software skills: Database design, querying, and reporting

Business skills: Inventory management

6-10 In this exercise, you will use database software to design a database for managing inventory for a small business. Sylvester's Bike Shop, located in San Francisco, California, sells road, mountain, hybrid, leisure, and children's bicycles. Currently, Sylvester's purchases bikes from three suppliers but plans to add new suppliers in the near future. Using the information found in the tables in MyLab MIS, build a simple relational database to manage information about Sylvester's suppliers and products. Once you have built the database, perform the following activities.

- Prepare a report that identifies the five most expensive bicycles. The report should list the bicycles in descending order from most expensive to least expensive, the quantity on hand for each, and the markup percentage for each.
- Prepare a report that lists each supplier, its products, the quantities on hand, and associated reorder levels. The report should be sorted alphabetically by supplier. For each supplier, the products should be sorted alphabetically.
- Prepare a report listing only the bicycles that are low in stock and need to be reordered. The report should provide supplier information for the items identified.
- Write a brief description of how the database could be enhanced to further improve management of the business. What tables or fields should be added? What additional reports would be useful?

Improving Decision Making: Searching Online Databases for Overseas Business Resources

Software skills: Online databases

Business skills: Researching services for overseas operations

6-11 This project develops skills in searching web-enabled databases with information about products and services in faraway locations.

Your company is located in Greensboro, North Carolina, and manufactures office furniture of various types. You are considering opening a facility to manufacture and sell your products in Australia. You would like to contact organizations that offer many services necessary for you to open your Australian office and manufacturing facility, including lawyers, accountants, import-export experts, and telecommunications equipment and support firms. Access the following online databases to locate companies that you would like to meet with during your upcoming trip: Australian Business Directory Online, AustraliaTrade Now, and the Nationwide Business Directory of Australia. If necessary, use search engines such as Yahoo and Google.

- List the companies you would contact on your trip to determine whether they can help you with these and any other functions you think are vital to establishing your office.
- Rate the databases you used for accuracy of name, completeness, ease of use, and general helpfulness.

Collaboration and Teamwork Project

Identifying Entities and Attributes in an Online Database

6-12 With your team of three or four other students, select an online database to explore, such as AOL Music, iGo.com, or the Internet Movie Database. Explore one of these websites to see what information it provides. Then list the entities and attributes that the company running the website must keep track of in its databases. Diagram the relationship between the entities you have identified. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Big Data in the Asia-Pacific Takes On the COVID-19 Pandemic

CASE STUDY

In December 2019, an epidemic of a novel coronavirus broke out in Wuhan, China, and quickly spread across the country to the rest of the world. As of October 28, 2020, there were more than 44 million confirmed cases of COVID-19 in 215 countries, with approximately 1.1 million deaths reported worldwide. Teams around the world raced to develop a vaccine. For instance, Pfizer, a global pharmaceutical company, partnered with BioNTech, a German biotechnology company, and at the conclusion of its Phase-3 trial in December 2020, it became the first to be authorized for emergency use in both the United Kingdom and the United States. The National Research Centre for Epidemiology and Microbiology in Russia has also developed a vaccine called Sputnik V, which it approved for release in August 2020.

During the months before an efficacious vaccine was developed and made available to the global community, various community containment measures and lockdowns were extensively implemented across countries to flatten the pandemic curve by slowing down the spread of the virus. Among the Asian countries, China went into a strict lockdown for one month but managed to return to some degree of normalcy. Similarly, Taiwan and South Korea managed to flatten the epidemic curve swiftly after monitoring the devastating outbreak in Wuhan. Their proactive responses to contain the outbreak included effective and vital interventions to promote social distancing, prompt isolation strategies, detection of active cases, active involvement of various policymakers to fund the cost associated with the pandemic, and the extensive use of big data for contact tracing to track individuals who may have come into contact with those who were tested positive.

Big data gives healthcare providers a competitive edge with the benefits of the “3Vs”: volume, variety, and velocity. Some of the unique considerations with respect to big data in healthcare include timeliness in the synchronization of health information updates, ownership of health data that legally belongs to individuals with medical needs, data privacy and security, heterogeneity of data (structured, semistructured, and unstructured), and incompleteness of the data due to the continuous stream of it

being fed into the systems. Nevertheless, harnessing such data provides new opportunities and life-saving outcomes. During the pandemic, big data was used to track, control, analyze, and eventually flatten the curve. Valuable information gleaned from big data helped in expediting the development of vaccines by providing more accurate and dynamic insights. This information, in conjunction with the Protein Data Bank—the sole global repository of three-dimensional structured data on large biomolecules such as proteins and nucleic acids—paved the way for medical researchers to understand the nature of the coronavirus and develop vaccination for it.

Big data also provided information to detect suspected COVID-19 infections, enabling an innovative epistemological approach to controlling the outbreak. The high volume of data helped in studying the pattern and rate of spread of the infection, and government bodies were able to optimize resource allocation and execute timely action.

In combating the COVID-19 crisis, Taiwan set a good example through its application of big data, artificial intelligence (AI), and frequent digital communication. The use of these technologies helped slow the spread of the COVID-19 virus through systematic tracking of the proliferation of the virus while providing citizens with real-time data on ways to minimize the risk of contracting it. AI was used extensively by the Taiwanese government to create real-time digital updates to caution its people about where infections had been detected.

The government conducted detailed mapping of the spread and systemic contact tracing across the country. The mapping was initiated during the outbreak’s infancy and was able to curb the transmission of the virus early on. In addition, a team of programmers developed map-based code using Google Maps to detect and track the travel history of an individual over a specific period, and analytics highlighted whether the individual had come in contact with “red areas,” or hotspots of coronavirus infection.

As most Taiwanese have signed up for the National Health Insurance (NHI), their health data is instantly available to the government. The NHI cards have many embedded security features to

prevent counterfeiting, and the data is protected through strict authorization features. A mutual recognition system allows medical personnel to retrieve health information of the NHI cardholders from the database using their own health professional cards. During the pandemic, Taiwan integrated its NHI database with its comprehensive immigration database and collection of travel histories. Foreigners were asked to scan a QR code and then fill out an online health declaration form, after which mobile technologies generated datasets for them. Through this integration, Taiwan generated high-volume datasets for analysis, which allowed researchers to create a management system that provided greater access to health and travel data for tracking purposes. This voluminous data was made accessible to healthcare providers to track 14-day travel histories and early symptoms of COVID-19 infection. This integration and analysis of big data allowed officials to distinguish between high-risk and low-risk individuals and decide between quarantining and issuing medical authorization.

Taiwan's success in flattening the curve may be attributed to its past experiences in combating the SARS epidemic in 2003. During this period, infrastructures such as active surveillance and screening systems using infrared thermal imaging scanning were implemented in most airports. These now proved beneficial in detecting COVID-19 symptoms and tracking the infected. However, Taiwan clearly owes much of its success to the emerging technologies that deploy big data analytics.

Big data is in the process of transforming Malaysia's digital ecosystem, and the pandemic has played a significant role in accelerating this digitization process. The government was already committed to adopting measures using big data analytics, which had gained wide popularity in the digitally networked nation. Data from various divisions of the healthcare sector were fed into big data analytics tools and enabled communal screenings, systemic contact tracing, and close monitoring of the impact of the virus. Among the measures implemented by the Malaysian government were the implementation of the Movement Control Order (MCO), the Enhanced Movement Control Order (EMCO), the Restricted Movement Control Order (RMCO), and the Controlled Movement Control Order (CMCO) based on the number of infected cases and the risk category obtained from the Ministry of Health database. This proved effective in controlling the spread

of the virus, particularly in Selangor state, which had recorded the highest number of COVID-19 cases in Malaysia.

As a way forward, the government also introduced the MySejahtera application to assist in monitoring the outbreak. This mobile application captured the users' personal information, such as their name, identity card number, contact number, email address, residential address, and age, and fed it into the Ministry of Health's database for epidemiological analysis. Identity card numbers were verified with the National Registration Department to weed out bad data. Data from MySejahtera was extracted for contact tracing when a positive case was reported. There was a strict data process flow; the data was accessible to just seven people across the Crisis Preparedness and Response Centre (CPRC), the disease control center of MOH, and the Ministry of Health and National Cyber Security Agency (NACSA), which is responsible for data security and governance.

MySejahtera was equipped with a customized dashboard to track locations using a check-in feature that enabled visitor management for private and government premises. Once a COVID-19 case was confirmed, the CPRC acted immediately to retrieve data—using check-in timestamps at particular venues—on close contacts and other individuals who might have been in proximity to the infected person. Tracking of close contacts was prioritized for venues that carried a high probability of contracting COVID-19, such as enclosed and crowded venues like shopping malls and restaurants. Low-risk transmission venues were more likely to be omitted from the analysis.

Big data has thus proven to be a key player in flattening the COVID-19 curve in many of the Asia-Pacific countries. It has reduced the number of cases and deaths through early detection, provided pandemic prediction with high accuracy, assisted in effective disease management, and even improved patient experience. The use of analytics tools was particularly robust in Malaysia, where the Sungai Buloh Hospital's Infectious Disease Department team was awarded the Global Health Award in recognition of its determined fight against the COVID-19 virus. In addition, the World Brands Foundation has acknowledged the health director-general's leadership and his team's hard work in their efficient management of the coronavirus outbreak in the country.

The COVID-19 pandemic has left an indelible impact on human life and culture, but these victories in the Asia-Pacific countries have shown that success depends on governments' and organizations' willingness to act quickly and their readiness to harness the potential benefits of current and new technology.

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CASE STUDY QUESTIONS

- 6-13** Describe the role of big data in flattening the COVID-19 pandemic curve in Taiwan and Malaysia.
- 6-14** What features should be included in a mobile application intended to combat COVID-19, such as MySejahtera?
- 6-15** What are the challenges of big data in healthcare?

Case contributed by Imran Medi and Chandra Reka Ramachandiran, Asia Pacific University of Technology and Innovation

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7

Telecommunications, the Internet, and Wireless Technology

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 7-1** What are the principal components of telecommunications networks and key networking technologies?
- 7-2** What are the different types of networks?
- 7-3** How do the Internet and Internet technology work, and how do they support communication and e-business?
- 7-4** What are the principal technologies and standards for wireless networking, communication, and Internet access?
- 7-5** How will MIS help my career?

CHAPTER CASES

Alibaba: Redefining Traditional Retailing
Monitoring Employees on Networks:
Unethical or Good Business?
Talking Cars Make for Better Road Safety
Google, Apple, and Facebook Battle for Your
Internet Experience

VIDEO CASES

Telepresence Moves out of the Boardroom
and into the Field
Virtual Collaboration with IBM Sametime

MyLab MIS

Discussion Questions: 7-5, 7-6, 7-7; Hands-On MIS Projects: 7-8, 7-9, 7-10, 7-11;
eText with Conceptual Animations

Alibaba: Redefining Traditional Retailing

In 2020 Alibaba opened its 200th Hema (or Freshhippo) Supermarket, which it believes represents the "New Retail," a seamless experience that combines digital and physical retail. Using apps, facial recognition payment, self-checkout, digitized inventories, and artificial intelligence, Alibaba's omnichannel supermarkets offer a look at the future of all retail worldwide. The supermarkets deviate from the conventional retailer in one major respect: they have succeeded in seamlessly merging the offline and online retail spaces.

Alibaba has re-imagined traditional brick-and-mortar retailing, with Internet and wireless technologies playing a facilitating role in this new kind of store. Alibaba Group's founder, Jack Ma, in a letter to shareholders, laid out the Group's strategic focus given that the retail industry is moving toward an omnichannel business model that focuses on the integration of online, offline, logistics, and data across a single value chain.

The Hema stores serve as the test bed for this strategy, not only in terms of how the customer interfaces with a retail store but also in the way in which the store learns and adapts to its customers. By requiring all customers to engage with the store through the Hema app, Alibaba has evolved the conventional store loyalty card further: it continuously acquires information from its customers, not only with regard to the purchases they make but also to other products of interest that they may have scanned. This information provides a wealth of data that the organization mines through big data analytics, determining preferences from what they scan or purchase and even from their path through the store.

Through a combination of web and wireless technologies, Alibaba curates its fresh goods, allowing customers to view such details as the item's production date, location, and nutritional details, in addition to complementary products and even recommended recipes, all by scanning a QR code. All interactions between the customer and the store take place through the supermarket's app.

Customers install the app and link it to either their AliPay or Taobao account, which serves as the payment medium for all transactions. Free Wi-Fi is provided in-store for customers to scan QR codes placed next to each product using their smartphone, and customers can not only make purchases but also submit ingredients to in-store chefs to prepare. To cap it all, they can request delivery of their goods within a 3-km radius of the store.

Three thousand items are available within the Hema stores, but a further 11,000 items are available to purchase through the app itself, further blurring



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the lines between offline and online retailing. The Hema app also leverages artificial intelligence to remember the purchasing behavior of customers and makes personalized shopping recommendations. Based on fully exploiting the capabilities afforded by Internet and wireless technologies, this next step in the evolution of retail is providing organizations with newer, deeper insights into their customers' preferences and behavior even as it enhances the customer's shopping experience.

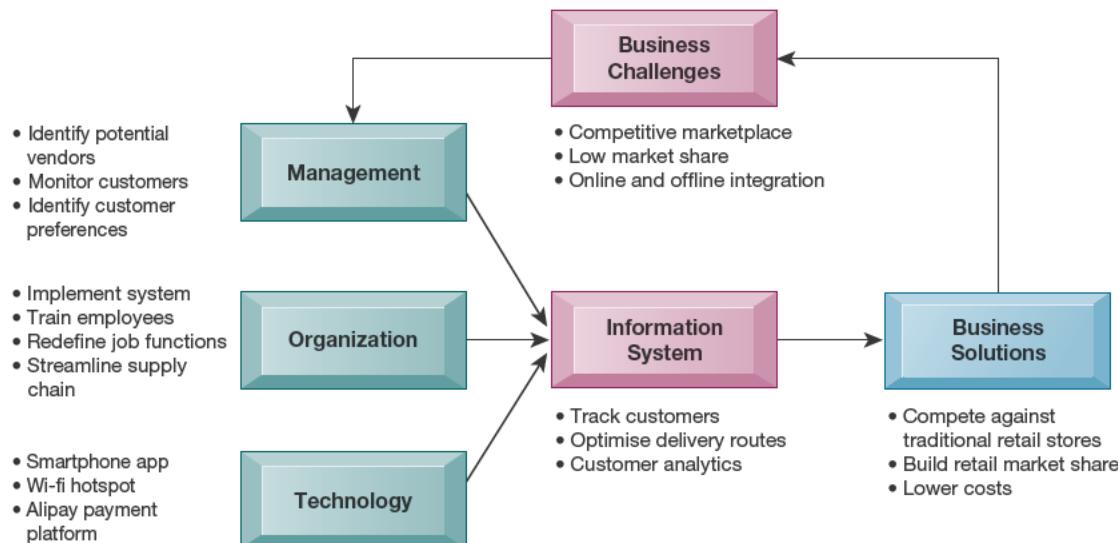
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Case contributed by Imran Medi, Asia Pacific University of Technology and Innovation

Alibaba's leveraging of the Internet to not only enter the traditional retail space but also to redefine it illustrates the capabilities and potential of wireless technologies. Alibaba increased profitability in a crowded market, in which even large and well-established retailers have limited market share and small levels of return per retail space. Hema's seamless integration of its physical and online stores proved to be very appealing to customers, while the central role of the Hema app in the interaction between the customer and the store is enabling the company to better manage its supply chain.

The chapter-opening diagram highlights the important issues raised by this chapter. Alibaba as well as other e-commerce-based organizations (such as Amazon) are venturing into the brick-and-mortar retail space, leveraging their expertise in web-based technologies to reshape traditional retail. However, the Chinese retail market is an especially competitive one.

As the primary payment alternative to cash transactions, Alibaba capitalized on its users' familiarity with the Alipay platform to build its entire retail shopping experience around a smartphone app. Wi-fi technology allows customers



to view information relating to a product that is far in excess of what is feasible through the traditional shelf-based store arrangement. Meanwhile, the app is enabling Alibaba to tailor its products to the exact preferences of its customers.

Here are some questions to think about: How does wireless technology allow the organization to better understand its customers? How will the use of web technology drive change across brick-and-mortar retailing?

7-1 What are the principal components of telecommunications networks and key networking technologies?

If you run or work in a business, you can't do it without networks. You need to communicate rapidly with your customers, suppliers, and employees. Until about 1990, businesses used the postal system or telephone system with voice or fax for communication. Today, however, you and your employees use computers, email, text messaging, the Internet, mobile phones, and mobile computers connected to wireless networks for this purpose. Networking and the Internet are now nearly synonymous with doing business.

Networking and Communication Trends

Firms in the past used two fundamentally different types of networks: telephone networks and computer networks. Telephone networks historically handled voice communication, and computer networks handled data traffic. Telephone companies built telephone networks throughout the twentieth century by using voice transmission technologies (hardware and software), and these companies almost always operated as regulated monopolies throughout the world. Computer companies originally built computer networks to transmit data between computers in different locations.

Thanks to continuing telecommunications deregulation and information technology innovation, telephone and computer networks are converging into a single digital network using shared Internet-based standards and technology. Telecommunications providers today, such as BT, offer data transmission, Internet access, mobile phone service, and television programming as well as voice service. Cable companies, such as Liberty Global, Telefónica and Deutsche Telekom, among others, offer voice service and Internet access. Computer networks have expanded to include Internet telephone and video services.

Both voice and data communication networks have also become more powerful (faster), more portable (smaller and mobile), and less expensive. For instance, the typical Internet connection speed in 2000 was 56 kilobits per second, but today the majority of U.S. households have high-speed **broadband** connections provided by telephone and cable TV companies running from 5 to over 900 megabits per second. The cost for this service has fallen exponentially, from 50 cents per kilobit in 2000 to a tiny fraction of a cent today.

Increasingly, voice and data communication, as well as Internet access, are taking place over broadband wireless platforms such as mobile phones, mobile handheld devices, and PCs in wireless networks. According to eMarketer, there almost 3.5 billion worldwide mobile Internet users, over 45% of the world's population (eMarketer, Inc., 2020).

What Is a Computer Network?

If you had to connect the computers for two or more employees in the same office, you would need a computer network. In its simplest form, a network consists of two or more connected computers. Figure 7.1 illustrates the major hardware, software, and transmission components in a simple network: a client computer and a dedicated server computer, network interfaces, a connection medium, network operating system software, and either a hub or a switch.

Each computer on the network contains a network interface device to link the computer to the network. The connection medium for linking network components can be a telephone wire, coaxial cable, or radio signal in the case of cell phone and wireless local area networks (Wi-Fi networks).

The **network operating system (NOS)** routes and manages communications on the network and coordinates network resources. It can reside on every computer in the network or primarily on a dedicated server computer for all the applications on the network. A server is a computer on a network that performs important network functions for client computers, such as displaying web pages, storing data, and storing the network operating system (hence controlling the network). Microsoft Windows Server and Linux are the most widely used network operating systems.

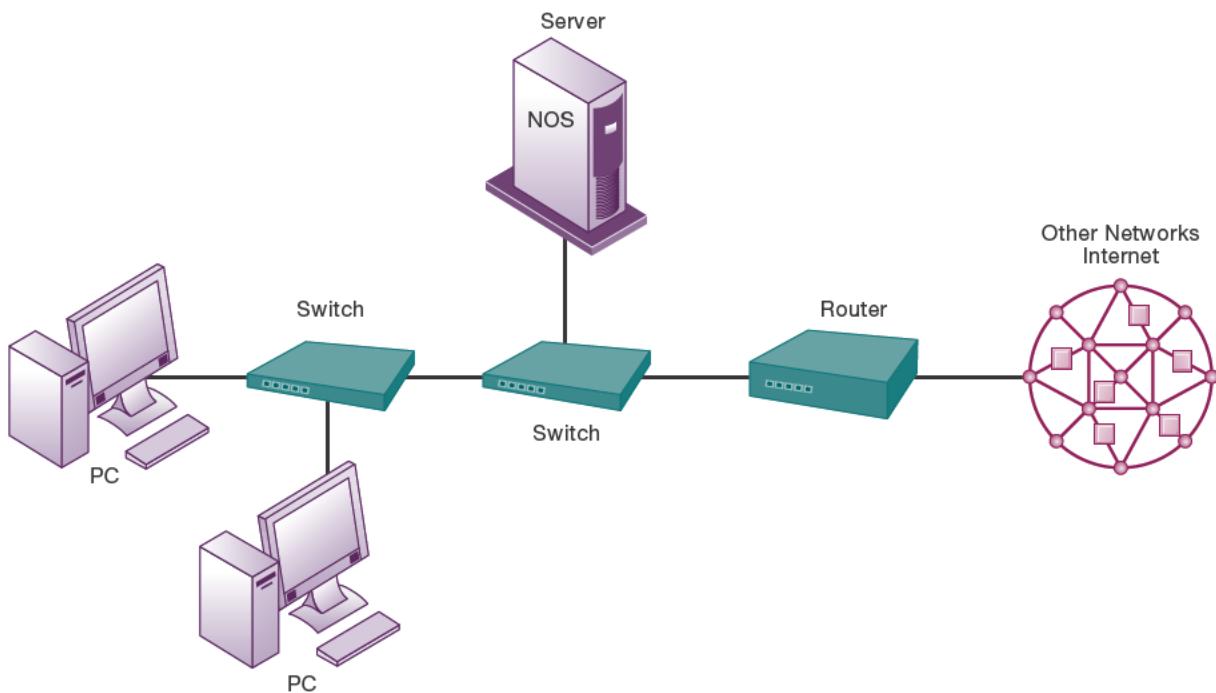
Most networks also contain a switch or a hub acting as a connection point between the computers. **Hubs** are simple devices that connect network components, sending a packet of data to all other connected devices. A **switch** has more intelligence than a hub and can filter and forward data to a specified destination on the network.

What if you want to communicate with another network, such as the Internet? You would need a router. A **router** is a communications processor that routes packets of data through different networks, ensuring that the data sent get to the correct address.

FIGURE 7.1

COMPONENTS OF A SIMPLE COMPUTER NETWORK

Illustrated here is a simple computer network consisting of computers, a network operating system (NOS) residing on a dedicated server computer, cable (wiring) connecting the devices, switches, and a router.



Network switches and routers have proprietary software built into their hardware for directing the movement of data on the network. This can create network bottlenecks and makes the process of configuring a network more complicated and time-consuming. **Software-defined networking (SDN)** is a networking approach in which many of these control functions are managed by one central program, which can run on inexpensive commodity servers that are separate from the network devices themselves. This is especially helpful in a cloud computing environment with many pieces of hardware because it allows a network administrator to manage traffic loads in a flexible and more efficient manner.

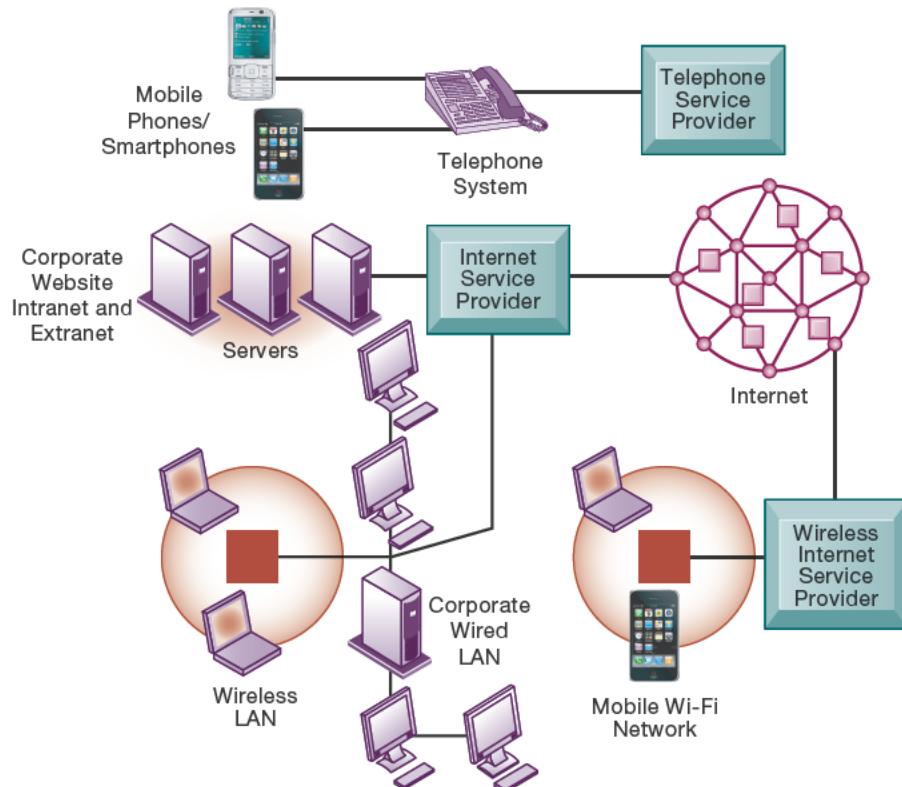
Networks in Large Companies

The network we've just described might be suitable for a small business, but what about large companies with many locations and thousands of employees? As a firm grows, its small networks can be tied together into a corporate-wide networking infrastructure. The network infrastructure for a large corporation consists of a large number of these small local area networks linked to other local area networks and to firmwide corporate networks. A number of powerful servers support a corporate website, a corporate intranet, and perhaps an extranet. Some of these servers link to other large computers supporting back-end systems.

Figure 7.2 provides an illustration of these more complex, larger-scale corporate-wide networks. Here the corporate network infrastructure supports a mobile sales force using mobile phones and smartphones, mobile employees

FIGURE 7.2 CORPORATE NETWORK INFRASTRUCTURE

Today's corporate network infrastructure is a collection of many networks from the public switched telephone network to the Internet to corporate local area networks linking workgroups, departments, or office floors.



linking to the company website, and internal company networks using mobile wireless local area networks (Wi-Fi networks). In addition to these computer networks, the firm's infrastructure may include a separate telephone network that handles most voice data. Many firms are dispensing with their traditional telephone networks and using Internet telephones that run on their existing data networks (described later).

As you can see from this figure, a large corporate network infrastructure uses a wide variety of technologies—everything from ordinary telephone service and corporate data networks to Internet service, wireless Internet, and mobile phones. One of the major problems facing corporations today is how to integrate all the different communication networks and channels into a coherent system that enables information to flow from one part of the corporation to another and from one system to another.

Key Digital Networking Technologies

Contemporary digital networks and the Internet are based on three key technologies: client/server computing, the use of packet switching, and the development of widely used communications standards (the most important of which is Transmission Control Protocol/Internet Protocol, or TCP/IP) for linking disparate networks and computers.

Client/Server Computing

Client/server computing, introduced in Chapter 5, is a distributed computing model in which some of the processing power is located within small, inexpensive client computers and resides literally on desktops or laptops or in handheld devices. These powerful clients are linked to one another through a network that is controlled by a network server computer. The server sets the rules of communication for the network and provides every client with an address so others can find it on the network.

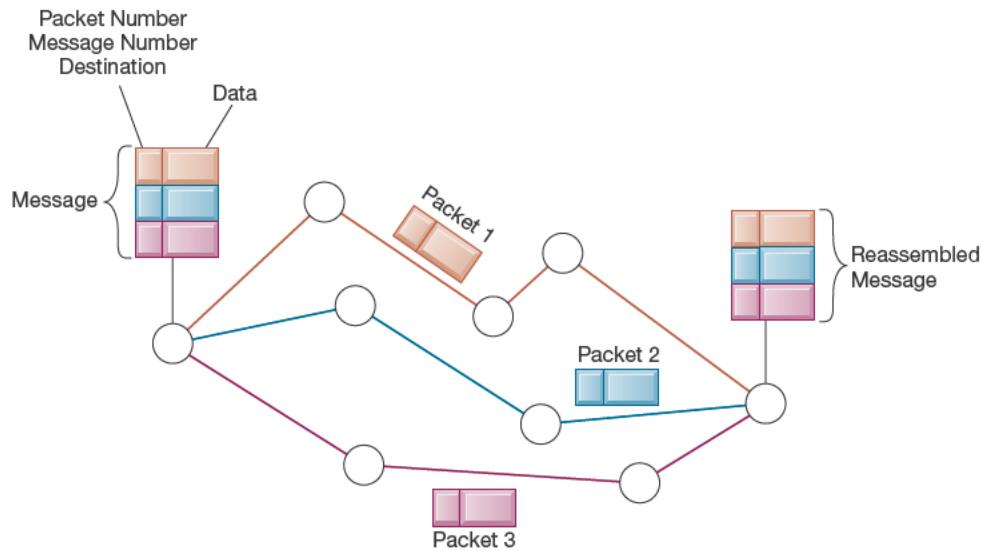
Client/server computing has largely replaced centralized mainframe computing in which nearly all the processing takes place on a central large mainframe computer. Client/server computing has extended computing to departments, workgroups, factory floors, and other parts of the business that could not be served by a centralized architecture. It also makes it possible for personal computing devices such as PCs, laptops, and mobile phones to be connected to networks such as the Internet. The Internet is the largest implementation of client/server computing.

Packet Switching

Packet switching is a method of slicing digital messages into parcels called packets, sending the packets along different communication paths as they become available, and then reassembling the packets once they arrive at their destinations (see Figure 7.3). Prior to the development of packet switching, computer networks used leased, dedicated telephone circuits to communicate with other computers in remote locations. In circuit-switched networks, such as the telephone system, a complete point-to-point circuit is assembled, and then communication can proceed. These dedicated circuit-switching techniques were expensive and wasted available communications capacity—the circuit was maintained regardless of whether any data were being sent.

FIGURE 7.3 PACKET-SWITCHED NETWORKS AND PACKET COMMUNICATIONS

Data are grouped into small packets, which are transmitted independently over various communications channels and reassembled at their final destination.



Packet switching is more efficient. Messages are first broken down into small fixed bundles of data called packets. The packets include information for directing the packet to the right address and for checking transmission errors along with the data. The packets are transmitted over various communications channels by using routers, each packet traveling independently. Packets of data originating at one source will be routed through many paths and networks before being reassembled into the original message when they reach their destinations.

TCP/IP and Connectivity

In a typical telecommunications network, diverse hardware and software components need to work together to transmit information. Different components in a network communicate with each other by adhering to a common set of rules called protocols. A **protocol** is a set of rules and procedures governing transmission of information between two points in a network.

In the past, diverse proprietary and incompatible protocols often forced business firms to purchase computing and communications equipment from a single vendor. However, today, corporate networks are increasingly using a single, common, worldwide standard called **Transmission Control Protocol/Internet Protocol (TCP/IP)**. TCP/IP was developed during the early 1970s to support U.S. Department of Defense Advanced Research Projects Agency (DARPA) efforts to help scientists transmit data among different types of computers over long distances.

TCP/IP uses a suite of protocols, the main ones being TCP and IP. TCP refers to the Transmission Control Protocol, which handles the movement of data between computers. TCP establishes a connection between the computers, sequences the transfer of packets, and acknowledges the packets sent. IP refers to the Internet Protocol (IP), which is responsible for the delivery of packets and includes the disassembling and reassembling of packets during transmission.

FIGURE 7.4 THE TRANSMISSION CONTROL PROTOCOL/INTERNET PROTOCOL (TCP/IP) REFERENCE MODEL

This figure illustrates the four layers of the TCP/IP reference model for communications.

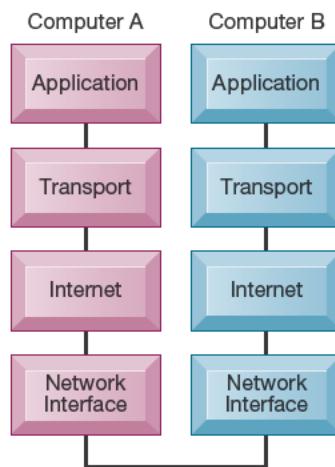


Figure 7.4 illustrates the four-layered Department of Defense reference model for TCP/IP, and the layers are described as follows:

1. Application layer. The Application layer enables client application programs to access the other layers and defines the protocols that applications use to exchange data. One of these application protocols is the Hypertext Transfer Protocol (HTTP), which is used to transfer web page files.
2. Transport layer. The Transport layer is responsible for providing the Application layer with communication and packet services. This layer includes TCP and other protocols.
3. Internet layer. The Internet layer is responsible for addressing, routing, and packaging data packets called IP datagrams. The Internet Protocol is one of the protocols used in this layer.
4. Network Interface layer. At the bottom of the reference model, the Network Interface layer is responsible for placing packets on and receiving them from the network medium, which could be any networking technology.

Two computers using TCP/IP can communicate even if they are based on different hardware and software platforms. Data sent from one computer to the other passes downward through all four layers, starting with the sending computer's Application layer and passing through the Network Interface layer. After the data reach the recipient host computer, they travel up the layers and are reassembled into a format the receiving computer can use. If the receiving computer finds a damaged packet, it asks the sending computer to retransmit it. This process is reversed when the receiving computer responds.

7-2 What are the different types of networks?

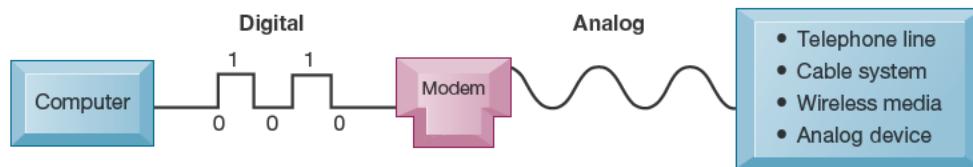
Let's look more closely at alternative networking technologies available to businesses.

Signals: Digital Versus Analog

There are two ways to communicate a message in a network: an analog signal or a digital signal. An *analog signal* is represented by a continuous waveform that passes through a communications medium and has been used for audio communication. The most common analog devices are the telephone handset,

FIGURE 7.5 FUNCTIONS OF THE MODEM

A modem is a device that translates digital signals into analog form (and vice versa) so that computers can transmit data over analog networks such as telephone and cable networks.



the speaker on your computer, or your iPhone earphone, all of which create analog waveforms that your ear can hear.

A *digital signal* is a discrete, binary waveform rather than a continuous waveform. Digital signals communicate information as strings of two discrete states: 1 bits and 0 bits, which are represented as on-off electrical pulses. Computers use digital signals and require a modem to convert these digital signals into analog signals that can be sent over (or received from) telephone lines, cable lines, or wireless media that use analog signals (see Figure 7.5). **Modem** stands for modulator-demodulator. Cable modems connect your computer to the Internet by using a cable network. DSL modems connect your computer to the Internet using a telephone company's landline network. Wireless modems perform the same function as traditional modems, connecting your computer to a wireless network that could be a cell phone network or a Wi-Fi network.

Types of Networks

There are many kinds of networks and ways of classifying them. One way of looking at networks is in terms of their geographic scope (see Table 7.1).

Local Area Networks

If you work in a business that uses networking, you are probably connecting to other employees and groups via a local area network. A **local area network (LAN)** is designed to connect personal computers and other digital devices within a half-mile or 500-meter radius. LANs typically connect a few computers in a small office, all the computers in one building, or all the computers in several buildings in close proximity. LANs also are used to link to long-distance wide area networks (WANs, described later in this section) and other networks around the world, using the Internet.

Review Figure 7.1, which could serve as a model for a small LAN that might be used in an office. One computer is a dedicated network server, providing users with access to shared computing resources in the network, including software programs and data files.

TABLE 7.1 TYPES OF NETWORKS

TYPE	AREA
Local area network (LAN)	Up to 500 meters (half a mile); an office or floor of a building
Campus area network (CAN)	Up to 1,000 meters (a mile); a college campus or corporate facility
Metropolitan area network (MAN)	A city or metropolitan area
Wide area network (WAN)	A regional, transcontinental, or global area

The server determines who gets access to what and in which sequence. The router connects the LAN to other networks, which could be the Internet, or another corporate network, so that the LAN can exchange information with networks external to it. The most common LAN operating systems are Windows and Linux.

Ethernet is the dominant LAN standard at the physical network level, specifying the physical medium to carry signals between computers, access control rules, and a standardized set of bits that carry data over the system. Originally, Ethernet supported a data transfer rate of 10 megabits per second (Mbps). Newer versions, such as Gigabit Ethernet, support a data transfer rate of 1 gigabit per second (Gbps).

The LAN illustrated in Figure 7.1 uses a client/server architecture in which the network operating system resides primarily on a single server, and the server provides much of the control and resources for the network. Alternatively, LANs may use a **peer-to-peer** architecture. A peer-to-peer network treats all processors equally and is used primarily in small networks with ten or fewer users. The various computers on the network can exchange data by direct access and can share peripheral devices without going through a separate server.

Larger LANs have many clients and multiple servers, with separate servers for specific services such as storing and managing files and databases (file servers or database servers), managing printers (print servers), storing and managing email (mail servers), or storing and managing web pages (web servers).

Metropolitan and Wide Area Networks

Wide area networks (WANs) span broad geographical distances—regions, states, continents, or the entire globe. The most universal and powerful WAN is the Internet. Computers connect to a WAN through public networks, such as the telephone system or private cable systems, or through leased lines or satellites. A **metropolitan area network (MAN)** is a network that spans a metropolitan area, usually a city and its major suburbs. Its geographic scope falls between a WAN and a LAN.

Transmission Media and Transmission Speed

Networks use different kinds of physical transmission media, including twisted pair wire, coaxial cable, fiber-optic cable, and media for wireless transmission. Each has advantages and limitations. A wide range of speeds is possible for any given medium, depending on the software and hardware configuration. Table 7.2 compares these media.

TABLE 7.2 PHYSICAL TRANSMISSION MEDIA

TRANSMISSION MEDIUM	DESCRIPTION	SPEED
Twisted pair wire	Strands of copper wire twisted in pairs for voice and data communications. Includes CAT5 and CAT6 cabling, with CAT6 capable of gigabit speeds.	CAT5: 10 Mbps-100 Mbps CAT6: Up to 10 Gbps
Coaxial cable	Thickly insulated copper wire, which is capable of high-speed data transmission and less subject to interference than twisted wire. Currently used for cable TV and for networks with longer runs (more than 100 meters).	Up to 1 Gbps
Fiber-optic cable	Strands of clear glass fiber, transmitting data as pulses of light generated by lasers. Useful for high-speed transmission of large quantities of data. More expensive than other physical transmission media; used for last-mile delivery to customers and the Internet backbone.	15 Mbps to 6+ Tbps
Wireless transmission media	Based on radio signals of various frequencies and includes both terrestrial and satellite microwave systems and cellular networks. Used for long-distance, wireless communication, and Internet access.	Up to 600+ Mbps

Bandwidth: Transmission Speed

The total amount of digital information that can be transmitted through any telecommunications medium is measured in bits per second (bps). One signal change, or cycle, is required to transmit one or several bits; therefore, the transmission capacity of each type of telecommunications medium is a function of its frequency. The number of cycles per second that can be sent through that medium is measured in **hertz**—one hertz is equal to one cycle of the medium.

The range of frequencies that can be accommodated on a particular telecommunications channel is called its **bandwidth**. The bandwidth is the difference between the highest and lowest frequencies that can be accommodated on a single channel. The greater the range of frequencies, the greater the bandwidth and the greater the channel's transmission capacity.

7-3 How do the Internet and Internet technology work, and how do they support communication and e-business?

The Internet has become an indispensable personal and business tool—but what exactly is the Internet? How does it work, and what does Internet technology have to offer for business? Let's look at the most important Internet features.

What Is the Internet?

The Internet is the world's most extensive public communication system. It's also the world's largest implementation of client/server computing and internetworking, linking millions of individual networks all over the world. This global network of networks began in the early 1970s as a U.S. Department of Defense project to link scientists and university professors around the world.

Most homes and small businesses connect to the Internet by subscribing to an Internet service provider. An **Internet service provider (ISP)** is a commercial organization with a permanent connection to the Internet that sells temporary connections to retail subscribers. Individuals also connect to the Internet through their business firms, universities, or research centers that have designated Internet domains.

There is a variety of services for ISP Internet connections. Connecting via a traditional telephone line and modem, at a speed of 56.6 kilobits per second (Kbps), used to be the most common form of connection worldwide, but high-speed broadband connections have largely replaced it. Digital subscriber line, cable, satellite Internet connections, and T lines provide these broadband services.

Digital subscriber line (DSL) technologies operate over existing telephone lines to carry voice, data, and video at transmission rates ranging from 385 Kbps to over 100 Mbps, depending on usage patterns and distance. Fios (Verizon's fiber optic cable service) can deliver over 900 Mbps, although most home service delivers 100 Mbps. **Cable Internet connections** provided by cable television vendors use digital cable coaxial lines to deliver high-speed Internet access to homes and businesses. They can provide high-speed access to the Internet between 20 and 100 Mbps, with high-speed cable Internet download speed approaching 1 Gbps. Where DSL and cable services are unavailable, it is possible

to access the Internet via satellite, although some satellite Internet connections have slower upload speeds than other broadband services.

T1 and T3 are international telephone standards for digital communication. They are leased, dedicated lines suitable for businesses or government agencies requiring high-speed guaranteed service levels. **T1 lines** offer guaranteed delivery at 1.54 Mbps, and T3 lines offer delivery at 45 Mbps. The Internet does not provide similar guaranteed service levels but, simply, best effort.

Internet Addressing and Architecture

The Internet is based on the TCP/IP networking protocol suite described earlier in this chapter. Every device connected to the Internet (or another TCP/IP network) is assigned a unique **Internet Protocol (IP) address** consisting of a string of numbers.

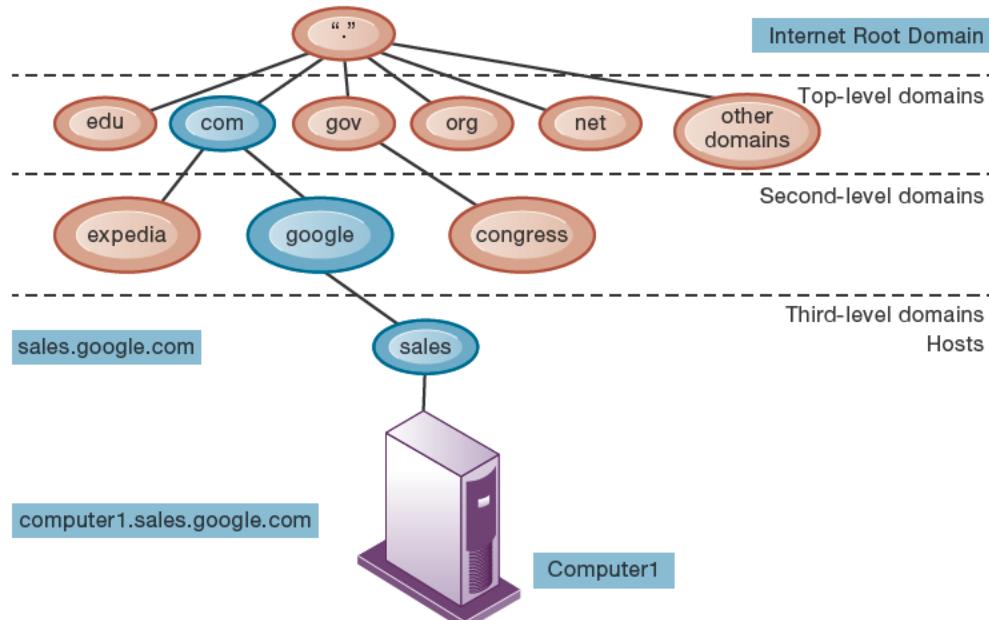
When a user sends a message to another user on the Internet or another TCP/IP network, the message is first decomposed into packets. Each packet contains its destination address. The packets are then sent from the client to the network server and from there on to as many other servers as necessary to arrive at a specific computer with a known address. At the destination address, the packets are reassembled into the original message.

The Domain Name System

Because it would be incredibly difficult for Internet users to remember long strings of numbers, an IP address can be represented by a natural language convention called a **domain name**. The **Domain Name System (DNS)** converts domain names to IP addresses. DNS servers maintain a database containing IP addresses mapped to their corresponding domain names. To access a computer on the Internet, users need only specify its domain name, such as Expedia.com,

FIGURE 7.6 THE DOMAIN NAME SYSTEM

The Domain Name System is a hierarchical system with a root domain, top-level domains, second-level domains, and host computers at the third level.



DNS has a hierarchical structure (see Figure 7.6). At the top of the DNS hierarchy is the root domain. The child domain of the root is called a top-level domain, and the child domain of a top-level domain is called a second-level domain. Top-level domains are two- and three-character names you are familiar with from surfing the web; for example, .com, .edu, .gov, and the various country codes such as .ca for Canada or .it for Italy. Second-level domains have two parts, designating a top-level name and a second-level name—such as buy.com, nyu.edu, or amazon.ca. A host name at the bottom of the hierarchy designates a specific computer on either the Internet or a private network.

The following list shows the most common domain extensions currently available and officially approved. Countries also have domain names such as .uk, .au, and .fr (United Kingdom, Australia, and France, respectively), and there is a new class of internationalized top-level domains that use non-English characters. In the future, this list will expand to include many more types of organizations and industries as follows:

- .com Commercial organizations/businesses
- .edu Educational institutions
- .gov U.S. government agencies
- .mil U.S. military
- .net Network computers
- .org Any type of organization
- .biz Business firms
- .info Information providers

Internet Architecture and Governance

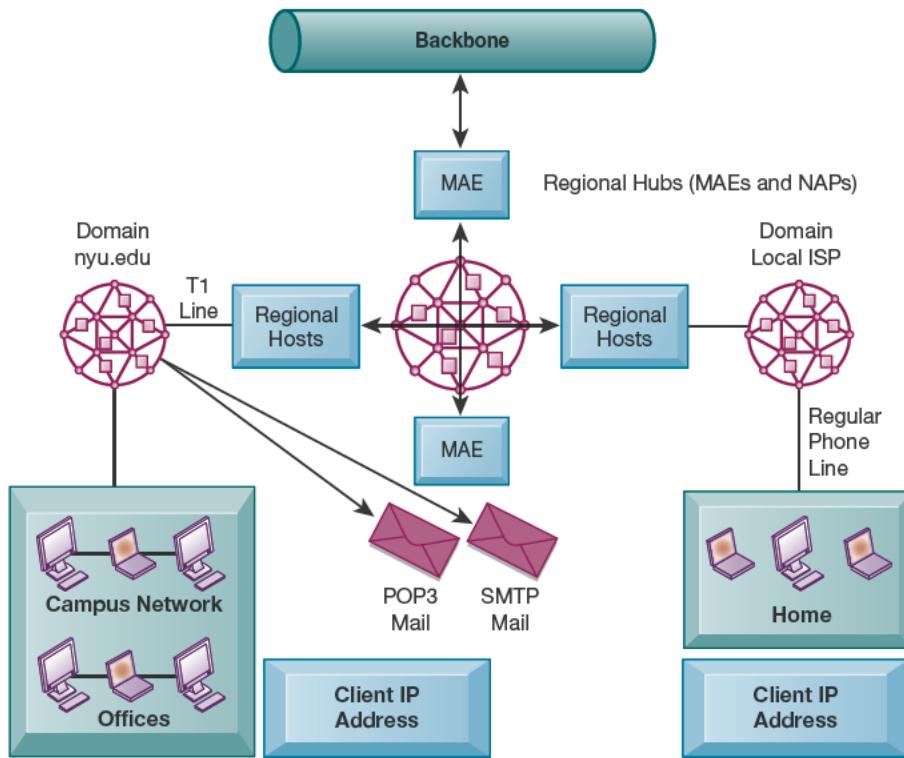
Internet data traffic is carried over transcontinental high-speed backbone networks that generally operate in the gigabit range (see Figure 7.7). These trunk lines are typically owned by long-distance telephone companies (called *network service providers*) or by national governments. Local connection lines are owned by regional telephone and cable television companies in the United States and in other countries that connect retail users in homes and businesses to the Internet. The regional networks lease access to ISPs, private companies, and government institutions.

Each organization pays for its own networks and its own local Internet connection services, a part of which is paid to the long-distance trunk line owners. Individual Internet users pay ISPs for using their service, and they generally pay a flat subscription fee, no matter how much or how little they use the Internet. No one owns the Internet, and it has no formal management. However, worldwide Internet policies are established by a number of professional organizations and government bodies, including the Internet Architecture Board (IAB), which helps define the overall structure of the Internet; the Internet Corporation for Assigned Names and Numbers (ICANN), which manages the domain name system; and the World Wide Web Consortium (W3C), which sets Hypertext Markup Language and other programming standards for the web.

These organizations influence government agencies, network owners, ISPs, and software developers with the goal of keeping the Internet operating as efficiently as possible. The Internet must also conform to the laws of the sovereign nation-states in which it operates as well as to the technical infrastructures that exist within the nation-states. Although in the early years of the Internet and the web there was very little legislative or executive interference, this situation

FIGURE 7.7 INTERNET NETWORK ARCHITECTURE

The Internet backbone connects to regional networks, which in turn provide access to Internet service providers, large firms, and government institutions. Network access points (NAPs) and metropolitan area exchanges (MAEs) are hubs where the backbone intersects regional and local networks and where backbone owners connect with one another.



is changing as the Internet plays a growing role in the distribution of information and knowledge, including content that some find objectionable.

The Future Internet: IPv6 and Internet2

The Internet was not originally designed to handle billions of users and the transmission of massive quantities of data. Because of sheer Internet population growth, the world is about to run out of available IP addresses using the old addressing convention. The old system based on 32-bit addresses is being replaced by a new version of IP addressing called **IPv6** (Internet Protocol version 6), which contains 128-bit addresses (2 to the power of 128), or more than a quadrillion possible unique addresses. IPv6 is compatible with most modems and routers sold today, and IPv6 will fall back to the old addressing system if IPv6 is not available on local networks. The transition to IPv6 will take several years as systems replace older equipment.

Internet2 is an advanced networking consortium serving 317 U.S. universities, 60 government agencies, 43 regional and state education networks, 59 leading corporations, and 70 national research and education network partners from more than 100 countries. To connect these communities, Internet2 developed a high-capacity, 100 Gbps network that serves as a test bed for leading-edge technologies that may eventually migrate to the public Internet, including large-scale network performance measurement and management tools, secure identity and access management tools, and capabilities such as scheduling high-bandwidth, high-performance circuits.

Internet Services and Communication Tools

The Internet is based on client/server technology. Individuals using the Internet control what they do through client applications on their computers, such as web browser software. The data, including email messages and web pages, are stored on servers. A client uses the Internet to request information from a particular web server on a distant computer, and the server sends the requested information back to the client over the Internet. Client platforms today include not only PCs and other computers but also smartphones and tablets.

Internet Services

A client computer connecting to the Internet has access to a variety of services. These services include email, chatting and instant messaging, electronic discussion groups, **Telnet**, **File Transfer Protocol (FTP)**, and the web. Table 7.3 provides a brief description of these services.

Each Internet service is implemented by one or more software programs. All the services may run on a single server computer, or different services may be allocated to different machines. Figure 7.8 illustrates one way these services can be arranged in a multitiered client/server architecture.

Email enables messages to be exchanged from computer to computer, with capabilities for routing messages to multiple recipients, forwarding messages, and attaching text documents or multimedia files to messages. Most email today is sent through the Internet. The cost of email is far lower than equivalent voice, postal, or overnight delivery costs, and email messages can arrive anywhere in the world in a matter of seconds.

Chatting enables two or more people who are simultaneously connected to the Internet to hold live, interactive conversations. **Chat** systems now support voice and video chat as well as written conversations. Many online retail businesses offer chat services on their websites to attract visitors, to encourage repeat purchases, and to improve customer service.

Instant messaging is a type of chat service that enables participants to create their own private chat channels. The instant messaging system alerts the user whenever someone on his or her private list is online so that the user can initiate a chat session with other individuals. Instant messaging systems for consumers include Yahoo! Messenger, Google Hangouts, AOL Instant Messenger, and Facebook Messenger. Companies concerned with security use proprietary communications and messaging systems such as IBM Sametime.

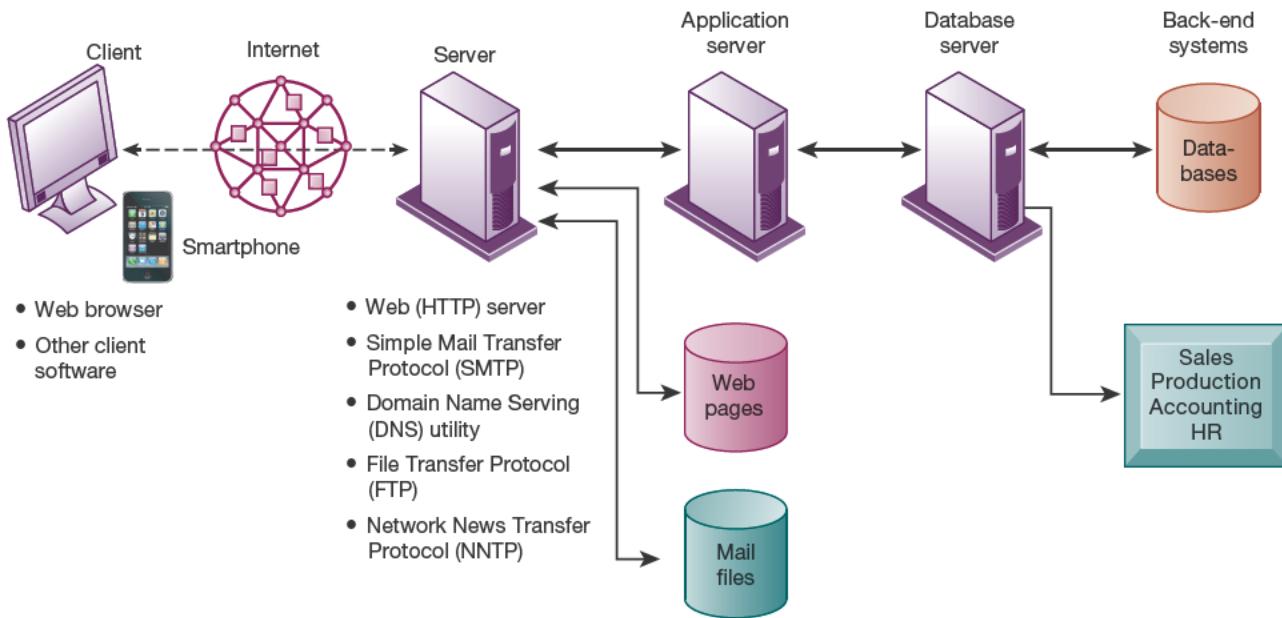
Newsgroups are worldwide discussion groups posted on Internet electronic bulletin boards on which people share information and ideas on a defined topic such as radiology or rock bands. Anyone can post messages on these bulletin boards for others to read.

TABLE 7.3 MAJOR INTERNET SERVICES

CAPABILITY	FUNCTIONS SUPPORTED
Email	Person-to-person messaging; document sharing
Chatting and instant messaging	Interactive conversations
Newsgroups	Discussion groups on electronic bulletin boards
Telnet	Logging on to one computer system and doing work on another
File Transfer Protocol (FTP)	Transferring files from computer to computer
World Wide Web	Retrieving, formatting, and displaying information (including text, audio, graphics, and video) by using hypertext links

FIGURE 7.8 CLIENT/SERVER COMPUTING ON THE INTERNET

Client computers running web browsers and other software can access an array of services on servers over the Internet. These services may all run on a single server or on multiple specialized servers.



Employee use of email, instant messaging, and the Internet is supposed to increase worker productivity, but the accompanying Interactive Session on Management shows that this may not always be the case. Many company managers now believe they need to monitor and even regulate their employees' online activity, but is this ethical? Although there are some strong business reasons companies may need to monitor their employees' email and web activities, what does this mean for employee privacy?

Voice over IP

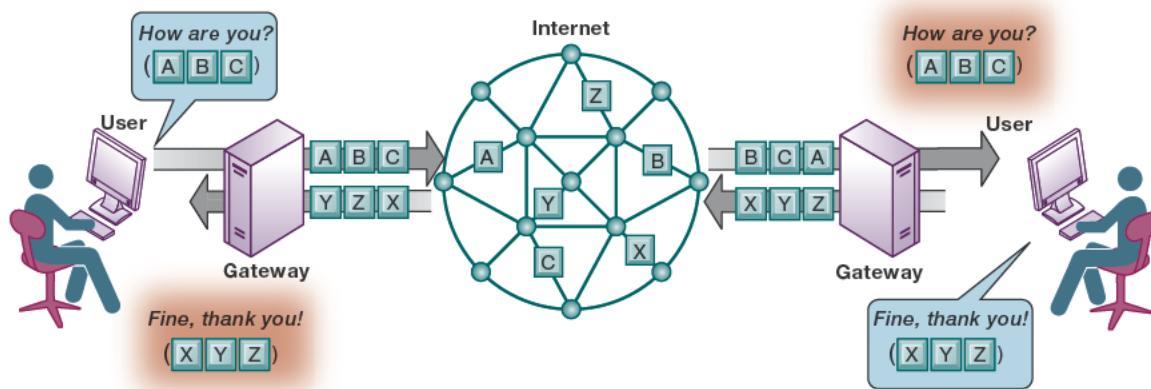
The Internet has also become a popular platform for voice transmission and corporate networking. **Voice over IP (VoIP)** technology delivers voice information in digital form using packet switching, avoiding the tolls charged by local and long-distance telephone networks (see Figure 7.9). Calls that would ordinarily be transmitted over public telephone networks travel over the corporate network based on the Internet protocol, or over the public Internet. Voice calls can be made and received with a computer equipped with a microphone and speakers or with a VoIP-enabled telephone.

Firms such as Vonage provide VoIP service bundled with high-speed Internet and cable offerings. Skype offers free VoIP worldwide using a peer-to-peer network, and Google has its own free VoIP service.

Although up-front investments are required for an IP phone system, VoIP can reduce communication and network management costs by 20 to 30 percent. For example, VoIP saves Virgin Entertainment Group \$700,000 per year in long-distance bills. In addition to lowering long-distance costs and eliminating monthly fees for private lines, an IP network provides a single voice-data infrastructure for both telecommunications and computing services. Companies no longer have to maintain separate networks or provide support services and personnel for each type of network.

FIGURE 7.9 HOW VOICE OVER IP WORKS

A VoIP phone call digitizes and breaks up a voice message into data packets that may travel along different routes before being reassembled at the final destination. A processor nearest the call's destination, called a gateway, arranges the packets in the proper order and directs them to the telephone number of the receiver or the IP address of the receiving computer.



Unified Communications

In the past, each of the firm's networks for wired and wireless data, voice communications, and videoconferencing operated independently of each other and had to be managed separately by the information systems department. Now, however, firms can merge disparate communications modes into a single universally accessible service using unified communications technology. **Unified communications** integrates disparate channels for voice communications, data communications, instant messaging, email, and electronic conferencing into a single experience by which users can seamlessly switch back and forth between different communication modes. Presence technology shows whether a person is available to receive a call.

Turning Point, a not-for-profit health and social care provider serving hospitals, prisons, and primary care settings across England and Wales, has achieved agility and cost savings by using Cisco Unified Communications Manager (CallManager). CallManager provides an integrated enterprise-wide infrastructure for voice and video calling, instant messaging, and mobility. The organization is able to centralize call control and session management. For instance, employees can start a chat session and then escalate this interaction to a phone call.

Virtual Private Networks

What if you had a marketing group charged with developing new products and services for your firm with members spread across the United States? You would want them to be able to email each other and communicate with the home office without any chance that outsiders could intercept the communications. Large private networking firms offer secure, private, dedicated networks to customers, but this is expensive. A lower-cost solution is to create a virtual private network within the public Internet.

A **virtual private network (VPN)** is a secure, encrypted, private network that has been configured within a public network to take advantage of

INTERACTIVE SESSION MANAGEMENT

Monitoring Employees on Networks: Unethical or Good Business?

The Internet has become an extremely valuable business tool, but it's also a huge distraction for workers on the job. Employees are wasting valuable company time by surfing inappropriate websites (Facebook, shopping, sports, etc.), sending and receiving personal email, texting to friends, and downloading videos and music. According to a survey by International Data Corp (IDC), 30 to 40 percent of Internet access is spent on non-work-related browsing, and a staggering 60 percent of all online purchases are made during working hours. UK-based employment site MyJobGroup.co.uk surveyed 1,000 British workers and found that almost 6 percent of them spent over an hour a day using social media of some kind, including *Facebook*. This is roughly one-eighth of their workday. By extension, about 2 million of Britain's 34-million-person workforce likely were doing the same, costing the British economy about 14 billion pounds in lost productivity.

Many companies have begun monitoring employee use of email and the Internet, sometimes without their knowledge. Many tools are now available for this purpose from vendors such as Veriato OsMonitor, Work Examiner, Mobistealth, and Spytech. These products enable companies to record online searches, monitor file downloads and uploads, record keystrokes, keep tabs on emails, create transcripts of chats, or take certain screenshots of images displayed on computer screens. Instant messaging, text messaging, and social media monitoring are also increasing.

Microsoft Corporation collects and analyzes data on the frequency of chats, emails, and meetings between its staff and clients using its own Office 365 services to measure employee productivity, management effectiveness, and work-life balance. Tracking email, chats, and calendar appointments can show how employees spend an average of 20 hours of their work time each week. The company only allows managers to look at groups of five or more workers.

Microsoft sales team members have received personalized dashboards that show how they spend their time, but this information is shielded from managers. The dashboards offers recommendations on how to build out networks of contacts and spend more time with customers rather than in internal meetings.

Microsoft also sells workplace analytics software to other companies, such as Macy's Inc., which analyzed data on staff work-life balance by measuring how many hours employees spent sending emails and logged in online outside of business hours. Mortgage giant Freddie Mac used Microsoft's tools to gauge how much time workers spent in meetings and try to determine whether some of those gatherings were redundant.

Although U.S. companies have the legal right to monitor employee Internet and email activity while they are at work, is such monitoring unethical, or is it simply good business? Managers worry about the loss of time and employee productivity when employees are focusing on personal rather than company business. Too much time on personal business translates into lost revenue. Some employees may even be billing time they spend pursuing personal interests online to clients, thus overcharging them.

If personal traffic on company networks is too high, it can also clog the company's network so that legitimate business work cannot be performed. GMI Insurance Services, which serves the U.S. transportation industry, found that employees were downloading a great deal of music and streaming video and storing the files on company servers. GMI's server backup space was being eaten up.

When employees use email or the web (including social networks) at employer facilities or with employer equipment, anything they do, including anything illegal, carries the company's name. Therefore, the employer can be traced and held liable. Management in many firms fear that racist, sexually explicit, or other potentially offensive material accessed or traded by their employees could result in adverse publicity and even lawsuits for the firm. Even if the company is found not to be liable, responding to lawsuits could run up huge legal bills. Companies also fear leakage of confidential information and trade secrets through email or social networks. U.S. companies have the legal right to monitor what employees are doing with company equipment during business hours. The question is whether electronic surveillance is an appropriate tool for maintaining an efficient and positive workplace. Some companies try to ban all personal activities on corporate networks—zero tolerance.

Others block employee access to specific websites or social sites, closely monitor email messages, or limit personal time on the web.

Should all employees be monitored while working? Not necessarily. Not every workforce, workplace, or work culture and environment is a candidate for electronic surveillance. The decision depends on the company and the work environment an employer wants to create. A major concern of some employers is the potential damage to a work culture that fosters trust, employee commitment, and motivation. Electronic surveillance of employees could prove highly counterproductive in such an environment.

No solution is problem-free, but many consultants believe companies should write corporate policies on employee email, social media, and Internet use. Many workers are unaware that employers have the right to monitor and collect data about them. The policies

should include explicit ground rules that state, by position or level, under what circumstances employees can use company facilities for email, blogging, or web surfing. The policies should also inform employees whether these activities are monitored and explain why.

The rules should be tailored to specific business needs and organizational cultures. For example, investment firms will need to allow many of their employees access to other investment sites. A company dependent on widespread information sharing, innovation, and independence could very well find that monitoring creates more problems than it solves.

Sources: "How Do Employers Monitor Internet Usage at Work?" wisegeek.com, accessed March 1, 2020; Sarah Krouse, "The New Ways Your Boss Is Spying on You," *Wall Street Journal*, July 19, 2019; www.privacyrights.org, accessed February 15, 2020; and Susan M. Heathfield, "Surfing the Web at Work," thebalancecareers.com, November 25, 2019.

CASE STUDY QUESTIONS

1. Should managers monitor employee email and Internet usage? Why or why not?
2. Describe an effective email and web use policy for a company.
3. Should managers inform employees that their web behavior is being monitored? Or should managers monitor secretly? Why or why not?

the economies of scale and management facilities of large networks, such as the Internet (see Figure 7.10). A VPN provides your firm with secure, encrypted communications at a much lower cost than the same capabilities offered by traditional non-Internet providers that use their private networks to secure communications. VPNs also provide a network infrastructure for combining voice and data networks.

Several competing protocols are used to protect data transmitted over the public Internet, including Point-to-Point Tunneling Protocol (PPTP). In a process called *tunneling*, packets of data are encrypted and wrapped inside IP packets. By adding this wrapper around a network message to hide its content, business firms create a private connection that travels through the public Internet.

The Web

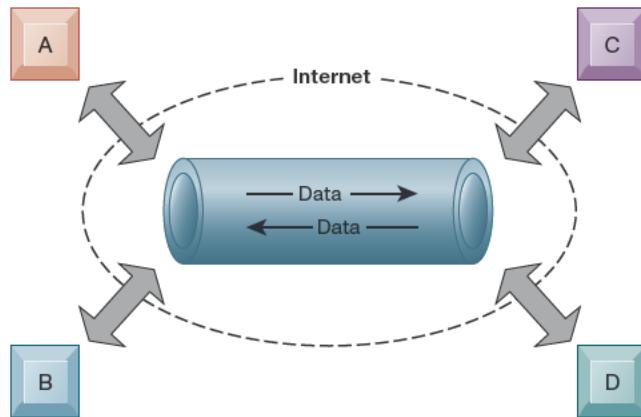
The web is the most popular Internet service. It's a system with universally accepted standards for storing, retrieving, formatting, and displaying information by using a client/server architecture. Web pages are formatted using hypertext, embedded links that connect documents to one another and that also link pages to other objects, such as sound, video, or animation files. When you click a graphic and a video clip plays, you have clicked a hyperlink. A typical **website** is a collection of web pages linked to a home page.

Hypertext

Web pages are based on a standard Hypertext Markup Language (HTML), which formats documents and incorporates dynamic links to other documents and other objects stored in the same or remote computers (see Chapter 5). Web pages are

FIGURE 7.10 A VIRTUAL PRIVATE NETWORK USING THE INTERNET

This VPN is a private network of computers linked using a secure tunnel connection over the Internet. It protects data transmitted over the public Internet by encoding the data and wrapping them within the Internet protocol. By adding a wrapper around a network message to hide its content, organizations can create a private connection that travels through the public Internet.



accessible through the Internet because web browser software operating your computer can request web pages stored on an Internet host server by using the **Hypertext Transfer Protocol (HTTP)**. HTTP is the communications standard that transfers pages on the web. For example, when you type a web address in your browser, such as <http://www.sec.gov>, your browser sends an HTTP request to the sec.gov server requesting the home page of sec.gov.

HTTP is the first set of letters at the start of every web address, followed by the domain name, which specifies the organization's server computer that is storing the web page. Most companies have a domain name that is the same as or closely related to their official corporate name. The directory path and web page name are two more pieces of information within the web address that help the browser track down the requested page. Together, the address is called a **uniform resource locator (URL)**. When typed into a browser, a URL tells the browser software exactly where to look for the information. For example, in the URL <http://www.megacorp.com/content/features/082610.html>, *http* names the protocol that displays web pages, *www.megacorp.com* is the domain name, *content/features* is the directory path that identifies where on the domain web server the page is stored, and *082610.html* is the web page name and the name of the format it is in. (It is an HTML page.)

Web Servers

A web server is software for locating and managing stored web pages. It locates the web pages a user requests on the computer where they are stored and delivers the web pages to the user's computer. Server applications usually run on dedicated computers, although they can all reside on a single computer in small organizations.

The leading web servers in use today are Microsoft Internet Information Services (IIS) and Apache HTTP Server. Apache is an open source product that is free of charge and can be downloaded from the web.

Searching for Information on the Web

No one knows for sure how many web pages there really are. The surface web is the part of the web that search engines visit and about which information is recorded.

For instance, Google indexed an estimated 5 billion pages in 2019, and this reflects a large portion of the publicly accessible web page population. But there is a deep web that contains an estimated 1 trillion additional pages, many of them proprietary (such as the pages of *Financial Times*, which cannot be visited without a subscription or access code), or that are stored in protected corporate databases. Facebook, with web pages of text, photos, and media for more than 2 billion members, is a closed web, and its pages are not completely searchable by Google or other search engines. A small portion of the deep web called the **dark web** has been intentionally hidden from search engines, uses masked IP addresses, and is accessible only with a special web browser in order to preserve anonymity. The dark web has become a haven for criminals because it allows the buying and selling of illicit goods, including credit card and Social Security numbers, with complete anonymity.

Search Engines Obviously, with so many web pages, finding specific ones that can help you or your business, nearly instantly, is an important problem. The question is, how can you find the one or two pages you really want and need out of billions of indexed web pages? **Search engines** attempt to solve the problem of finding useful information on the web nearly instantly and, arguably, they are the killer app of the Internet era. Today's search engines can sift through HTML files; files of Microsoft Office applications; PDF files; and audio, video, and image files. There are hundreds of search engines in the world, but the vast majority of search results come from Google, Baidu, Yahoo, and Microsoft's Bing (see Figure 7.11). While we typically think of Amazon as an online store, it is also a powerful product search engine.

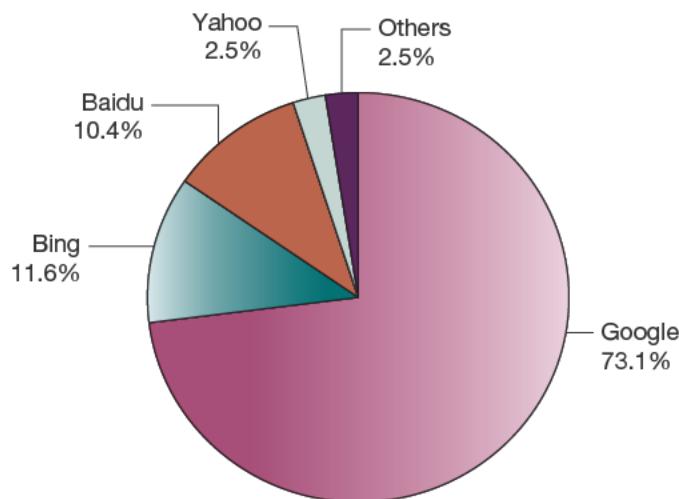
Web search engines started out in the early 1990s as relatively simple software programs that roamed the nascent web, visiting pages and gathering information about the content of each page. The first search engines were simple keyword indexes of all the pages they visited, leaving users with lists of pages that may not have been truly relevant to their search.

In 1994, Stanford University computer science students David Filo and Jerry Yang created a hand-selected list of their favorite web pages and called it "Yet Another Hierarchical Officious Oracle," or Yahoo. Yahoo was not initially a search engine but rather an edited selection of websites organized by categories the editors found useful. Currently, Yahoo relies on Microsoft's Bing for search results.

FIGURE 7.11 TOP DESKTOP/LAPTOP WEB SEARCH ENGINES WORLDWIDE

Google is the world's most popular search engine.

Source: Based on data from Net Market Share, February 2020.



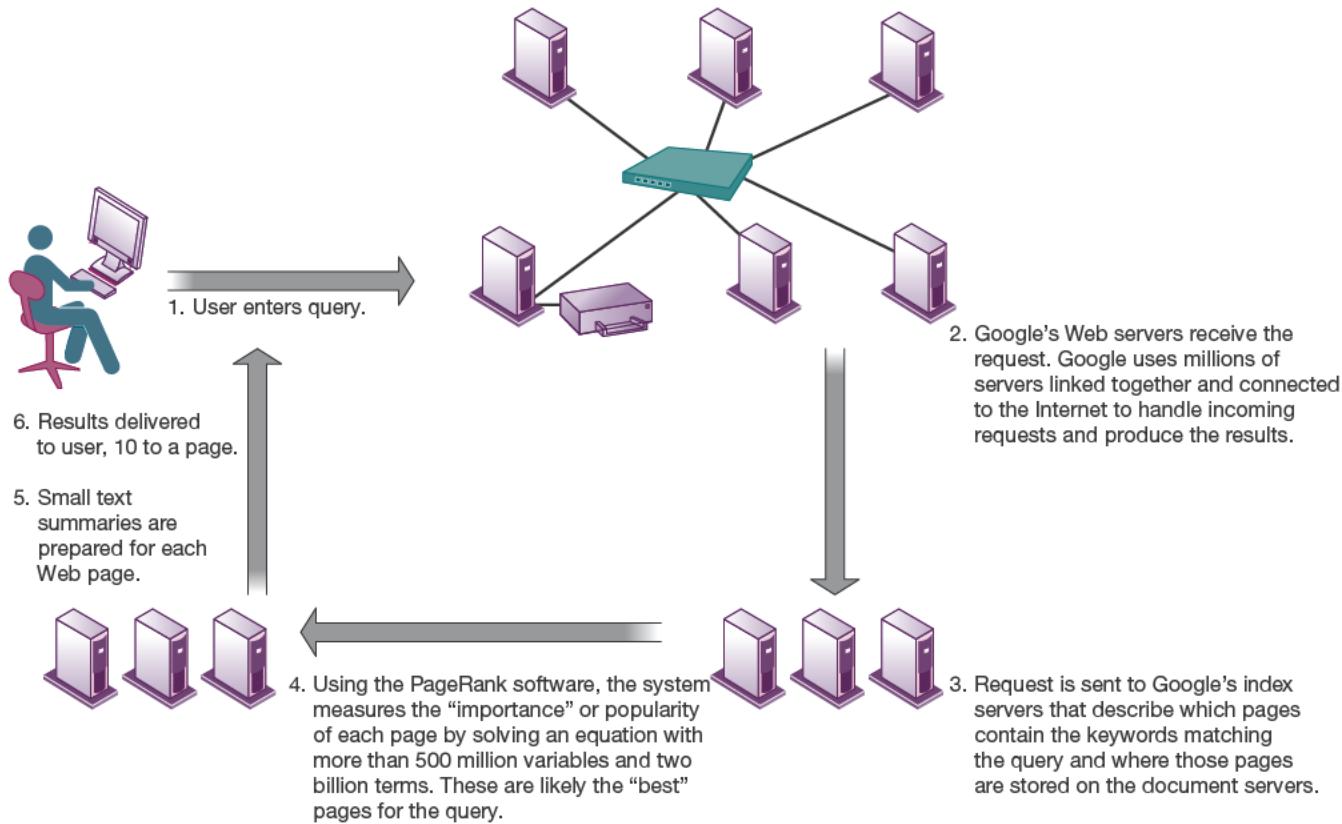
In 1998, Larry Page and Sergey Brin, two other Stanford computer science students, released their first version of Google. This search engine was different. Not only did it index each web page's words but it also ranked search results based on the relevance of each page. Page patented the idea of a page ranking system (called *PageRank System*), which essentially measures the popularity of a web page by calculating the number of sites that link to that page as well as the number of pages to which it links. The premise is that popular web pages are more relevant to users. Brin contributed a unique web crawler program that indexed not only keywords on a page but also combinations of words (such as authors and the titles of their articles). These two ideas became the foundation for the Google search engine. Figure 7.12 illustrates how Google works.

Mobile Search Mobile search from smartphones and tablets makes up more than 50 percent of all searches and will expand rapidly in the next few years. Google, Amazon, and Yahoo have developed new search interfaces to make searching and shopping from smartphones more convenient. Google revised its search algorithm to favor sites that look good on smartphone screens. Although smartphones are widely used to shop, actual purchases typically take place on laptops or desktops, followed by tablets.

Semantic Search Another way for search engines to become more discriminating and helpful is to make search engines capable of understanding what we are really looking for. Called **semantic search**, the goal is to build a search engine that can really understand human language and behavior. Google and other search engine firms are attempting to refine search engine algorithms to capture

FIGURE 7.12 HOW GOOGLE WORKS

The Google search engine is continuously crawling the web, indexing the content of each page, calculating its popularity, and storing the pages so that it can respond quickly to user requests to see a page. The entire process takes about half a second.



more of what the user intended and the meaning of a search. Rather than evaluate each word separately in a search, Google's Hummingbird search algorithm tries to evaluate an entire sentence, focusing on the meaning behind the words. For instance, if your search is a long sentence like "Google annual report selected financial data 2020," Hummingbird should be able to figure out that you really want Google's parent company Alphabet's annual Form 10-K report filed with the U.S. Securities and Exchange Commission in February 2020.

Google searches also take advantage of Knowledge Graph, an effort of the search algorithm to anticipate what you might want to know more about as you search on a topic. Results of the knowledge graph appear on the right of the screen on many search result pages and contain more information about the topic or person you are searching on. For example, if you search "Lake Lucerne," the search engine will return basic facts about Lucerne (altitude, average temperature, and local fish), a map, and hotel accommodations. Google has made **predictive search** part of most search results. This part of the search algorithm guesses what you are looking for and suggests search terms as you type your search words. Google has continued to refine its search algorithms using mathematical modeling and artificial intelligence machine learning (see Chapter 11) to make its responses to queries even more accurate and intelligent (Copeland, 2019)..

Visual Search and the Visual Web Although search engines were originally designed to search text documents, the explosion of photos and videos on the Internet created a demand for searching and classifying these visual objects. Facial recognition software can create a digital version of a human face. You can also search for people on Facebook by using their digital image to find and identify them. Facebook is now using artificial intelligence technology to make its facial recognition capabilities more accurate.

Searching photos, images, and video has become increasingly important as the web becomes more visual. The **visual web** refers to websites such as Pinterest, where pictures replace text documents, where users search pictures, and where pictures of products replace display ads for products. Pinterest is a social networking site that provides users (as well as brands) with an online board to which they can pin interesting pictures. Pinterest had 335 million active users worldwide in 2020. Instagram is another example of the visual web. Instagram is a photo and video sharing site that allows users to take pictures, enhance them, and share them with friends on other social sites such as Facebook and Twitter. In 2020, Instagram had 1 billion active users.

Intelligent Agent Shopping Bots Chapter 11 describes the capabilities of software agents with built-in intelligence that can gather or filter information and perform other tasks to assist users. **Shopping bots** use intelligent agent software for searching the Internet for shopping information. Shopping bots such as MySimon or PriceGrabber, and travel search tools like Trivago, can help people interested in making a purchase or renting a vacation room filter and retrieve information according to criteria the users have established, and in some cases negotiate with vendors for price and delivery terms.

Search Engine Marketing Search engines have become major advertising platforms and shopping tools by offering what is now called **search engine marketing**. Searching for information is one of the web's most popular activities. Over 90 percent of web traffic comes through search engines, and search engine marketing accounts for over 40 percent of digital ad spending worldwide (eMarketer 2020d). With this huge audience, search engines are

the foundation for the most lucrative form of online marketing and advertising: search engine marketing. When users enter a search term on Google, Bing, Yahoo, or any of the other sites serviced by these search engines, they receive two types of listings: sponsored links, for which advertisers have paid to be listed (usually at the top of the search results page), and unsponsored, organic search results. In addition, advertisers can purchase small text boxes on the side of search results pages. The paid, sponsored advertisements are the fastest growing form of Internet advertising and are powerful new marketing tools that precisely match consumer interests with advertising messages at the right moment. Search engine marketing monetizes the value of the search process.

Because search engine marketing is so effective (it has the highest click-through rate and the highest return on ad investment), companies seek to optimize their websites for search engine recognition. The better optimized the page is, the higher a ranking it will achieve in search engine result listings. **Search engine optimization (SEO)** is the process of improving the quality and volume of web traffic to a website by employing a series of techniques that help a website achieve a higher ranking with the major search engines when certain keywords and phrases are put into the search field. One technique is to make sure that the keywords used in the website description match the keywords likely to be used as search terms by prospective customers. For example, your website is more likely to be among the first ranked by search engines if it uses the keyword *lighting* rather than *lamps* if most prospective customers are searching for *lighting*. It is also advantageous to link your website to as many other websites as possible because search engines evaluate such links to determine the popularity of a web page and how it is linked to other content on the web.

Search engines can be gamed by scammers who create thousands of phony website pages and link them to a single retailer's site in an attempt to fool Google's search engine. Firms can also pay so-called link farms to link to their site. Google changed its search algorithm to deal with this problem by examining the quality of links more carefully with the intent of down-ranking sites that have a suspicious pattern of sites linking to them.

In general, search engines have been very helpful to small businesses that cannot afford large marketing campaigns. Because shoppers are looking for a specific product or service when they use search engines, they are what marketers call hot prospects—people who are looking for information and often intending to buy. Moreover, search engines charge only for click-throughs to a site. Merchants do not have to pay for ads that don't work, only for ads that receive a click. Consumers benefit from search engine marketing because ads for merchants appear only when consumers are looking for a specific product. Thus, search engine marketing saves consumers cognitive energy and reduces search costs (including the cost of transportation needed to search for products physically). One study estimated the global value of search to both merchants and consumers to be more than \$800 billion, with about 65 percent of the benefit going to consumers in the form of lower search costs and lower prices (McKinsey & Company, 2011).

Sharing Information on the Web

Today's websites don't just contain static content—they enable people to collaborate, share information, and create new services and content online. Today's web can support interactivity, real-time user control, social participation (sharing), and user-generated content. The technologies and services behind these

features include cloud computing, software mashups and apps, blogs, RSS, wikis, and social networks. We have already described cloud computing, mashups, and apps in Chapter 5 and introduced social networks in Chapter 2.

A **blog**, the popular term for a weblog, is a personal website that typically contains a series of chronological entries (newest to oldest) by its author and links to related web pages. The blog may include a *blogroll* (a collection of links to other blogs) and *trackbacks* (a list of entries in other blogs that refer to a post on the first blog). Most blogs allow readers to post comments on the blog entries as well. The act of creating a blog is often referred to as blogging. Blogs can be hosted by a third-party service such as Blogger.com or TypePad.com, and blogging features have been incorporated into social networks such as Facebook and collaboration platforms such as IBM Notes. WordPress is a leading open source blogging tool and content management system. **Microblogging**, used in Twitter or other platforms with serious space or size constraints, is a type of blogging that features very small elements of content such as short sentences, individual images, or video links.

Blog pages are usually based on templates provided by the blogging service or software. Therefore, millions of people without HTML skills of any kind can post their own web pages and share content with others. Although blogs have become popular personal publishing tools, they also have business uses (see Chapters 2 and 10).

If you're an avid blog reader, you might use RSS to keep up with your favorite blogs without constantly checking them for updates. **RSS**, which stands for Really Simple Syndication or Rich Site Summary, pulls specified content from websites and feeds it automatically to users' computers. RSS reader software gathers material from the websites or blogs that you tell it to scan and brings new information from those sites to you. RSS readers are available through websites such as Google and Yahoo, and they have been incorporated into the major web browsers and email programs.

Blogs allow visitors to add comments to the original content, but they do not allow visitors to change the original posted material. **Wikis**, in contrast, are collaborative websites on which visitors can add, delete, or modify content, including the work of previous authors. *Wiki* comes from the Hawaiian word for "quick."

Wiki software typically provides a template that defines layout and elements common to all pages, displays user-editable software program code, and then renders the content into an HTML-based page for display in a web browser. Some wiki software allows only basic text formatting, whereas other tools allow the use of tables, images, or even interactive elements, such as polls or games. Most wikis provide capabilities for monitoring the work of other users and correcting mistakes.

Because wikis make information sharing so easy, they have many business uses. The U.S. Department of Homeland Security's National Cyber Security Center (NCSC) deployed a wiki to facilitate information sharing with other federal agencies on threats, attacks, and responses and as a repository for technical and standards information. Pixar Wiki is a collaborative community wiki for publicizing the work of Pixar Animation Studios. The wiki format allows anyone to create or edit an article about a Pixar film.

Social networking sites enable users to build communities of friends and professional colleagues. Members typically create a profile—a web page for posting photos, videos, audio files, and text—and then share these profiles with others on the service identified as their friends or contacts. Social networking sites are highly interactive, offer real-time user control, rely on user-generated content, and are broadly based on social participation and sharing of content

and opinions. Leading social networking sites include Facebook, Twitter, and LinkedIn (for professional contacts).

Social networking has radically changed how people spend their time online; how people communicate and with whom; how business people stay in touch with customers, suppliers, and employees; how providers of goods and services learn about their customers; and how advertisers reach potential customers. The large social networking sites are also application development platforms where members can create and sell software applications to other members of the community. Facebook alone has millions of apps and websites integrated with it, including applications for gaming, video sharing, and communicating with friends and family. We talk more about business applications of social networking in Chapters 2 and 10, and you can find social networking discussions in many other chapters of this book.

The Future Web

The future Internet is becoming visible. Its key features are more tools for individuals to make sense out of the trillions of pages on the Internet, or the millions of apps available for smartphones and a visual, even three-dimensional (3D) web where you can walk through pages in a 3D environment. (Review the discussion of semantic search and visual search earlier in this chapter.)

Even closer in time is a pervasive web that controls everything from a city's traffic lights and water usage, to the lights in your living room, to your car's rear view mirror, not to mention managing your calendar and appointments. This is referred to as the **Internet of Things (IoT)** and is based on billions of Internet-connected sensors throughout our physical world. Objects, animals, or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

General Electric, IBM, HP, Oracle, and hundreds of smaller startups, are building smart machines, factories, and cities through extensive use of remote sensors and fast cloud computing. By 2025 more than 75 billion IoT devices will be connected to the web (Maayan, 2020). Over time, more and more everyday physical objects will be connected to the Internet and will be able to identify themselves to other devices, creating networks that can sense and respond as data changes. The re-imagination of retailing by Alibaba in its Hema stores described in the chapter-opening case is an IoT application, as is the vehicle-to-everything technology discussed in the Interactive Session on Technology.

The App Internet is another element in the future web. The growth of apps within the mobile platform is astounding. More than 80 percent of mobile minutes in the United States are generated through apps, as opposed to browsers. Apps give users direct access to content and are much faster than loading a browser and searching for content.

Other complementary trends leading toward a future web include more widespread use of cloud computing and software as a service (SaaS) business models, ubiquitous connectivity among mobile platforms and Internet access devices, and the transformation of the web from a network of separate siloed applications and content into a more seamless and interoperable whole.

INTERACTIVE SESSION TECHNOLOGY

Talking Cars Make for Better Road Safety

Toward the end of 2015, Toyota, Japan's biggest manufacturer of small-sized vehicles, began to offer the Intelligent Transportation System (ITS) Connect safety package. ITS Connect overcomes the constraints of other similar systems that rely on line-of-sight limited sensors, such as poor function in extreme weather and blind spots, by enabling cars to talk to one another. The system allows a vehicle's onboard computer to perform vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) wireless communication continuously with other vehicles and with roadside infrastructure (lamp poles and traffic light poles).

ITS Connect allows effective communication within a radius of up to 300 meters at a frequency of 760 MHz, which was previously used in analog television broadcasting. Each V2V message contains basic data about the vehicle's position, speed, acceleration, type and size, and the timestamp, as well as free fields reserved for service expansion to be defined by individual applications such as the nearest intersection ahead. A vehicle with ITS Connect keeps broadcasting such messages and "listening to" these messages from other vehicles or infrastructure for analysis, and it responds accordingly long before a danger is visually perceived.

The ITS Connect system is designed to avoid collisions with other vehicles, pedestrians, and cyclists, by either changing the speed automatically (in case a vehicle ahead brakes abruptly) or by giving instant audio or visual safety information to the driver of any approaching vehicle from either side when passing through an intersection. By providing drivers with timely information and feedback, such as a reminder to give way to an approaching emergency vehicle or a countdown to a traffic signal change, the system can improve driving efficiency. The package also enables cooperative adaptive cruise control (CACC), which uses information obtained from V2V messages to automatically adjust the speed of an automobile to match that of the vehicle ahead.

Toyota and its allies began to promote Wi-Fi-based DSRC using the 5.9 GHz frequency band in the United States and European markets in 2017. Another standard of vehicular communication, cellular-vehicle-to-everything (C-V2X), appeared in 2018 and is trying to win different regional markets before DSRC becomes the mainstream. C-V2X consists of

not only V2V and V2I but also vehicle-to-pedestrians (V2P) direct communications and vehicle-to-network (V2N) operations. V2P allows communications between vehicles and the mobile phones of non-vehicle road users, such as pedestrians and cyclists. V2N refers to exchange of traffic information, like the incidence of traffic jams, between vehicles and cloud-based data centers.

Since the two standards are adopted by different countries and regions and neither is mainstream, automotive parts manufacturing companies such as Continental AG and Autotalk have decided to let their products "speak" both "languages" by being compatible with both standards, thus giving flexibility to vehicle manufacturers and end users.

Regardless of standard, vehicular communications are expected to improve road safety by reducing 80 percent of traffic accidents, particularly collisions. In addition, V2X can increase efficiency in coordination of traffic flow through platooning and green waves. Platooning refers to a system in which multiple trucks drive together as a convoy, each at a consistent distance from the other, with the lead truck using a CACC application. This allows drivers on long-distance trips to take turns resting, and if the convoy is aerodynamic-optimal, fuel consumption is reduced as well. A green wave refers to a situation in which a series of traffic lights at several intersections turn green in perfect timing to allow continuous traffic flow in the same direction. The data collected in vehicular communication can be used to analyze patterns in traffic flow and in urban planning. Proper use of platooning and green waves could optimize mobility, improve congestion, save fuel, and reduce pollution.

These advances in vehicular communications are also paving the way toward the realization of the driverless automobile. In fact, Release 16 of 5G C-V2X, using a new radio-based sidelink, allows multicast communication to support advanced functions such as autonomous driving. The development of automatic driving is expected to provide further opportunities not only for the car-makers, telecommunication service providers, and chipset manufacturers but also for other sectors, such as shipment, logistics, insurance, and mobile healthcare.

However, regardless of standard, worries abound regarding data security and privacy issues. Vehicular

communications involve the transmittal of sensitive data, such as vehicle ID, and this data can be leaked. Malicious interception and alteration of transmitted messages could allow specific vehicles to be tracked, or false reports of misconduct to be generated.

Sources: Autotalks, [auto-talks.com](http://autotalks.com), accessed December 31, 2020; Continental AG, continental.com, accessed December 31, 2020; ITS Connect Promotion Consortium, itsconnect-pc.org, accessed December 31, 2020; Toyota Motor Corporation, global.toyota, accessed December 31, 2020; Jason Ellis and Shailesh Patil, "How NR-based Sidelink Expands 5G C-V2X to Support New Advanced Use Cases," qualcomm.com, March 31, 2020; K. Momota, "Connectivity Technologies Attracting Attention Due to Frequent Traffic Accidents," Furuno.com, May 31, 2019; Kristen Hall-Geisler, "In Japan, Priuses Can Talk to Other Priuses," TechCrunch, August 17, 2016.

CASE STUDY QUESTIONS

1. What are the pros and cons of the V2X technology?
2. What can be done to speed up the adoption of V2X technology among vehicle owners?
3. What other applications can you think of for the ITS Connect?

Case contributed by Joyce Chan, City University of Hong Kong

7-4 What are the principal technologies and standards for wireless networking, communication, and Internet access?

Welcome to the wireless revolution! Cell phones, smartphones, tablets, and wireless-enabled personal computers have morphed into portable media and computing platforms that let you perform many of the computing tasks you used to do at your desk, and a whole lot more. We introduced smartphones in our discussions of the mobile digital platform in Chapters 1 and 5. **Smartphones** such as the iPhone, Android phones, and BlackBerry combine the functionality of a cell phone with that of a mobile laptop computer with Wi-Fi capability. This makes it possible to combine music, video, Internet access, and telephone service in one device. A large part of the Internet is becoming a mobile, access-anywhere, broadband service for the delivery of video, music, and web search.

Cellular Systems

Worldwide, there are almost 4.9 billion mobile phone users, with over 3.1 billion using smartphones (eMarketer, 2020b, 2020). Mobile is now the leading digital platform, with total activity on smartphones and tablets accounting for two-thirds of digital media time spent (Anderson, 2019).

Digital cellular service uses several competing standards. In Europe and much of the rest of the world outside the United States, the standard is Global System for Mobile Communications (GSM). GSM's strength is its international roaming capability. There are GSM cell phone systems in the United States, including T-Mobile and AT&T.

A competing standard in the United States is Code Division Multiple Access (CDMA), which is the system Verizon and Sprint use. CDMA was developed by the military during World War II. It transmits over several frequencies, occupies the entire spectrum, and randomly assigns users to a range of frequencies over time, making it more efficient than GSM.

Earlier generations of cellular systems were designed primarily for voice and limited data transmission in the form of short text messages. Today wireless carriers offer 3G and 4G networks. **3G networks**, with transmission speeds ranging from 144 Kbps for mobile users in, say, a car, to more than 2 Mbps for stationary users, offer transmission speeds appropriate for email and web browsing, but are too slow for videos. **4G networks** have much higher speeds, up to 100 Mbps download and 50 Mbps upload, with more than enough capacity for watching high-definition video on your smartphone. Long Term Evolution (LTE) and mobile Worldwide Interoperability for Microwave Access (WiMax—see the following section) are the current 4G standards.

The next generation of wireless technology, called **5G**, is designed to support transmission of very large amounts of data in the gigabit range, with fewer transmission delays and the ability to connect many more devices (such as sensors and smart devices) at once than existing cellular systems. 5G technology will be needed for self-driving vehicles, smart cities, and extensive use of the Internet of Things (IoT). AT&T, Verizon, and other carriers are starting to launch 5G networks, in the United States which will also improve the speed and intensive data-handling of smartphones. Mobile Internet users will be able to download entire movies within seconds.

Wireless Computer Networks and Internet Access

An array of technologies provides high-speed wireless access to the Internet for PCs and mobile devices. These new high-speed services have extended Internet access to numerous locations that could not be covered by traditional wired Internet services and have made ubiquitous computing, anywhere, anytime, a reality.

Bluetooth

Bluetooth is the popular name for the 802.15 wireless networking standard, which is useful for creating small **personal area networks (PANs)**. It links up to eight devices within a 10-meter area using low-power, radio-based communication and can transmit up to 722 Kbps in the 2.4-GHz band.

Wireless phones, pagers, computers, printers, and computing devices using Bluetooth communicate with each other and even operate each other without direct user intervention (see Figure 7.13). For example, a person could direct a notebook computer to send a document file wirelessly to a printer. Bluetooth connects wireless keyboards and mice to PCs or cell phones to earpieces without wires. Bluetooth has low power requirements, making it appropriate for battery-powered handheld computers or cell phones.

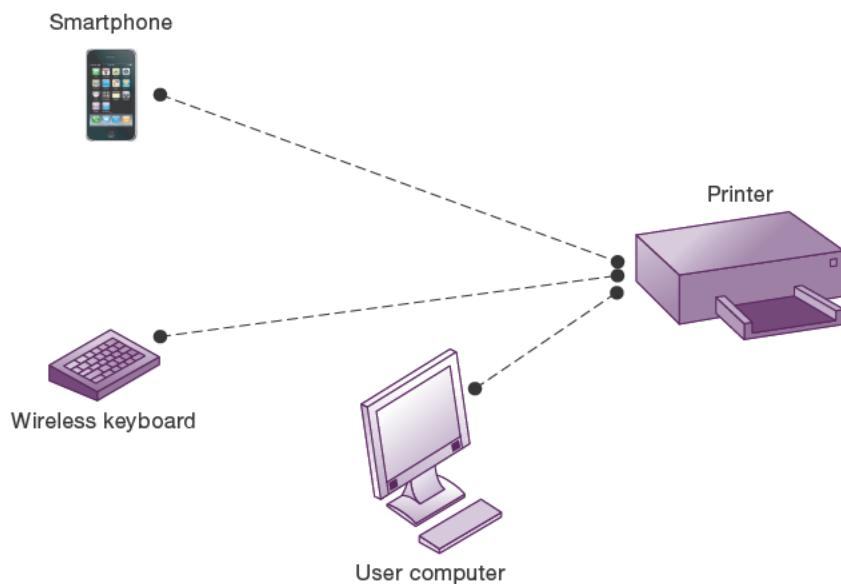
Although Bluetooth lends itself to personal networking, it has uses in large corporations. For example, FedEx drivers use Bluetooth to transmit the delivery data captured by their handheld computers to cellular transmitters, which forward the data to corporate computers. Drivers no longer need to spend time docking their handheld units physically in the transmitters, and Bluetooth has saved FedEx \$20 million per year.

Wi-Fi and Wireless Internet Access

The 802.11 set of standards for wireless LANs and wireless Internet access is also known as **Wi-Fi**. The first of these standards to be widely adopted was 802.11b, which can transmit up to 11 Mbps in the unlicensed 2.4-GHz band and has an effective distance of 30 to 50 meters. The 802.11g standard can transmit up to 54 Mbps in the 2.4-GHz range. 802.11n is capable of transmitting over

FIGURE 7.13 A BLUETOOTH NETWORK (PAN)

Bluetooth enables a variety of devices, including cell phones, smartphones, wireless keyboards and mice, PCs, and printers, to interact wirelessly with each other within a small, 30-foot (10-meter) area. In addition to the links shown, Bluetooth can be used to network similar devices to send data from one PC to another, for example.



100 Mbps and 802.11ac can transmit up to 1 Gbps. Today's PCs and tablets have built-in support for Wi-Fi, as do the iPhone, iPad, and other smartphones.

In most Wi-Fi communication, wireless devices communicate with a wired LAN using access points. An access point is a box consisting of a radio receiver/transmitter and antennas that links to a wired network, router, or hub.

Figure 7.14 illustrates an 802.11 wireless LAN that connects a small number of mobile devices to a larger wired LAN and to the Internet. Most wireless devices are client machines. The servers that the mobile client stations need to use are on the wired LAN. The access point controls the wireless stations and acts as a bridge between the main wired LAN and the wireless LAN. The access point also controls the wireless stations.

The most popular use for Wi-Fi today is for high-speed wireless Internet service. In this instance, the access point plugs into an Internet connection, which could come from a cable service or DSL telephone service. Computers within range of the access point use it to link wirelessly to the Internet.

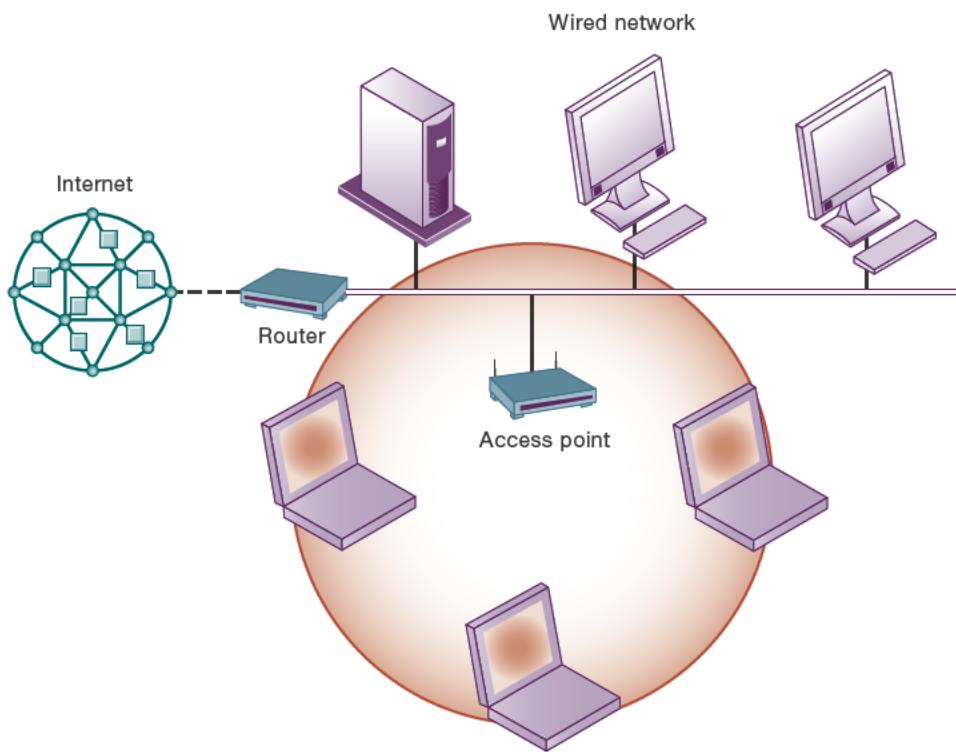
Hotspots are locations with one or more access points providing wireless Internet access and are often in public places. Some hotspots are free or do not require any additional software to use; others may require activation and the establishment of a user account by providing a credit card number over the web.

Businesses of all sizes are using Wi-Fi networks to provide low-cost wireless LANs and Internet access. Wi-Fi hotspots can be found in hotels, airport lounges, libraries, cafes, and college campuses to provide mobile access to the Internet. University of London is one of many campuses where students now use Wi-Fi for research, course work, and entertainment.

Wi-Fi technology poses several challenges, however. One is Wi-Fi's security features, which make these wireless networks vulnerable to intruders. We provide more detail about Wi-Fi security issues in Chapter 8.

FIGURE 7.14 AN 802.11 WIRELESS LAN

Mobile laptop computers equipped with network interface cards link to the wired LAN by communicating with the access point. The access point uses radio waves to transmit network signals from the wired network to the client adapters, which convert them to data that the mobile device can understand. The client adapter then transmits the data from the mobile device back to the access point, which forwards the data to the wired network.



Another drawback of Wi-Fi networks is susceptibility to interference from nearby systems operating in the same spectrum, such as wireless phones, microwave ovens, or other wireless LANs. However, wireless networks based on the 802.11n standard solve this problem by using multiple wireless antennas in tandem to transmit and receive data and technology called MIMO (multiple input multiple output) to coordinate multiple simultaneous radio signals.

WiMax

A surprisingly large number of areas in the United States and throughout the world do not have access to Wi-Fi or fixed broadband connectivity. The range of Wi-Fi systems is no more than 300 feet from the base station, making it difficult for rural groups that don't have cable or DSL service to find wireless access to the Internet.

The Institute of Electrical and Electronics Engineers (IEEE) developed a family of standards known as WiMax to deal with these problems. **WiMax**, which stands for Worldwide Interoperability for Microwave Access, is the popular term for IEEE Standard 802.16. It has a wireless access range of up to 31 miles and transmission speed of 30–40 Mbps (and up to 1 Gbps for fixed stations).

WiMax antennas are powerful enough to beam high-speed Internet connections to rooftop antennas of homes and businesses that are miles away. Cellular handsets and laptops with WiMax capabilities are appearing in the marketplace. Mobile WiMax is one of the 4G network technologies we discussed earlier in this chapter.

RFID and Wireless Sensor Networks

Mobile technologies are creating new efficiencies and ways of working throughout the enterprise. In addition to the wireless systems we have just described, radio frequency identification systems and wireless sensor networks are having a major impact.

Radio Frequency Identification (RFID) and Near Field Communication (NFC)

Radio frequency identification (RFID) systems provide a powerful technology for tracking the movement of goods throughout the supply chain. RFID systems use tiny tags with embedded microchips containing data about an item and its location to transmit radio signals over a short distance to RFID readers. The RFID readers then pass the data over a network to a computer for processing. Unlike bar codes, RFID tags do not need line-of-sight contact to be read.

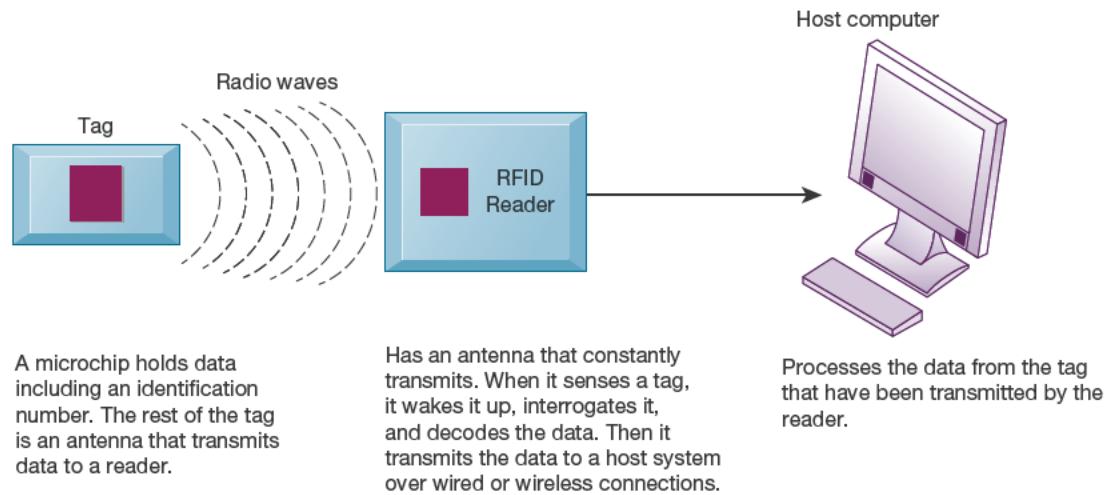
The RFID tag is electronically programmed with information that can uniquely identify an item plus other information about the item such as its location, where and when it was made, or its status during production. The reader emits radio waves in ranges anywhere from 1 inch to 100 feet. When an RFID tag comes within the range of the reader, the tag is activated and starts sending data. The reader captures these data, decodes them, and sends them back over a wired or wireless network to a host computer for further processing (see Figure 7.15). Both RFID tags and antennas come in a variety of shapes and sizes.

In inventory control and supply chain management, RFID systems capture and manage more detailed information about items in warehouses or in production than bar coding systems. If a large number of items are shipped together, RFID systems track each pallet, lot, or even unit item in the shipment. This technology may help companies such as Walmart improve receiving and storage operations by improving their ability to see exactly what stock is stored in warehouses or on retail store shelves.

Walmart has installed RFID readers at store receiving docks to record the arrival of pallets and cases of goods shipped with RFID tags. The RFID reader

FIGURE 7.15 HOW RFID WORKS

RFID uses low-powered radio transmitters to read data stored in a tag at distances ranging from 1 inch to 100 feet. The reader captures the data from the tag and sends them over a network to a host computer for processing.



reads the tags a second time just as the cases are brought onto the sales floor from backroom storage areas. Software combines sales data from Walmart's point-of-sale systems and the RFID data regarding the number of cases brought out to the sales floor. The program determines which items will soon be depleted and automatically generates a list of items to pick in the warehouse to replenish store shelves before they run out. This information helps Walmart reduce out-of-stock items, increase sales, and further shrink its costs.

The cost of RFID tags used to be too high for widespread use, but now it starts at around 7 cents per tag in the United States. As the price decreases, RFID is starting to become cost-effective for many applications.

In addition to installing RFID readers and tagging systems, companies may need to upgrade their hardware and software to process the massive amounts of data produced by RFID systems—transactions that could add up to tens or hundreds of terabytes.

Software is used to filter, aggregate, and prevent RFID data from overloading business networks and system applications. Applications often need to be redesigned to accept large volumes of frequently generated RFID data and to share those data with other applications. Major enterprise software vendors now offer RFID-ready versions of their supply chain management applications.

Tap-and-go services like Apple Pay or Google Wallet use an RFID-related technology called **near field communication (NFC)**. NFC is a short-range wireless connectivity standard that uses electromagnetic radio fields to enable two compatible devices to exchange data when brought within a few centimeters of each other. A smartphone or other NFC-compatible device sends out radio frequency signals that interact with an NFC tag found in compatible card readers or smart posters. The signals create a current that flows through the NFC tag, allowing the device and the tag to communicate with one another. In most cases the tag is passive and only sends out information while the other device (such as a smartphone) is active and can both send and receive information. (There are NFC systems where both components are active.)

NFC is used in wireless payment services, to retrieve information, and even to exchange videos or information with friends on the go. You could share a website link by passing your phone over a friend's phone, while waving the phone in front of a poster or display containing an NFC tag could show information about what you're viewing at a museum or exhibit.

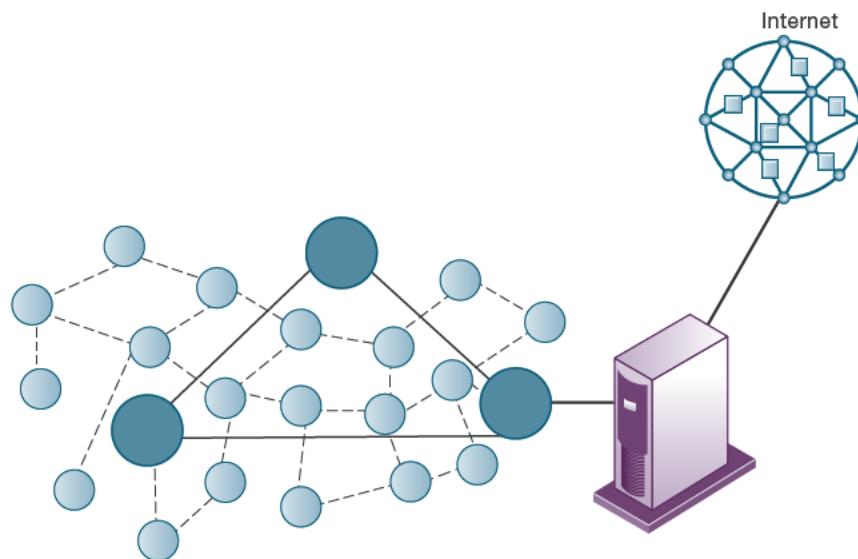
Wireless Sensor Networks

If your company wanted state-of-the art technology to monitor building security or detect hazardous substances in the air, it might deploy a wireless sensor network. **Wireless sensor networks (WSNs)** are networks of interconnected wireless devices that are embedded in the physical environment to provide measurements of many points over large spaces. These devices have built-in processing, storage, and radio frequency sensors and antennas. They are linked into an interconnected network that routes the data they capture to a computer for analysis. These networks range from hundreds to thousands of nodes. Figure 7.16 illustrates one type of wireless sensor network, with data from individual nodes flowing across the network to a server with greater processing power. The server acts as a gateway to a network based on Internet technology.

Wireless sensor networks are valuable for uses such as monitoring environmental changes; monitoring traffic or military activity; protecting property; efficiently operating and managing machinery and vehicles; establishing security perimeters; monitoring supply chain management; or detecting chemical, biological, or radiological material.

FIGURE 7.16 A WIRELESS SENSOR NETWORK

The small circles represent lower-level nodes, and the larger circles represent higher-level nodes. Lower-level nodes forward data to each other or to higher-level nodes, which transmit data more rapidly and speed up network performance.



Output from RFID systems and wireless networks is fueling the Internet of Things (IoT), introduced earlier in this chapter, in which machines such as jet engines, power plant turbines, or agricultural sensors constantly gather data and send the data over the Internet for analysis. The re-imagination of retailing by Alibaba in its Hema stores, described in the chapter-opening case, is an example of an IoT application. You'll find more examples of the Internet of Things in Chapters 2 and 12.



7-5 How will MIS help my career?

Here is how Chapter 7 and this book can help you find a job as an automotive digital advisor.

The Company

Autoworld, a large and fast-growing Danish automobile dealership based in Copenhagen, is looking for an automotive digital advisor to run its digital marketing program. The company has more than 500 vehicles for sale, 170 employees, and three locations for selling and servicing new and used vehicles.

Position Description

The automotive digital assistant will be part of a team assisting the dealership group with online marketing, including search engine optimization (SEO) and search engine marketing (SEM), social media and reputation management, and website management. Job responsibilities include coordinating efforts for the dealership owner, dealership managers, and marketing manager in the following areas:

- Online advertising, SEO, and SEM.
- Social media management, including managing the dealership's overall social media and content calendar and developing new content.
- Online reputation management.
- Website management.
- Maintaining the dealership's blog.

Job Requirements

- College graduate in marketing
- Knowledge of digital marketing and social media
- Microsoft Office skills
- Knowledge of automotive sales and content management systems desirable

Interview Questions

1. Have you ever taken any digital marketing courses?
2. Have you any experience running a digital marketing campaign? Did you use SEO and SEM? How did you measure the effectiveness of your social media campaign and audience growth?
3. Do you have any experience with social media management software?
4. Do you have any experience with online reputation management or online inventory management?
5. Have you ever maintained a blog?
6. What is your level of proficiency with Microsoft Office software?

Author Tips

1. Review the discussions of search, search engine marketing, and blogs in this chapter and also the discussions of e-commerce marketing and building an e-commerce presence in Chapter 10.
2. Use the web to learn more about SEO, SEM, social media management, and online reputation management and software tools used for this work. Look into how to generate metrics reports using standardized tools and how to put together analyses and recommendations based on the social media data.
3. Look at how major auto dealers in large metropolitan areas are using social media channels. Are they creating content on YouTube, Instagram, Facebook, and Twitter? Which channels are generating higher levels of audience engagement?
4. Inquire about exactly what you would have to do for website management and required software skills.
5. Inquire about the Microsoft Office skills you would need for this job. Bring examples of the work you have done with this software.

REVIEW SUMMARY

7-1 What are the principal components of telecommunications networks and key networking technologies?

A simple network consists of two or more connected computers. Basic network components include computers, network interfaces, a connection medium, network operating system software, and either a hub or a switch. The networking infrastructure for a large company includes the traditional telephone system, mobile cellular communication, wireless local area networks, videoconferencing systems, a corporate website, intranets, extranets, and an array of local and wide area networks, including the Internet.

Contemporary networks have been shaped by the rise of client/server computing, the use of packet switching, and the adoption of Transmission Control Protocol/Internet Protocol (TCP/IP) as a universal communications standard for linking disparate networks and computers, including the Internet. Protocols provide a common set of rules that enable communication among diverse components in a telecommunications network.

7-2 What are the different types of networks?

The principal physical transmission media are twisted copper telephone wire, coaxial copper cable, fiber-optic cable, and wireless transmission.

Local area networks (LANs) connect PCs and other digital devices within a 500-meter radius and are used today for many corporate computing tasks. Wide area networks (WANs) span broad geographical distances, ranging from several miles to entire continents and are often private networks that are independently managed. Metropolitan area networks (MANs) span a single urban area.

Digital subscriber line (DSL) technologies, cable Internet connections, and T1 lines are often used for high-capacity Internet connections.

7-3 How do the Internet and Internet technology work, and how do they support communication and e-business?

The Internet is a worldwide network of networks that uses the client/server model of computing and the TCP/IP network reference model. Every computer on the Internet is assigned a unique numeric IP address. The Domain Name System (DNS) converts IP addresses to more user-friendly domain names. Worldwide Internet policies are established by organizations and government bodies such as the Internet Architecture Board (IAB) and the World Wide Web Consortium (W3C).

Major Internet services include email, newsgroups, chatting, instant messaging, Telnet, FTP, and the web. Web pages are based on Hypertext Markup Language (HTML) and can display text, graphics, video, and audio. Website directories, search engines, and RSS technology help users locate the information they need on the web. RSS, blogs, social networking, and wikis are current information-sharing capabilities of the web. The future web will feature more semantic search, visual search, prevalence of apps, and interconnectedness of many different devices (Internet of Things).

Firms are also starting to realize economies by using VoIP technology for voice transmission and virtual private networks (VPNs) as low-cost alternatives to private WANs.

7-4 What are the principal technologies and standards for wireless networking, communication, and Internet access?

Cellular networks are evolving toward high-speed, high-bandwidth, digital packet-switched transmission. 3G networks are capable of transmitting data at speeds ranging from 144 Kbps to more than 2 Mbps. 4G networks are capable of transmission speeds of 100 Mbps, and 5G networks capable of transmitting in the gigabit range among many devices are starting to be rolled out.

Major cellular standards include Code Division Multiple Access (CDMA), which is used primarily in the United States, and Global System for Mobile Communications (GSM), which is the standard in Europe and much of the rest of the world.

Standards for wireless computer networks include Bluetooth (802.15) for small personal area networks (PANs), Wi-Fi (802.11) for local area networks (LANs), and WiMax (802.16) for metropolitan area networks (MANs).

Radio frequency identification (RFID) systems provide a powerful technology for tracking the movement of goods by using tiny tags with embedded data about an item and its location. RFID readers read the radio signals transmitted by these tags and pass the data over a network to a computer for processing. Wireless sensor networks (WSNs) are networks of interconnected wireless sensing and transmitting devices that are embedded in the physical environment to provide measurements of many points over large spaces.

Key Terms

- 3G networks*, 309
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MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

7-1 What are the principal components of telecommunications networks and key networking technologies?

- Describe the features of a simple network and the network infrastructure for a large company.

- Name and describe the principal technologies and trends that have shaped contemporary telecommunications systems.

7-2 What are the different types of networks?

- Define an analog and a digital signal.
- Distinguish between a LAN, MAN, and WAN.

7-3 How do the Internet and Internet technology work, and how do they support communication and e-business?

- Define the Internet, describe how it works, and explain how it provides business value.
- Explain how the Domain Name System (DNS) and IP addressing system work.
- List and describe the principal Internet services.
- Define and describe VoIP and virtual private networks and explain how they provide value to businesses.
- List and describe alternative ways of locating information on the web.
- Describe how online search technologies are used for marketing.

7-4 What are the principal technologies and standards for wireless networking, communication, and Internet access?

- Define Bluetooth, Wi-Fi, WiMax, and 3G, 4G, and 5G networks.
- Describe the capabilities of each and for which types of applications each is best suited.
- Define RFID, explain how it works, and describe how it provides value to businesses.
- Define near field communication (NFC) and explain how it works.
- Define WSNs, explain how they work, and describe the kinds of applications that use them.

Discussion Questions

7-5 It has been said that within the next few years, smartphones will become the single most important digital device we own. Discuss the implications of this statement.

7-6 Should all major retailing and manufacturing companies switch to RFID? Why or why not?

7-7 What are some of the issues to consider in determining whether the Internet would provide your business with a competitive advantage?

Hands-On MIS Projects

The projects in this section give you hands-on experience evaluating and selecting communications technology, using spreadsheet software to improve selection of telecommunications services, and using web search engines for business research. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

7-8 LionClaw is a Singapore-based clothing brand with a sustainability profile. Management now wants each garment to be accompanied by a tag with a link to a website where the customer can read more about the work environment in the clothing factory, where the fabric is coming from, and so on. Use the web to search for an RFID, NFC, or QR code system for generating codes and printing tags. Work out the differences and choose from these systems to determine the best option for LionClaw.

7-9 BestMed Medical Supplies Corporation sells medical and surgical products and equipment from more than 700 manufacturers to hospitals, health clinics, and medical offices. The company employs 500 people at seven locations throughout Europe, including account managers, customer service and support representatives, and warehouse staff. Employees communicate by traditional telephone voice services, email, instant messaging, and cell phones. Management is inquiring about whether the company should adopt a system for unified communications. What factors should be considered? What are the key decisions that must be made in determining whether to adopt this technology? Use the web, if necessary, to find out more about unified communications and its costs.

Improving Decision Making: Using Spreadsheet Software to Evaluate Wireless Services

Software skills: Spreadsheet formulas, formatting

Business skills: Analyzing telecommunications services and costs

- 7-10** In this project, you'll use the web to research alternative wireless services and use spreadsheet software to calculate wireless service costs for a sales force.

You would like to equip your sales force of 35, based in St. Louis, Missouri, with mobile phones that have capabilities for voice transmission, text messaging, Internet access, and taking and sending photos. Use the web to select two wireless providers that offer nationwide voice and data service as well as good service in your home area. Examine the features of the mobile handsets and wireless plans offered by each of these vendors. Assume that each of the 35 salespeople will need unlimited voice, text, and data service in the United States and the ability to take and send photos. Use your spreadsheet software to determine the wireless service and handset that will offer the best pricing per user over a two-year period. For the purposes of this exercise, you do not need to consider corporate discounts.

Achieving Operational Excellence: Using Web Search Engines for Business Research

Software skills: Web search tools

Business skills: Researching new technologies

- 7-11** This project will help develop your Internet skills in using web search engines for business research. Use Google and Bing to obtain information about ethanol as an alternative fuel for motor vehicles. If you wish, try some other search engines as well. Compare the volume and quality of information you find with each search tool. Which tool is the easiest to use? Which produced the best results for your research? Why?

Collaboration and Teamwork Project

Evaluating Smartphones

- 7-12** Form a group with three or four of your classmates. Compare the capabilities of Apple's iPhone with a smartphone from another vendor with similar features. Your analysis should consider the purchase cost of each device, the wireless networks where each device can operate, plan and handset costs, and the services available for each device. You should also consider other capabilities of each device, including available software, security features, and the ability to integrate with existing corporate or PC applications. Which device would you select? On what criteria would you base your selection? If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Google, Apple, and Facebook Battle for Your Internet Experience

CASE STUDY

Three Internet titans—Google, Apple, and Facebook—are in an epic struggle to dominate your Internet experience, and caught in the crossfire are search, music, video, and other media along with the devices you use for all of these things. Mobile devices with advanced functionality and ubiquitous Internet access are rapidly overtaking traditional desktop machines as the most popular form of computing. Today, people spend more than half their time online using mobile devices that take advantage of a growing cloud of computing capacity. It's no surprise, then, that today's tech titans are aggressively battling for control of this brave new online world.

Apple, which started as a personal computer company, quickly expanded into software and consumer electronics. Since upending the music industry with its iPod MP3 player, and the iTunes digital music service, Apple took mobile computing by storm with the iPhone, iPod Touch, and iPad. Now Apple wants to be the computing platform of choice for the Internet.

Apple's competitive strength is based not on its hardware platform alone but on its superior user interface and mobile software applications, in which it is a leader. Apple's App Store offers more than two million apps for mobile and tablet devices. Applications greatly enrich the experience of using a mobile device, and whoever creates the most appealing set of devices and applications will derive a significant competitive advantage over rival companies. Apps are the new equivalent of the traditional browser.

Apple thrives on its legacy of innovation. In 2011, it unveiled Siri (Speech Interpretation and Recognition Interface), a combination search/navigation tool and personal assistant. Siri promises personalized recommendations that improve as it gains user familiarity—all from a verbal command. Google countered by quickly releasing its own intelligent assistant tools Google Now and then Google Assistant.

Apple faces strong competition for its phones and tablets both in the United States and in developing markets like China from inexpensive Chinese smartphones and from Samsung Android phones with sophisticated capabilities. iPhone sales have started to slow, but Apple is not counting on hardware devices alone for future growth. Services have always played a large part in the Apple ecosystem, and they have

emerged as a major revenue source. Apple has more than one billion active devices in circulation worldwide, creating a huge installed base of users willing to purchase services and a source of new revenue streams. Apple's services business, which includes Apple's music (both downloads and subscriptions), video sales and rentals, books, apps (including in-app purchases, subscriptions and advertising), iCloud storage, and payments, has been growing 18 percent year over year.

As Apple rolls out more gadgets, such as the Watch and HomePod, its services revenue will continue to expand and diversify, deepening ties with Apple users. According to CEO Tim Cook, Apple has become one of the largest service businesses in the world. This service-driven strategy is not without worry because both Google and Facebook offer stiff competition in the services area and Apple will need to offer some of its services on non-Apple devices to remain in this market. Google continues to be the world's leading search engine, accounting for about 75 percent of web searches from laptop and desktop devices and over 90 percent of the mobile search market. About 84 percent of the revenue from Google's parent company Alphabet comes from ads, most of them on Google's search engine. Google dominates online advertising. However, Google is slipping in its position as the gateway to the Internet. New search startups focus on actions and apps instead of the web. Facebook has become an important gateway to the web as well.

In 2005, Google had purchased the Android open source mobile operating system to compete in mobile computing. Google provides Android at no cost to smartphone manufacturers, generating revenue indirectly through app purchases and advertising. Many different manufacturers have adopted Android as a standard. In contrast, Apple allows only its own devices to use its proprietary operating system, and all the apps it sells can run only on Apple products. Android is deployed on over 85 percent of smartphones worldwide; is the most common operating system for tablets; and runs on watches, car dashboards, and TVs—thousands of distinct devices. Google wants to extend Android to as many devices as possible.

Google's Android could gain even more market share in the coming years, which could be problematic for Apple as it tries to maintain customer loyalty and keep software developers focused on the iOS platform. Whoever has the dominant smartphone operating system will have control over the apps where smartphone users spend most of their time and built-in channels for serving ads to mobile devices. Google is starting to monitor the content inside Android mobile apps and provide links pointing to that content featured in Google's search results on smartphones. Google cannot monitor or track usage of iPhone apps. Since more than half of global search queries come from mobile devices, the company revised its search algorithms to add "mobile friendliness" to the 200 or so factors it uses to rank websites on its search engine. This favors sites that look good on smartphone screens. The cost-per-click paid for mobile ads has trailed desktop ads, but the gap between computer and mobile ads fees is narrowing. Google instituted a design change to present a cleaner mobile search page.

Seven Google products and services, including Search, YouTube, and Maps, have more than a billion users each. Google's ultimate goal is to knit its services and devices together so that Google users will interact with the company seamlessly all day long and everyone will want to use Google. Much of Google's efforts to make its search and related services more powerful and user-friendly in the years ahead are based on the company's investments in artificial intelligence and machine learning (see Chapter 11). The goal is to evolve search into more of a smart assistance capability, where computers can understand what people are saying and respond conversationally with the right information at the right moment. Google Assistant is meant to provide a continuing, conversational dialogue between users and the search engine.

Facebook is the world's largest social networking service, with 2.6 billion monthly active users. People use Facebook to stay connected with their friends and family and to express what matters most to them. Facebook Platform enables developers to build applications and websites that integrate with Facebook to reach its global network of users and to build personalized and social products. Facebook is so pervasive and appealing that it has become users' primary gateway to the Internet. For a lot of people, Facebook is the Internet. Whatever they do on the Internet is through Facebook.

Facebook has persistently worked on ways to convert its popularity and trove of user data into advertising dollars, with the expectation that these dollars will increasingly come from mobile smartphones and tablets. As of early 2020, 98 percent of active user accounts worldwide accessed the social network via smartphone and tablet. Facebook ads allow companies to target its users based on their real identities and expressed interests rather than educated guesses derived from web-browsing habits and other online behavior.

In early 2019, over 98 percent of Facebook's global revenue came from advertising, and 92 percent of that ad revenue was from mobile advertising. Many of those ads are highly targeted by age, gender, and other demographics. Facebook is now a serious competitor to Google in the mobile ad market and is trying to compete with emerging mobile platforms. Together, Facebook and Google dominate the digital ad industry and have been responsible for almost all of its growth. Facebook has overhauled its home page to give advertisers more opportunities and more information with which to target markets. The company is expanding advertising in products such as the Instagram feed, Stories, WhatsApp, Facebook Watch video on demand service, and Messenger, although the majority of ad revenue still comes from its news feed. Facebook has its own personalized search tool to challenge Google's dominance of search. Facebook CEO Mark Zuckerberg is convinced that social networking is the ideal way to use the web and to consume all of the other content people might desire, including news and video. That makes it an ideal marketing platform for companies. But he also knows that Facebook can't achieve long-term growth and prosperity based on social networking alone. During the past few years Facebook has moved into virtual reality, messaging, video, and more.

Facebook is challenging YouTube as the premier destination for personal videos, developing its own TV programming, and making its messages "smarter" by deploying chatbots. Chatbots are stripped-down software agents that understand what you type or say and respond by answering questions or executing tasks, and they run in the background of Facebook's Messenger service (see Chapter 11). Within Facebook Messenger, you can chat with friends or a business, send money securely, and share pictures and videos. Zuckerberg has said that he intends to help bring the next billion people online by attracting users in developing countries with affordable web connectivity.

Facebook has launched several services in emerging markets designed to get more people online so they can explore web applications, including its social network. Facebook wants to beam the Internet to underserved areas through the use of drones and satellites along with other technologies. Zuckerberg thinks that Facebook could eventually be an Internet service provider to underserved areas.

Monetization of personal data drives both Facebook and Google's business models. However, this practice also threatens individual privacy. The consumer surveillance underlying Facebook and Google's free services has come under siege from users, regulators, and legislators on both sides of the Atlantic. Calls for restricting Facebook and Google's collection and use of personal data have gathered steam, especially after recent revelations about Russian agents trying to use Facebook to sway American voters and Facebook's uncontrolled sharing of user data with third-party companies (see the Chapter 4 ending case study). Both companies will have to come to terms with the European Union's new privacy law, called the General Data Protection Regulation (GDPR), that requires companies to obtain consent from users before processing their data, and which may inspire more stringent privacy legislation in the United States. Business models that depend less on ads and more on subscriptions have been proposed, although any effort to curb the use of consumer data would put the business model of the ad-supported Internet—and possibly Facebook and Google—at risk. Also pressuring Facebook and Google's ad-driven business models are Apple privacy protection features that allow users of its devices to opt out of targeted advertising.

These tech giants are also being scrutinized for monopolistic behavior. In the United States, Google drives 89 percent of Internet search, 95 percent of young adults on the Internet use a Facebook product, and Google and Apple provide 99 percent of mobile phone operating systems. Critics have called for breaking up these mega-companies or regulating them as Standard Oil and AT&T once were. In July

2018 European Union (EU) regulators fined Google's parent company \$5 billion for forcing cellphone makers that use the company's Android operating system to install Google search and browser apps. Less than a year later, EU antitrust regulators fined Alphabet an additional \$1.7 billion for restrictive advertising practices in its Adsense business unit. Have these companies become so large that they are squeezing consumers and innovation? How governments answer this question will also affect how Apple, Google, and Facebook will fare and what kind of Internet experience they will be able to provide.

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CASE STUDY QUESTIONS

7-13 Compare the business models and core competencies of Google, Apple, and Facebook.

7-14 Why is mobile computing so important to these three firms? Evaluate the mobile strategies of each firm.

7-15 Which company and business model do you think is most likely to dominate the Internet, and why?

7-16 What difference would it make to a business or to an individual consumer if Apple, Google, or Facebook dominated the Internet experience? Explain your answer.

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8

Securing Information Systems

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 8-1** Why are information systems vulnerable to destruction, error, and abuse?
- 8-2** What is the business value of security and control?
- 8-3** What are the components of an organizational framework for security and control?
- 8-4** What are the most important tools and technologies for safeguarding information resources?
- 8-5** How will MIS help my career?

CHAPTER CASES

- Cyberattacks in the Asia-Pacific Target the Weakest Link: People
- Capital One: A Big Bank Heist from the Cloud
- PayPal Ups Its Digital Resiliency
- Bulgaria: A Whole Nation Hacked

VIDEO CASES

- Stuxnet and Cyberwarfare
- Cyberespionage: The Chinese Threat
- Instructional Videos:*
- Sony PlayStation Hacked; Data Stolen from 77 Million Users
- Meet the Hackers: Anonymous Statement on Hacking Sony

MyLab MIS

Discussion Questions: 8-5, 8-6, 8-7; Hands-On MIS Projects: 8-8, 8-9, 8-10, 8-11;
eText with Conceptual Animations

Cyberattacks in the Asia-Pacific Target the Weakest Link: People

Since the Asia-Pacific (APAC) region's focus on IT and the Internet has increased, it has become the next big target for cyberattacks. Geopolitical tensions and relatively weaker cyber regulations in the APAC region have further increased the risk of cyber exploitation.

Countries like Singapore are much more vulnerable than most other Asian countries because technology is so pervasive—forming, as it were, the country's digital lifeline. For example, in August 2017, hackers targeted Singapore Airlines (SIA), emailing the company's customers prior to its 70th anniversary and promising free tickets and prizes if they responded to survey questions. These attacks mimicked SIA's communications patterns and were personalized to include even the customer's frequent-flyer category. The emails were so legitimate-seeming that many customers had no worries at all about divulging their personal data. The attackers also replied to phone calls using the modified caller IDs of SIA's official telephone numbers. Additionally, a fake website resembling the official one was created to further gain the confidence of consumers.

Such attacks, called phishing, have become prevalent in Singapore, with as many as four in ten Singapore executives having fallen prey to them. In this case, SIA acted quickly in response, turning to traditional as well as social media to warn its customers. It also created a feedback page on its official website to advise customers about the authenticity of emails purportedly from SIA.

The banking industry has also been a key target of phishing, and one of its more prominent victims was the Overseas Chinese Banking Corporation (OCBC), which had earned plaudits for its exceptional management in Singapore and the Asia-Pacific. OCBC was targeted using both a phishing website and phone phishing, and over a two-week period received a total of 1,081 complaints about phone calls made by attackers impersonating the bank. The call would typically start with an automated voice message requesting a response, following which it would be transferred to a Mandarin-speaking person of non-local origin who would ask for sensitive information like personal and banking details. The OCBC now issues warnings to its customers and offers a security guarantee whereby victims of online fraud are guaranteed a full refund (subject to terms and conditions).

In July 2018, the government of Singapore revealed that hackers had broken into the nation's healthcare system and stole 1.5 million health records, including those of the prime minister. Authorities believe the attack was state-sponsored and very professional. Between December 2018 and June 2019, there were eight waves of cyberattacks across Southeast Asia, launched against governments, embassies,



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and organizations with government links. The attacks included the circulation of fake government documents and press releases, attached to which were malware designed to compromise the security of the unwitting recipient. Cybersecurity experts have linked the attacks to a cyber espionage group named Rancor.

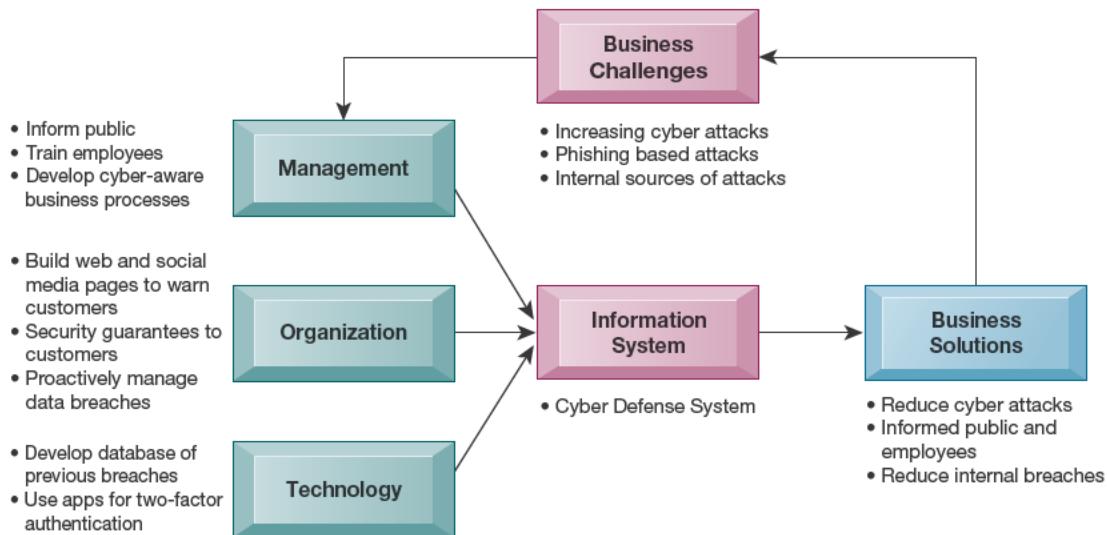
Attacks from external sources such as the above are often the most visible, but a majority of the data leaks in Asia—as high as 56 percent—are from internal sources, including company staff and executives. One of the reasons is that many Asian companies are highly networked and deal with numerous external partners. For example, several Development Bank of Singapore (DBS) employees in Hong Kong were arrested for an alleged leak of customer data. The staff had purportedly bribed department managers for customers' data, which they passed on to call centers in mainland China. These call centers would try to persuade customers to accept bank loans, and the commissions were shared with the DBS staff. Suspicion arose when many customers complained about receiving marketing calls from DBS, and the monthly sales of some of the DBS staff were found to exceed HK\$1 million (\$183,870).

According to a report by Kaspersky Lab, there were 1.6 million cyberattacks on small and medium-sized enterprises in Southeast Asia in the first six months of 2020. Vietnam suffered the highest number of attacks with 464,300 cases, a 39 percent increase from 2019. One of the main reasons cited for the massive increase in such attacks was cybercriminals trying to take advantage of the greater number of employees working from home and thereby following less stringent protocols.

Sources: Janet Dang, "Vietnam among Top of Cyberattack in South East Asia," *Vietnam Times*, August 29, 2020; Ravie Lakshmanan, "Chinese Hacking Group Targets Southeast Asian Governments with Data-stealing Malware," TNW, October 2, 2019, thenextweb.com; Adrian Wan, "New UN Tool Maps Asia-Pacific Cybersecurity Landscape," Internet Society, January 29, 2019; Aaron Tan, "APAC Cyber Security Landscape to Become More Tumultuous in 2019" computerweekly.com, December 19, 2018; Matthew Field, "Cyber Attack on Singapore Health Database Steals Details of 1.5m Including Prime Minister," *The Telegraph*, July 20, 2018; S. Barker, "Employees, C-level & IT staff behind More Than Half of ASEAN Data Leaks," securitybrief.asia, October 24, 2017; L. Lam, "Singapore Airlines Giving Away Free Tickets? It's a Phishing Scam, SIA Warns," straitstimes.com, August 26, 2017; Channel NewsAsia, "Beware of Emails, Calls Claiming Singapore Airlines Is Giving Away Free Tickets: SIA," channelnewsasia.com, August 26 2017; PwC, Global State of Information Security® Survey 2017, Singapore, pwc.com, 2017; G. Aaron and R. Rasmussen, Global Phishing Survey: Trends and Domain Name Use in 2016, Anti Phishing Working Group, docs.apwg.org, June 26, 2017; I. Tham, "Singtel Vendor Fined \$10k for Data Breach," straitstimes.com, April 18, 2017; "Sharp Rise in Phone Scams Impersonating OCBC, Says Bank," straitstimes.com, July 18, 2016; E. Estopace, "Asia-Pacific's 'Cyber Five' Nations More Vulnerable to Cyberattack," www.enterpriseinnovation.net, February 29, 2016.

Case contributed by Neerja Sethi and Vijay Sethi, Nanyang Technological University

Information systems security can be compromised in many ways, as illustrated by the examples in the opening case. Protecting systems through technical means—firewalls, intrusion detection systems, etc.—is necessary but not sufficient by itself. From employees within the organization to customers without, people are vital cogs in the security wheel, which rests on many different pillars, as shown in the opening diagram. It also involves designing robust business processes and monitoring them, as the DBS case demonstrated, where unusually high sales numbers led to the detection of a data breach.



Here are some questions to think about: What security vulnerabilities were exploited by hackers? What management, organizational, and technological factors contributed to these security weaknesses? What was the business impact of these problems? How important are ethics and morals to information systems security?

8-1 Why are information systems vulnerable to destruction, error, and abuse?

Can you imagine what would happen if you tried to link to the Internet without a firewall or antivirus software? Your computer would be disabled within a few seconds, and it might take you many days to recover. If you used the computer to run your business, you might not be able to sell to your customers or place orders with your suppliers while it was down. And you might find that your computer system had been penetrated by outsiders, who perhaps stole or destroyed valuable data, including confidential payment data from your customers. If too much data was destroyed or divulged, your business might never be able to recover!

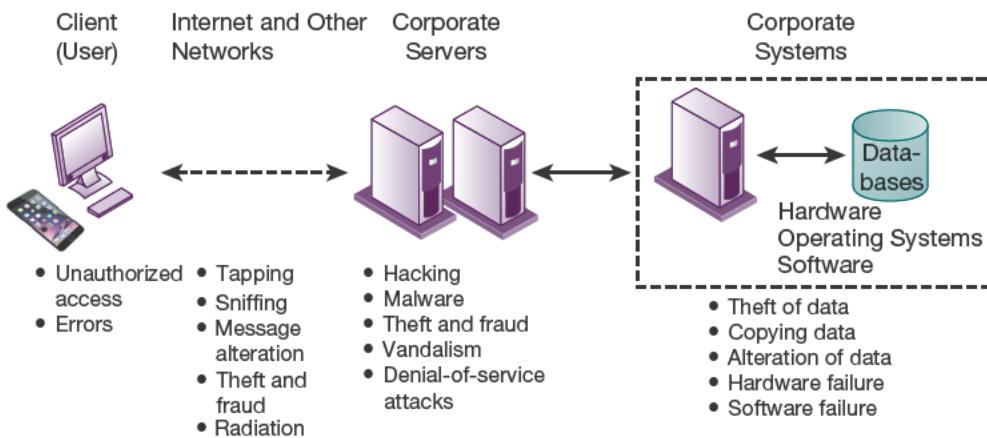
In short, if you operate a business today, you need to make security and control a top priority. **Security** refers to the policies, procedures, and technical measures used to prevent unauthorized access, alteration, theft, or physical damage to information systems. **Controls** are methods, policies, and organizational procedures that ensure the safety of the organization's assets, the accuracy and reliability of its records, and operational adherence to management standards.

Why Systems are Vulnerable

When large amounts of data are stored in electronic form, they are vulnerable to many kinds of threats. Through communications networks, information systems in different locations are interconnected. The potential for unauthorized access or damage is not limited to a single location but can occur at many access points in the network. Figure 8.1 illustrates the most common threats

FIGURE 8.1**CONTEMPORARY SECURITY CHALLENGES AND VULNERABILITIES**

The architecture of a web-based application typically includes a web client, a server, and corporate information systems linked to databases. Each of these components presents security challenges and vulnerabilities. Floods, fires, power failures, and other electrical problems can cause disruptions at any point in the network.



against contemporary information systems. They can stem from technical, organizational, and environmental factors compounded by poor management decisions. In the multitier client/server computing environment illustrated here, vulnerabilities exist at each layer and in the communications between the layers. Users at the client layer can cause harm by introducing errors or by accessing systems without authorization. It is possible to access data flowing over networks, steal valuable data during transmission, or alter data without authorization. Radiation may disrupt a network at various points as well. Intruders can launch denial-of-service attacks or malicious software to disrupt the operation of websites. Those capable of penetrating corporate systems can steal, destroy, or alter corporate data stored in databases or files.

Systems malfunction if computer hardware breaks down, is not configured properly, or is damaged by improper use or criminal acts. Errors in programming, improper installation, or unauthorized changes cause computer software to fail. Power failures, floods, fires, or other natural disasters can also disrupt computer systems.

Domestic or offshore partnering with another company contributes to system vulnerability if valuable information resides on networks and computers outside the organization's control. Without strong safeguards, valuable data could be lost, be destroyed, or fall into the wrong hands, revealing important trade secrets or information that violates personal privacy.

Portability makes cell phones, smartphones, and tablet computers easy to lose or steal. Smartphones share the same security weaknesses as other Internet devices and are vulnerable to malicious software and penetration from outsiders. Smartphones that corporate employees use often contain sensitive data such as sales figures, customer names, phone numbers, and email addresses. Intruders may also be able to access internal corporate systems through these devices.

Internet Vulnerabilities

Large public networks, such as the Internet, are more vulnerable than internal networks because they are virtually open to anyone. The Internet is so huge that when abuses do occur, they can have an enormously widespread impact.

When the Internet links to the corporate network, the organization's information systems are even more vulnerable to actions from outsiders.

Vulnerability has also increased from widespread use of email, instant messaging (IM), and peer-to-peer (P2P) file-sharing programs. Email may contain attachments that serve as springboards for malicious software or unauthorized access to internal corporate systems. Employees may use email messages to transmit valuable trade secrets, financial data, or confidential customer information to unauthorized recipients. Instant messaging activity over the Internet can in some cases be used as a back door to an otherwise secure network. Sharing files over P2P networks, such as those for illegal music sharing, can also transmit malicious software or expose information on either individual or corporate computers to outsiders.

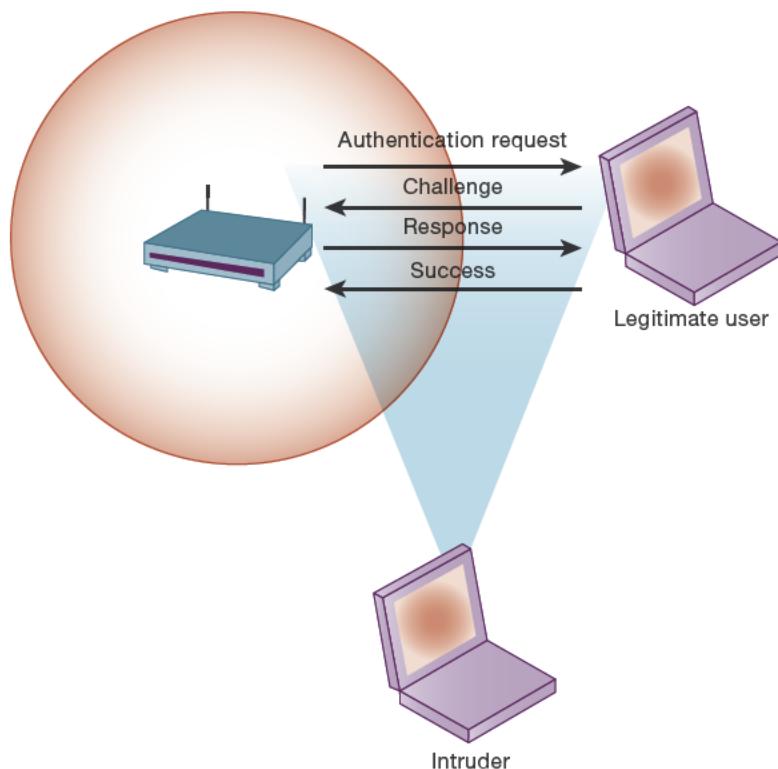
Wireless Security Challenges

Both Bluetooth and Wi-Fi networks are susceptible to hacking by eavesdroppers. Local area networks (LANs) using the 802.11 standard can be easily penetrated by outsiders armed with laptops, wireless cards, external antennae, and hacking software. Hackers use these tools to detect unprotected networks, monitor network traffic, and, in some cases, gain access to the Internet or to corporate networks.

Wi-Fi transmission technology was designed to make it easy for stations to find and hear one another. The service set identifiers (SSIDs) that identify the access points in a Wi-Fi network are broadcast multiple times and can be picked up fairly easily by intruders' sniffer programs (see Figure 8.2). Wireless networks in many locations do not have basic protections against **war driving**,

FIGURE 8.2 WI-FI SECURITY CHALLENGES

Many Wi-Fi networks can be penetrated easily by intruders using sniffer programs to obtain an address to access the resources of a network without authorization.



in which eavesdroppers drive by buildings or park outside and try to intercept wireless network traffic.

An intruder who has associated with an access point by using the correct SSID is capable of accessing other resources on the network. For example, the intruder could use the Windows operating system to determine which other users are connected to the network, access their computer hard drives, and open or copy their files.

Intruders also use the information they have gleaned to set up rogue access points on a different radio channel in physical locations close to users to force a user's radio network interface controller (NIC) to associate with the rogue access point. Once this association occurs, hackers using the rogue access point can capture the names and passwords of unsuspecting users.

Malicious Software: Viruses, Worms, Trojan Horses, and Spyware

Malicious software programs are referred to as **malware** and include a variety of threats such as computer viruses, worms, and Trojan horses. (See Table 8.1.) A **computer virus** is a rogue software program that attaches itself to other software programs or data files to be executed, usually without user knowledge or permission. Most computer viruses deliver a payload. The payload may be relatively benign, such as instructions to display a message or image, or it may be highly destructive—destroying programs or data, clogging computer memory, reformatting a computer's hard drive, or causing programs to run improperly. Viruses typically spread from computer to computer when humans take an action, such as sending an email attachment or copying an infected file.

Worms are independent computer programs that copy themselves from one computer to other computers over a network. Unlike viruses, worms can operate on their own without attaching to other computer program files and rely less on human behavior to spread rapidly from computer to computer. Worms destroy data and programs as well as disrupt or even halt the operation of computer networks.

Worms and viruses are often spread over the Internet from files of downloaded software; from files attached to email transmissions; or from compromised email messages, online ads, or instant messaging. Viruses have also invaded computerized information systems from infected external storage devices or infected machines. Especially prevalent today are **drive-by downloads**,

TABLE 8.1 EXAMPLES OF MALICIOUS CODE

NAME	TYPE	DESCRIPTION
Cryptolocker	Ransomware/Trojan	Hijacks users' photos, videos, and text documents; encrypts them with virtually unbreakable asymmetric encryption; and demands ransom payment for them.
Conficker	Worm	First detected in November 2008 and still a problem. Uses flaws in Windows software to take over machines and link them into a virtual computer that can be commanded remotely. Had nearly 10 million computers worldwide under its control. Difficult to eradicate.
Sasser.ftp	Worm	First appeared in May 2004. Spread over the Internet by attacking random IP addresses. Causes computers to continually crash and reboot and infected computers to search for more victims. Affected millions of computers worldwide and caused an estimated \$14.8 billion to \$18.6 billion in damages.
ILOVEYOU	Virus	First detected on May 3, 2000. Script virus written in Visual Basic script and transmitted as an attachment to email with the subject line ILOVEYOU. Overwrites music, image, and other files with a copy of itself and did an estimated \$10 billion to \$15 billion in damage.

consisting of malware that comes with a downloaded file that a user intentionally or unintentionally requests.

Hackers can do to a smartphone just about anything they can do to any Internet-connected device: request malicious files without user intervention, delete files, transmit files, install programs running in the background to monitor user actions, and potentially convert the smartphone to a robot in a botnet to send email and text messages to anyone. According to IT security experts, mobile devices now pose the greatest security risks, outpacing those from larger computers. Kaspersky Lab reported there were 116.5 million malicious mobile malware attacks in 2018, double the number of the previous year (Kaspersky Lab, 2019).

Android, which is the world's leading mobile operating system, is the mobile platform targeted by most hackers. Mobile device viruses pose serious threats to enterprise computing because so many wireless devices are now linked to corporate information systems.

Blogs, wikis, and social networking sites such as Facebook, Twitter, and LinkedIn have emerged as new conduits for malware. Members are more likely to trust messages they receive from friends, even if this communication is not legitimate. For example, the Facebook Messenger virus is caused by phishing messages sent from a hijacked Facebook account. Malicious spam messages are sent to everybody in the victim's Facebook contact list (2-Spyware, 2020).

The Internet of Things (IoT) introduces additional security challenges from the Internet-linked devices themselves, their platforms and operating systems, their communications, and even the systems to which they're connected. New security tools will be required to protect IoT devices and platforms from both information attacks and physical tampering, to encrypt their communications, and to address new challenges such as attacks that drain batteries. Many IoT devices such as sensors have simple processors and operating systems that may not support sophisticated security approaches.

Many malware infections are Trojan horses. A **Trojan horse** is a software program that appears to be benign but then does something other than expected. The Trojan horse is not itself a virus because it does not replicate, but it is often a way for viruses or other malicious code to be introduced into a computer system. The term *Trojan horse* is based on the huge wooden horse the Greeks used to trick the Trojans into opening the gates to their fortified city during the Trojan War.

An example of a modern-day Trojan horse is the Zeus (Zbot) Trojan, which infected more than 3.6 million computers in 2009 and still poses a threat. It has been used to steal login credentials for banking by surreptitiously capturing people's keystrokes as they use their computers. Zeus is spread mainly through drive-by downloads and phishing, and recent variants have been difficult to eradicate.

SQL injection attacks exploit vulnerabilities in poorly coded web application software to introduce malicious program code into a company's systems and networks. These vulnerabilities occur when a web application fails to validate properly or filter data a user enters on a web page, which might occur when ordering something online. An attacker uses this input validation error to send a rogue SQL query to the underlying database to access the database, plant malicious code, or access other systems on the network. Malware known as **ransomware** is proliferating on both desktop and mobile devices. Ransomware tries to extort money from users by taking control of their computers, blocking access to files, or displaying annoying pop-up messages. For example, in 2019, twenty-two Texas cities were held hostage for millions of dollars after

ransomware called Sodinokibi infiltrated their computer systems and encrypted their data (Fruhlinger 2020). You can get ransomware from downloading an infected attachment, clicking a link inside an email, or visiting the wrong website.

Some types of **spyware** also act as malicious software. These small programs install themselves surreptitiously on computers to monitor user web-surfing activity and serve up advertising. Thousands of forms of spyware have been documented. Many users find such spyware annoying and an infringement on their privacy. Some forms of spyware are especially nefarious. **Keyloggers** record every keystroke made on a computer to steal serial numbers for software, to launch Internet attacks, to gain access to email accounts, to obtain passwords to protected computer systems, or to pick up personal information such as credit card or bank account numbers. The Zeus Trojan described earlier uses keylogging. Other spyware programs reset web browser home pages, redirect search requests, or slow performance by taking up too much computer resources.

Hackers and Computer Crime

A **hacker** is an individual who intends to gain unauthorized access to a computer system. Within the hacking community, the term *cracker* is typically used to denote a hacker with criminal intent, although in the public press, the terms *hacker* and *cracker* are used interchangeably. Hackers gain unauthorized access by finding weaknesses in the security protections websites and computer systems employ. Hacker activities have broadened beyond mere system intrusion to include theft of goods and information as well as system damage and **cyber-vandalism**, the intentional disruption, defacement, or even destruction of a website or corporate information system.

Spoofing and Sniffing

Hackers attempting to hide their true identities often spoof, or misrepresent, themselves by using fake email addresses or masquerading as someone else. **Spoofing** may also involve redirecting a web link to an address different from the intended one, with the site masquerading as the intended destination. For example, if hackers redirect customers to a fake website that looks almost exactly like the true site, they can then collect and process orders, effectively stealing business as well as sensitive customer information from the true site. We will provide more detail about other forms of spoofing in our discussion of computer crime.

A **sniffer** is a type of eavesdropping program that monitors information traveling over a network. When used legitimately, sniffers help identify potential network trouble spots or criminal activity on networks, but when used for criminal purposes, they can be damaging and very difficult to detect. Sniffers enable hackers to steal proprietary information from anywhere on a network, including email messages, company files, and confidential reports.

Denial-of-Service Attacks

In a **denial-of-service (DoS) attack**, hackers flood a network server or web server with many thousands of false communications or requests for services to crash the network. The network receives so many queries that it cannot keep up with them and is thus unavailable to service legitimate requests. A **distributed denial-of-service (DDoS) attack** uses numerous computers to inundate and overwhelm the network from many launch points.

Although DoS attacks do not destroy information or access restricted areas of a company's information systems, they often cause a website to shut down, making it impossible for legitimate users to access the site. For busy e-commerce sites, these attacks are costly; while the site is shut down, customers cannot

make purchases. Especially vulnerable are small and midsize businesses whose networks tend to be less protected than those of large corporations.

Perpetrators of DDoS attacks often use thousands of PCs infected with malicious software without their owners' knowledge and organized into a **botnet**. Hackers create these botnets by infecting other people's computers with bot malware that opens a back door through which an attacker can give instructions to the infected computer. When hackers infect enough computers, they can use the amassed resources of the botnet to launch DDoS attacks, phishing campaigns, or unsolicited spam email.

Ninety percent of the world's spam and 80 percent of the world's malware are delivered by botnets. A recent example is the Mirai botnet, which infected numerous IoT devices (such as Internet-connected surveillance cameras) in October 2016 and then used them to launch a DDoS attack against Dyn, whose servers monitor and reroute Internet traffic. The Mirai botnet overwhelmed the Dyn servers, taking down Etsy, GitHub, Netflix, Shopify, SoundCloud, Spotify, Twitter, and a number of other major websites. A Mirai botnet variant attacked financial firms in January 2018, and Mirai variants are still active.

Computer Crime

Most hacker activities are criminal offenses, and the vulnerabilities of systems we have just described make them targets for other types of **computer crime** as well. Computer crime is defined by the U.S. Department of Justice as "any violations of criminal law that involve a knowledge of computer technology for their perpetration, investigation, or prosecution." Table 8.2 provides examples of the computer as both a target and an instrument of crime.

No one knows the magnitude of computer crime—how many systems are invaded, how many people engage in the practice, or the total economic damage. According to Accenture and the Ponemon Institute's Ninth Annual Cost of Cyber Crime Study, the average annualized cost of cybercrime security for benchmarked organizations was U.S. \$13 million in 2018 (Accenture, 2019).

TABLE 8.2 EXAMPLES OF COMPUTER CRIME

COMPUTERS AS TARGETS OF CRIME

- Breaching the confidentiality of protected computerized data
- Accessing a computer system without authority
- Knowingly accessing a protected computer to commit fraud
- Intentionally accessing a protected computer and causing damage negligently or deliberately
- Knowingly transmitting a program, program code, or command that intentionally causes damage to a protected computer
- Threatening to cause damage to a protected computer

COMPUTERS AS INSTRUMENTS OF CRIME

- Theft of trade secrets
- Unauthorized copying of software or copyrighted intellectual property, such as articles, books, music, and video
- Schemes to defraud
- Using email or messaging for threats or harassment
- Intentionally attempting to intercept electronic communication
- Illegally accessing stored electronic communications, including email and voice mail
- Transmitting or possessing child pornography by using a computer

Many companies are reluctant to report computer crimes because the crimes may involve employees or that publicizing vulnerability will hurt their reputations. The most economically damaging kinds of computer crime are DoS attacks, activities of malicious insiders, and web-based attacks.

Identity Theft

With the growth of the Internet and electronic commerce, identity theft has become especially troubling. **Identity theft** is a crime in which an imposter obtains key pieces of personal information, such as social security numbers, driver's license numbers, or credit card numbers, to impersonate someone else. The information may be used to obtain credit, merchandise, or services in the name of the victim or to provide the thief with false credentials. Identity theft has flourished on the Internet, with credit card files a major target of website hackers. According to the 2020 Identity Fraud Study by Javelin Strategy & Research, identity fraud losses in the United States reached \$16.9 billion in 2019 (Javelin, 2020).

One popular tactic is a form of spoofing called **phishing**. Phishing involves setting up fake websites or sending email messages that look like those of legitimate businesses to ask users for confidential personal data. The email message instructs recipients to update or confirm records by providing social security numbers, bank and credit card information, and other confidential data, either by responding to the email message, by entering the information at a bogus website, or by calling a telephone number. eBay, PayPal, Amazon.com, Walmart, and a variety of banks have been among the top spoofed companies. In a more targeted form of phishing called *spear phishing*, messages appear to come from a trusted source, such as an individual within the recipient's own company or a friend.

Phishing techniques called evil twins and pharming are harder to detect. **Evil twins** are wireless networks that pretend to offer trustworthy Wi-Fi connections to the Internet, such as those in airport lounges, hotels, or coffee shops. The bogus network looks identical to a legitimate public network. Fraudsters try to capture passwords or credit card numbers of unwitting users who log on to the network.

Pharming redirects users to a bogus web page, even when the individual types the correct web page address into his or her browser. This is possible if pharming perpetrators gain access to the Internet address information Internet service providers (ISPs) store to speed up web browsing and flawed software on ISP servers allows the fraudsters to hack in and change those addresses.

According to the Ponemon Institute and IBM Security's 2019 Cost of a Data Breach Report, the total average cost of a data breach among the 507 companies surveyed globally was \$3.92 million (Ponemon, 2019). Moreover, brand damage can be significant although hard to quantify. In addition to the data breaches described in case studies for this chapter, Table 8.3 describes other major data breaches.

The U.S. Congress addressed the threat of computer crime in 1986 with the Computer Fraud and Abuse Act, which makes it illegal to access a computer system without authorization. Most states have similar laws, and nations in Europe have comparable legislation. Congress passed the National Information Infrastructure Protection Act in 1996 to make malware distribution and hacker attacks to disable websites federal crimes.

U.S. legislation, such as the Wiretap Act, Wire Fraud Act, Economic Espionage Act, Electronic Communications Privacy Act, CAN-SPAM Act, and Protect Act of 2003, covers computer crimes involving intercepting electronic

TABLE 8.3 MAJOR DATA BREACHES

DATA BREACH	DESCRIPTION
Marriott	In November 2018, the world's largest hotel company revealed that a hack in the reservation database for its Starwood properties may have exposed the personal information of up to 500 million guests. Exposed data included names, phone numbers, email addresses, passport numbers, date of birth, and credit card numbers. State-sponsored Chinese hackers copied and encrypted data, and took steps toward removing them. In March 2020, Marriott was hacked again after the login credentials of 2 employees were used.
Yahoo	In September and December 2016, Yahoo disclosed that it had been the target of two of the biggest data breaches ever, with sensitive information stolen from more than 1 billion user accounts in 2013 and 500 million in 2014. State-sponsored hackers found a way to forge credentials to log into some users' accounts without a password. These data breaches forced Yahoo to lower its selling price by \$300 million when it was acquired by Verizon in June 2017. In October 2017, Verizon reported that every single Yahoo account had actually been hacked—3 billion accounts, including email, Tumblr, Flickr, and Fantasy.
Danish Tax Administration	A software error in the Danish tax administration's self-service tax portal accidentally exposed the personal identification numbers for 1.26 million Danish citizens, a fifth of the country's total population. The leak was discovered in January 2020 and had gone undetected for 5 years. Every time a user updated account details in the portal's settings section, their personal identification number would be added to the URL, which would then be collected by analytics services running on the site -- in this case, Adobe and Google.
EasyJet	UK budget airline EasyJet announced on May 19, 2020 that a cyberattack may have exposed information belonging to 9 million customers, including over 2,200 credit card records with CVV numbers. The sensitive personal data leaked included full names, email addresses, and travel data that specified departure dates, arrival dates, and booking dates. EasyJet is facing an £18 billion class-action lawsuit filed on behalf of customers impacted by the data breach..

communication, using electronic communication to defraud, stealing trade secrets, illegally accessing stored electronic communications, using email for threats or harassment, and transmitting or possessing child pornography. All 50 U.S. states, the District of Columbia, Guam, Puerto Rico and the Virgin Islands have enacted legislation requiring private or governmental entities to notify individuals of security breaches involving personally identifiable information.

Click Fraud

When you click an ad displayed by a search engine, the advertiser typically pays a fee for each click, which is supposed to direct potential buyers to its products. **Click fraud** occurs when an individual or computer program fraudulently clicks an online ad without any intention of learning more about the advertiser or making a purchase. Click fraud has become a serious problem at Google and other websites that feature pay-per-click online advertising.

Some companies hire third parties (typically from low-wage countries) to click a competitor's ads fraudulently to weaken them by driving up their marketing costs. Click fraud can also be perpetrated with software programs doing the clicking, and botnets are often used for this purpose. Search engines such as Google attempt to monitor click fraud and have made some changes to curb it.

Global Threats: Cyberterrorism and Cyberwarfare

The cyber criminal activities we have described—launching malware, DoS attacks, and phishing probes—are borderless. Attack servers for malware are now hosted in more than 200 countries and territories. The leading sources of malware attacks include the United States, China, Brazil, India, Germany, and Russia. The global nature of the Internet makes it possible for cybercriminals to operate—and to do harm—anywhere in the world.

Internet vulnerabilities have also turned individuals and even entire nation-states into easy targets for politically motivated hacking to conduct sabotage and espionage. **Cyberwarfare** is a state-sponsored activity designed to cripple and defeat another state or nation by penetrating its computers or networks to cause damage and disruption. Examples include efforts of Russian hackers to disrupt U.S. 2016 presidential elections and to penetrate the U.S. power grid. Cyberwarfare also includes defending against these types of attacks.

Cyberwarfare is more complex than conventional warfare. Although many potential targets are military, a country's power grids, dams, financial systems, communications networks, and voting systems can also be crippled. Nonstate actors such as terrorists or criminal groups can mount attacks, and it is often difficult to tell who is responsible. Nations must constantly be on the alert for new malware and other technologies that could be used against them, and some of these technologies developed by skilled hacker groups are openly for sale to interested governments.

Cyberwarfare attacks have become much more widespread, sophisticated, and potentially devastating. Foreign hackers have stolen source code and blueprints to the oil and water pipelines and power grid of the United States and infiltrated the Department of Energy's networks hundreds of times. Over the years, hackers have stolen plans for missile tracking systems, satellite navigation devices, surveillance drones, and leading-edge jet fighters.

According to U.S. intelligence, more than 30 countries are developing offensive cyberattack capabilities, including Russia, China, Iran, and North Korea. Their cyberarsenals include collections of malware for penetrating industrial, military, and critical civilian infrastructure controllers; email lists and text for phishing attacks on important targets; and algorithms for DoS attacks. U.S. cyberwarfare efforts are concentrated in the United States Cyber Command, which coordinates and directs the operations and defense of Department of Defense information networks and prepares for military cyberspace operations. Cyberwarfare poses a serious threat to the infrastructure of modern societies, since their major financial, health, government, and industrial institutions rely on the Internet for daily operations.

Internal Threats: Employees

We tend to think the security threats to a business originate outside the organization. In fact, company insiders pose serious security problems. Studies have found that user lack of knowledge is the single greatest cause of network security breaches. Many employees forget their passwords to access computer systems or allow coworkers to use them, which compromises the system. Malicious intruders seeking system access sometimes trick employees into revealing their passwords by pretending to be legitimate members of the company in need of information. This practice is called **social engineering**.

Insiders bent on harm have also exploited their knowledge of the company to break into corporate systems, including those running in the cloud. The Interactive Session on Technology shows how a former employee at Amazon Web Services used her knowledge of Amazon cloud security to steal many millions of Capital One Financial customer records stored by Amazon's cloud computing service.

INTERACTIVE SESSION TECHNOLOGY

Capital One: A Big Bank Heist from the Cloud

Capital One Financial Corporation is an American bank holding company specializing in credit cards, auto loans, banking, and savings accounts. It is the eleventh largest bank in the United States in terms of assets and an aggressive user of information technology to drive its business. Capital One was an early adopter of cloud computing and a major client of Amazon Web Services (AWS). Capital One has been trying to move more critical parts of its IT infrastructure to Amazon's cloud infrastructure in order to focus on building consumer applications and other needs.

On July 29, 2019, Capital One and its customers received some very bad news. Capital One had been breached, exposing over 140,000 Social Security numbers, 80,000 bank account numbers, tens of millions of credit card applications, and one million Canadian social insurance numbers (equivalent to Social Security numbers in the US). It was one of the largest thefts of data ever from a bank.

The culprit turned out to be Paige Thompson, a former employee of Amazon Web Services, which hosted the Capital One database that was breached. Thompson was arrested in Seattle and charged with one count of computer fraud and abuse. She had worked for the same server business that court papers said Capital One was using. Thompson could face up to five years in prison and a \$250,000 fine.

The bank believed it was unlikely that Thompson disseminated the information or used it for fraud. But it will still cost the bank up to \$150 million, including paying for credit monitoring of affected customers.

Amazon Web Services hosts remote servers that organizations use to store their data. Large enterprises such as Capital One build their own web applications using Amazon's cloud servers and data storage services data so they can use the information for their specific needs.

The F.B.I. agent investigating the breach reported that Ms. Thompson had gained access to Capital One's sensitive data through a "misconfiguration" of a firewall on a web application. (A firewall monitors incoming and outgoing network traffic and blocks unauthorized access.) This allowed her to communicate with the server where

Capital One was storing its data and customer files. Capital One stated it had immediately fixed the configuration vulnerability once it had been detected. Amazon said its customers fully control the applications they build and that it had found no evidence that its underlying cloud services had been compromised.

Thompson was able to access and steal this sensitive information only because Capital One had misconfigured its Amazon server. Thompson could then trick a system in the cloud to uncover the credentials she needed to access Capital One's customer records. Thompson's crime was considered an insider threat, since she had worked at Amazon years earlier. However, outsiders also try to search for and exploit this type of misconfiguration, and server misconfigurations are commonplace. Misconfigurations are also easily fixed, so many do not consider them a breach. Sometimes it's difficult to determine whether tinkering with misconfigurations represents a criminal activity or security research.

Thompson was able to tap into Amazon's metadata service, which has the credentials and other data required to manage servers in the cloud. Ms. Thompson ran a scan of the Internet to identify vulnerable computers that could provide access to a company's internal networks. She found a computer managing communications between Capital One's cloud and the public Internet that had been misconfigured, with weak security settings. Through that opening Thompson was able to request the credentials required to find and read Capital One data stored in the cloud from the metadata service. Once Thompson located the Capital One data, she was able to download them without triggering any alerts. Thompson also boasted online that she had used the same techniques to access large amounts of online data from other organizations.

Amazon has stated that none of its services, including the metadata service, were the cause of the break-in and that AWS offers monitoring tools for detecting this type of incident. It is unclear why none of these alerting tools triggered an alarm when Thompson was hacking into Capital One. Thompson began hacking Capital One on

March 12, 2019, but went undetected until an outside researcher tipped off Capital One 127 days later. According to C. J. Moses, deputy chief information security officer for AWS, Amazon restricts most staff members from accessing its broader internal infrastructure in order to protect against “witting or unwitting” data breaches.

Security professionals have known about misconfiguration problems and the ability to steal credentials from the metadata service since at least 2014. Amazon believes it is the customer’s responsibility to solve them. Some customers have failed to do so. When security researcher Brenton Thomas conducted an Internet scan in February 2019, he found more than 800 Amazon accounts that allowed similar access to the metadata service. (Amazon’s cloud computing service has over one million users.) But Thomas also found other cloud computing companies with misconfigured services as well, including Microsoft’s Azure cloud.

Whatever the cloud service, the pool of talent capable of launching similar attacks is expanding. Given the nature of cloud services, any person who has worked on developing technology at any of the

major cloud computing companies can learn how these systems work in practice.

Capital One had a reputation for strong cloud security. The bank had conducted extensive due diligence before deciding to move to cloud computing in 2015. However, before the giant data breach, Capital One employees had raised concerns internally about high turnover in the company’s cybersecurity unit and tardiness in installing some software to help spot and defend against hacks. The cybersecurity unit is responsible for ensuring Capital One’s firewalls are properly configured and for scanning the Internet for evidence of a data breach. In recent years there have been many changes among senior leaders and staffers. About a third of Capital One’s cybersecurity employees left the company in 2018.

Sources: Robert McMillan, “How the Accused Capital One Hacker Stole Reams of Data from the Cloud,” *Wall Street Journal*, August 4, 2019; Emily Flitter and Karen Weiser, “Capital One Data Breach Compromises Data of Over 100 Million,” *New York Times*, July 29, 2019; James Randle and Catherine Stupp, “Capital One Breach Highlights Dangers of Insider Threats,” *Wall Street Journal*, July 31, 2019. Peter Rudgeair, AnnaMaria Andriotis, and David Benoit, “Capital One Hack Hits the Reputation of a Tech-Savvy Bank,” *Wall Street Journal*, July 31, 2019.

CASE STUDY QUESTIONS

1. What management, organization, and technology factors were responsible for the Capital One hack?
2. Was this an insider hack? Explain your answer.
3. What steps could have been taken to prevent the Capital One hack?
4. Should companies handling sensitive data use cloud computing services? Explain your answer.

Software Vulnerability

Software errors pose a constant threat to information systems, causing untold losses in productivity and sometimes endangering people who use or depend on systems. Growing complexity and size of software programs, coupled with demands for rapid delivery to markets, have contributed to an increase in software flaws or vulnerabilities.

A major problem with software is the presence of hidden **bugs** or program code defects. Studies have shown that it is virtually impossible to eliminate all bugs from large programs. The main source of bugs is the complexity of decision-making code. A relatively small program of several hundred lines will contain tens of decisions leading to hundreds or even thousands of paths. Important programs within most corporations are usually much larger, containing tens of thousands or even millions of lines of code, each with many times the choices and paths of the smaller programs.

Zero defects cannot be achieved in larger programs. Complete testing simply is not possible. Fully testing programs that contain thousands of choices and millions of paths would require thousands of years. Even with rigorous testing,

you would not know for sure that a piece of software was dependable until the product proved itself after much operational use.

Flaws in commercial software not only impede performance but also create security vulnerabilities that open networks to intruders. Each year security firms identify thousands of software vulnerabilities in Internet and PC software. For example, in May 2019 Facebook had to fix a flaw in its WhatsApp encrypted-messsaging app that allowed attackers to install spyware on mobile phones (McMillan, 2019). Especially troublesome are **zero-day vulnerabilities**, which are holes in the software unknown to its creator. Hackers then exploit this security hole before the vendor becomes aware of the problem and hurries to fix it. This type of vulnerability is called *zero-day* because the author of the software has zero days after learning about it to patch the code before it can be exploited in an attack. Sometimes security researchers spot the software holes, but more often, they remain undetected until an attack has occurred.

To correct software flaws once they are identified, the software vendor creates small pieces of software called **patches** to repair the flaws without disturbing the proper operation of the software. It is up to users of the software to track these vulnerabilities, test, and apply all patches. This process is called *patch management*.

Because a company's IT infrastructure is typically laden with multiple business applications, operating system installations, and other system services, maintaining patches on all devices and services a company uses is often time-consuming and costly. Malware is being created so rapidly that companies have very little time to respond between the time a vulnerability and a patch are announced and the time malicious software appears to exploit the vulnerability.

Newly Discovered Vulnerabilities in Microprocessor Design

Recently discovered vulnerabilities such as Spectre and Meltdown stem from flaws in the design of computer microprocessor chips, which enable hackers using malicious software programs to gain access to data that were thought to be completely protected. These vulnerabilities affect nearly every computer chip manufactured in the last 20 years. Major software vendors have rolled out workaround patches, but the only way to truly fix Meltdown and Spectre is to replace the affected processors.

8-2 What is the business value of security and control?

Companies have very valuable information assets to protect. Systems often house confidential information about individuals' taxes, financial assets, medical records, and job performance reviews. They also can contain information on corporate operations, including trade secrets, new product development plans, and marketing strategies. Government systems may store information on weapon systems, intelligence operations, and military targets. These information assets have tremendous value, and the repercussions can be devastating if they are lost, destroyed, or placed in the wrong hands. Systems that are unable to function because of security breaches, disasters, or malfunctioning technology can have permanent impacts on a company's financial health. Some experts believe that 40 percent of all businesses will not recover from application or data losses that are not repaired within three days.

Inadequate security and control may result in serious legal liability. Businesses must protect not only their own information assets but also those of customers,

employees, and business partners. Failure to do so may open the firm to costly litigation for data exposure or theft. An organization can be held liable for needless risk and harm created if the organization fails to take appropriate protective action to prevent loss of confidential information, data corruption, or breach of privacy. For example, U.S. retailer Target had to pay \$39 million to several U.S. banks servicing Mastercard that were forced to reimburse Target customers millions of dollars when those customers lost money due to a massive 2013 hack of Target's payment systems affecting 40 million people. Target also paid \$67 million to Visa for the data hack and \$10 million to settle a class-action lawsuit brought by Target customers. Developing a sound security and control framework that protects business information assets is of critical importance to the entire enterprise, including senior management. It can no longer be limited to the IT department (Rothrock et al., 2018).

Legal and Regulatory Requirements for Electronic Records Management

Government regulations worldwide are forcing companies to take security and control more seriously by mandating the protection of data from abuse, exposure, and unauthorized access. Firms face new legal obligations, such as the General Data Protection Regulation (GDPR) in the EU (see Chapter 4), for the retention and storage of electronic records as well as for privacy protection.

In the U.S., regulations of this type tend to be industry-specific. For instance, the Health Insurance Portability and Accountability Act (**HIPAA**) of 1996 outlines security and privacy rules and procedures for simplifying the administration of healthcare billing and automating the transfer of healthcare data between healthcare providers, payers, and plans. It specifies privacy, security, and electronic transaction standards for healthcare providers handling patient information, requires the retention of patient information for six years, and provides penalties for breaches of medical privacy, disclosure of patient records by email, or unauthorized network access. In the UK, the Records Management Code of Practice for Health and Social Care 2020 supplements the GDPR with specific regulations for managing such records (NHS, 2020).

The U.S. Financial Services Modernization Act of 1999, better known as the **Gramm-Leach-Bliley Act** requires financial institutions to ensure the security and confidentiality of customer data. Data must be stored on a secure medium, and special security measures must be enforced to protect such data on storage media and during transmittal.

The U.S. Public Company Accounting Reform and Investor Protection Act of 2002, better known as the **Sarbanes-Oxley Act**, is designed to protect investors in public companies. It imposes responsibility on companies and their management to safeguard the accuracy and integrity of financial information that is used internally and released externally. One of the Learning Tracks for this chapter discusses Sarbanes-Oxley in detail. In the UK, the Companies Act 2006, the UK Corporate Governance Code, and UK listings rules for public companies impose similar requirements (Hinks, 2020).

Sarbanes-Oxley is fundamentally about ensuring that internal controls are in place to govern the creation and documentation of information in financial statements. Because information systems are used to generate, store, and transport such data, the legislation requires firms to consider information systems security and other controls required to ensure the integrity, confidentiality, and accuracy of their data. Each system application that deals with critical financial reporting data requires controls to make sure the data are accurate. Controls

to secure the corporate network, prevent unauthorized access to systems and data, and ensure data integrity and availability in the event of disaster or other disruption of service are essential as well.

Electronic Evidence and Computer Forensics

Security, control, and electronic records management have become essential for responding to legal actions. Much of the evidence today for stock fraud, embezzlement, theft of company trade secrets, computer crime, and many civil cases is in digital form. In addition to information from printed or typewritten pages, legal cases today increasingly rely on evidence represented as digital data stored on portable storage devices and computer hard disk drives as well as in email, text messages, and e-commerce transactions over the Internet.

In a legal action, a firm is obligated to respond to a discovery request for access to information that may be used as evidence, and the company is required by law to produce those data. The cost of responding to a discovery request can be enormous if the company has trouble assembling the required data or the data have been corrupted or destroyed. Courts now impose severe financial and even criminal penalties for improper destruction of electronic documents.

An effective electronic document retention policy ensures that electronic documents, email, and other records are well organized, accessible, and neither retained too long nor discarded too soon. It also reflects an awareness of how to preserve potential evidence for computer forensics. **Computer forensics** is the scientific collection, examination, authentication, preservation, and analysis of data held on or retrieved from computer storage media in such a way that the information can be used as evidence in a court of law. It deals with the following problems:

- Recovering data from computers while preserving evidential integrity
- Securely storing and handling recovered electronic data
- Finding significant information in a large volume of electronic data
- Presenting the information to a court of law

Electronic evidence may reside on computer storage media in the form of computer files and as *ambient data*, which are not visible to the average user. An example might be a file that has been deleted on a PC hard drive. Data that a computer user may have deleted on computer storage media can often be recovered through various techniques. Computer forensics experts try to recover such hidden data for presentation as evidence.

An awareness of computer forensics should be incorporated into a firm's contingency planning process. The CIO, security specialists, information systems staff, and corporate legal counsel should all work together to have a plan in place that can be executed if a legal need arises. You can find out more about computer forensics in the Learning Tracks for this chapter.

8-3 What are the components of an organizational framework for security and control?

Even with the best security tools, your information systems won't be reliable and secure unless you know how and where to deploy them. You'll need to know where your company is at risk and what controls you must have in place to protect your information systems. You'll also need to develop a security

policy and plans for keeping your business running if your information systems aren't operational.

Information Systems Controls

Information systems controls are both manual and automated and consist of general and application controls. **General controls** govern the design, security, and use of computer programs and the security of data files in general throughout the organization's information technology infrastructure. On the whole, general controls apply to all computerized applications and consist of a combination of hardware, software, and manual procedures that create an overall control environment.

General controls include software controls, physical hardware controls, computer operations controls, data security controls, controls over the systems development process, and administrative controls. Table 8.4 describes the functions of each of these controls.

Application controls are specific controls unique to each computerized application, such as payroll or order processing. They include both automated and manual procedures that ensure that only authorized data are completely and accurately processed by that application. Application controls can be classified as (1) input controls, (2) processing controls, and (3) output controls.

Input controls check data for accuracy and completeness when they enter the system. There are specific input controls for input authorization, data conversion, data editing, and error handling. *Processing controls* establish that data are complete and accurate during updating. *Output controls* ensure that the results of computer processing are accurate, complete, and properly distributed. You can find more detail about application and general controls in our Learning Tracks.

Information systems controls should not be an afterthought. They need to be incorporated into the design of a system and should consider not only how the system will perform under all possible conditions but also the behavior of organizations and people using the system.

TABLE 8.4 GENERAL CONTROLS

TYPE OF GENERAL CONTROL	DESCRIPTION
Software controls	Monitor the use of system software and prevent unauthorized access and use of software programs, system software, and computer programs.
Hardware controls	Ensure that computer hardware is physically secure and check for equipment malfunction. Organizations that are critically dependent on their computers also must make provisions for backup or continued operation to maintain constant service.
Computer operations controls	Oversee the work of the computer department to ensure that programmed procedures are consistently and correctly applied to the storage and processing of data. They include controls over the setup of computer processing jobs and backup and recovery procedures for processing that ends abnormally.
Data security controls	Ensure that valuable business data files maintained internally or by an external hosting service are not subject to unauthorized access, change, or destruction while they are in use or in storage.
Implementation controls	Audit the systems development process at various points to ensure that the process is properly controlled and managed.
Administrative controls	Formalize standards, rules, procedures, and control disciplines to ensure that the organization's general and application controls are properly executed and enforced.

TABLE 8.5 ONLINE ORDER PROCESSING RISK ASSESSMENT

EXPOSURE	PROBABILITY OF OCCURRENCE (%)	LOSS RANGE/AVERAGE (\$)	EXPECTED ANNUAL LOSS (\$)
Power failure	30%	\$5,000–\$200,000 (\$102,500)	\$30,750
Embezzlement	5%	\$1,000–\$50,000 (\$25,500)	\$1,275
User error	98%	\$200–\$40,000 (\$20,100)	\$19,698

Risk Assessment

Before your company commits resources to security and information systems controls, it must know which assets require protection and the extent to which these assets are vulnerable. A risk assessment helps answer these questions and determine the most cost-effective set of controls for protecting assets.

A **risk assessment** determines the level of risk to the firm if a specific activity or process is not properly controlled. Not all risks can be anticipated and measured, but most businesses will be able to acquire some understanding of the risks they face. Business managers working with information systems specialists should try to determine the value of information assets, points of vulnerability, the likely frequency of a problem, and the potential for damage. For example, if an event is likely to occur no more than once a year, with a maximum of a \$1000 loss to the organization, it is not wise to spend \$20,000 on the design and maintenance of a control to protect against that event. However, if that same event could occur at least once a day, with a potential loss of more than \$300,000 a year, \$100,000 spent on a control might be entirely appropriate.

Table 8.5 illustrates sample results of a risk assessment for an online order processing system that processes 30,000 orders per day. The likelihood of each exposure occurring over a one-year period is expressed as a percentage. The next column shows the highest and lowest possible loss that could be expected each time the exposure occurred and an average loss calculated by adding the highest and lowest figures and dividing by two. The expected annual loss for each exposure can be determined by multiplying the average loss by its probability of occurrence.

This risk assessment shows that the probability of a power failure occurring in a one-year period is 30 percent. Loss of order transactions while power is down could range from \$5,000 to \$200,000 (averaging \$102,500) for each occurrence, depending on how long processing is halted. The probability of embezzlement occurring over a yearly period is about 5 percent, with potential losses ranging from \$1,000 to \$50,000 (and averaging \$25,500) for each occurrence. User errors have a 98 percent chance of occurring over a yearly period, with losses ranging from \$200 to \$40,000 (and averaging \$20,100) for each occurrence.

After the risks have been assessed, system builders will concentrate on the control points with the greatest vulnerability and potential for loss. In this case, controls should focus on ways to minimize the risk of power failures and user errors because anticipated annual losses are highest for these areas.

Security Policy

After you've identified the main risks to your systems, your company will need to develop a security policy for protecting the company's assets. A **security policy** consists of statements ranking information risks, identifying acceptable security goals, and identifying the mechanisms for achieving these goals. What are the firm's most important information assets? Who generates and controls

this information in the firm? What existing security policies are in place to protect the information? What level of risk is management willing to accept for each of these assets? Is it willing, for instance, to lose customer credit data once every 10 years? Or will it build a security system for credit card data that can withstand the once-in-a-hundred-years disaster? Management must estimate how much it will cost to achieve this level of acceptable risk.

The security policy drives other policies determining acceptable use of the firm's information resources and which members of the company have access to its information assets. An **acceptable use policy (AUP)** defines acceptable uses of the firm's information resources and computing equipment, including desktop and laptop computers, mobile devices, telephones, and the Internet. A good AUP defines unacceptable and acceptable actions for every user and specifies consequences for noncompliance.

Figure 8.3 is one example of how an organization might specify the access rules for different levels of users in the human resources function. It specifies what portions of a human resource database each user is permitted to access, based on the information required to perform that person's job. The database contains sensitive personal information such as employees' salaries, benefits, and medical histories.

The access rules illustrated here are for two sets of users. One set of users consists of all employees who perform clerical functions, such as inputting employee data into the system. All individuals with this type of profile can update the system but can neither read nor update sensitive fields, such as salary, medical history, or earnings data. Another profile applies to a divisional manager, who cannot update the system but who can read all employee data fields

FIGURE 8.3 ACCESS RULES FOR A PERSONNEL SYSTEM

These two examples represent two security profiles or data security patterns that might be found in a personnel system. Depending on the security profile, a user would have certain restrictions on access to various systems, locations, or data in an organization.

SECURITY PROFILE 1	
User: Personnel Dept. Clerk	
Location: Division 1	
Employee Identification Codes with This Profile:	00753, 27834, 37665, 44116
Data Field Restrictions	Type of Access
All employee data for Division 1 only	Read and Update
• Medical history data	None
• Salary	None
• Pensionable earnings	None

SECURITY PROFILE 2	
User: Divisional Personnel Manager	
Location: Division 1	
Employee Identification Codes with This Profile:	27321
Data Field Restrictions	Type of Access
All employee data for Division 1 only	Read Only

for his or her division, including medical history and salary. We provide more detail about the technologies for user authentication later on in this chapter.

Disaster Recovery Planning and Business Continuity Planning

If you run a business, you need to plan for events, such as power outages, floods, earthquakes, or terrorist attacks, that will prevent your information systems and your business from operating. **Disaster recovery planning** devises plans for the restoration of disrupted computing and communications services. Disaster recovery plans focus primarily on the technical issues involved in keeping systems up and running, such as which files to back up and the maintenance of backup computer systems or disaster recovery services.

For example, MasterCard maintains a duplicate computer center in Kansas City, Missouri, to serve as an emergency backup to its primary computer center in St. Louis. Rather than build their own backup facilities, many firms contract with cloud-based disaster recovery services or firms such as SunGard Availability Services that provide sites with spare computers around the country where subscribing firms can run their critical applications in an emergency.

Business continuity planning focuses on how the company can restore business operations after a disaster strikes. The business continuity plan identifies critical business processes and determines action plans for handling mission-critical functions if systems go down. PricewaterhouseCoopers LLP (PwC) UK has developed business continuity plans to provide resilient and recoverable operations to service its clients in the event of crises such as the collapse of a key supplier, employees off sick in a pandemic, or the failure of a critical system shutting down services. There are continuity plans for how PwC uses technology, operates engagement teams, and utilizes internal PwC services. PwC designed the most important aspects of how it delivers client service to be fault tolerant, minimizing any single-points-of-failure.

Business managers and information technology specialists need to work together on both types of plans to determine which systems and business processes are most critical to the company. They must conduct a business impact analysis to identify the firm's most critical systems and the impact a systems outage would have on the business. Management must determine the maximum amount of time the business can survive with its systems down and which parts of the business must be restored first.

The Role of Auditing

How does management know that information systems security and controls are effective? To answer this question, organizations must conduct comprehensive and systematic audits. An **information systems audit** examines the firm's overall security environment as well as controls governing individual information systems. The auditor should trace the flow of sample transactions through the system and perform tests, using, if appropriate, automated audit software. The information systems audit may also examine data quality.

Security audits review technologies, procedures, documentation, training, and personnel. A thorough audit will even simulate an attack or disaster to test the response of the technology, information systems staff, and business employees.

The audit lists and ranks all control weaknesses and estimates the probability of their occurrence. It then assesses the financial and organizational impact of each threat. Figure 8.4 is a sample auditor's listing of control weaknesses for

FIGURE 8.4 SAMPLE AUDITOR'S LIST OF CONTROL WEAKNESSES

This chart is a sample page from a list of control weaknesses that an auditor might find in a loan system in a local commercial bank. This form helps auditors record and evaluate control weaknesses and shows the results of discussing those weaknesses with management as well as any corrective actions management takes.

Function: Loans Location: Peoria, IL		Prepared by: J. Ericson Date: June 16, 2020	Received by: T. Benson Review date: June 28, 2020	
Nature of Weakness and Impact	Chance for Error/Abuse		Notification to Management	
	Yes/ No	Justification	Report date	Management response
User accounts with missing passwords Network configured to allow some sharing of system files Software patches can update production programs without final approval from Standards and Controls group	Yes	Leaves system open to unauthorized outsiders or attackers	5/10/20	Eliminate accounts without passwords Ensure only required directories are shared and that they are protected with strong passwords
	Yes	Exposes critical system files to hostile parties connected to the network	5/10/20	
	No	All production programs require management approval; Standards and Controls group assigns such cases to a temporary production status		

a loan system. It includes a section for notifying management of such weaknesses and for management's response. Management is expected to devise a plan for countering significant weaknesses in controls.

8-4 What are the most important tools and technologies for safeguarding information resources?

Businesses have an array of technologies for protecting their information resources. They include tools for managing user identities, preventing unauthorized access to systems and data, ensuring system availability, and ensuring software quality.

Identity Management and Authentication

Midsize and large companies have complex IT infrastructures and many systems, each with its own set of users. **Identity management** software automates the process of keeping track of all these users and their system privileges, assigning each user a unique digital identity for accessing each system. It also includes tools for authenticating users, protecting user identities, and controlling access to system resources.

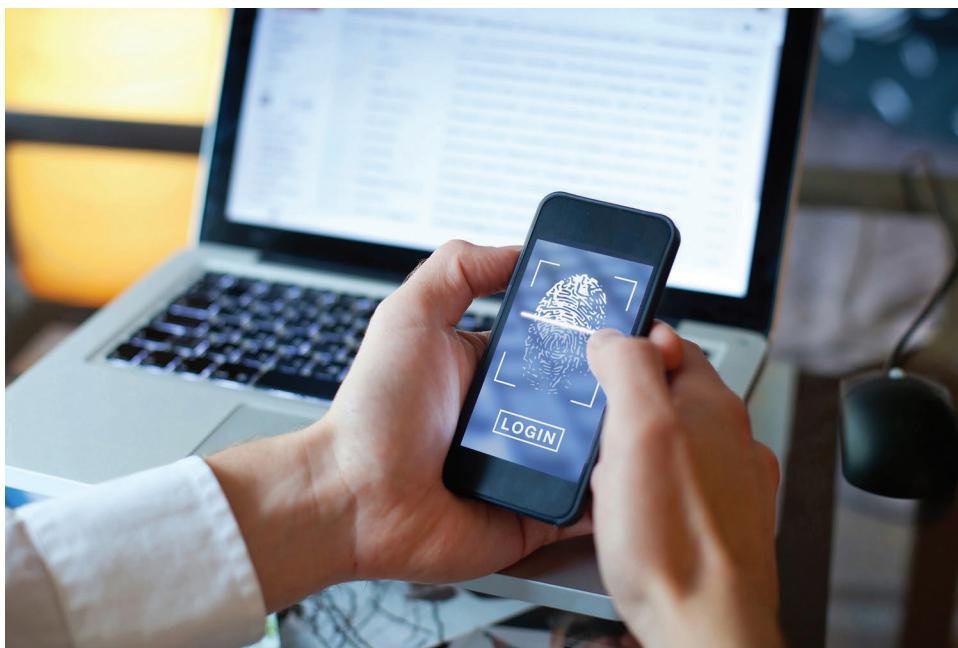
To gain access to a system, a user must be authorized and authenticated. **Authentication** refers to the ability to know that a person is who he or she claims to be. Authentication is often established by using **passwords** known

only to authorized users. An end user uses a password to log on to a computer system and may also use passwords for accessing specific systems and files. However, users often forget passwords, share them, or choose poor passwords that are easy to guess, which compromises security. Password systems that are too rigorous hinder employee productivity. When employees must change complex passwords frequently, they often take shortcuts, such as choosing passwords that are easy to guess or keeping their passwords at their workstations in plain view. Passwords can also be sniffed if transmitted over a network or stolen through social engineering.

New authentication technologies, such as tokens, smart cards, and biometric authentication, overcome some of these problems. A **token** is a physical device, similar to an identification card, that is designed to prove the identity of a single user. Tokens are small gadgets that typically fit on key rings and display passcodes that change frequently. A **smart card** is a device about the size of a credit card that contains a chip formatted with access permission and other data. (Smart cards are also used in electronic payment systems.) A reader device interprets the data on the smart card and allows or denies access.

Biometric authentication uses systems that read and interpret individual human traits, such as fingerprints, irises, and voices to grant or deny access. Biometric authentication is based on the measurement of a physical or behavioral trait that makes each individual unique. It compares a person's unique characteristics, such as the fingerprints, face, voice, or retinal image, against a stored profile of these characteristics to determine any differences between these characteristics and the stored profile. If the two profiles match, access is granted. Fingerprint and facial recognition technologies are just beginning to be used for security applications, with many PC laptops (and some smartphones) equipped with fingerprint identification devices and some models with built-in webcams and face recognition software. Financial service firms such as Vanguard and Fidelity have implemented voice authentication systems for their clients.

The steady stream of incidents in which hackers have been able to access traditional passwords highlights the need for more secure means of authentication. **Two-factor authentication** increases security by validating users through



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This smartphone has a biometric fingerprint reader for fast yet secure access to files and networks. New models of PCs and smartphones are starting to use biometric identification to authenticate users.

a multistep process. To be authenticated, a user must provide two means of identification, one of which is often a physical token, such as a smartcard or chip-enabled bank card, and the other of which is typically data, such as a password or personal identification number (PIN). Biometric data, such as fingerprints, iris prints, or voice prints, can also be used as one of the authenticating mechanisms. A common example of two-factor authentication is a bank card; the card itself is the physical item, and the PIN is the other piece of data that goes with it.

Firewalls, Intrusion Detection Systems, and Anti-malware Software

Without protection against malware and intruders, connecting to the Internet would be very dangerous. Firewalls, intrusion detection systems, and anti-malware software have become essential business tools.

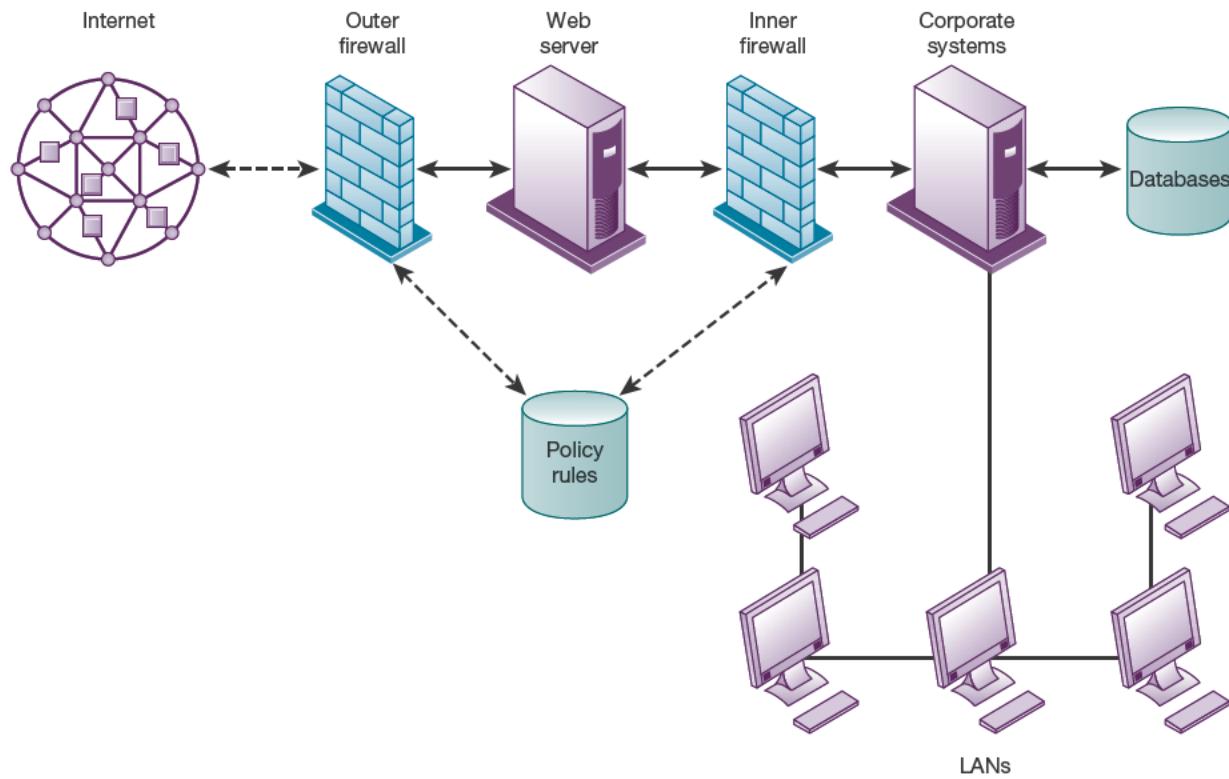
Firewalls

Firewalls prevent unauthorized users from accessing private networks. A firewall is a combination of hardware and software that controls the flow of incoming and outgoing network traffic. It is generally placed between the organization's private internal networks and distrusted external networks, such as the Internet, although firewalls can also be used to protect one part of a company's network from the rest of the network (see Figure 8.5).

The firewall acts like a gatekeeper that examines each user's credentials before it grants access to a network. The firewall identifies names, IP addresses, applications, and other characteristics of incoming traffic. It checks this

FIGURE 8.5 A CORPORATE FIREWALL

The firewall is placed between the firm's private network and the public Internet or another distrusted network to protect against unauthorized traffic.



information against the access rules that the network administrator has programmed into the system. The firewall prevents unauthorized communication into and out of the network.

In large organizations, the firewall often resides on a specially designated computer separate from the rest of the network, so no incoming request directly accesses private network resources. There are a number of firewall screening technologies, including static packet filtering, stateful inspection, Network Address Translation, and application proxy filtering. They are frequently used in combination to provide firewall protection.

Packet filtering examines selected fields in the headers of data packets flowing back and forth between the trusted network and the Internet, examining individual packets in isolation. This filtering technology can miss many types of attacks.

Stateful inspection provides additional security by determining whether packets are part of an ongoing dialogue between a sender and a receiver. It sets up state tables to track information over multiple packets. Packets are accepted or rejected based on whether they are part of an approved conversation or attempting to establish a legitimate connection.

Network Address Translation (NAT) can provide another layer of protection when static packet filtering and stateful inspection are employed. NAT conceals the IP addresses of the organization's internal host computer(s) to prevent sniffer programs outside the firewall from ascertaining them and using that information to penetrate internal systems.

Application proxy filtering examines the application content of packets. A proxy server stops data packets originating outside the organization, inspects them, and passes a proxy to the other side of the firewall. If a user outside the company wants to communicate with a user inside the organization, the outside user first communicates with the proxy application, and the proxy application communicates with the firm's internal computer. Likewise, a computer user inside the organization goes through the proxy to talk with computers on the outside.

To create a good firewall, an administrator must maintain detailed internal rules identifying the people, applications, or addresses that are allowed or rejected. Firewalls can deter, but not completely prevent, network penetration by outsiders and should be viewed as one element in an overall security plan.

Intrusion Detection Systems

In addition to firewalls, commercial security vendors now provide intrusion detection tools and services to protect against suspicious network traffic and attempts to access files and databases. **Intrusion detection systems** feature full-time monitoring tools placed at the most vulnerable points or hot spots of corporate networks to detect and deter intruders continually. The system generates an alarm if it finds a suspicious or anomalous event. Scanning software looks for patterns indicative of known methods of computer attacks such as bad passwords, checks to see whether important files have been removed or modified, and sends warnings of vandalism or system administration errors. The intrusion detection tool can also be customized to shut down a particularly sensitive part of a network if it receives unauthorized traffic.

Anti-malware Software

Defensive technology plans for both individuals and businesses must include anti-malware protection for every computer. **Anti-malware software** prevents, detects, and removes malware, including computer viruses, computer worms,

Trojan horses, spyware, and adware. However, most anti-malware software is effective only against malware already known when the software was written. To remain effective, the software must be continually updated. Even then it is not always effective because some malware can evade detection. Organizations need to use additional malware detection tools for better protection.

Unified Threat Management Systems

To help businesses reduce costs and improve manageability, security vendors have combined into a single appliance various security tools, including firewalls, virtual private networks, intrusion detection systems, and web content filtering and anti-spam software. These comprehensive security management products are called **unified threat management (UTM)** systems. UTM products are available for all sizes of networks. Leading UTM vendors include Fortinet, Sophos, and Check Point, and networking vendors such as Cisco Systems and Juniper Networks provide some UTM capabilities in their products.

Securing Wireless Networks

The initial security standard developed for Wi-Fi, called Wired Equivalent Privacy (WEP), is not very effective because its encryption keys are relatively easy to crack. WEP provides some margin of security, however, if users remember to enable it. Corporations can further improve Wi-Fi security by using it in conjunction with virtual private network (VPN) technology when accessing internal corporate data.

In June 2004, the Wi-Fi Alliance industry trade group finalized the 802.11i specification (also referred to as Wi-Fi Protected Access 2 or WPA2) that replaces WEP with stronger security standards. Instead of the static encryption keys used in WEP, the new standard uses much longer keys that continually change, making them harder to crack. The most recent specification is WPA3, introduced in 2018.

Encryption and Public Key Infrastructure

Many businesses use encryption to protect digital information that they store, physically transfer, or send over the Internet. **Encryption** is the process of transforming plain text or data into cipher text that cannot be read by anyone other than the sender and the intended receiver. Data are encrypted by using a secret numerical code, called an encryption key, that transforms plain data into cipher text. The message must be decrypted by the receiver.

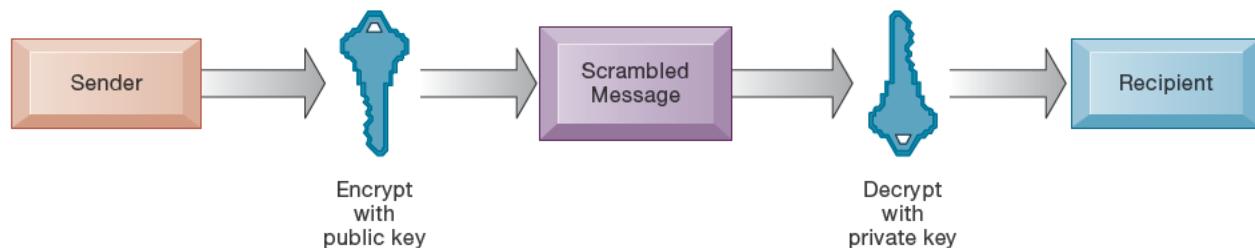
Two methods for encrypting network traffic on the web are SSL and S-HTTP. **Secure Sockets Layer (SSL)** and its successor, Transport Layer Security (TLS), enable client and server computers to manage encryption and decryption activities as they communicate with each other during a secure web session. **Secure Hypertext Transfer Protocol (S-HTTP)** is another protocol used for encrypting data flowing over the Internet, but it is limited to individual messages, whereas SSL and TLS are designed to establish a secure connection between two computers.

The capability to generate secure sessions is built into Internet client browser software and servers. The client and the server negotiate what key and what level of security to use. Once a secure session is established between the client and the server, all messages in that session are encrypted.

Two methods of encryption are symmetric key encryption and public key encryption. In symmetric key encryption, the sender and receiver establish a

FIGURE 8.6 PUBLIC KEY ENCRYPTION

A public key encryption system can be viewed as a series of public and private keys that lock data when they are transmitted and unlock data when they are received. The sender locates the recipient's public key in a directory and uses it to encrypt a message. The message is sent in encrypted form over the Internet or a private network. When the encrypted message arrives, the recipient uses his or her private key to decrypt the data and read the message.



secure Internet session by creating a single encryption key and sending it to the receiver so both the sender and receiver share the same key. The strength of the encryption key is measured by its bit length. Today, a typical key will be 56 to 256 bits long (a string of from 56 to 256 binary digits) depending on the level of security desired. The longer the key, the more difficult it is to break the key. The downside is that the longer the key, the more computing power it takes for legitimate users to process the information.

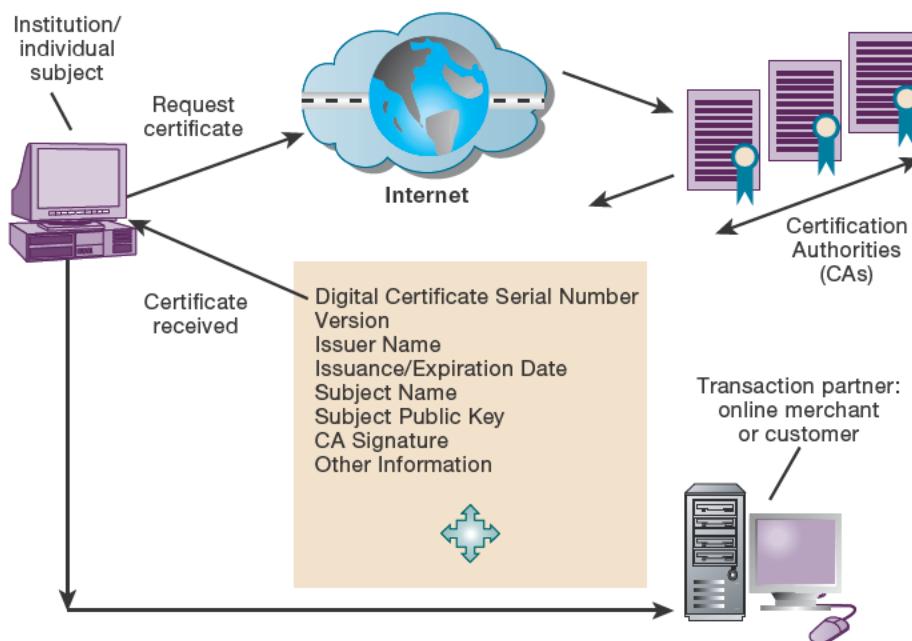
The problem with all symmetric encryption schemes is that the key itself must be shared somehow among the senders and receivers, which exposes the key to outsiders who might just be able to intercept and decrypt the key. A more secure form of encryption called **public key encryption** uses two keys: one shared (or public) and one totally private as shown in Figure 8.6. The keys are mathematically related so that data encrypted with one key can be decrypted using only the other key. To send and receive messages, communicators first create separate pairs of private and public keys. The public key is kept in a directory, and the private key must be kept secret. The sender encrypts a message with the recipient's public key. On receiving the message, the recipient uses his or her private key to decrypt it.

Digital certificates are data files used to establish the identity of users and electronic assets for protection of online transactions (see Figure 8.7). A digital certificate system uses a trusted third party, known as a certificate authority (CA), to validate a user's identity. There are many CAs in the United States and around the world, including Symantec, GoDaddy, and Comodo.

The CA verifies a digital certificate user's identity offline. This information is put into a CA server, which generates an encrypted digital certificate containing owner identification information and a copy of the owner's public key. The certificate authenticates that the public key belongs to the designated owner. The CA makes its own public key available either in print or perhaps on the Internet. The recipient of an encrypted message uses the CA's public key to decode the digital certificate attached to the message, verifies it was issued by the CA, and then obtains the sender's public key and identification information contained in the certificate. By using this information, the recipient can send an encrypted reply. The digital certificate system would enable, for example, a credit card user and a merchant to validate that their digital certificates were issued by an authorized and trusted third party before they exchange data. **Public key infrastructure (PKI)**, the use of public key cryptography working with a CA, is now widely used in e-commerce.

FIGURE 8.7 DIGITAL CERTIFICATES

Digital certificates help establish the identity of people or electronic assets. They protect online transactions by providing secure, encrypted, online communication.



Securing Transactions with Blockchain

Blockchain, which we introduced in Chapter 6, is gaining attention as an alternative approach for securing transactions and establishing trust among multiple parties. A blockchain is a chain of digital “blocks” that contain records of transactions. Each block is connected to all the blocks before and after it, and the blockchains are continually updated and kept in sync. This makes it difficult to tamper with a single record because one would have to change the block containing that record as well as those linked to it to avoid detection.

Once recorded, a blockchain transaction cannot be changed. The records in a blockchain are secured through cryptography, and all transactions are encrypted. Blockchain network participants have their own private keys that are assigned to the transactions they create and act as a personal digital signature. If a record is altered, the signature will become invalid, and the blockchain network will know immediately that something is amiss. Because blockchains aren’t contained in a central location, they don’t have a single point of failure and cannot be changed from a single computer. Researchers point out, however, that blockchain is vulnerable in some of the same ways as conventional, centralized record-keeping systems. Blockchain systems still need careful attention to security and control as do other systems with high security requirements (Madnick, 2020).

Ensuring System Availability

As companies increasingly rely on digital networks for revenue and operations, they need to take additional steps to ensure that their systems and applications are always available. Firms such as those in the airline and

financial services industries with critical applications requiring online transaction processing have traditionally used fault-tolerant computer systems for many years to ensure 100 percent availability. In **online transaction processing**, transactions entered online are immediately processed by the computer. Multitudinous changes to databases, reporting, and requests for information occur each instant.

Fault-tolerant computer systems contain redundant hardware, software, and power supply components that create an environment that provides continuous, uninterrupted service. Fault-tolerant computers use special software routines or self-checking logic built into their circuitry to detect hardware failures and automatically switch to a backup device. Parts from these computers can be removed and repaired without disruption to the computer or downtime. **Downtime** refers to periods of time in which a system is not operational.

Security Outsourcing

Many companies, especially small businesses, lack the resources or expertise to provide a secure high-availability computing environment on their own. They can outsource many security functions to **managed security service providers (MSSPs)** that monitor network activity and perform vulnerability testing and intrusion detection. SecureWorks, AT&T, Verizon, IBM, Perimeter eSecurity, and Symantec are leading providers of MSSP services.

Achieving Digital Resiliency

Today's organizations are much more hypernetworked and interconnected than in the past, with important parts of their IT infrastructures maintained remotely in the cloud, managed by outsiders, and accessible by mobile devices. Firms are embracing the concept of **digital resiliency** to deal with the realities of this new digital environment. Digital resiliency deals with how to maintain and increase the resilience of an organization and its business processes in an all-pervasive digital environment, not just the resiliency of the IT function. In addition to computing, storage, and networking technologies, digital resiliency calls attention to managerial and organizational issues such as corporate policies and goals, business processes, organizational culture, business requirements, accountability, and business risk management. These factors can affect how well an organization can actually utilize and manage network connectivity, applications, databases, and data centers, its ability to provide 24/7 availability for business, and its ability to respond to changing business conditions. A single weak link in this chain can cause an outage or prevent the firm from responding to new challenges and opportunities, if resiliency has not been explicitly designed in, measured, and tested.

For example, many companies whose employees were required to work at home in the spring of 2020 to avoid exposure to the coronavirus were unsure of whether they had enough server capacity to support thousands more people working remotely. Had they used a digital resiliency approach, this contingency would have been better anticipated and planned for.

The Interactive Session on Management illustrates how PayPal, a heavily technology-driven business, was able to increase its digital resiliency by paying more attention to measuring the operational effectiveness of its data center teams and the reduction of employee errors.

INTERACTIVE SESSION MANAGEMENT

PayPal Ups Its Digital Resiliency

PayPal Holdings, Inc. is an American company operating a worldwide online payments system that supports online money transfers and serves as an electronic alternative to traditional payment methods like checks and money orders. The company operates as a payment processor for online vendors, auction sites, and many other commercial users. You've probably used PayPal if you've bought something from eBay or from an e-commerce website. It is a very well-established and widely accepted payment system. As of the first quarter of 2020, PayPal had 325 million active users. In 2019, PayPal processed 12.4 billion payment transactions and generated \$17.77 billion in revenue.

Obviously this is a company that has to work vigilantly to make its services ultrasecure and available 24/7 throughout the world, and PayPal maintains very high standards of security and reliability. But management wanted to make sure the company was doing the best job possible, so it turned to Uptime Institute to evaluate the way PayPal ran its data centers and its level of digital resiliency. Uptime Institute is a consulting group focusing on improving the performance, efficiency, and reliability of business critical infrastructure through innovation, collaboration, and independent performance certifications.

Although data centers try to operate sites full of cost-saving technologies and innovative new approaches, they still struggle with the ongoing performance and reliability of these sites due to the operational plans in place. Various levels of staffing and experience along with limited or inaccurate written documentation of operational processes create inconsistent behaviors and service outages.

Uptime Institute had found that the majority of reported data center outages are directly related to human error. This could be operator error or management error in its decisions regarding staffing, maintenance, training, or overall rigor of operation. With human error responsible for so many data center incidents, organizations need to take a more holistic approach to staffing, organizational practices, maintenance and operations activities, management, and planning.

Sean Tugwell, PayPal's Director of Data Center Architecture and Engineering, wanted to make sure his company had achieved a high level of digital resilience and 99.999 percent availability across all data centers. He also wanted to make sure the colos working with PayPal were sufficiently resilient as well. (A colocation data center, often referred to as a "colo," is a large data center facility that rents out rack space to other businesses for their servers or other computing equipment.)

Uptime Institute's M&O Assessment measures the operational effectiveness of the teams within a data center, focusing on five behaviors that should be proactive, practiced, and informed. These behaviors apply to staffing and organization, maintenance, training, planning, coordination and management, and operating conditions. In early 2018, PayPal received Uptime Institute's M&O Stamp of Approval for its PHX01 data center, earning a very high first-time score of 96.2 percent. Several other PayPal data centers received high first-time scores of 100 percent, further indicating that PayPal had a high level of data center sophistication and maturity.

PayPal also scored well in its implementation of the Service Now platform, which is used for improving procedural approval workflows, maintenance management for critical data center infrastructure, incident management, and space and power planning. One area where PayPal shined was its approach to staffing and organization. Its Facilities Operations group has at least three facilities technicians on site at all times, and these technicians undergo rigorous training to ensure they have comprehensive and in-depth knowledge of a variety of systems and equipment.

PayPal's Facilities Operations group is also responsible for preventive and corrective maintenance at a data center. The group creates and implements on-site maintenance standards and procedures to make sure data center maintenance work is successfully completed and documented. In this area, too, PayPal scored very well—all its data centers had no items for deferred maintenance. PayPal's Preventive Maintenance Program helps the company keep equipment in like-new condition.

New hires at PayPal's Facility Operations Team are required to complete an initial training program before they are allowed to work on shift. PayPal also has a training program for vendors who will be performing on-site maintenance.

To promote effective planning, coordination, and management that will result in greater uptime, PayPal has developed various procedures and standards, which are available in its ServiceNow Knowledge Base. This helps promote consistency across all of PayPal's data centers, and also reduces the chance for human error at each site. PayPal's financial team creates, reviews, and tracks budgets to ensure the budget for each data center is appropriate for supporting the firm's business objectives.

Consistency has become even more important for PayPal as it uses more colocation companies to add to its computing capacity. PayPal was able to use the M&O Stamp of Approval program to evaluate its colocation data center vendors. New vendor contracts now require that a data center vendor achieve Uptime Institute's M&O Stamp of Approval and maintain that rating as long as PayPal is a customer.

A high priority for PayPal's Data Center Services Team is reducing business costs. Any data center

downtime, whether from a company data center or colo, creates a loss to the business, in terms of number of transactions processed, customer service, and the time and resources required to solve the downtime problem. Uptime Institute's M&O Stamp of Approval promotes this goal, and also helps teams make sure that there are no surprises when new teams and operational practices are introduced to the company.

Given the critical importance of digital resiliency, in addition to its M&O Assessment, Uptime Institute has also recently introduced a Digital Resiliency Assessment program. This program specifically focuses on the resiliency of a firm's internal and cloud-based digital infrastructure, spanning its end users, networks, applications, databases, and data centers, to identify any weak links in the chain and validate the resiliency of the entire system.

Sources: Uptime Institute, "Digital Infrastructure Resiliency Assessment," and "PayPal," www.uptimeinstitute.com, accessed March 24, 2020; Craig Smith, "Amazing PayPal Statistics and Facts (2020) by the Numbers," DMR, March 12, 2020; and investor.paypal.com, accessed March 23, 2020.

CASE STUDY QUESTIONS

1. Why is digital resiliency so important for a company such as PayPal?
2. How did PayPal benefit from measuring its digital resiliency? What issues did it address?
3. What is the role of management and organizational issues in making an organization's IT infrastructure more resilient?

Security Issues for Cloud Computing and the Mobile Digital Platform

Although cloud computing and the emerging mobile digital platform have the potential to deliver powerful benefits, they pose new challenges to system security and reliability. We now describe some of these challenges and how they should be addressed.

Security in the Cloud

When processing takes place in the cloud, accountability and responsibility for protection of sensitive data still reside with the company owning that data. Using the public cloud disrupts traditional cybersecurity models that many companies have built up over years. As companies make use of the public cloud, they need to revise their cybersecurity practices in order to consume public-cloud services in a way that enables them both to protect critical data and to fully exploit the speed and agility that these services provide.

Managing security and privacy for cloud services is similar to managing traditional IT infrastructures. However, the risks may be different because some, but not all, responsibilities shift to the cloud service provider. The category of cloud service (IaaS, PaaS, or SaaS) affects exactly how these responsibilities are shared. For IaaS, the provider typically supplies and is responsible for securing basic IT resources such as machines, storage systems, and networks. The cloud services customer is typically responsible for its operating system, applications, and corporate data placed into the cloud computing environment. This means that most of the responsibility for securing the applications and the corporate data falls on the customer.

Cloud service customers should carefully review their cloud services agreement with their cloud provider to make sure their applications and data hosted in cloud services are secured in accordance with their security and compliance policies. However, although many organizations know how to manage security for their own data center—they're unsure of exactly what they need to do when they shift computing work to the cloud. They need new tool sets and skill sets to manage cloud security from their end to configure and launch cloud instances, manage identity and access controls, update security controls to match configuration changes, and protect workloads and data. There's a misconception among many IT departments that whatever happens in the cloud is not their responsibility. It is essential to update security requirements developed for enterprise data centers to produce requirements suitable for the use of cloud services.

Cloud computing is highly distributed. Cloud applications reside in large remote data centers and server farms that supply business services and data management for multiple corporate clients. To save money and keep costs low, cloud computing providers often distribute work to data centers around the globe where work can be accomplished most efficiently.

Cloud users need to confirm that regardless of where their data are stored, they are protected at a level that meets their corporate requirements. They should stipulate that the cloud provider store and process data in specific jurisdictions according to the privacy rules of those jurisdictions. Cloud clients should find how the cloud provider segregates their corporate data from those of other companies and ask for proof that encryption mechanisms are sound. It's also important to know how the cloud provider will respond if a disaster strikes, whether the provider will be able to restore your data completely, and how long this should take. Cloud users should also ask whether cloud providers will submit to external audits and security certifications. These kinds of controls can be written into the service level agreement (SLA) before signing with a cloud provider. The Cloud Security Alliance (CSA) has created industrywide standards for cloud security, specifying best practices to secure cloud computing.

Securing Mobile Platforms

If mobile devices are performing many of the functions of computers, they need to be secured like desktops and laptops against malware, theft, accidental loss, unauthorized access, and hacking attempts. Mobile devices accessing corporate systems and data require special protection. Companies should make sure that their corporate security policy includes mobile devices, with additional details on how mobile devices should be supported, protected, and used. They will need mobile device management tools to authorize all devices in use; to maintain accurate inventory records on all mobile devices, users, and applications; to control updates to applications; and to lock down or erase lost or stolen devices so they can't be compromised. Data loss prevention technology can identify where critical data are saved, who is accessing the data, how data

are leaving the company, and where the data are going. Firms should develop guidelines stipulating approved mobile platforms and software applications as well as the required software and procedures for remote access of corporate systems. The organization's mobile security policy should forbid employees from using unsecured, consumer-based applications for transferring and storing corporate documents and files or sending such documents and files to oneself by email without encryption. Companies should encrypt communication whenever possible. All mobile device users should be required to use the password feature found in every smartphone.

Ensuring Software Quality

In addition to implementing effective security and controls, organizations can improve system quality and reliability by employing software metrics and rigorous software testing. Software metrics are objective assessments of the system in the form of quantified measurements. Ongoing use of metrics allows the information systems department and end users to measure the performance of the system jointly and identify problems as they occur. Examples of software metrics include the number of transactions that can be processed in a specified unit of time, online response time, the number of payroll checks printed per hour, and the number of known bugs per hundred lines of program code. For metrics to be successful, they must be carefully designed, formal, objective, and used consistently.

Early, regular, and thorough testing will contribute significantly to system quality. Many view testing as a way to prove the correctness of work they have done. In fact, we know that all sizable software is riddled with errors, and we must test to uncover these errors.

Good testing begins before a software program is even written, by using a *walkthrough*—a review of a specification or design document by a small group of people carefully selected based on the skills needed for the particular objectives being tested. When developers start writing software programs, coding walkthroughs can also be used to review program code. However, code must be tested by computer runs. When errors are discovered, the source is found and eliminated through a process called *debugging*. You can find out more about the various stages of testing required to put an information system into operation in Chapter 13. Our Learning Tracks also contain descriptions of methodologies for developing software programs that contribute to software quality.

8-5 How will MIS help my career?

Here is how Chapter 8 and this book can help you find an entry-level job as an identity access and management support specialist.



The Company

Value Supermarkets, a major supermarket grocery store chain headquartered in the UK, is looking to fill an entry-level position for an identity access and management support specialist. The company has over 100 stores, more than 5,000 workers, and nearly a million monthly shoppers.

Position Description

The identity access and management support specialist will be responsible for monitoring the company's identity management system to ensure that the company is meeting its audit and compliance controls. This position reports to the company's security operations manager. Job responsibilities include:

- Performing data integrity testing of identity management system integrations with business applications.
- Integrating Windows Active Directory files with the identity management system.
- Maintaining information on system user roles and privileges.

Job Requirements

- Bachelor's degree
- Proficiency with computers
- Ability to multitask and work independently
- Attention to detail
- Strong time management skills
- Ability to communicate with both technical and nontechnical staff

Interview Questions

1. What do you know about authentication and identity management? Have you ever worked with identity management or other IT security systems? What did you do with this software?
2. Have you ever worked with Windows Active Directory? What exactly did you do with this software?
3. What knowledge and experience do you have with ensuring data integrity?
4. Can you give an example of a situation where you had to multitask and manage your time and how you handled it?
5. Can you tell us about the computer experience you've had? What software tools have you worked with?

Author Tips

1. Review the last two sections of this chapter, especially the discussions of identity management and authentication. Also review the Chapter 6 discussions of data integrity and data quality.
2. Use the web to find out more about identity management, data integrity testing, leading identity management software tools, and Windows Active Directory.
3. Use the web to find out more about the company, the kinds of systems it uses, and who might be using those systems.

REVIEW SUMMARY

8-1 Why are information systems vulnerable to destruction, error, and abuse?

Digital data are vulnerable to destruction, misuse, error, fraud, and hardware or software failures. The Internet is designed to be an open system and makes internal corporate systems more vulnerable to actions from outsiders. Hackers can unleash denial-of-service (DoS) attacks or penetrate corporate networks, causing serious system disruptions. Wi-Fi networks can easily be penetrated by intruders using sniffer programs to obtain an address to access the resources of the network. Malware can disable systems and websites, with mobile devices a major target. The dispersed nature of cloud computing makes it difficult to track unauthorized activity or to apply controls from afar. Software presents problems because software bugs may be impossible to eliminate and because software vulnerabilities can be exploited by hackers and malicious software. End users often introduce errors.

8-2 What is the business value of security and control?

Lack of sound security and control can cause firms relying on computer systems for their core business functions to lose sales and productivity. Information assets, such as confidential employee records, trade secrets, or business plans, lose much of their value if they are revealed to outsiders or if they expose the firm to legal liability. Laws, such as HIPAA, the Sarbanes-Oxley Act, and the Gramm-Leach-Bliley Act, require companies to practice stringent electronic records management and adhere to strict standards for security, privacy, and control. Legal actions requiring electronic evidence and computer forensics also require firms to pay more attention to security and electronic records management.

8-3 What are the components of an organizational framework for security and control?

Firms need to establish a good set of both general and application controls for their information systems. A risk assessment evaluates information assets, identifies control points and control weaknesses, and determines the most cost-effective set of controls. Firms must also develop a coherent corporate security policy and plans for continuing business operations in the event of disaster or disruption. The security policy includes policies for acceptable use and identity management. Comprehensive and systematic information systems auditing helps organizations determine the effectiveness of security and controls for their information systems.

8-4 What are the most important tools and technologies for safeguarding information resources?

Firewalls prevent unauthorized users from accessing a private network when it is linked to the Internet. Intrusion detection systems monitor private networks for suspicious network traffic and attempts to access corporate systems. Passwords, tokens, smart cards, and biometric authentication are used to authenticate system users. Anti-malware software checks computer systems for infections by viruses and worms and often eliminates the malicious software. Encryption, the coding and scrambling of messages, is a widely used technology for securing electronic transmissions over unprotected networks. Blockchain technology enables companies to create and verify tamperproof transactions on a network without a central authority. Digital certificates combined with public key encryption provide further protection of electronic transactions by authenticating a user's identity. Companies can use fault-tolerant computer systems to make sure that their information systems are always available. Use of software metrics and rigorous software testing help improve software quality and reliability.

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MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

8-1 Why are information systems vulnerable to destruction, error, and abuse?

- List and describe the most common threats against contemporary information systems.
- Define malware and distinguish among a virus, a worm, and a Trojan horse.
- Define a hacker and explain how hackers create security problems and damage systems.
- Define computer crime. Provide two examples of crime in which computers are targets and two examples in which computers are used as instruments of crime.
- Define identity theft and phishing and explain why identity theft is such a big problem today.
- Describe the security and system reliability problems employees create.
- Explain how software defects affect system reliability and security.

8-2 What is the business value of security and control?

- Explain how inadequate security and control may result in serious legal liability.

- Define the term electronic evidence and explain its importance.

8-3 What are the components of an organizational framework for security and control?

- Define general controls and describe each type of general control.
- Define application controls and describe each type of application control.
- Describe the function of risk assessment and explain how it is conducted for information systems.
- Define and describe the following: security policy, acceptable use policy, and identity management.
- Explain how information systems auditing promotes security and control.

8-4 What are the most important tools and technologies for safeguarding information resources?

- Describe the nature of a token in the context of authentication.
- Describe how two-factor authentication can help to reduce fraud, hacking, and security breaches.

- Explain how an intrusion detection system works.
- Explain why an organization might choose to use a unified threat management system.
- Explain how a digital certificate works and why it might give a site visitor a greater sense of security.
- Explain why small businesses in particular might opt to use managed security service providers.
- Explain how employing software metrics can improve system quality and reliability.

Discussion Questions

- 8-5** Security isn't simply a technology issue, it's a business issue. Discuss. MyLab MIS
- 8-6** If you were developing a business continuity plan for your company, where would you start? What aspects of the business would the plan address? MyLab MIS
- 8-7** Suppose your business had an e-commerce website where it sold goods and accepted credit card payments. Discuss the major security threats to this website and their potential impact. What can be done to minimize these threats? MyLab MIS

Hands-On MIS Projects

The projects in this section give you hands-on experience analyzing security vulnerabilities, using spreadsheet software for risk analysis, and using web tools to research security outsourcing services. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 8-8** VidHongKong is planning a new Internet venture for renting and watching movies online. Their planned solution comprises a newly built web portal, a new database for keeping records of movies, movie rentals, and customers; a new CRM system; and specialized software for connecting the new system to their existing information system. Perform a security analysis for the new venture. Consider examples of risks for the new website, the new database, the new CRM system, the link to the existing information system, and the end products (the movies).
- 8-9** A survey of your firm's IT infrastructure has identified a number of security vulnerabilities. Review the data about these vulnerabilities, which can be found in a table in MyLab MIS. Use the table to answer the following questions:
- Calculate the total number of vulnerabilities for each platform. What is the potential impact on the organization of the security problems for each computing platform?
 - If you only have one information systems specialist in charge of security, which platforms should you address first in trying to eliminate these vulnerabilities? Second? Third? Last? Why?
 - Identify the types of control problems these vulnerabilities illustrate and explain the measures that should be taken to solve them.
 - What does your firm risk by ignoring the security vulnerabilities identified?

Improving Decision Making: Using Spreadsheet Software to Perform a Security Risk Assessment

Software skills: Spreadsheet formulas and charts

Business skills: Risk assessment

- 8-10** This project uses spreadsheet software to calculate anticipated annual losses from various security threats identified for a small company.
- Mercer Paints is a paint manufacturing company located in Alabama that uses a network to link its business operations. A security risk assessment that management requested identified a number of potential exposures. These exposures, their associated probabilities, and average losses are summarized in a table, which can be found in MyLab MIS. Use the table to answer the following questions:

- In addition to the potential exposures listed, identify at least three other potential threats to Mercer Paints, assign probabilities, and estimate a loss range.
- Use spreadsheet software and the risk assessment data to calculate the expected annual loss for each exposure.
- Present your findings in the form of a chart. Which control points have the greatest vulnerability? What recommendations would you make to Mercer Paints? Prepare a written report that summarizes your findings and recommendations.

Improving Decision Making: Evaluating Security Outsourcing Services

Software skills: Web browser and presentation software

Business skills: Evaluating business outsourcing services

8-11 This project will help develop your Internet skills in using the web to research and evaluate security outsourcing services.

- You have been asked to help your company's management decide whether to outsource security or keep the security function within the firm. Search the web to find information to help you decide whether to outsource security and to locate security outsourcing services.
- Present a brief summary of the arguments for and against outsourcing computer security for your company.
- Select two firms that offer computer security outsourcing services and compare them and their services.
- Prepare an electronic presentation for management, summarizing your findings. Your presentation should make the case of whether your company should outsource computer security. If you believe your company should outsource, the presentation should identify which security outsourcing service you selected and justify your decision.

Collaboration and Teamwork Project

Evaluating Security Software Tools

8-12 With a group of three or four students, use the web to research and evaluate security products from two competing vendors, such as for anti-malware software, firewalls, or antispyware software. For each product, describe its capabilities, for what types of businesses it is best suited, and its cost to purchase and install. Which is the best product? Why? If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Bulgaria: A Whole Nation Hacked

CASE STUDY

In July 2019, an anonymous hacker emailed Bulgarian media outlets to proclaim that they had gained access to the database of the Bulgarian tax service. As is often the case with hacks, many of the details were unclear, but one thing stood out: this was an attack of a staggering scope. Bulgaria has a population of around 7 million people, and the Bulgarian news media reported that the hacker had gained access to the data of 5.1 million. Analysts quickly concluded that almost everyone who paid taxes in the country had been hacked. The precise data that were accessed was not entirely clear, but it was certain that vital information like names, addresses, data regarding income, and social security numbers had been compromised.

The incident prompted a flurry of questions in the press and online: Who did it? How did it take place—what vulnerabilities in the tax service's systems did the hacker use to gain access? Could it have been prevented? Were the Bulgarian authorities sloppy, or were their cybersecurity efforts the best that could be expected and the hack unavoidable? Most importantly, what was the impact of this hack, both for the 5 million Bulgarians whose data had been accessed and the Bulgarian authorities?

The first question is yet to be adequately answered. The Bulgarian police, undoubtedly under severe pressure to produce a suspect, briefly detained Kristiyen Boykov, a young “computer wizard” employed by a firm focusing on cybersecurity. It was believed that he had perpetrated the attack to make the point that Bulgaria needed to do more to protect its data. In 2017, he had exposed vulnerabilities in the website of the Bulgarian Ministry of Education, and he subsequently gave an interview on Bulgarian television explaining that he had exposed these flaws as a matter of “civic duty.”

The then 20-year-old suspect denied all involvement and was released, though prosecutors continued to insist that he is the main culprit, conceding only that others may have been involved as well. They pointed to an email linked to the hack that was sent from one of the computers in Boykov’s possession. When the hack took place, it was assumed to be an attack from outside the country, for the email in which the hack was announced had been sent from a Russian IP address. However, as the investigation progressed, it became clear that this IP address was simply a smokescreen and the email had in fact originated within Bulgaria.

What vulnerabilities did the hacker exploit? Cybersecurity experts in Bulgaria quickly concluded that the attack was perpetrated through a system created to file VAT returns from outside Bulgaria. They identified it as an SQL injection attack, which takes place when corrupted input is fed into a system; instead of performing the tasks that it is supposed to, the system performs the orders it received through the corrupted input. SQL injection attacks are often explained using the metaphor of a fully automated bus: it obeys the commands it gets and will halt at the right stops if it is told to, but if the commands are corrupted, the bus may, for instance, halt every three minutes whether there is a stop or not.

Could the hack have been prevented? Looking at the statistics, it becomes clear that the Bulgarian hack is not the only one to have been perpetrated by using an SQL injection; between 2017 and 2019, almost two-thirds of all attacks on software applications were carried out by the same method. However, there are ways to protect computer systems against such an attack, and they are not complicated. One of these, is, of course, to use the right software and make sure that the patches for it are applied as soon as they become available. A powerful protection against SQL injection in particular is the use of so-called prepared statements. By using such statements, only certain input is accepted: to use the metaphor of the bus again, you cannot simply, for instance, tell the bus to stop all the time; you can only enter the name of specific streets.

As always, suspicion is a powerful protective tool in cybersecurity. When dealing with sensitive data, it is important to monitor access to the system that hosts it and, importantly, log and study unsuccessful efforts to send input (which sometimes prove to be an attempt to hack the system). It is also useful to try hacking your own system; if the Bulgarian tax service had enlisted its own “hacking squad,” it would surely have found the vulnerability early on and prevented the attack.

None of these strategies were in place in Bulgaria, according to the country’s cybersecurity experts. The hacker boasted of having obtained access to the system several years before the date of the actual attack, and the email announcement to the press contemptuously referred to cybersecurity in Bulgaria as a “parody” of a real one. That may be a harsh judgment, but it is true that many experts had issued the same warnings as the hacker for a long time. Indeed, several months before the

tax database hack, the Commercial Registry of Bulgaria was attacked as well. After the tax hack took place, it became clear that the Commercial Registry had yet another vulnerability: anyone could gain access to thousands of social security numbers stored on the website of the Commercial Registry merely by performing a search on Google.

The scale and depth of the tax hack, however, alerts us to the fact that official databases and systems around the world have been frequently attacked. One of the most spectacular hacks of a government agency took place in 2016, causing the Central Bank of Bangladesh to lose over \$80 million. The loss of money would have been much higher—the hackers targeted a total of around a billion dollars—but for mistakes in the wiring instructions that caused several orders to transfer money from the bank to be blocked in the United States. Investigations into the causes and perpetrators of this hack are still ongoing.

In 2019, Germany was shocked by one of the biggest data hacks in recent history when very personal details of major politicians (including Chancellor Angela Merkel) were published on Twitter. The German authorities immediately stressed that no really sensitive information had been accessed, but the hack was a huge embarrassment nonetheless, compounded by the fact that the data had been online for several months before their discovery. To add insult to injury, the hack had been perpetrated by a 20-year-old student using commonplace techniques.

The Bulgarian case, however, stands apart, as the hack targeted data from almost everyone in the country who paid taxes. But what made cybersecurity in Bulgaria particularly vulnerable—allegedly the real motivation behind the 2019 hack? To begin with, Bulgarian authorities make a distinction between critical infrastructure and non-critical databases. Critical infrastructure is mostly linked to defense facilities and systems. Bulgaria is a member of NATO, so non-members could try to gain access to Bulgarian defense systems to spy on the alliance, hence their categorization as critical. The tax databases were not considered critical and thus received less attention from the state's cybersecurity experts.

These experts are now urging the Bulgarian authorities to step up their efforts to protect their data systems because the impact of such hacks is potentially devastating. Hackers often sell data to criminal gangs, and the data of tax-paying Bulgarians are especially interesting to them as they do not change quickly: people do not change houses or addresses every year and, generally speaking, their income does not fluctuate dramatically either. After the 2019 tax hack, *The New York Times* cited

one cybersecurity expert as saying that the data obtained could easily be sold for about \$200 million. The Bulgarian news media have already reported fraudulent schemes mostly targeting the elderly in the country, though it is not clear if there is a clear link with the tax hack.

Sadly, the risks will remain in place for many years to come, with two in particular standing out: credit card fraud and identity theft. According to some reports in the Bulgarian news media, the hacked income data goes as far back as 2007. It would be easy for criminals to use this data to make lists of people in Bulgaria who are more affluent and use credit cards. Fortunately, credit card use is not widespread in Bulgaria, but if criminals do succeed in perpetrating this kind of fraud, the costs for both the individual and the bank in question may be huge. There is a huge political price for the Bulgarian authorities to pay as well. Tax-paying citizens need to be sure that their data are being kept safe. Few people like paying taxes to begin with, but they should never feel that they put their financial security at risk the next time they file a tax report. Bulgaria is a member of the European Union and must abide by the General Data Protection Regulation, a strict set of rules that obliges governments and companies to protect the privacy of citizens and clients. The tax authority was fined €3 million for the breach of data by the country's privacy watchdog. While many of the Bulgarians whose data were illegally accessed may feel that this fine is justified, experts say that this does not solve the problem: Bulgaria needs to take steps to hire more cybersecurity experts and review the security of all data systems.

However, being a member of the European Union has added another wrinkle to Bulgaria's cybersecurity problems. Cybersecurity experts are in short supply thanks to freedom of movement, as talented IT workers can easily migrate from Bulgaria to other member states of the European Union where the salaries are more competitive than what the Bulgarian government offers. This point was forcefully made by Boyko Borissov, the Prime Minister of Bulgaria, after the attack on the tax database took place. According to him, the Bulgarian state pays cybersecurity experts a monthly salary of around 1,500 Bulgarian leva (approximately €770), but in the private sector the starting salary is at least six times that amount.

Prime Minister Borissov also said that he had considered the idea of outsourcing Bulgarian cybersecurity to experts in other countries, but the costs had proven prohibitive. Aside from the troubling legal implications of giving foreigners access to the sensitive data of Bulgarian citizens, the government would have to trust that the systems of the company it had hired were safe

themselves—sadly, that is not always the case. The Bulgarian government is now working on a project to create a special cybersecurity unit consisting of experts who are paid well above the average Bulgarian salary.

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"Wizard' Cybersecurity Expert Charged with Record Hack of Bulgarian Tax Agency," Reuters, July 16, 2019; Kate Connolly, "German Cyber Attack: Man Admits Massive Data Breach, Say Police," *The Guardian*, January 8, 2019; "Hacked: The Bangladesh Bank Heist," Al-Jazeera, May 24, 2018.

CASE STUDY QUESTIONS

- 8-13** Identify and describe the security and control issues related to the hacking technique discussed in this case.
- 8-14** What managerial issues are faced by Bulgarian civil servants in charge of cybersecurity?
- 8-15** Discuss the potential impact of the Bulgarian tax hack.
- 8-16** How can data breaches like this be prevented?

Case contributed by Bernard Bouwman

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PART THREE

Key System Applications for the Digital Age

CHAPTER 9

Achieving Operational Excellence and Customer Intimacy: Enterprise Applications

CHAPTER 10

E-commerce: Digital Markets, Digital Goods

CHAPTER 11

Managing Knowledge and Artificial Intelligence

CHAPTER 12

Enhancing Decision Making

PART THREE examines the core information system applications businesses are using today to improve operational excellence and decision making. These applications include enterprise systems; systems for supply chain management, customer relationship management, artificial intelligence, and knowledge management; e-commerce applications; and business intelligence systems. This part answers questions such as: How can enterprise applications improve business performance? How do firms use e-commerce to extend the reach of their businesses? How can systems improve decision making and help companies benefit from artificial intelligence and knowledge management?

9

Achieving Operational Excellence and Customer Intimacy: Enterprise Applications

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 9-1** How do enterprise systems help businesses achieve operational excellence?
- 9-2** How do supply chain management systems coordinate planning, production, and logistics with suppliers?
- 9-3** How do customer relationship management systems help firms achieve customer intimacy?
- 9-4** What are the challenges that enterprise applications pose, and how are enterprise applications taking advantage of new technologies?
- 9-5** How will MIS help my career?

CHAPTER CASES

- Lenzing Sustainably Balances Supply and Demand
- CRM Helps Adidas Know Its Customers One Shoe Buyer at a Time
- Versum's ERP Transformation
- The Coronavirus Pandemic Disrupts Supply Chains Around the World

VIDEO CASES

- Maersk Develops a Global Shipping Management System

MyLab MIS

Discussion Questions: 9-5, 9-6, 9-7; Hands-On MIS Projects: 9-8, 9-9, 9-10, 9-11;
eText with Conceptual Animations

Lenzing Sustainably Balances Supply and Demand

The Austria-based Lenzing Group supplies high-quality specialty fibers for the global fashion industry, sports and outdoor wear, and protection wear. Its botanic cellulose fibers, used in production of textile and nonwoven products, have much less damaging impact on the environment than traditional materials. The company has production sites in major global markets along with a worldwide network of sales and marketing offices, 6,500 employees, and 2019 revenue surpassing \$2.3 billion. Lenzing's supply chain involves many different members, including spinners, weavers, mills, dye works and converters, as well as fashion brands and retailers.

According to Robert van de Kerkhof, Lenzing's chief commercial officer, the fashion industry is the second largest polluter worldwide. It production processes generate waste, and the end products themselves are generally non-biodegradable and rarely recycled. Lenzing adheres to very high environmental standards and has numerous international sustainability certifications for its business processes. It is considered the most sustainable company in its sector.

Lenzing wants to do more, and is focusing on innovations in both its products and processes to minimize its environmental impact while still meeting the needs of its end consumers. The company needed to create an end-to-end supply chain planning process that precisely matches supply and demand, minimizing inefficiencies while maximizing profitability. Lenzing had been using Excel spreadsheets, and manually intensive processes could not do the job, given the complexity of the company's worldwide business model and supply chain. More powerful software tools were required to digitally link demand forecasting, sales planning, and operations planning in order to create a highly accurate and efficient end-to-end supply chain.

Lenzing needed to overhaul its Sales & Operations Planning (S&OP) processes to fully integrate business planning processes and completely eliminate manual work. The sales and operations planning (S&OP) process enables companies to realize revenue, margin, and operating performance gains through improved decision support and cross-functional alignment. Lenzing selected JDA Sales & Operations Planning for this purpose.

JDA Sales & Operations Planning supports six distinct enterprise processes and associated scenario planning: demand review, supply review, demand-supply balancing, financial review, continuous plan refinement, and business performance management. Companies using this software are able to take a



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cross-functional approach to integrated business planning that unites all the moving parts across their supply chain to meet demand across markets, serving both immediate and long-term strategic goals. When risks, opportunities, or threats interfere with strategic execution, the entire organization can act swiftly and decisively to get back on track. The system provides visibility across departments and can identify performance gaps and provide what-if resolution. There is improved sales forecast accuracy, transparency, business alignment, and decision making.

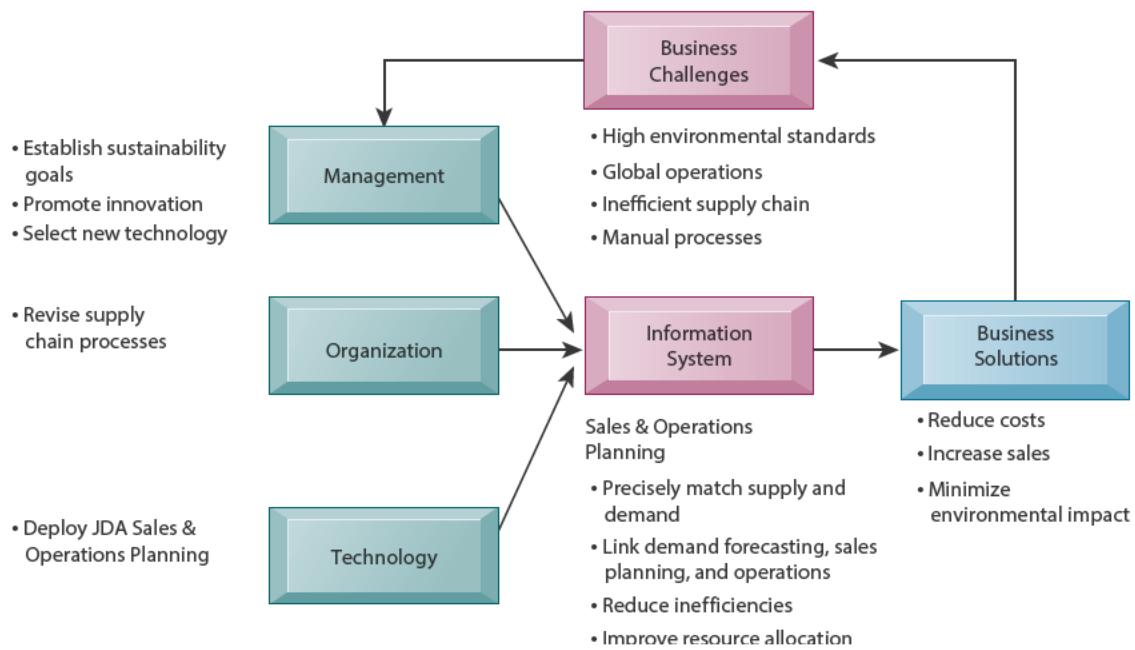
Lenzing was able to quickly launch its JDA Sales & Operations Planning system using the JDA Cloud software as a service (SaaS). Returns on investment were immediate, with a 50 percent reduction in planning and decision-making time. The company had better visibility into its supply chain, leading to greater forecast accuracy and better decisions. Profitability and resource utilization improved, with better capabilities for allocating critical resources to the most profitable markets and product applications. The system helped Lenzing minimize waste, and its entire supply chain became leaner.

Sources: Bloomberg, "Greener Fashion Industry Could Unlock \$100 Billion in Value," January 22, 2020; www.jda.com, accessed January 8, 2020; www.lenzing.com, accessed January 8, 2020; JDA Software, "World Leader in Specialty Fibers Made from Renewable Materials Creates a Digital Supply Chain Optimizing Profits and Sustainability," August 6, 2019.

Lenzing's problems with balancing supply and demand in a global marketplace illustrate the critical role of supply chain management systems in business. Lenzing's business performance was impeded because it could not accurately predict exactly the quantity of fiber materials other members of its supply chain needed in many different locations around the world. Lenzing's existing systems were highly manual and lacked the flexibility and power to do this. Lenzing's products were not always available when customers ordered them. Sometimes this left the company holding too much inventory it couldn't sell or not enough at the right time or place to fulfill customer orders. This was not only added to costs, but was environmentally wasteful.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. Lenzing's supply chain is far-reaching, servicing customers ordering fibers in many different locations around the globe. Lenzing's legacy systems were unable to coordinate demand, inventory, and supply planning across its entire global enterprise. The way it managed its supply chain was highly wasteful and ran counter to its corporate mission to promote sustainability. Implementing JDA software tools for Sales & Operations Planning has made it much easier for Lenzing's managers to access and analyze data for forecasting, inventory planning, and fulfillment, greatly improving both decision making and operational efficiency across the global enterprise.

Here are some questions to think about: How have Lenzing's business model and objectives been affected by having an inefficient supply chain? How did JDA software tools improve operations and decision making at Lenzing?



9-1 How do enterprise systems help businesses achieve operational excellence?

Around the globe, companies are increasingly becoming more connected, both internally and with other companies. If you run a business, you'll want to be able to react instantaneously when a customer places a large order or when a shipment from a supplier is delayed. You may also want to know the impact of these events on every part of the business and how the business is performing at any point in time, especially if you're running a large company. Enterprise systems provide the integration to make this possible. Let's look at how they work and what they can do for the firm.

What Are Enterprise Systems?

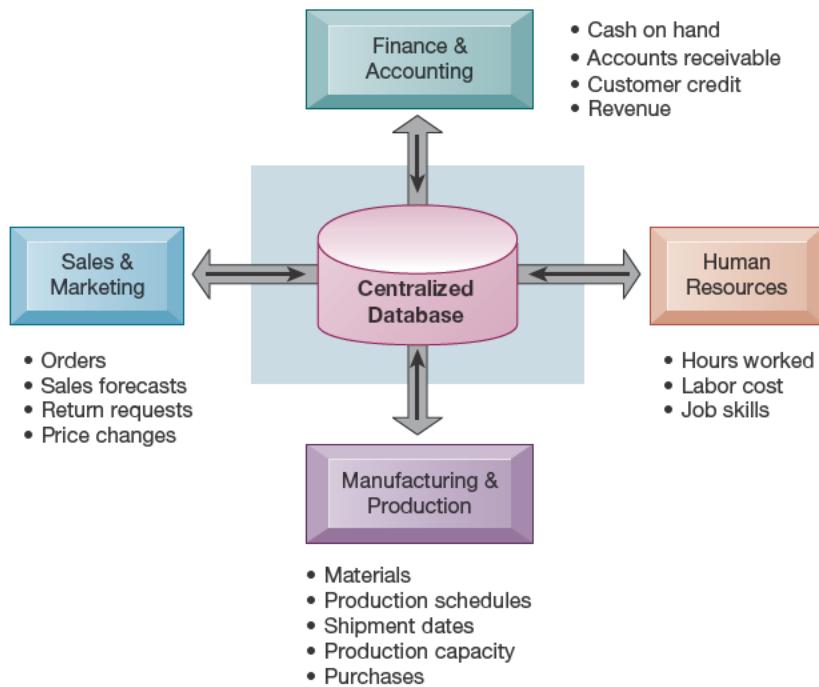
Imagine that you had to run a business based on information from tens or even hundreds of databases and systems, none of which could speak to one another. Imagine your company had 10 major product lines, each produced in separate factories, and each with separate and incompatible sets of systems controlling production, warehousing, and distribution.

At the very least, your decision making would often be based on manual hard-copy reports, often out of date, and it would be difficult to understand what is happening in the business as a whole. Sales personnel might not be able to tell at the time they place an order whether the ordered items are in inventory, and manufacturing could not easily use sales data to plan for new production. You now have a good idea of why firms need a special enterprise system to integrate information.

Chapter 2 introduced enterprise systems, also known as enterprise resource planning (ERP) systems, which are based on a suite of integrated software modules and a common central database. The database collects data from many divisions and departments in a firm and from a large number of key business processes in manufacturing and production, finance and accounting, sales and marketing, and human resources, making the data

FIGURE 9.1 HOW ENTERPRISE SYSTEMS WORK

Enterprise systems feature a set of integrated software modules and a central database by which business processes and functional areas throughout the enterprise can share data.



available for applications that support nearly all an organization's internal business activities. When new information is entered by one process, the information is made immediately available to other business processes (see Figure 9.1).

If a sales representative places an order for tire rims, for example, the system verifies the customer's credit limit, schedules the shipment, identifies the best shipping route, and reserves the necessary items from inventory. If inventory stock is insufficient to fill the order, the system schedules the manufacture of more rims, ordering the needed materials and components from suppliers. Sales and production forecasts are immediately updated. General ledger and corporate cash levels are automatically updated with the revenue and cost information from the order. Users can tap into the system and find out where that particular order is at any minute. Management can obtain information at any point in time about how the business is operating. The system can also generate enterprise-wide data for management analyses of product cost and profitability.

Enterprise Software

Enterprise software is built around thousands of predefined business processes that reflect best practices. Table 9.1 describes some of the major business processes that enterprise software supports.

Companies implementing this software first have to select the functions of the system they wish to use and then map their business processes to the predefined business processes in the software. Configuration tables provided by the software manufacturer enable the firm to tailor a particular aspect of the system to the way it does business. For example, the firm could use these

TABLE 9.1 BUSINESS PROCESSES SUPPORTED BY ENTERPRISE SYSTEMS

Financial and accounting processes , including general ledger, accounts payable, accounts receivable, fixed assets, cash management and forecasting, product-cost accounting, cost-center accounting, asset accounting, tax accounting, credit management, and financial reporting
Human resources processes , including personnel administration, time accounting, payroll, personnel planning and development, benefits accounting, applicant tracking, time management, compensation, workforce planning, performance management, and travel expense reporting
Manufacturing and production processes , including procurement, inventory management, purchasing, shipping, production planning, production scheduling, material requirements planning, quality control, distribution, transportation execution, and plant and equipment maintenance
Sales and marketing processes , including order processing, quotes, contracts, product configuration, pricing, billing, credit checking, incentive and commission management, and sales planning

tables to select whether it wants to track revenue by product line, geographical unit, or distribution channel.

If the enterprise software does not support the way the organization does business, companies can rewrite some of the software to support the way their business processes work. However, enterprise software is unusually complex, and extensive customization may degrade system performance, compromising the information and process integration that are the main benefits of the system. If companies want to reap the maximum benefits from enterprise software, they must change the way they work to conform to the business processes defined by the software.

To implement a new enterprise system, Tasty Baking Company identified its existing business processes and then translated them into the business processes built into the SAP ERP software it had selected. To ensure that it obtained the maximum benefits from the enterprise software, Tasty Baking Company deliberately planned for customizing less than 5 percent of the system and made very few changes to the SAP software itself. It used as many tools and features that were already built into the SAP software as it could. SAP has more than 3,000 configuration tables for its enterprise software.

Leading enterprise software vendors include SAP, Oracle, IBM, Infor Global Solutions, and Microsoft. Versions of enterprise software packages are designed for small and medium-sized businesses and on-demand software services running in the cloud (see Section 9-4).

Business Value of Enterprise Systems

Enterprise systems provide value by both increasing operational efficiency and providing firmwide information to help managers make better decisions. Large companies with many operating units in different locations have used enterprise systems to enforce standard practices and data so that everyone does business the same way worldwide.

Coca-Cola, for instance, implemented a SAP enterprise system to standardize and coordinate important business processes in 200 countries. Lack of standard, companywide business processes had prevented the company from using its worldwide buying power to obtain lower prices for raw materials and from reacting rapidly to market changes.

Enterprise systems help firms respond rapidly to customer requests for information or products. Because the system integrates order, manufacturing, and delivery data, manufacturing is better informed about producing only what customers have ordered, procuring exactly the right number of components or

raw materials to fill actual orders, staging production, and minimizing the time that components or finished products are in inventory.

Alcoa, the world's leading producer of aluminum and aluminum products with operations spanning 31 countries and more than 200 locations, had initially been organized around lines of business, each of which had its own set of information systems. Many of these systems were redundant and inefficient. Alcoa's costs for executing requisition-to-pay and financial processes were much higher, and its cycle times were longer than those of other companies in its industry. (Cycle time refers to the total elapsed time from the beginning to the end of a process.) The company could not operate as a single worldwide entity.

After implementing enterprise software from Oracle, Alcoa eliminated many redundant processes and systems. The enterprise system helped Alcoa reduce requisition-to-pay cycle time by verifying receipt of goods and automatically generating receipts for payment. Alcoa's accounts payable transaction processing dropped 89 percent. Alcoa was able to centralize financial and procurement activities, which helped the company reduce nearly 20 percent of its worldwide costs.

Enterprise systems provide much valuable information for improving management decision making. Corporate headquarters has access to up-to-the-minute data on sales, inventory, and production and uses this information to create more accurate sales and production forecasts. Enterprise software includes analytical tools to use data the system captures to evaluate overall organizational performance. Enterprise system data have common standardized definitions and formats that are accepted by the entire organization. Performance figures mean the same thing across the company. Enterprise systems allow senior management to find out easily at any moment how a particular organizational unit is performing, determine which products are most or least profitable, and calculate costs for the company as a whole. For example, Alcoa's enterprise system includes functionality for global human resources management that shows correlations between investment in employee training and quality, measures the companywide costs of delivering services to employees, and measures the effectiveness of employee recruitment, compensation, and training.

9-2 How do supply chain management systems coordinate planning, production, and logistics with suppliers?

If you manage a small firm that makes a few products or sells a few services, chances are you will have a small number of suppliers. You could coordinate your supplier orders and deliveries by using just a telephone and fax machine. But if you manage a firm that produces more complex products and services, you will have hundreds of suppliers, and each of your suppliers will have its own set of suppliers. Suddenly, you will need to coordinate the activities of hundreds or even thousands of other firms to produce your products and services. Supply chain management (SCM) systems, which we introduced in Chapter 2, are an answer to the problems of supply chain complexity and scale.

The Supply Chain

A firm's **supply chain** is a network of organizations and business processes for procuring raw materials, transforming these materials into intermediate and finished products, and distributing the finished products to customers. It links

suppliers, manufacturing plants, distribution centers, retail outlets, and customers to supply goods and services from source through consumption. Materials, information, and payments flow through the supply chain in both directions.

Goods start out as raw materials and, as they move through the supply chain, are transformed into intermediate products (also referred to as components or parts) and, finally, into finished products. The finished products are shipped to distribution centers and from there to retailers and customers. Returned items flow in the reverse direction from the buyer back to the seller.

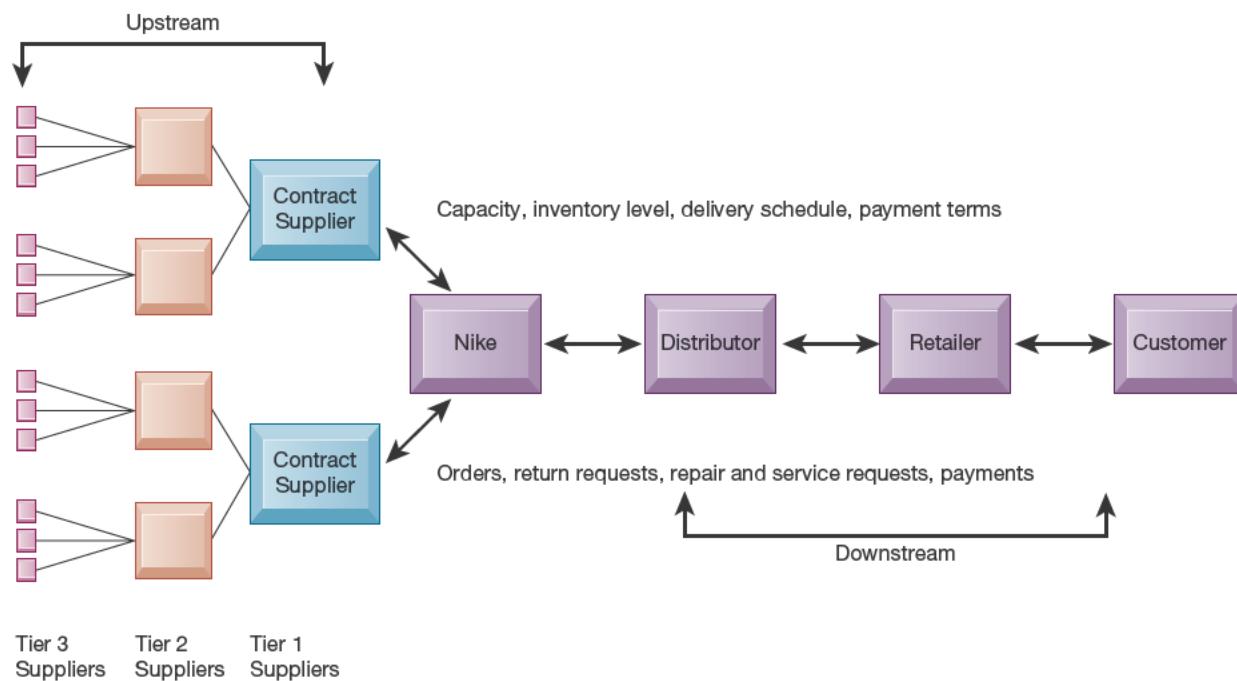
Let's look at the supply chain for Nike sneakers as an example. Nike designs, markets, and sells sneakers, socks, athletic clothing, and accessories throughout the world. Its primary suppliers are contract manufacturers with factories in China, Thailand, Indonesia, Brazil, and other countries. These companies fashion Nike's finished products.

Nike's contract suppliers do not manufacture sneakers from scratch. They obtain components for the sneakers—the laces, eyelets, uppers, and soles—from other suppliers and then assemble them into finished sneakers. These suppliers in turn have their own suppliers. For example, the suppliers of soles have suppliers for synthetic rubber, suppliers for chemicals used to melt the rubber for molding, and suppliers for the molds into which to pour the rubber. Suppliers of laces have suppliers for their thread, for dyes, and for the plastic lace tips.

Figure 9.2 provides a simplified illustration of Nike's supply chain for sneakers; it shows the flow of information and materials among suppliers, Nike, Nike's distributors, retailers, and customers. Nike's contract manufacturers are its primary suppliers. The suppliers of soles, eyelets, uppers, and laces are the secondary (Tier 2) suppliers. Suppliers to these suppliers are the tertiary (Tier 3) suppliers.

FIGURE 9.2 NIKE'S SUPPLY CHAIN

This figure illustrates the major entities in Nike's supply chain and the flow of information upstream and downstream to coordinate the activities involved in buying, making, and moving a product. Shown here is a simplified supply chain, with the upstream portion focusing only on the suppliers for sneakers and sneaker soles.



The *upstream* portion of the supply chain includes the company's suppliers, the suppliers' suppliers, and the processes for managing relationships with them. The *downstream* portion consists of the organizations and processes for distributing and delivering products to the final customers. Companies that manufacture, such as Nike's contract suppliers of sneakers, also manage their own *internal supply chain processes* for transforming materials, components, and services their suppliers furnish into finished products or intermediate products (components or parts) for their customers and for managing materials and inventory.

The supply chain illustrated in Figure 9.2 has been simplified. It only shows two contract manufacturers for sneakers and only the upstream supply chain for sneaker soles. Nike has hundreds of contract manufacturers turning out finished sneakers, socks, and athletic clothing, each with its own set of suppliers. The upstream portion of Nike's supply chain actually comprises thousands of entities. Nike also has numerous distributors and many thousands of retail stores where its shoes are sold, so the downstream portion of its supply chain also is large and complex.

Information Systems and Supply Chain Management

Inefficiencies in the supply chain, such as parts shortages, underused plant capacity, excessive finished goods inventory, or high transportation costs, are caused by inaccurate or untimely information. For example, manufacturers may keep too many parts in inventory because they do not know exactly when they will receive their next shipments from their suppliers. Suppliers may order too few raw materials because they do not have precise information on demand. These supply chain inefficiencies waste as much as 25 percent of a company's operating costs.

If a manufacturer had perfect information about exactly how many units of product customers wanted, when they wanted them, and when they could be produced, it would be possible to implement a highly efficient **just-in-time strategy**. Components would arrive exactly at the moment they were needed, and finished goods would be shipped as they left the assembly line.

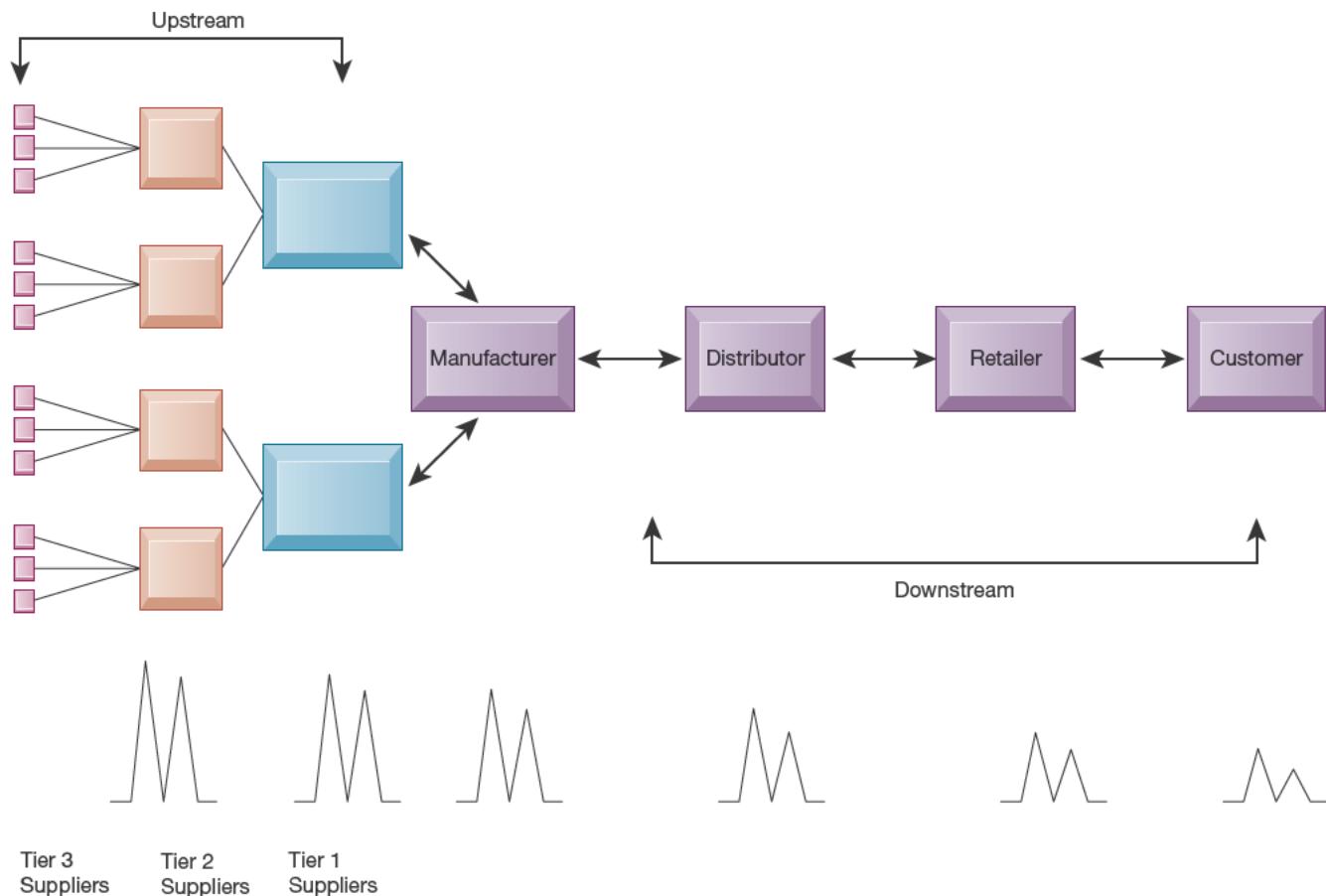
In a supply chain, however, uncertainties arise because many events cannot be foreseen—uncertain product demand, late shipments from suppliers, defective parts or raw materials, or production process breakdowns. To satisfy customers, manufacturers often deal with such uncertainties and unforeseen events by keeping more material or products in inventory than they think they may actually need. The *safety stock* acts as a buffer for the lack of flexibility in the supply chain. Although excess inventory is expensive, low fill rates are also costly because business may be lost from canceled orders.

One recurring problem in supply chain management is the **bullwhip effect**, in which information about the demand for a product gets distorted as it passes from one entity to the next across the supply chain. A slight rise in demand for an item might cause different members in the supply chain—distributors, manufacturers, suppliers, secondary suppliers (suppliers' suppliers), and tertiary suppliers (suppliers' suppliers' suppliers)—to stockpile inventory so each has enough just in case. These changes ripple throughout the supply chain, magnifying what started out as a small change from planned orders and creating excess inventory, production, warehousing, and shipping costs (see Figure 9.3).

For example, Procter & Gamble (P&G), a global company with operations in over 80 countries, found it had excessively high inventories of its Pampers disposable diapers at various points along its supply chain because of such

FIGURE 9.3 THE BULLWHIP EFFECT

Inaccurate information can cause minor fluctuations in demand for a product to be amplified as one moves further back in the supply chain. Minor fluctuations in retail sales for a product can create excess inventory for distributors, manufacturers, and suppliers.



distorted information. Although customer purchases in stores were fairly stable, orders from distributors spiked when P&G offered aggressive price promotions. Pampers and Pampers' components accumulated in warehouses along the supply chain to meet demand that did not actually exist. To eliminate this problem, P&G revised its marketing, sales, and supply chain processes and used more accurate demand forecasting.

The bullwhip effect is tamed by reducing uncertainties about demand and supply when all members of the supply chain have accurate and up-to-date information. If all supply chain members share dynamic information about inventory levels, schedules, forecasts, and shipments, they have more precise knowledge about how to adjust their sourcing, manufacturing, and distribution plans. Supply chain management systems provide the kind of information that helps members of the supply chain make better purchasing and scheduling decisions.

Supply Chain Management Software

Supply chain software is classified as either software to help businesses plan their supply chains (supply chain planning) or software to help them execute the supply chain steps (supply chain execution). **Supply chain planning systems** enable the firm to model its existing supply chain, generate demand forecasts for products, and develop optimal sourcing and manufacturing plans.

Such systems help companies make better decisions, such as determining how much of a specific product to manufacture in a given time period; establishing inventory levels for raw materials, intermediate products, and finished goods; determining where to store finished goods; and identifying the transportation mode to use for product delivery (see the chapter-opening case study).

For example, if a large customer places a larger order than usual or changes that order on short notice, it can have a widespread impact throughout the supply chain. Additional raw materials or a different mix of raw materials may need to be ordered from suppliers. Manufacturing may have to change job scheduling. A transportation carrier may have to reschedule deliveries. Supply chain planning software makes the necessary adjustments to production and distribution plans. Information about changes is shared among the relevant supply chain members so that their work can be coordinated. One of the most important—and complex—supply chain planning functions is **demand planning**, which determines how much product a business needs to make to satisfy all its customers' demands. JDA Software, SAP, and Oracle all offer supply chain management solutions.

Supply chain execution systems manage the flow of products through distribution centers and warehouses to ensure that products are delivered to the right locations in the most efficient manner. They track the physical status of goods, the management of materials, warehouse and transportation operations, and financial information involving all parties. An example is the Warehouse Management System (WMS) that Haworth Incorporated uses. Haworth is a world-leading manufacturer and designer of office furniture, with distribution centers in four states. The WMS tracks and controls the flow of finished goods from Haworth's distribution centers to its customers. Acting on shipping plans for customer orders, the WMS directs the movement of goods based on immediate conditions for space, equipment, inventory, and personnel.

Global Supply Chains and the Internet

Before the Internet, supply chain coordination was hampered by the difficulties of making information flow smoothly among disparate internal supply chain systems for purchasing, materials management, manufacturing, and distribution. It was also difficult to share information with external supply chain partners because the systems of suppliers, distributors, or logistics providers were based on incompatible technology platforms and standards. Enterprise and supply chain management systems enhanced with Internet technology supply some of this integration.

A manager uses a web interface to tap into suppliers' systems to determine whether inventory and production capabilities match demand for the firm's products. Business partners use web-based supply chain management tools to collaborate online on forecasts. Sales representatives access suppliers' production schedules and logistics information to monitor customers' order status.

Global Supply Chain Issues

More and more companies are entering international markets, outsourcing manufacturing operations, and obtaining supplies from other countries as well as selling abroad. Their supply chains extend across multiple countries and regions. There are additional complexities and challenges to managing a global supply chain.

Global supply chains typically span greater geographic distances and time differences than domestic supply chains and have participants from a number of countries. Performance standards may vary from region to region or from nation to nation. Supply chain management may need to reflect foreign government regulations and cultural differences.

The Internet helps companies manage many aspects of their global supply chains, including sourcing, transportation, communications, and international finance. Today's apparel industry, for example, relies heavily on outsourcing to contract manufacturers in China and other low-wage countries. Apparel companies are starting to use the web to manage their global supply chain and production issues. (Review the discussion of Li & Fung in Chapter 3.)

In addition to contract manufacturing, globalization has encouraged outsourcing warehouse management, transportation management, and related operations to third-party logistics providers, such as UPS Supply Chain Solutions and DHL, the global delivery service. These logistics services offer web-based software to give their customers a better view of their global supply chains. Customers can check a secure website to monitor inventory and shipments, helping them run their global supply chains more efficiently.

Demand-Driven Supply Chains: From Push to Pull Manufacturing and Efficient Customer Response

In addition to reducing costs, supply chain management systems facilitate efficient customer response, enabling the workings of the business to be driven more by customer demand. (We introduced efficient customer response systems in Chapter 3.)

Earlier supply chain management systems were driven by a push-based model (also known as build-to-stock). In a **push-based model**, production master schedules are based on forecasts or best guesses of demand for products, and products are pushed to customers. With new flows of information made possible by web-based tools, supply chain management more easily follows a pull-based model. In a **pull-based model**, also known as a demand-driven or build-to-order model, actual customer orders or purchases trigger events in the supply chain. Transactions to produce and deliver only what customers have ordered move up the supply chain from retailers to distributors to manufacturers and eventually to suppliers. Only products to fulfill these orders move back down the supply chain to the retailer. Manufacturers use only actual order demand information to drive their production schedules and the procurement of components or raw materials, as illustrated in Figure 9.4. Walmart's continuous replenishment system described in Chapter 3 is an example of the pull-based model.

FIGURE 9.4 PUSH- VERSUS PULL-BASED SUPPLY CHAIN MODELS

The difference between push- and pull-based models is summarized by the slogan "Make what we sell, not sell what we make."

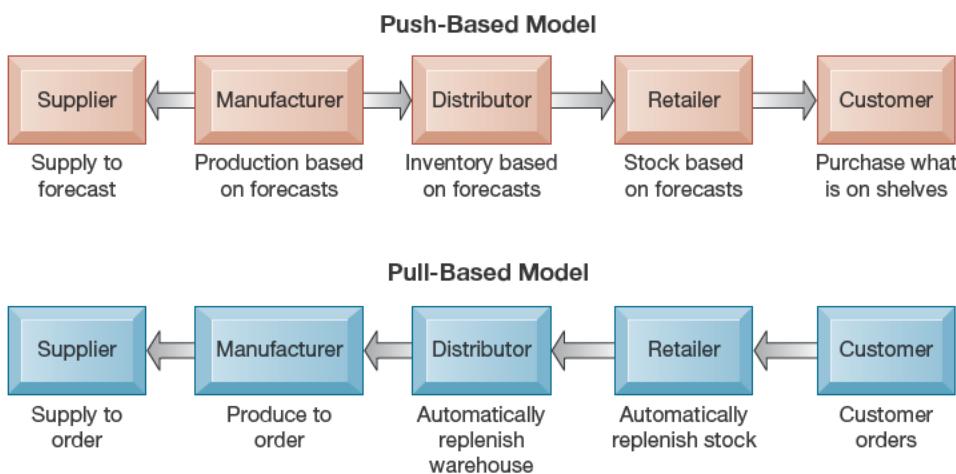
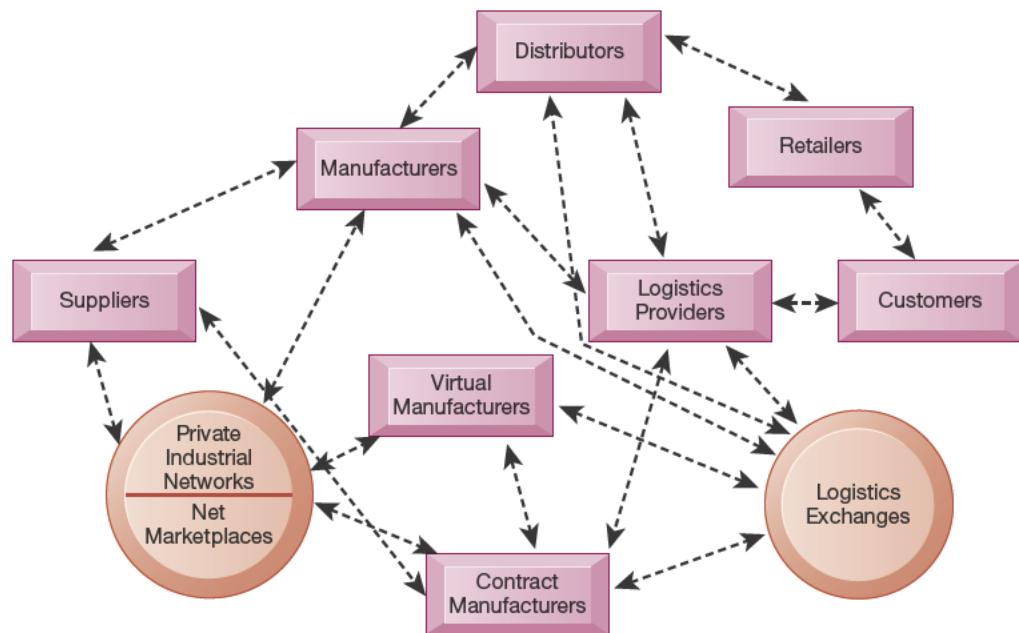


FIGURE 9.5 THE EMERGING INTERNET-DRIVEN SUPPLY CHAIN

The emerging Internet-driven supply chain operates like a digital logistics nervous system. It provides multidirectional communication among firms, networks of firms, and e-marketplaces so that entire networks of supply chain partners can immediately adjust inventories, orders, and capacities.



The Internet and Internet technology make it possible to move from sequential supply chains, where information and materials flow sequentially from company to company, to concurrent supply chains, where information flows in many directions simultaneously among members of a supply chain network. Complex supply networks of manufacturers, logistics suppliers, outsourced manufacturers, retailers, and distributors can adjust immediately to changes in schedules or orders. Ultimately, the Internet will enable a digital logistics nervous system for supply chains (see Figure 9.5).

Business Value of Supply Chain Management Systems

You have just seen how supply chain management systems enable firms to streamline both their internal and external supply chain processes and provide management with more accurate information about what to produce, store, and move. By implementing a networked and integrated supply chain management system, companies match supply to demand, reduce inventory levels, improve delivery service, speed product time to market, and use assets more effectively.

Total supply chain costs represent the majority of operating expenses for many businesses and in some industries approach 75 percent of the total operating budget. Reducing supply chain costs has a major impact on firm profitability.

In addition to reducing costs, supply chain management systems help increase sales. If a product is not available when a customer wants it, customers often try to purchase it from someone else. More precise control of the supply chain enhances the firm's ability to have the right product available for customer purchases at the right time.

9-3 How do customer relationship management systems help firms achieve customer intimacy?

You've probably heard phrases such as "the customer is always right" or "the customer comes first." Today these words ring truer than ever. Because competitive advantage based on an innovative new product or service is often very short lived, companies are realizing that their most enduring competitive strength may be their relationships with their customers. Some say that the basis of competition has switched from who sells the most products and services to who "owns" the customer and that customer relationships represent a firm's most valuable asset.

What Is Customer Relationship Management?

What kinds of information would you need to build and nurture strong, long-lasting relationships with customers? You'd want to know exactly who your customers are, how to contact them, whether they are costly to service and sell to, what kinds of products and services they are interested in, and how much money they spend on your company. If you could, you'd want to make sure you knew each of your customers well, as if you were running a small-town store. And you'd want to make your good customers feel special.

In a small business operating in a neighborhood, it is possible for business owners and managers to know their customers well on a personal, face-to-face basis, but in a large business operating on a metropolitan, regional, national, or even global basis, it is impossible to know your customer in this intimate way. In these kinds of businesses, there are too many customers and too many ways that customers interact with the firm (over the web, the phone, email, blogs, and in person). It becomes especially difficult to integrate information from all these sources and deal with the large number of customers.

A large business's processes for sales, service, and marketing tend to be highly compartmentalized, and these departments do not share much essential customer information. Some information on a specific customer might be stored and organized in terms of that person's account with the company. Other pieces of information about the same customer might be organized by products that were purchased. In this traditional business environment, there is no convenient way to consolidate all this information to provide a unified view of a customer across the company.

This is where customer relationship management systems help. Customer relationship management (CRM) systems, which we introduced in Chapter 2, capture and integrate customer data from all over the organization, consolidate the data, analyze the data, and then distribute the results to various systems and customer touch points across the enterprise. A **touch point** (also known as a contact point) is a method of interaction with the customer, such as telephone, email, customer service desk, conventional mail, Facebook, Twitter, website, wireless device, or retail store. Well-designed CRM systems provide a single enterprise view of customers that is useful for improving both sales and customer service (see Figure 9.6).

Good CRM systems provide data and analytical tools for answering questions such as these: What is the value of a particular customer to the firm over his or her lifetime? Who are our most loyal customers? Who are our most profitable customers? What do these profitable customers want to buy? Firms use the answers to these questions to acquire new customers, provide better service and support to existing customers, customize their offerings more precisely to customer preferences, and provide ongoing value to retain profitable customers.

FIGURE 9.6 CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

CRM systems examine customers from a multifaceted perspective. These systems use a set of integrated applications to address all aspects of the customer relationship, including customer service, sales, and marketing.



Customer Relationship Management Software

Commercial CRM software packages range from niche tools that perform limited functions, such as personalizing websites for specific customers, to large-scale enterprise applications that capture myriad interactions with customers, analyze them with sophisticated reporting tools, and link to other major enterprise applications, such as supply chain management and enterprise systems. The more comprehensive CRM packages contain modules for **partner relationship management (PRM)** and **employee relationship management (ERM)**.

PRM uses many of the same data, tools, and systems as customer relationship management to enhance collaboration between a company and its selling partners. If a company does not sell directly to customers but rather works through distributors or retailers, PRM helps these channels sell to customers directly. It provides a company and its selling partners with the ability to trade information and distribute leads and data about customers, integrating lead generation, pricing, promotions, order configurations, and availability. It also provides a firm with tools to assess its partners' performances so it can make sure its best partners receive the support they need to close more business.

ERM software deals with employee issues that are closely related to CRM, such as setting objectives, employee performance management, performance-based compensation, and employee training. Major CRM application software vendors include Oracle, SAP, Salesforce.com, and Microsoft Dynamics CRM.

Customer relationship management systems typically provide software and online tools for sales, customer service, and marketing. We briefly describe some of these capabilities.

Sales Force Automation

Sales force automation (SFA) modules in CRM systems help sales staff increase productivity by focusing sales efforts on the most profitable customers, those who are good candidates for sales and services. SFA modules provide sales prospect and contact information, product information, product configuration capabilities, and sales quote generation capabilities. Such software can assemble information about a particular customer's past purchases to help the salesperson make personalized recommendations. SFA modules enable sales, marketing, and shipping departments to share customer and prospect information easily. SFA increases each salesperson's efficiency by reducing the cost per sale as well as the cost of acquiring new customers and retaining old ones. SFA modules also provide capabilities for sales forecasting, territory management, and team selling.

Customer Service

Customer service modules in CRM systems provide information and tools to increase the efficiency of call centers, help desks, and customer support staff. They have capabilities for assigning and managing customer service requests.

One such capability is an appointment or advice telephone line. When a customer calls a standard phone number, the system routes the call to the correct service person, who inputs information about that customer into the system only once. When the customer's data are in the system, any service representative can handle the customer relationship. Improved access to consistent and accurate customer information helps call centers handle more calls per day and decrease the duration of each call. Thus, call centers and customer service groups achieve greater productivity, reduced transaction time, and higher quality of service at lower cost. Customers are happier because they spend less time on the phone restating their problem to customer service representatives.

CRM systems may also include web-based self-service capabilities: The company website can be set up to provide personalized support information as well as the option to contact customer service by phone for additional assistance.

Marketing

CRM systems support direct-marketing campaigns by providing capabilities to capture prospect and customer data, provide product and service information, qualify leads for targeted marketing, and schedule and track direct-marketing mailings or email (see Figure 9.7). Marketing modules also include tools for analyzing marketing and customer data, identifying profitable and unprofitable customers, designing products and services to satisfy specific customer needs and interests, and identifying opportunities for cross-selling.

Cross-selling is the marketing of complementary products to customers. (For example, in financial services, a customer with a checking account might be sold a money market account or a home improvement loan.) CRM tools also help firms manage and execute marketing campaigns at all stages, from planning to determining the rate of success for each campaign. For example, Kenya Airways uses Oracle Marketing Cloud to track the revenue generated from automated marketing campaigns and to identify data that would target the campaigns more effectively.

Figure 9.8 illustrates the most important capabilities for sales, service, and marketing processes found in major CRM software products. Like enterprise software, this software is business-process driven, incorporating hundreds of

FIGURE 9.7 HOW CRM SYSTEMS SUPPORT MARKETING

Customer relationship management software provides a single point for users to manage and evaluate marketing campaigns across multiple channels, including email, direct mail, telephone, the web, and social media.

Responses by Channel for January 2021
Promotional Campaign

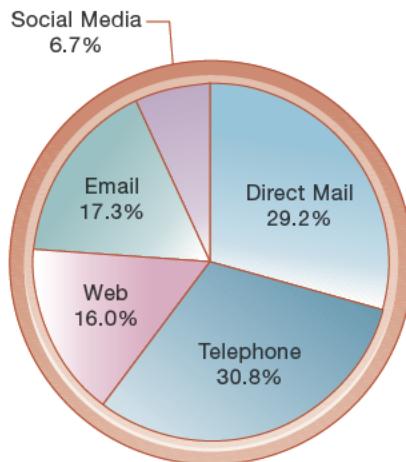


FIGURE 9.8 CRM SOFTWARE CAPABILITIES

The major CRM software products support business processes in sales, service, and marketing, integrating customer information from many sources. Included is support for both the operational and analytical aspects of CRM.

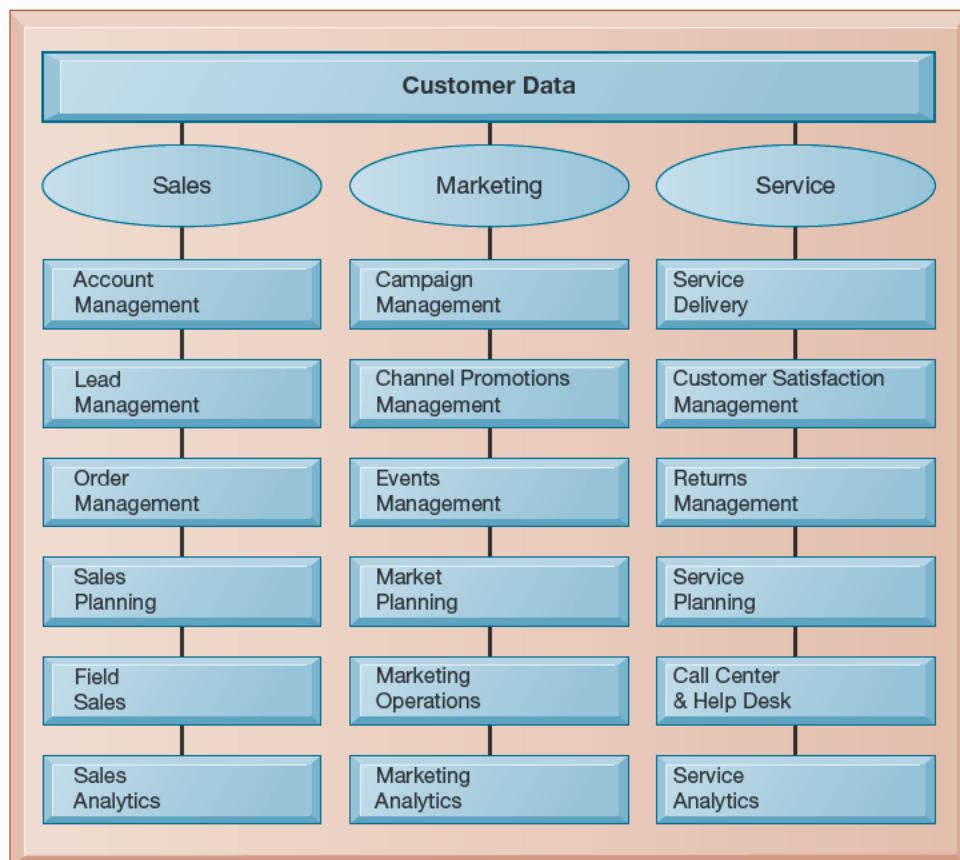
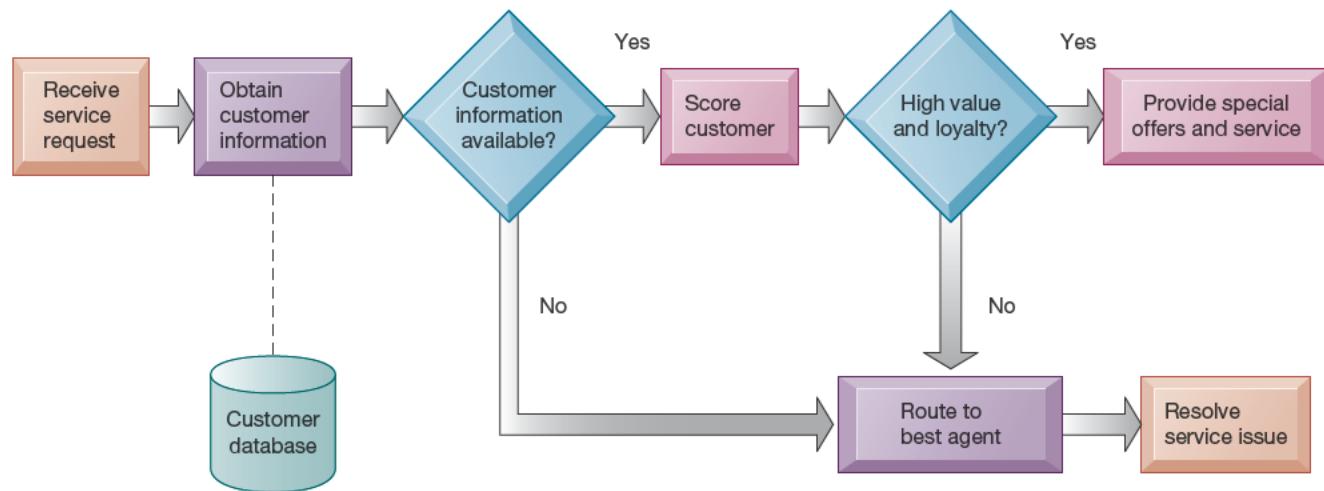


FIGURE 9.9 CUSTOMER LOYALTY MANAGEMENT PROCESS MAP

This process map shows how a best practice for promoting customer loyalty through customer service would be modeled by customer relationship management software. The CRM software helps firms identify high-value customers for preferential treatment.



business processes thought to represent best practices in each of these areas. To achieve maximum benefit, companies need to revise and model their business processes to conform to the best-practice business processes in the CRM software.

Figure 9.9 illustrates how a best practice for increasing customer loyalty through customer service might be modeled by CRM software. Directly servicing customers provides firms with opportunities to increase customer retention by singling out profitable long-term customers for preferential treatment. CRM software can assign each customer a score based on that person's value and loyalty to the company and provide that information to help call centers route each customer's service request to agents who can best handle that customer's needs. The system would automatically provide the service agent with a detailed profile of that customer that includes his or her score for value and loyalty. The service agent would use this information to present special offers or additional services to the customer to encourage the customer to keep transacting business with the company. You will find more information on other best-practice business processes in CRM systems in our Learning Tracks.

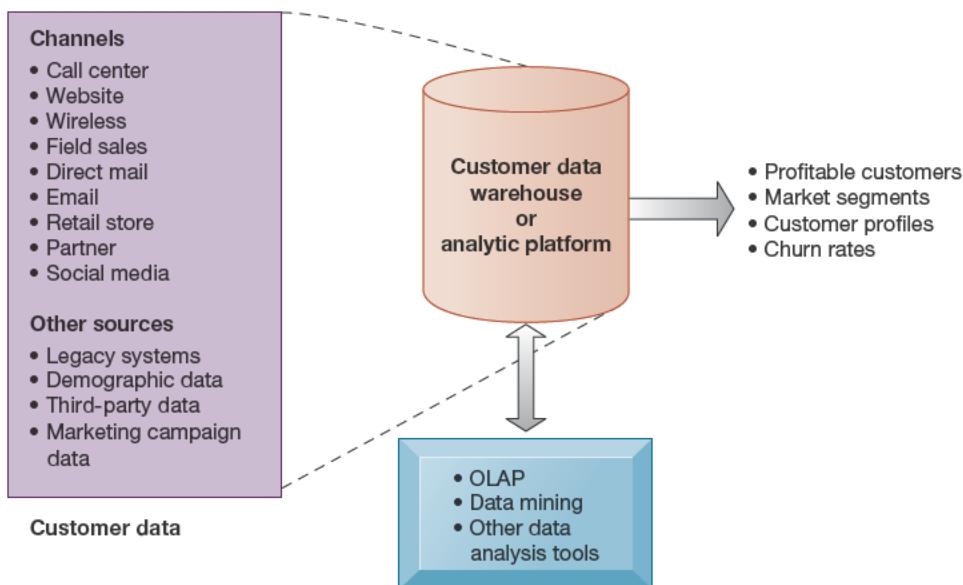
Operational and Analytical CRM

All of the applications we have just described support either the operational or analytical aspects of customer relationship management. **Operational CRM** includes customer-facing applications, such as tools for sales force automation, call center and customer service support, and marketing automation. **Analytical CRM** includes applications that analyze customer data generated by operational CRM applications to provide information for improving business performance.

Analytical CRM applications are based on data from operational CRM systems, customer touch points, and other sources that have been organized in data warehouses or analytic platforms for use in online analytical processing (OLAP), data mining, and other data analysis techniques (see

FIGURE 9.10 ANALYTICAL CRM

Analytical CRM uses a customer data warehouse or analytic platform and tools to analyze customer data collected from the firm's customer touch points and from other sources.



Chapter 6). Customer data collected by the organization might be combined with data from other sources, such as customer lists for direct-marketing campaigns purchased from other companies or demographic data. Such data are analyzed to identify buying patterns, to create segments for targeted marketing, and to pinpoint profitable and unprofitable customers (see Figure 9.10).

Another important output of analytical CRM is the customer's lifetime value to the firm. **Customer lifetime value (CLTV)** is based on the relationship between the revenue produced by a specific customer, the expenses incurred in acquiring and servicing that customer, and the expected life of the relationship between the customer and the company.

Business Value of Customer Relationship Management Systems

Companies with effective customer relationship management systems realize many benefits, including increased customer satisfaction, reduced direct-marketing costs, more effective marketing, and lower costs for customer acquisition and retention. Information from CRM systems increases sales revenue by identifying the most profitable customers and segments for focused marketing and cross-selling (see the Interactive Session on Organizations).

Customer churn is reduced as sales, service, and marketing respond better to customer needs. The **churn rate** measures the number of customers who stop using or purchasing products or services from a company. It is an important indicator of the growth or decline of a firm's customer base.

INTERACTIVE SESSION ORGANIZATIONS

CRM Helps Adidas Know Its Customers One Shoe Buyer at a Time

Adidas is a leading global maker of athletic shoes, clothing, and accessories, selling 1.2 million pairs of shoes each day. The company is headquartered in Herzogenaurach, Germany, has over 57,000 employees worldwide, and produced net sales of 23.6 billion Euros (U.S. \$27 billion) in 2019. It is the second largest sportswear manufacturer in the world after Nike.

Adidas is also a leader in digital and online marketing. The company's most important store is no longer a physical store—it's a website. The Adidas website is a key channel for offering connected and personalized customer experiences that help differentiate Adidas from competitors and lead to increased sales. E-commerce is Adidas's most profitable point-of-sale channel, with online sales reaching 5.509 billion Euros (U.S. \$6.180 billion) in 2019.

Adidas does not compete on price but on the quality of its brand and the customer experience. The transition from brick-and-mortar to digital as the preferred shopping medium has shaped the way the company keeps up with changing customer preferences. Customers are clearly at the center of Adidas's business, and their experience with other online retailers such as Amazon has made them want a relationship with Adidas that is more personal.

To serve customers better and manage all of its relationships with them, Adidas turned to Salesforce.com, which features cloud-based tools for customer relationship management (CRM) and application development. Salesforce.com helps Adidas identify key customer segments, develop closer ties to customers, and design differentiated experiences tailored to each customer's needs. Salesforce CRM tools make it possible for Adidas to have a single view of each customer across all the various channels through which that person interacts with the company.

Salesforce Marketing Cloud is a CRM platform that allows marketers to create and manage marketing relationships and campaigns with customers. The Marketing Cloud incorporates integrated solutions for customer journey management, email, mobile, social media, web personalization, advertising, content creation, content management, and data analysis. Every imaginable customer interaction and engagement is covered. The software includes predictive analytics to help make decisions such as, for example, what channel would be preferable for a given message. A

component called Journey Builder helps marketers tailor campaigns to customers' behavior and needs, demographics, and communication channel preferences.

The Marketing Cloud is connected to Salesforce.com's Sales Cloud and Service Cloud to provide a unified experience and prevent customers from being contacted separately by representatives from sales, marketing, and service groups. Service Cloud is a platform for customer service and support. Companies using Service Cloud can automate service processes, streamline workflows, and locate key articles, topics, and experts with information to help the company's 1,100 customer service agents. Service Cloud can "listen" and respond to customers across a variety of social platforms and automatically route cases to the appropriate agent. Service for Apps makes it possible to embed customer support software into mobile applications, including features for live agent video chat, screen sharing, and on-screen guided assistance. Service Cloud makes it possible to deliver service that is more personalized and convenient in whatever form each customer prefers—email, web, social media, or telephone—all from a single application.

Adidas is able to deploy its centralized e-commerce site globally by using the Salesforce Commerce Cloud. Commerce Cloud supports every language and currency required for the company's business throughout the globe. Adidas uses the knowledge of individual customers and their preferences obtained through Commerce Cloud to create better products, which can be manufactured and delivered to the customer very rapidly. Adidas is also using the Salesforce DMP data management platform to capture online and web behavior from digital actions across all channels and devices.

To move even closer to the customer, Adidas developed a mobile app that customizes content, interactions, and products based on the customer's personal preferences and behavior that have been identified via various digital points of engagement. The app features customized product recommendations, color preference and location, order tracking, blog posts, personalized articles, videos, real-time updates concerning an individual's sport and sports star preferences, and an intelligent online chat tool called Einstein to help answer customer questions and make more customized product recommendations. The app works with Apple Pay and Android Pay mobile payment systems.

Jacqueline Smith-Dubendorfer, Adidas Vice President of Digital Experience Design, believes that using Salesforce for customer relationship management has enhanced the company's ability to treat each customer as an individual. Who is this person? How much do we know about that individual? Where did that person come from? What is that person interested in? With Salesforce CRM tools, Adidas can now answer these questions much more easily. CRM provides the information for Adidas to adapt what it presents to the customer to deliver as close as it can

to what the customer is actually looking for. Adidas can now connect one-to-one with every customer, across multiple channels and on any device.

Sources: "Adidas," www.salesforce.com, accessed February 11, 2020; www.adidas-group.com, accessed February 10, 2020; "Roundup: E-Commerce Sales Increase for Adidas," digitalcommerce360, August 9, 2019; Stuart Lauchlan, "Dreamforce 2018; Adidas Gets Closer to Customers by Adopting an Athletic Mindset in Business. Diginomica, September 27, 2018; and Nadia Cameron, "Adidas Taps Data and Technology Smarts to Build Personalized Digital Engagement with Customers," CMO, November 7, 2017.

CASE STUDY QUESTIONS

1. Analyze Adidas using the competitive forces and value chain model.
2. What is Adidas's business strategy? What is the role of customer relationship management in that strategy?
3. How do information systems support Adidas's strategy?
4. How did using Salesforce.com make Adidas more competitive? How did it change the way the company ran its business?
5. Give an example of two business decisions that were improved by using Salesforce.com.

9-4 What are the challenges that enterprise applications pose, and how are enterprise applications taking advantage of new technologies?

Many firms have implemented enterprise systems and systems for supply chain and customer relationship management because they are such powerful instruments for achieving operational excellence and enhancing decision making. But precisely because they are so powerful in changing the way the organization works, they are challenging to implement. Let's briefly examine some of these challenges as well as new ways of obtaining value from these systems.

Enterprise Application Challenges

Promises of dramatic reductions in inventory costs, order-to-delivery time, more efficient customer response, and higher product and customer profitability make enterprise systems and systems for SCM and CRM very alluring. But to obtain this value, you must clearly understand how your business has to change to use these systems effectively.

Enterprise applications involve complex pieces of software that are expensive to purchase and implement. According to a 2020 survey of 181 ERP users conducted by Panorama Consulting Group, 38 percent of ERP projects experienced cost overruns, and these overruns averaged 66 percent over budget. (Panorama Consulting Group, 2020). Changes in project scope and additional customization work add to implementation delays and costs.

Enterprise applications require not only deep-seated technological changes but also fundamental changes in the way the business operates. Companies must make sweeping changes to their business processes to work with the software. Employees must accept new job functions and responsibilities. They must learn how to perform

a new set of work activities and understand how the information they enter into the system can affect other parts of the company. This requires new organizational learning and should also be factored into ERP implementation costs.

SCM systems require multiple organizations to share information and business processes. Each participant in the system may have to change some of its processes and the way it uses information to create a system that best serves the supply chain as a whole.

Some firms experienced enormous operating problems and losses when they first implemented enterprise applications because they didn't understand how much organizational change was required. For example, supermarket giant Woolworth's Australia encountered data-related problems when it transitioned from an antiquated home-grown ERP system to SAP. Weekly profit-and-loss reports tailored for individual stores couldn't be generated for nearly 18 months. The company had to change its data collection procedures, but failed to understand its own processes or properly document these business processes. U.S. discount retailer Kmart had trouble getting products to store shelves when it first implemented i2 Technologies (now JDA Software) SCM software. The i2 software did not work well with Kmart's promotion-driven business model, which created sharp spikes in demand for products.

Enterprise applications also introduce switching costs. When you adopt an enterprise application from a single vendor, such as SAP, Oracle, or others, it is very costly to switch vendors, and your firm becomes dependent on the vendor to upgrade its product and maintain your installation.

Enterprise applications are based on organization-wide definitions of data. You'll need to understand exactly how your business uses its data and how the data would be organized in a CRM, SCM, or ERP system. CRM systems typically require some data cleansing work.

Enterprise software vendors are addressing these problems by offering pared-down versions of their software and fast-start programs for small and medium-sized businesses and best-practice guidelines for larger companies. Companies are also achieving more flexibility by using cloud applications for functions not addressed by the basic enterprise software so that they are not constrained by a single do-it-all type of system.

Companies adopting enterprise applications can also save time and money by keeping customizations to a minimum. For example, Kennametal, a global \$2 billion metal-cutting tools company, had spent \$10 million over 13 years maintaining an ERP system with more than 6,400 customizations. The company replaced it with a plain-vanilla, uncustomized version of SAP enterprise software and changed its business processes to conform to the software. Office Depot, which sells to customers in 60 countries, avoided customization when it moved from in-house systems to the Oracle ERP Cloud. The retailer used best practices embedded in Oracle's Supply Chain Management Cloud and in its cloud-based Human Capital Management (HCM) and Enterprise Performance Management (EPM) systems. By not customizing its Oracle ERP applications, Office Depot simplified its information systems and reduced the cost of maintaining and managing them (Thibodeau, 2018).

Next-Generation Enterprise Applications

Today, enterprise application vendors are delivering more value by becoming more flexible, user-friendly, web-enabled, mobile, and capable of integration with other systems. Stand-alone enterprise systems, customer relationship management systems, and SCM systems are becoming a thing of the past. The major enterprise software vendors have created what they call *enterprise solutions*,

enterprise suites, or e-business suites to make their CRM, SCM, and ERP systems work closely with each other and link to systems of customers and suppliers.

Next-generation enterprise applications also include cloud solutions as well as more functionality available on mobile platforms. (See the Learning Track on Wireless Applications for Customer Relationship Management, Supply Chain Management, and Healthcare.) Large enterprise software vendors such as SAP, Oracle, and Microsoft now feature cloud versions of their flagship ERP systems and also cloud-based products for small and medium-sized businesses. SAP, for example, offers SAP S/4HANA Cloud for large companies, and SAP Business ByDesign and SAP Business One enterprise software for medium-sized and small businesses. Microsoft offers the Dynamics 365 cloud version of its ERP and CRM software. Cloud-based enterprise systems are also offered by smaller vendors such as NetSuite. The Interactive Session on Technology describes how Versum Materials was able to transform its business using a new cloud-based ERP system.

The undisputed global market leader in cloud-based CRM systems is Salesforce.com, which we described in Chapter 5. Salesforce.com delivers its service through Internet-connected computers or mobile devices, and it is widely used by small, medium-sized, and large enterprises. As cloud-based products mature, more companies, including very large FT Global 500 firms, are choosing to run all or part of their enterprise applications in the cloud.

Social CRM

CRM software vendors are enhancing their products to take advantage of social networking technologies. These social enhancements help firms identify new ideas more rapidly, improve team productivity, and deepen interactions with customers (see Chapter 10). Using **social CRM** tools, businesses can better engage with their customers by, for example, analyzing their sentiments about their products and services.

Social CRM tools enable a business to connect customer conversations and relationships from social networking sites to CRM processes. The leading CRM vendors now offer such tools to link data from social networks to their CRM software. SAP, Salesforce.com, and Oracle CRM products feature technology to monitor, track, and analyze social media activity on Facebook, LinkedIn, Twitter, YouTube, and other sites. Business intelligence and analytics software vendors such as SAS also have capabilities for social media analytics (with several measures of customer engagement across a variety of social networks) along with campaign management tools for testing and optimizing both social and traditional web-based campaigns.

Salesforce.com connected its system for tracking leads in the sales process with social-listening and social-media marketing tools, enabling users to tailor their social-marketing dollars to core customers and observe the resulting comments. If an ad agency wants to run a targeted Facebook or Twitter ad, these capabilities make it possible to aim the ad specifically at people in the client's lead pipeline who are already being tracked in the CRM system. Users will be able to view tweets as they take place in real time and perhaps uncover new leads. They can also manage multiple campaigns and compare them all to figure out which ones generate the highest click-through rates and cost per click.

Business Intelligence in Enterprise Applications

Enterprise application vendors have added business intelligence features to help managers obtain more meaningful information from the massive amounts of data these systems generate, including data from the Internet of Things (IoT). HANA in-memory computing technology enables SAP's enterprise applications

INTERACTIVE SESSION TECHNOLOGY

Versum's ERP Transformation

Versum Materials is an electronic materials company supplying premier specialty gases and products to the semiconductor industry chip manufacturing process. It merged with Merck in late 2019 and operates a network of offices, manufacturing sites, and research and development (R&D) centers in Asia, Europe, and North America. In October 2016, Versum was divested from its parent company, Air Products, and transitioned from a \$10 billion industrial gas and chemical company that predominantly sold large volumes of inexpensive products such as cylinders of pure oxygen, nitrogen, hydrogen, and helium, to an independent \$1 billion company selling highly regulated gases and chemicals for semiconductor manufacturing.

After separating from Air Products, Versum continued to rely on its former parent company's information systems under a transition service agreement (TSA). This was only an interim solution, however, since Versum really needed its own IT infrastructure and enterprise system to support its new business model and plans for growth. The company was given a very ambitious deadline of 18–24 months to get off the TSA and have its own systems in place.

When determining what ERP system to put in place, Versum Materials had a few options: The first was to copy Air Products' existing 20+-year-old SAP ERP system. The second was to bring the same customizations and functionality to a new SAP ERP system and the third was to start completely from scratch with all-new servers, software, and processes. Versum selected the third option because it provided an opportunity to wipe the slate clean and implement processes that worked for its specific business.

The legacy ERP system had been heavily customized with various upgrades over the years, and most of those customizations were for the parent company's industrial gas division, which had very different information requirements than the new Versum. Versum Materials management didn't want to continue using that system when it was not really suited for the business.

To find the new replacement system, Versum Materials looked at different ERP providers and products. Management ultimately elected to stick with SAP software because it had all the capabilities for satisfying the industry's legal regulatory requirements and because it appeared to be the quickest and easiest to implement in a short timeframe. If

Versum had tried to put in a totally new non-SAP ERP system, employees and IT staff would have had to learn a whole new unfamiliar system, and this could not be easily accomplished in short order. The training and the issues with people's understanding and knowledge for a new software package would have dramatically impacted the business.

Versum Materials decided to make SAP S/4HANA the foundation of its new system.

S/4HANA is an integrated ERP system that runs on SAP's in-memory database, SAP HANA (see Chapter 6). Instead of running the new SAP ERP system in a data center of its own, Versum Materials opted to implement the system in a private cloud, with a hosting provider that would manage the cloud SAP S/4HANA platform running in its own physical data center. This saved the company from making a large up-front capital investment in the new system and the responsibility for managing the system.

Versum implemented its SAP S/4HANA system by taking advantage of SAP and industry best practices embedded in the software and creating consistent processes across business units. The typical SAP implementation is rolled out in phases, often country by country for global enterprises. Companies with global supply chains where materials or products are manufactured or shipped from one country to another must convert supply chain data from the old system to the new system quickly and cleanly to keep products flowing. Versum Materials has a global supply chain spanning more than 10 countries, so a phased rollout would have required putting temporary interfaces in place to feed data from the previous system to the new system to enable the new system to go live country-by-country. Versum's transition services agreement (TSA) did not allow enough time for that option, so the new ERP system had to go live everywhere all at once.

A "big-bang" system rollout also was advantageous because it forced Versum to keep the system simple, with fewer problems to address. Dragging the program out and rolling out Taiwan one month and Korea the next, for example, would have taken much longer and been much more complicated, notes Sally Giomalis, SAP Program Director of Versum Materials. Versum had anticipated that the new system would initially have problems taking orders, creating purchase orders, or shipping products to customers.

Working with Accenture consultants, Versum found the implementation went smoothly with minimal disruption to its business.

When Versum went live with SAP S/4HANA release 1610, it also rolled out other SAP solutions, including modules for SAP Business Warehouse optimized for SAP HANA, SAP Business Planning and Consolidation, SAP Global Trade Services, the SAP Advanced Planning and Optimization component of SAP Supply Chain Management, SAP Solution Manager, SAP Process Integration, SAP Data Services, and SAP governance, risk, and compliance (GRC), as well as some non-SAP applications. The entire implementation took just 15 months.

During the course of implementing the new system, Versum did run up against some challenges, especially with converting the data from the old system. Versum had to run through three cycles of data cleansing to obtain sufficiently accurate invoicing, address, and contact information. The data structure in the old SAP ERP system was not the same as that for the new SAP S/4HANA system, which had a new hierarchical

Business Partner structure. In the old SAP ERP system, the Customer structure (ship to, bill to, contact, and vendor) consisted of all different data objects. In the new SAP S/4HANA structure, all those different data objects are part of a new object called Business Partner. In the old structure, a customer and the vendor could be the same thing, but they were two different entities. In the new structure, if the company sells to a customer but also buys from that customer, they are under a single Business Partner record.

The new SAP S/4HANA system makes it easier for Versum to optimize operations, manage costs, and take advantage of real-time analytics. The company now has a solid foundation for operating as a stand-alone company specializing in specialty materials.

Sources: "Business Transformation Through SAP S/4HANA," www.accenture.com, accessed January 10, 2020; www.versummaterials.com, accessed January 10, 2020; Lauren Bonneau, "How the Guiding Principles of Standardize, Harmonize, Simplify, and Scalable Led to a 'Ghostly Quiet' Go-Live," *SAP Insider*, February 26, 2019; and David Beltz, "Versum Materials: Implementing SAP S/4HANA for Business Transformation," www.accenture.com, accessed January 10, 2020.

CASE STUDY QUESTIONS

1. Define the problem in this case study. What management, organization, and technology factors contributed to the problem?
2. Was the SAP S/4 HANA SaaS solution a good one for Versum? Explain your answer.
3. What challenges did Versum encounter implementing the new system?
4. How did the new system change the way Versum ran its business?

to perform much more rapid and complex data analysis. Included are tools for flexible reporting; ad hoc analysis; interactive dashboards; what-if scenario analysis; data visualization; and AI machine learning to analyze very large bodies of data, make connections, make predictions, and provide more accurate recommendations for customer purchases and operations optimization (see Chapter 11). Salesforce.com offers an Einstein AI tool for optimizing product recommendations that enables its customers to generate between 9 percent and 10 percent additional revenue (Fluckinger, 2020).



9-5 How will MIS help my career?

Here is how Chapter 9 and this book can help you find a job as a manufacturing management trainee.

The Company

XYZ Global Industrial Components is a large U.S.-headquartered company with 40 global manufacturing facilities and more than 4,000 employees worldwide, and it has an open position for a new college graduate in its Manufacturing

Management Program. The company produces fastener, engineered, and linkage and suspension components for automotive, heavy-duty trucks, aerospace, electric utility, telecommunications, and other industries worldwide.

Position Description

The Manufacturing Management Program is a rotational, two-year program designed to nurture and train future managers by enabling recent college graduates to acquire critical skills and industry experience in plant, technical, and corporate environments. Job responsibilities include:

- Working with business units and project teams on systems implementation, including implementation of ERP and JDA manufacturing systems.
- Understanding business processes and data requirements for each business unit.
- Proficiency in supporting and conducting business requirement analysis sessions.
- Tracking and documenting changes to functional and business specifications.
- Writing user documentation, instructions, and procedures.
- Monitoring and documenting post-implementation problems and revision requests.

Job Requirements

- Bachelor's degree in IT, MIS, engineering, or related field or equivalent, with a GPA higher than 3.0
- Demonstrated skills in Microsoft Office Suite
- Strong written and verbal communication skills
- Proven track record of accomplishments both inside and outside the educational setting
- Experience in a leadership role in a team

Interview Questions

- Describe the projects you have worked on in a team. Did you play a leadership role? Exactly what did you do to help your team achieve its goal? Were any of these projects IT projects?
- What do you know about ERP or JDA manufacturing systems? Have you ever worked with them? What exactly did you do with these systems?
- Tell us what you can do with Microsoft Office software. Which tools have you used? Do you have any Access and Excel skills? What kinds of problems have you used these tools to solve? Did you take courses in Access or Excel?

Author Tips

1. Do some research on the company, its industry, and the kinds of challenges it faces. Look through the company's LinkedIn page and read its posts over the past twelve months. Are there any key trends in the LinkedIn posts for this company?
2. Review this text's Chapter 9 on enterprise applications, Chapter 13 on developing systems, and Chapter 14 on IT project management and implementation.
3. View YouTube videos created by major IT consulting firms that discuss the latest trends in manufacturing technology and enterprise systems.
4. Inquire how you would be using Microsoft Office tools for the job and what Excel and Access skills you would be expected to demonstrate. Bring examples of the work you have done with this software. Show that you would be eager to learn what you don't know about these tools to fulfill your job assignments.
5. Bring examples of your writing demonstrating your analytical skills and project experience.

REVIEW SUMMARY

9-1 How do enterprise systems help businesses achieve operational excellence?

Enterprise software is based on a suite of integrated software modules and a common central database. The database collects data from and feeds the data into numerous applications that can support nearly all of an organization's internal business activities. When one process enters new information, the information is made available immediately to other business processes.

Enterprise systems support organizational centralization by enforcing uniform data standards and business processes throughout the company and a single unified technology platform. The firmwide data that enterprise systems generate help managers evaluate organizational performance.

9-2 How do supply chain management systems coordinate planning, production, and logistics with suppliers?

Supply chain management (SCM) systems automate the flow of information among members of the supply chain so they can use it to make better decisions about when and how much to purchase, produce, or ship. More accurate information from supply chain management systems reduces uncertainty and the impact of the bullwhip effect.

Supply chain management software includes software for supply chain planning and for supply chain execution. Internet technology facilitates the management of global supply chains by providing the connectivity for organizations in different countries to share supply chain information. Improved communication among supply chain members also facilitates efficient customer response and movement toward a demand-driven model.

9-3 How do customer relationship management systems help firms achieve customer intimacy?

Customer relationship management (CRM) systems integrate and automate customer-facing processes in sales, marketing, and customer service, providing an enterprise-wide view of customers. Companies can use this customer knowledge when they interact with customers to provide them with better service or sell new products and services. These systems also identify profitable or unprofitable customers or opportunities to reduce the churn rate.

The major customer relationship management software packages provide capabilities for both operational CRM and analytical CRM. They often include modules for managing relationships with selling partners (partner relationship management) and for employee relationship management.

9-4 What are the challenges that enterprise applications pose, and how are enterprise applications taking advantage of new technologies?

Enterprise applications are difficult to implement. They require extensive organizational change, large new software investments, and careful assessment of how these systems will enhance organizational performance. Enterprise applications cannot provide value if they are implemented atop flawed processes or if firms do not know how to use these systems to measure performance improvements. Employees require training to prepare for new procedures and roles. Attention to data management is essential.

Enterprise applications are now more flexible, web-enabled, and capable of integration with other systems. They also can run in cloud infrastructures or on mobile platforms. CRM software has added social networking capabilities to enhance internal collaboration, deepen interactions with customers, and use data from social networking sites. Enterprise applications are incorporating business intelligence capabilities for analyzing the large quantities of data they generate.

Key Terms

Analytical CRM, 385

Bullwhip effect, 376

Churn rate, 386

Cross-selling, 383

Customer lifetime value (CLTV), 386

Demand planning, 378

Employee relationship management (ERM), 382

Enterprise software, 372

Just-in-time strategy, 376

Operational CRM, 385

Partner relationship management (PRM), 382

Pull-based model, 379

Push-based model, 379

Sales force automation (SFA), 383

Social CRM, 390

Supply chain, 374

Supply chain execution systems, 378

Supply chain planning systems, 377

Touch point, 381

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

9-1 How do enterprise systems help businesses achieve operational excellence?

- Identify six financial and accounting processes supported by enterprise systems.
- Explain how enterprise systems provide valuable information for improving management decision making.

9-2 How do supply chain management systems coordinate planning, production, and logistics with suppliers?

- List four likely parts of a retailer's supply chain.
- Distinguish between upstream and downstream portions of the supply chain.
- Identify the supply system likely to be used by a manufacturer with perfect information on future orders.
- Identify one of the most important and complex aspects of supply chain planning.
- Explain how supply chain costs can impact an organization's profitability.

9-3 How do customer relationship management systems help firms achieve customer intimacy?

- Identify three potential touch points for a retailer and explain what a touch point is.
- Describe the nature and purpose of sales force automation.
- Describe cross-selling and why it is important to a business.
- Distinguish between operational and analytical CRM.

9-4 What are the challenges that enterprise applications pose, and how are enterprise applications taking advantage of new technologies?

- List and describe the challenges enterprise applications pose.
- Explain how these challenges can be addressed.
- Describe how enterprise applications are taking advantage of cloud computing and business intelligence.
- Define social CRM and explain how customer relationship management systems are using social networking.

Discussion Questions

9-5 Supply chain management is less about managing the physical movement of goods and more about managing information. Discuss the implications of this statement.

9-6 If a company wants to implement an enterprise application, it had better do its

homework. Discuss the implications of this statement.

9-7 Which enterprise application should a business install first: ERP, SCM, or CRM? Explain your answer.

MyLab MIS

MyLab MIS

Hands-On MIS Projects

The projects in this section give you hands-on experience analyzing business process integration, suggesting supply chain management and customer relationship management applications, using database software to manage customer service requests, and evaluating supply chain management business services. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 9.8** Toronto-based Mercedes-Benz Canada, with a network of 55 dealers, did not know enough about its customers. Dealers provided customer data to the company on an ad hoc basis. Mercedes did not force dealers to report this information. There was no real incentive for dealers to share information with the company. How could CRM and PRM systems help solve this problem?
- 9.9** Office Depot sells a wide range of office supply products and services in the United States and internationally. The company tries to offer a wider range of office supplies at lower cost than other retailers by using just-in-time replenishment and tight inventory control systems. It uses information from a demand forecasting system and point-of-sale data to replenish its inventory in its 1,400 retail stores. Explain how these systems help Office Depot minimize costs and any other benefits they provide. Identify and describe other supply chain management applications that would be especially helpful to Office Depot.

Improving Decision Making: Using Database Software to Manage Customer Service Requests

Software skills: Database design; querying and reporting

Business skills: Customer service analysis

- 9.10** In this exercise, you'll use database software to develop an application that tracks customer service requests and analyzes customer data to identify customers meriting priority treatment.
- Prime Service is a large service company that provides maintenance and repair services for close to 1,200 commercial businesses in New York, New Jersey, and Connecticut. Its customers include businesses of all sizes. Customers with service needs call into its customer service department with requests for repairing heating ducts, broken windows, leaky roofs, broken water pipes, and other problems. The company assigns each request a number and writes down the service request number, the identification number of the customer account, the date of the request, the type of equipment requiring repair, and a brief description of the problem. The service requests are handled on a first-come-first-served basis. After the service work has been completed, Prime calculates the cost of the work, enters the price on the service request form, and bills the client. This arrangement treats the most important and profitable clients—those with accounts of more than \$70,000—no differently from its clients with small accounts. Management would like to find a way to provide its best customers with better service. It would also like to know which types of service problems occur most frequently so that it can make sure it has adequate resources to address them.

Prime Service has a small database with client account information, which can be found in MyLab MIS. Use database software to design a solution that would enable Prime's customer service representatives to identify the most important customers so that they could receive priority service. Your solution will require more than one table. Populate your database with at least 10 service requests. Create several reports that would be of interest to management, such as a list of the highest—and lowest—priority accounts and a report showing the most frequently occurring service problems. Create a report listing service calls that customer service representatives should respond to first on a specific date.

Achieving Operational Excellence: Evaluating Supply Chain Management Services

Software skills: Web browser and presentation software

Business skills: Evaluating supply chain management services

- 9.11** In addition to carrying goods from one place to another, some trucking companies provide supply chain management services and help their customers manage their information. In this project, you'll use the web to research and evaluate two of these business services. Investigate the websites of two companies,

UPS and Schneider National, to see how these companies' services can be used for supply chain management. Then respond to the following questions:

- What supply chain processes can each of these companies support for its clients?
- How can customers use the websites of each company to help them with supply chain management?
- Compare the supply chain management services these companies provide. Which company would you select to help your firm manage its supply chain? Why?

Collaboration and Teamwork Project

Analyzing Enterprise Application Vendors

- 9-12** With a group of three or four other students, use the web to research and evaluate the products of two vendors of enterprise application software. You could compare, for example, the SAP and Oracle enterprise systems, the supply chain management systems from JDA Software and SAP, or the customer relationship management systems of Oracle and Salesforce.com. Use what you have learned from these companies' websites to compare the software products you have selected in terms of business functions supported, technology platforms, cost, and ease of use. Which vendor would you select? Why? Would you select the same vendor for a small business (50–300 employees) as well as for a large one? If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

The Coronavirus Pandemic Disrupts Supply Chains Around the World

CASE STUDY

The COVID-19 pandemic has tested supply chains like no other event in recent history. Entire populations were isolating and quarantining, creating spikes in demand for certain products (such as hand sanitizer) and large drops in demand for others. Many businesses were shuttered for months, with small businesses, retail stores, and restaurants especially hard-hit. Large drops in demand, shortfalls in cash flow, worldwide port congestion, factory shutdowns, and disruptions to air cargo, trucking, and rail services paralyzed companies all over the world.

Customers changed their purchasing habits. Many started spending more on essentials, creating shortages across both e-commerce and brick-and-mortar retail stores. Changes in consumer spending behavior upended predictive models as customers shifted spending to new stores, channels, and product lines. At the same time, companies that didn't deal in essentials faced spending shortages, as millions of people found themselves out of work.

According to a March 11, 2020 analysis by Trading platform Forex.com, nearly 75 percent of all companies had already reported supply chain disruptions and that number was expected to rise to 80 percent. Manufacturing firms worldwide were especially affected by the shutdown of industrial activity in Wuhan, China, where the pandemic started. These firms had depended on components, materials, and finished goods made in China.

Most companies were unable to respond quickly and flexibly to supply chain disruptions caused by the order of magnitude of the coronavirus pandemic, which can only be done if the entire supply chain is visible. Most companies don't have supply chain visibility. (Supply chain visibility is the ability of parts, components, or products in transit to be tracked from the manufacturer to their final destination.) The majority of enterprises have only 20 percent visibility into their supply chains. Experts believe 70 to 80 percent visibility is required to deal with major supply chain disruptions.

The modern supply chain is incredibly fragile. Companies have built global supply chains based on outsourcing to external suppliers and incredibly thin margins of safety stock. (Safety stock is an additional quantity of an item held by a company in inventory in order to reduce the risk that the item will be out of stock.) The prevailing wisdom in supply chain management has embraced "lean" principles that try to optimize costs by minimizing safety stock, using "just in time" delivery to keep only 15–30 days of products on hand, and concentrating sourcing in a few countries. For example, over 80 percent of manufacturing facilities that produce components for drugs in the United States are located abroad, mainly in China. Many companies found it cheaper to manufacture goods in China and elsewhere in Asia, rather than do so closer to home. Auto parts, fashion, technology, medical gear, and drug components are especially vulnerable to supply chain disruptions in Asia.

To make supply chains more resilient, businesses need to eliminate their dependence on sourcing from a single supplier, region, or country. Large companies can build regional supply chains and diversify the location of their manufacturing plants and their suppliers (see the Chapter 15 Interactive Session on Management). They should also consider pulling back from inventory-optimization and safety stock calculations that optimize costs by keeping stock to a minimum and build some level of reserves to absorb shocks, even if this increases costs.

The cost of manufacturing has been one of the key justifications for moving manufacturing offshore. However, the labor cost component of manufacturing has been steadily growing smaller as new automation tools have been developed. Thirty years ago, when labor costs represented 30 to 40 percent of the cost to manufacture goods, U.S. manufacturers were tempted to move production offshore to Chinese factories replete with low-cost laborers assembling products by hand. Today, the trend is toward more automated factories, which lower the labor component and reduce profit-and-loss pressures. U.S. leadership in factory automation will

undoubtedly help bring some offshore manufacturing back home.

Switching to more digital tools for supply chain management can also be helpful. A contemporary supply chain management system increases transparency and responsiveness because all the activities in the supply chain are able to interact with one another in near real-time. There are new digital applications and platforms to help companies establish interconnected networks of what had been discrete, siloed supply chain processes and to manage their supply chains more flexibly. Gartner Inc. predicts that by 2023, at least 50 percent of global companies will be using artificial intelligence (see Chapter 11), advanced analytics, and the Internet of Things (IoT) in supply chain operations. Firms such as Procter & Gamble (P&G) are using artificial intelligence machine learning algorithms to perform demand planning for products such as Tide detergent multiple times per day. Other companies are implementing IoT technologies such as GPS and radio-frequency identification (RFID—see Chapter 7) devices to identify and track items in stores and warehouses, as well as real-time data on variables such as speed of delivery.

A word of caution: Even if a company uses digital supply chain management tools, they may need updating and fine-tuning in order to deal with major global shutdowns. The algorithms used by the supply chain management systems of large companies didn't work during the coronavirus pandemic. For example, Walmart, noted for its efficient state-of-the art supply chain management systems (see Chapter 3), found that disruptions during the pandemic made these systems unable to accurately predict how many diapers and garden hoses it needed to keep on store shelves.

Normally Walmart's system is able to accurately analyze inventory levels, historical purchasing trends, and discounts to recommend how much of a product to order. But the worldwide disruption caused by the COVID-19 pandemic caused the software's recommendations to change more frequently.

Most retail companies base their prediction of what customers will want and how much to order on some type of model or algorithm. Their models incorporate some understanding of how shocks like natural disasters disrupt supply chains and impact demand, using historical data to predict future

trends. Under normal conditions, these algorithms work fairly well. But global pandemics are something new that the models don't know how to take into account. Disasters like floods or hurricanes tend to be regional, but the COVID-19 pandemic disrupted the entire world. Production, transportation, and people's behavior changed dramatically during the pandemic. Because of these massive worldwide disruptions, the normal data feeding the models, including historical buying patterns, aren't as relevant.

The models in supply chain management software can still be used, but the data need to be changed. The people who manage supply chains will need to be more active in interpreting the projections rather than assuming the models will be able to capture everything that is going on. For example, Alloy, a consumer goods analytics company, has worked with a company that saw sales for its product rise 40 percent at a major retailer in March 2020 as the pandemic started to surge in the U.S. The retailer placed a very large order for April to handle the spike in sales, but Alloy's analysts knew that demand for the product had plummeted, and that the retailer wouldn't be able to sell everything it had ordered. Alloy told the retailer not to purchase so much of the product.

Technology for strengthening supply chains, in the form of innovations such as analytics, artificial intelligence, and machine learning alone won't shore up vulnerabilities and inefficiencies. Companies must rethink their strategies and redesign supply chains so that they're able to source product from multiple locations, depending on where a disruption occurs. One key lies in supply-chain mapping, without which companies can't devise workable recovery plans.

The small number of companies that had mapped their supply networks prior to the pandemic were better prepared to deal with disruptions. These companies were able to determine exactly which suppliers, sites, products, and parts were at risk, which could help them arrive at a solution more quickly. A company might assume that its biggest vulnerability lies with a primary supplier. A detailed breakdown of its supply chain could show instead that the highest risk comes from a small lower-tier supplier of a critical component that costs 10 cents.

However, supply network mapping is time-consuming and expensive, and most companies have not done so. (After the 2011 earthquake and tsunami, it took a team of 100 people at a Japanese semiconductor manufacturer over a year to map the company's supply networks into sub-tiers.) Instead, firms rely on human-supplied (and often anecdotal) information from their top-tier and a few lower-tier suppliers.

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CASE STUDY QUESTIONS

- 9-13** Define the problem described in this case study. What management, organization, and technology factors contributed to this problem?
- 9-14** To what extent can information technology solve this problem? Explain your answer.
- 9-15** What management, organization, and technology issues should be addressed to redesign supply chains to deal with major disruptions such as the coronavirus pandemic?

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10

E-commerce: Digital Markets, Digital Goods

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 10-1** What are the unique features of e-commerce, digital markets, and digital goods?
- 10-2** What are the principal e-commerce business and revenue models?
- 10-3** How has e-commerce transformed marketing?
- 10-4** How has e-commerce affected business-to-business transactions?
- 10-5** What is the role of m-commerce in business, and what are the most important m-commerce applications?
- 10-6** What issues must be addressed when building an e-commerce presence?
- 10-7** How will MIS help my career?

CHAPTER CASES

E-commerce Comes to the Dashboard: The Battle for the “Fourth Screen”
Deliveroo: Global Food Delivery App
Engaging “Socially” with Customers
An iDEAL Solution to the Single Online EU Market

VIDEO CASES

Walmart Takes On Amazon: A Battle of IT and Management Systems
Groupon: Deals Galore
Etsy: A Marketplace and Community

MyLab MIS

Discussion Questions: 10-7, 10-8, 10-9; Hands-On MIS Projects: 10-10, 10-11, 10-12, 10-13;
eText with Conceptual Animations

E-commerce Comes to the Dashboard: The Battle for the “Fourth Screen”

Businesses are always on the lookout for more ways to attract and sell to customers. Now they're zeroing in on your car's dashboard. The average American driver spends 51 minutes per day in a car, creating another opportunity to reach a captive audience. After television, computers, and mobile phones, car dashboards are emerging as the “fourth screen” for attracting consumer eyeballs.

Opportunities abound. Local doctors, restaurants, and other services could target ads based on typical driving routes. Drivers could order and pay for coffee or gasoline on their dashboard screens. Insurance companies monitoring driving patterns could offer lower rates to cautious drivers. Auto makers themselves could use data generated by a car's sensors to identify parts that need replacement and offer coupons and deals for repair services. According to McKinsey & Co. consultants, dashboard-based products and services could generate as much as \$750 billion in new revenue by 2030.

Auto makers are counting on what is displayed on car dashboards to build closer relationships with customers. Alphabet's Google and Apple desperately want to use dashboard displays as another platform for their apps and screens. A major battle is now raging between auto makers and big tech companies for control of the dashboard display.

Auto makers currently are at a disadvantage. New car models are designed and engineered several years out, and car owners tend to keep their cars longer than their smartphones. The older car displays weren't designed to be updated like smartphones.

Google and Apple have developed special software for car display systems called Android Auto and CarPlay that presents apps from smartphones on a vehicle's display screen using large icons and voice controls to help keep drivers' eyes on the road and hands on the wheel. Some car makers such as Chevrolet, Toyota, and Volvo are making their dashboard displays compatible with Android Auto and Apple CarPlay. Google recently created a new version of its Android operating system (Android Automotive) tailored for vehicle dashboards that does not need input from smartphones.

Auto makers such as Ford and Daimler AG believe they will be better off developing their own dashboard apps and system software. Volkswagen AG wants to keep control over the reams of consumer data generated by its vehicles' onboard electronics and has developed its own car operating system (vw.OS) and online store of apps and



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services that run in the cloud. Volkswagen's I.D. series of electric vehicles will be the company's first to use its dashboard systems. Ford is also developing its own dashboard system, but it will allow users to project some of their smartphone apps to the car screen.

The "fourth screen" comes with its own set of challenges. One is the potential for distracting drivers, who still need to keep their eyes on the road and hands on the wheel while their car is moving. Voice recognition might not work well for drivers barreling 70 mph on the highway, competing with wind and road noise and searching for a signal that may be going in and out.

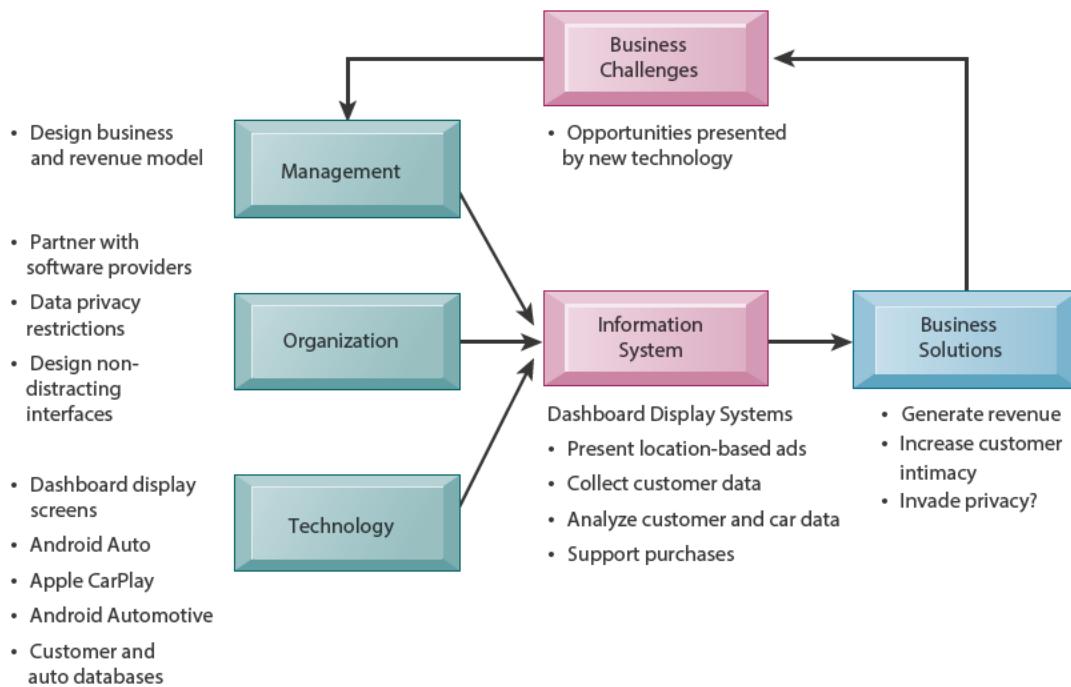
The "fourth screen" also presents challenges for privacy protection because its software is able to collect a large amount of personal data from cars and drivers. This is of special concern for European auto makers, who have stricter data protection standards than the United States. Volkswagen rejected Google's request to access data about a car's fuel levels so that Android could determine the need for gasoline and provide directions to a service station. Google had also asked BMW if sensors could be installed in the passenger seat to determine the occupant's weight, which would indicate whether the passenger was an adult or a child. A Google spokesperson has said that the company's data collection policy requires it to obtain driver approval before accessing any information.

Sources: Jackie Dove, "The Best Android Auto Apps for 2020," *Digital Trends*, January 5, 2020; Tim Higgins and Willam Boston, "The Battle for the Last Unconquered Screen—the One in Your Car," *Wall Street Journal*, April 6, 2019; Peter Koeppel, "The Fight for the Fourth Screen—Your Dashboard Display," *Koeppel Direct*, June 11, 2019; and Ronan Glon, "What Is Android Auto?" *Digital Trends*, June 23, 2019.

The Internet-enabled dashboard infotainment systems described here illustrate some of the major trends in e-commerce today. E-commerce is everywhere. Internet-based buying, selling, and advertising are no longer limited to the computer screen—they are taking place on mobile smartphones, tablets, and now on car dashboard displays. What is being bought and sold is not just products but information and services. These dashboard infotainment services use advanced data mining and location-based advertising to generate revenue from the user data they capture and also from on-screen purchases such as for gasoline. Apple, Google, and major auto makers are competing to deliver innovative infotainment services using cars' dashboard displays.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. The challenge facing auto makers and Big Tech companies is how to take advantage of opportunities presented by the Internet, improvements in dashboard display technology, and location-based technology to wring new profits from advertising and services for car drivers. Both the auto makers and tech companies have made major investments in technology to design and implement new e-commerce interfaces and operating systems for auto display screens and to collect and analyze large amounts of data about drivers and cars generated by in-car systems. What has not been resolved is whether these dashboard systems can truly function under all driving conditions without distracting drivers and without invading privacy.

Here are some questions to think about: What people, organization, and technology issues must be addressed when designing and implementing car dashboard display systems for e-commerce? What are the advantages and drawbacks to using this form of e-commerce?



10-1 What are the unique features of e-commerce, digital markets, and digital goods?

Today, purchasing goods and services online by using smartphones, tablets, and desktop computers has become ubiquitous. In 2020, an estimated 2.25 billion people (over 55% of the global Internet population) will purchase something online. Although most purchases still take place through traditional channels, e-commerce continues to grow rapidly and to transform the way many companies do business. E-commerce is composed of three major segments: retail goods, travel and services, and online content. In 2020, in the United States, e-commerce consumer sales of goods (\$675 billion), travel and services (about \$475 billion), and online content (about \$67 billion) will total about \$1.2 trillion.

Worldwide, online sales of retail goods will generate over \$3.9 trillion in 2020, almost 17% of total retail sales. Unlike traditional sales, which dropped by almost 6% due to the COVID-19 pandemic, worldwide e-commerce retail sales grew by over 16% in 2020. E-commerce is still a small part of the much larger retail goods market that takes place in physical stores. E-commerce has expanded from the desktop and home computer to mobile devices, from an isolated activity to a new social commerce, and from commerce focused on a national audience to local merchants and consumers whose location is known to mobile devices. Retail m-commerce now accounts for 65% of total retail e-commerce sales worldwide, with the majority of these purchases taking place on a smartphone. The key words for understanding this new e-commerce in 2020 are “social, mobile, local” (eMarketer, 2020a).

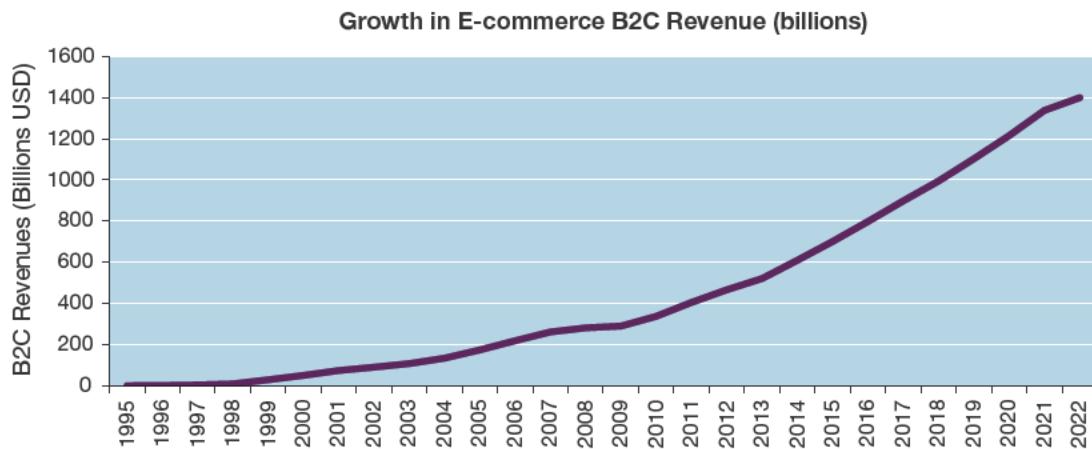
E-commerce Today

E-commerce refers to the use of the Internet and the web to transact business. More formally, e-commerce is about digitally enabled commercial transactions between and among organizations and individuals. For the

FIGURE 10.1 THE GROWTH OF E-COMMERCE IN THE UNITED STATES

U.S. B2C e-commerce revenues grew 15–25 percent per year until the recession of 2008–2009, when they slowed measurably. In 2020, e-commerce revenues are expected to grow at an estimated 13%.

Sources: Based on data from eMarketer, "US Retail Ecommerce Sales," 2020; eMarketer, "US Digital Travel Sales," 2020; authors' estimates.



most part, this refers to transactions that occur over the Internet and the web. Commercial transactions involve the exchange of value (e.g., money) across organizational or individual boundaries in return for products and services.

E-commerce began in 1995 when one of the first Internet portals, Netscape.com, accepted the first ads from major corporations and popularized the idea that the web could be used as a new medium for advertising and sales. No one envisioned at the time what would turn out to be an exponential growth curve for e-commerce retail sales, which doubled and tripled in the early years. E-commerce in the United States grew at double-digit rates until the recession of 2008–2009, when growth slowed to a crawl and revenues flattened (see Figure 10.1), which is not bad considering that traditional retail sales were shrinking by 5 percent annually during the recession. Since then, offline retail sales have been increasing in the range of 2 to 4 percent, whereas online e-commerce has been a stellar success, growing in the 12 to 15 percent range.

The rapid growth in e-commerce in the early years created a market bubble in e-commerce stocks, which burst in March 2001. A large number of e-commerce companies failed during this process. Yet for many others, such as Amazon, eBay, Expedia, and Google, the results have been more positive: soaring revenues, fine-tuned business models that produce profits, and rising stock prices. By 2006, e-commerce revenues returned to solid growth and have continued to be the fastest-growing form of retail trade in the United States, Europe, and Asia.

The New E-commerce: Social, Mobile, Local

One of the biggest changes is the extent to which e-commerce has become more social, mobile, and local. Online marketing once consisted largely of creating a corporate website, buying display ads on portal sites such as Yahoo,

TABLE 10.1 THE GROWTH OF E-COMMERCE**BUSINESS TRANSFORMATION**

E-commerce remains the fastest-growing form of commerce when compared to physical retail stores, services, and entertainment. Social, mobile, and local commerce have become the fastest-growing forms of e-commerce.

The breadth of e-commerce offerings grows, especially in the services economy, as well as entertainment, retail apparel, jewelry, appliances, and home furnishings. On-demand services like Uber, Lyft, Airbnb, meal delivery services, and pet-care services have further expanded online service offerings.

The online demographics of shoppers broaden to match that of ordinary shoppers.

Pure e-commerce business models are refined further to achieve higher levels of profitability, and traditional retail firms, such as Walmart, Zara, H&M, and others, have developed omnichannel business models to strengthen their dominant physical retail assets. Walmart, the world's largest retailer, has decided to take on Amazon with a more than \$1 billion investment in its e-commerce efforts, and is currently ranked third in e-commerce sales, with estimated online revenues in 2020 of \$35 billion, about 5 percent of all online retail e-commerce in the United States. Amazon, of course, is first with an estimated \$260 billion in 2020 online sales, about 40 percent of all retail e-commerce.

Small businesses and entrepreneurs continue to flood the e-commerce marketplace, often riding on infrastructures created by industry giants, such as Amazon, Apple, and Google, and increasingly taking advantage of cloud-based computing resources.

Mobile e-commerce has taken off worldwide with location-based services and entertainment downloads, including e-books, movies, music, and television shows. Mobile retail e-commerce is expected to generate about \$2.54 trillion in 2020 (eMarketer, 2020b).

TECHNOLOGY FOUNDATIONS

Wireless Internet connections (Wi-Fi, WiMax, 4G, and 5G smartphones) continue to expand.

Powerful smartphones and tablet computers provide access to music, web surfing, and entertainment as well as voice communication. Podcasting and streaming take off as platforms for distribution of video, radio, and user-generated content.

Mobile devices expand to include wearable computers such as Apple Watch and Fitbit trackers, along with in-home devices such as Amazon Alexa and Google Assistant.

The Internet broadband foundation becomes stronger in households and businesses as communication prices fall.

Social networking apps and sites such as Facebook, Twitter, LinkedIn, Instagram, and others seek to become a major new platform for e-commerce, marketing, and advertising (eMarketer, "U.S. Facebook Users and Penetration," February 2020).

Internet-based models of computing, such as smartphone apps, cloud computing, software as a service (SaaS), and platform as a service (PaaS), reduce the cost of building and maintaining e-commerce websites.

NEW BUSINESS MODELS EMERGE

Almost 80 percent of the global Internet population has joined an online social network, created blogs, and shared photos and music. Together, these sites create an online audience as large as that of television that is attractive to marketers. In 2020, social networking will account for an estimated 13.5 percent of time spent with digital media in the United States. Social sites have become the primary gateway to the Internet in news, music, and, increasingly, products and services (eMarketer, 2020b, 2019b).

The traditional advertising industry is disrupted as online advertising grows twice as fast as TV and print advertising; Google, Yahoo, and Facebook display more than 1 trillion ads a year.

On-demand service e-commerce sites such as Uber, Lyft, and Airbnb extend the market creator business model (on-demand model) to new areas of the economy.

Newspapers and other traditional media adopt online, interactive models but are losing advertising revenues to the online players such as Google, Facebook, and portals despite gaining online readers. Book publishing continues to grow slowly because of the growth in e-books and the continuing appeal of traditional trade books.

Online entertainment business models offering television, movies, music, and games grow with cooperation among the major copyright owners in the different media industries and with the Internet distributors such as Netflix, Amazon, Apple, and YouTube. Increasingly, the online distributors are moving into movie and TV production. Cable television is in modest decline, as some viewers cut or reduce their cable subscriptions and rely on Internet-based alternatives such as Roku or YouTube TV.

purchasing search-related ads on Google, and sending email messages. The workhorse of online marketing was the display ad. It still is, but it's increasingly being replaced by video ads, which are far more effective. Display ads from the very beginning of the Internet were based on television ads, where brand messages were flashed before millions of users who were not expected to respond immediately, ask questions, or make observations. If the ads did not work, the solution was often to repeat the ad. The primary measure of success was how many eyeballs (unique visitors) a website produced and how many impressions a marketing campaign generated. (An impression was one ad shown to one person.) Both of these measures were carryovers from the world of television, which measures marketing in terms of audience size and ad views.

From Eyeballs to Conversations: Conversational Commerce

After 2007, all this changed with the rapid growth of Facebook and other social sites, the explosive growth of smartphones beginning with the Apple iPhone, and the growing interest in local marketing. What's different about the new world of social-mobile-local e-commerce is the dual and related concepts of conversations and engagement. In the popular literature, this is often referred to as conversational commerce. Marketing in this new period is based on firms engaging in multiple online conversations with their customers, potential customers, and even critics. Your brand is being talked about on the web and social media (that's the conversation part), and marketing your firm, and building and restoring your brands require you to locate, identify, and participate in these conversations. Social marketing means all things social: listening, discussing, interacting, empathizing, and engaging. The emphasis in online marketing has shifted from a focus on eyeballs to a focus on participating in customer-oriented conversations. In this sense, social marketing is not simply a new ad channel but a collection of technology-based tools for communicating with shoppers. The leading social commerce platforms are Facebook, Instagram, Twitter, and Pinterest.

In the past, firms could tightly control their brand messaging and lead consumers down a funnel of cues that ended in a purchase. That is not true of social marketing. Consumer purchase decisions are increasingly driven by the conversations, choices, tastes, and opinions of their social network. Social marketing is all about firms participating in and shaping this social process.

From the Desktop to the Smartphone

Online advertising now makes up more than 55% of all advertising worldwide. Mobile marketing now constitutes over 70% of online marketing, and the remainder is browser-based desktop ads, search, display ads, video ads, email, and games (eMarketer, 2020d, 2020e).

Social, mobile, and local e-commerce are connected. As mobile devices become more powerful, they are more useful for accessing Facebook and other social sites. As mobile devices become more widely adopted, customers can use them to find local merchants, and merchants can use them to alert customers in their neighborhood of special offers.

Why E-commerce is Different

Why has e-commerce grown so rapidly? The answer lies in the unique nature of the Internet and the web. Simply put, the Internet and e-commerce technologies are much richer and more powerful than previous technology revolutions such as radio, television, and the telephone. Table 10.2 describes the unique features of the Internet and web as a commercial medium. Let's explore each of these unique features in more detail.

Ubiquity

In traditional commerce, a marketplace is a physical place, such as a retail store, that you visit to transact business. E-commerce is ubiquitous, meaning that it is available just about everywhere all the time. It makes it possible to shop from your desktop, at home, at work, or even from your car, using smartphones. The result is called a **marketspace**—a marketplace extended beyond traditional boundaries and removed from a temporal and geographic location.

From a consumer point of view, ubiquity reduces **transaction costs**—the costs of participating in a market. To transact business, it is no longer necessary to spend time or money traveling to a market, and much less mental effort is required to make a purchase.

TABLE 10.2 EIGHT UNIQUE FEATURES OF E-COMMERCE TECHNOLOGY

E-COMMERCE TECHNOLOGY DIMENSION	BUSINESS SIGNIFICANCE
<i>Ubiquity.</i> Internet/web technology is available everywhere: at work, at home, and elsewhere by desktop and mobile devices. Mobile devices extend service to local areas and merchants.	The marketplace is extended beyond traditional boundaries and is removed from a temporal and geographic location. Marketspace is created; shopping can take place anytime, anywhere. Customer convenience is enhanced, and shopping costs are reduced.
<i>Global Reach.</i> The technology reaches across national boundaries, around the earth.	Commerce is enabled across cultural and national boundaries seamlessly and without modification. The marketspace includes, potentially, billions of consumers and millions of businesses worldwide.
<i>Universal Standards.</i> There is one set of technology standards, namely Internet standards.	With one set of technical standards across the globe, disparate computer systems can easily communicate with each other.
<i>Richness.</i> Video, audio, and text messages are possible.	Video, audio, and text marketing messages are integrated into a single marketing message and consumer experience.
<i>Interactivity.</i> The technology works through interaction with the user.	Consumers are engaged in a dialogue that dynamically adjusts the experience to the individual and makes the consumer a participant in the process of delivering goods to the market.
<i>Information Density.</i> The technology reduces information costs and raises quality.	Information processing, storage, and communication costs drop dramatically, whereas currency, accuracy, and timeliness improve greatly. Information becomes plentiful, cheap, and more accurate.
<i>Personalization/Customization.</i> The technology allows personalized messages to be delivered to individuals as well as to groups.	Personalization of marketing messages and customization of products and services are based on individual characteristics.
<i>Social Technology.</i> The technology supports content generation and social networking.	New Internet social and business models enable user content creation and distribution and support social networks.

Global Reach

E-commerce technology permits commercial transactions to cross cultural and national boundaries far more conveniently and cost effectively than is true in traditional commerce. As a result, the potential market size for e-commerce merchants is roughly equal to the size of the world's online population (estimated to be about 4 billion).

In contrast, most traditional commerce is local or regional—it involves local merchants or national merchants with local outlets. Television, radio stations, and newspapers, for instance, are primarily local and regional institutions with limited, but powerful, national networks that can attract a national audience but not easily cross national boundaries to a global audience.

Universal Standards

One strikingly unusual feature of e-commerce technologies is that the technical standards of the Internet and, therefore, the technical standards for conducting e-commerce are universal standards. All nations around the world share them and enable any computer to link with any other computer regardless of the technology platform each is using. In contrast, most traditional commerce technologies differ from one nation to the next. For instance, television and radio standards differ around the world, as does cellular telephone technology.

The universal technical standards of the Internet and e-commerce greatly lower **market entry costs**—the cost merchants must pay simply to bring their goods to market. At the same time, for consumers, universal standards reduce **search costs**—the effort required to find suitable products.

Richness

Information **richness** refers to the complexity and content of a message. Traditional markets, national sales forces, and small retail stores have great richness; they can provide personal, face-to-face service, using aural and visual cues when making a sale. The richness of traditional markets makes them powerful selling or commercial environments. Prior to the development of the web, there was a trade-off between richness and reach; the larger the audience reached, the less rich the message. The web makes it possible to deliver rich messages with text, audio, and video simultaneously to large numbers of people.

Interactivity

Unlike any of the commercial technologies of the twentieth century, with the possible exception of the telephone, e-commerce technologies are interactive, meaning they allow for two-way communication between merchant and consumer and peer-to-peer communication among friends. Television, for instance, cannot ask viewers any questions or enter conversations with them, and it cannot request customer information to be entered on a form. In contrast, all these activities are possible on an e-commerce website or mobile app. Interactivity allows an online merchant to engage a consumer in ways similar to a face-to-face experience but on a massive, global scale.

Information Density

The Internet and the web vastly increase **information density**—the total amount and quality of information available to all market participants, consumers, and merchants alike. E-commerce technologies reduce information collection, storage, processing, and communication costs while greatly increasing the currency, accuracy, and timeliness of information.

Information density in e-commerce markets make prices and costs more transparent. **Price transparency** refers to the ease with which consumers

can find out the variety of prices in a market; **cost transparency** refers to the ability of consumers to discover the actual costs merchants pay for products.

There are advantages for merchants as well. Online merchants can discover much more about consumers than in the past. This allows merchants to segment the market into groups that are willing to pay different prices and permits the merchants to engage in **price discrimination**—selling the same goods, or nearly the same goods, to different targeted groups at different prices. For instance, an online merchant can discover a consumer's avid interest in expensive, exotic vacations and then pitch high-end vacation plans to that consumer at a premium price, knowing this person is willing to pay extra for such a vacation. At the same time, the online merchant can pitch the same vacation plan at a lower price to a more price-sensitive consumer. Information density also helps merchants differentiate their products in terms of cost, brand, and quality.

Personalization/Customization

E-commerce technologies permit **personalization**. Merchants can target their marketing messages to specific individuals by adjusting the message to a person's clickstream behavior, name, interests, and past purchases. The technology also permits **customization**—changing the delivered product or service based on a user's preferences or prior behavior. Given the interactive nature of e-commerce technology, much information about the consumer can be gathered in the marketplace at the moment of purchase. With the increase in information density, a great deal of information about the consumer's past purchases and behavior can be stored and used by online merchants.

The result is a level of personalization and customization unthinkable with traditional commerce technologies. For instance, you may be able to shape what you see on television by selecting a channel, but you cannot change the content of the channel you have chosen. In contrast, online news outlets such as the *Wall Street Journal Online* allow you to select the type of news stories you want to see first and give you the opportunity to be alerted when certain events happen.

Social Technology: User Content Generation and Social Networking

In contrast to previous technologies, the Internet and e-commerce technologies have evolved to be much more social by allowing users to create and share with their friends (and a larger worldwide community) content in the form of text, videos, music, or photos. By using these forms of communication, users can create new social networks and strengthen existing ones.

All previous mass media, including the printing press, use a broadcast model (one-to-many) in which content is created in a central location by experts (professional writers, editors, directors, and producers), with audiences concentrated in huge numbers to consume a standardized product. The new Internet and e-commerce empower users to create and distribute content on a large scale and permit users to program their own content consumption. The Internet provides a unique many-to-many model of mass communications.

Key Concepts in E-commerce: Digital Markets and Digital Goods in a Global Marketplace

The location, timing, and revenue models of business are based in some part on the cost and distribution of information. The Internet has created a digital marketplace where millions of people all over the world can exchange massive amounts of information directly, instantly, and free. As a result, the Internet has changed the way companies conduct business and increased their global reach.

The Internet reduces information asymmetry. An **information asymmetry** exists when one party in a transaction has more information that is important for the transaction than the other party. That information helps determine their relative bargaining power. In digital markets, consumers and suppliers can see the prices being charged for goods, and in that sense, digital markets are said to be more transparent than traditional markets.

For example, before automobile retailing sites appeared on the web, there was significant information asymmetry between auto dealers and customers. Only the auto dealers knew the manufacturers' prices, and it was difficult for consumers to shop around for the best price. Auto dealers' profit margins depended on this asymmetry of information. Today's consumers have access to a legion of websites providing competitive pricing information, and three-fourths of U.S. auto buyers use the Internet to shop around for the best deal. Thus, the web has reduced the information asymmetry surrounding an auto purchase. The Internet has also helped businesses seeking to purchase from other businesses reduce information asymmetries and locate better prices and terms.

Digital markets are flexible and efficient because they operate with reduced search and transaction costs, lower **menu costs** (merchants' costs of changing prices), greater price discrimination, and the ability to change prices dynamically based on market conditions. In **dynamic pricing**, the price of a product varies depending on the demand characteristics of the customer or the supply situation of the seller. For instance, online retailers from Amazon to Walmart change prices on thousands of products based on time of day, demand for the product, and users' prior visits to their sites. Using big data analytics, some online firms can adjust prices at the individual level based on behavioral targeting parameters such as whether the consumer is a price haggler (who will receive a lower price offer) versus a person who accepts offered prices and does not search for lower prices. Prices can also vary by zip code. Uber, along with other ride services, uses surge pricing to adjust prices of a ride based on demand (which always rises during storms and major conventions).

These new digital markets can either reduce or increase switching costs, depending on the nature of the product or service being sold, and they might cause some extra delay in gratification due to shipping times. Unlike a physical market, you can't immediately consume a product such as clothing purchased over the web (although immediate consumption is possible with digital music downloads and other digital products).

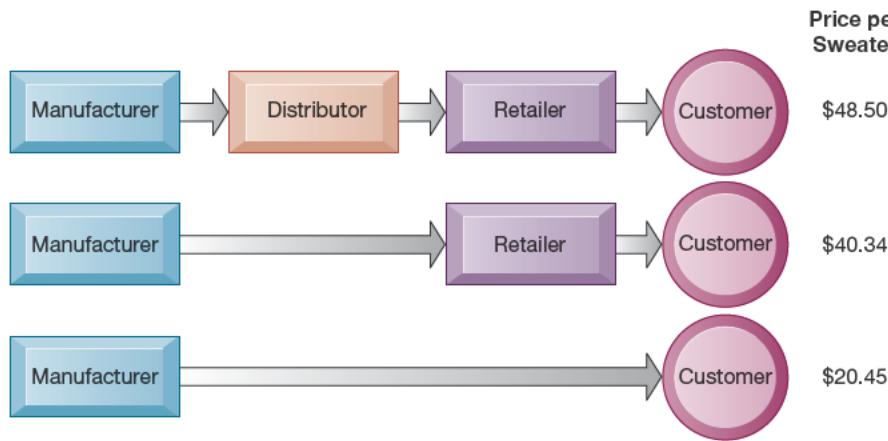
Digital markets provide many opportunities to sell directly to the consumer, bypassing intermediaries such as distributors or retail outlets. Eliminating intermediaries in the distribution channel can significantly lower purchase transaction costs. To pay for all the steps in a traditional distribution channel, a product may have to be priced as high as 135 percent of its original cost to manufacture.

Figure 10.2 illustrates how much savings result from eliminating each of these layers in the distribution process. By selling directly to consumers or reducing the number of intermediaries, companies can raise profits while charging lower prices. The removal of organizations or business process layers responsible for intermediary steps in a value chain is called **disintermediation**. E-commerce has also given rise to a completely new set of new intermediaries such as Amazon, eBay, PayPal, and Blue Nile. Therefore, disintermediation differs from one industry to another.

Disintermediation is affecting the market for services. Airlines and hotels operating their own reservation sites online earn more per ticket because they have eliminated travel agents as intermediaries. Table 10.3 summarizes the differences between digital markets and traditional markets.

FIGURE 10.2 THE BENEFITS OF DISINTERMEDIATION TO THE CONSUMER

The typical distribution channel has several intermediary layers, each of which adds to the final cost of a product, such as a sweater. Removing layers lowers the final cost to the customer.



Digital Goods

The Internet digital marketplace has greatly expanded sales of **digital goods**—goods that can be delivered over a digital network. Music tracks, video, Hollywood movies, software, newspapers, magazines, and books can all be expressed, stored, delivered, and sold as purely digital products. For the most part, digital goods are intellectual property, which is defined as “works of the mind.” Intellectual property is protected from misappropriation by copyright, patent, trademark, and trade secret laws (see Chapter 4). Today, all these products are delivered as digital streams or downloads while their physical counterparts decline in sales.

In general, for digital goods, the marginal cost of producing another unit is about zero (it costs nothing to make a copy of a music file). The cost of producing the original first unit, however, is relatively high—in fact, it is nearly the total cost of the product because there are few other costs of inventory and distribution. Costs of delivery over the Internet are low, marketing costs often remain the same, and pricing can be highly variable. On the Internet, the merchant can change prices as often as desired because of low menu costs.

TABLE 10.3 DIGITAL MARKETS COMPARED WITH TRADITIONAL MARKETS

	DIGITAL MARKETS	TRADITIONAL MARKETS
Information asymmetry	Asymmetry reduced	Asymmetry high
Search costs	Low	High
Transaction costs	Low (sometimes virtually nothing)	High (time, travel)
Delayed gratification	High (or lower in the case of a digital good)	Lower: purchase now
Menu costs	Low	High
Dynamic pricing	Low cost, instant	High cost, delayed
Price discrimination	Low cost, instant	High cost, delayed
Market segmentation	Low cost, moderate precision	High cost, less precision
Switching costs	Higher/lower (depending on product characteristics)	High
Network effects	Strong	Weaker
Disintermediation	More possible/likely	Less possible/unlikely

The impact of the Internet on the market for these kinds of digital goods is nothing short of revolutionary, and we see the results around us every day. Businesses dependent on physical products for sales—such as bookstores, music stores, book publishers, music labels, and film studios—face the possibility of declining sales and even destruction of their businesses. Newspaper and magazine subscriptions to print copies are declining, while online readership and subscriptions are expanding.

Total U.S. record label industry revenues fell nearly 50 percent from \$14 billion in 1999 to about \$7.7 billion in 2016, due almost entirely to the rapid decline in CD album sales and the growth of digital music services (both legal and illegal music piracy). But revenues increased in 2019 by 13 percent to over \$11 billion primarily through the growth of paid subscriptions (RIAA, 2020). The Apple iTunes Store has sold more than 25 billion songs since opening in 2003, providing a digital distribution model that has restored some of the revenues lost to digital music channels. Yet the download business is rapidly fading at Apple, as streaming becomes the dominant consumer path to music. Since iTunes, illegal downloading has been cut in half, and legitimate online music sales (both downloads and streaming) in the United States amounted to almost \$9.7 billion in 2019. As cloud streaming services expand, illegal downloading will decline further. Digital music sales, both digital download and streaming, account for almost 90 percent of all music revenues. The music labels make only about 32 cents from a single track download and only 0.5 cents for a streamed track. Although the record labels make revenue from ownership of the song (both words and music), the artists who perform the music make virtually nothing from streamed music.

The movie industry has been less severely disrupted than the music industry by illegal digital distribution platforms, because it is more difficult to download high-quality, pirated copies of full-length movies and because of the availability of low-cost, high-quality legal movies. The movie industry has struck lucrative distribution deals with Netflix, Google, Hulu, Amazon, and Apple, making it convenient to download and pay for high-quality movies and television series. Arrangements with online distributors have not been enough to compensate entirely for the loss in DVD sales, which have fallen precipitously between 2006 and 2020. Digital format streaming and downloads grew by 17.5 percent in 2019 and now makes up over 80 percent of U.S. home entertainment. As with television series, the demand for feature-length movies is expanding, in part because of the growth of smartphones, tablets, and smart TVs, making it easier to watch movies in more locations.

In 2020, over 3 billion Internet users worldwide are expected to view online video and movies, about 75 percent of the global Internet population (eMarketer, 2020f). There is little doubt that the Internet is becoming a major movie distribution and television channel that rivals cable television, and someday it may replace cable television entirely.

Table 10.4 describes digital goods and how they differ from traditional physical goods.

10-2 What are the principal e-commerce business and revenue models?

E-commerce is a fascinating combination of business models and new information technologies. Let's start with a basic understanding of the types of e-commerce and then describe e-commerce business and revenue models.

TABLE 10.4 HOW THE INTERNET CHANGES THE MARKETS FOR DIGITAL GOODS

	DIGITAL GOODS	TRADITIONAL GOODS
Marginal cost/unit	Zero	Greater than zero, high
Cost of production	High (most of the cost)	Variable
Copying cost	Approximately zero	Greater than zero, high
Distributed delivery cost	Low	High
Inventory cost	Low	High
Marketing cost	Variable	Variable
Pricing	More variable (bundling, random pricing games)	Fixed, based on unit costs

Types of E-commerce

There are many ways to classify electronic commerce transactions—one is by looking at the nature of the participants. The three major electronic commerce categories are business-to-consumer (B2C) e-commerce, business-to-business (B2B) e-commerce, and consumer-to-consumer (C2C) e-commerce.

- **Business-to-consumer (B2C)** electronic commerce involves retailing products and services to individual shoppers. Amazon, Walmart, and Apple Music are examples of B2C e-commerce.
- **Business-to-business (B2B)** electronic commerce involves sales of goods and services among businesses. Elemica's website for buying and selling chemicals and energy is an example of B2B e-commerce.
- **Consumer-to-consumer (C2C)** electronic commerce involves consumers selling directly to consumers. For example, eBay, the giant web auction site, enables people to sell their goods to other consumers by auctioning their merchandise off to the highest bidder or for a fixed price. eBay acts as a middleman by creating a digital platform for peer-to-peer commerce. Gumtree is an example of a popular C2C platform in the UK.

Another way of classifying electronic commerce transactions is in terms of the platforms participants use in a transaction. Until recently, most e-commerce transactions took place using a desktop PC connected to the Internet over a wired network. Several wireless mobile alternatives have emerged, such as smartphones and tablet computers. The use of handheld wireless devices for purchasing goods and services from any location is termed **mobile commerce or m-commerce**. All three types of e-commerce transactions can take place using m-commerce technology, which we discuss in detail in Section 10-5.

E-commerce Business Models

Changes in the economics of information described earlier have created the conditions for entirely new business models to appear while destroying older business models. Table 10.5 describes some of the most important Internet business models that have emerged. All, in one way or another, use the Internet (including apps on mobile devices) to add extra value to existing products and services or to provide the foundation for new products and services.

TABLE 10.5 INTERNET BUSINESS MODELS

CATEGORY	DESCRIPTION	EXAMPLES
E-tailer	Sells physical products directly to consumers or to individual businesses.	Amazon Farfetch
Transaction broker	Saves users money and time by processing online sales transactions and generating a fee each time a transaction occurs.	E*Trade.com Booking.com
Market creator	Provides a digital environment where buyers and sellers can meet, search for products, display products, and establish prices for those products; can serve consumers or B2B e-commerce, generating revenue from transaction fees.	eBay Exostar Elemica
Content provider	Creates revenue by providing digital content, such as news, music, photos, or video, over the web. The customer may pay to access the content, or revenue may be generated by selling advertising space.	FT.com Alamy Apple Music MSN Games
Community provider	Provides an online meeting place where people with similar interests can communicate and find useful information.	Facebook Twitter
Portal	Provides initial point of entry to the web along with specialized content and other services.	Yahoo MSN AOL
Service provider	Provides applications such as photo sharing, video sharing, and user-generated content as services; provides other services such as online data storage and backup.	Google Docs Photobucket.com Dropbox

Portal

Portals are gateways to the web and are often defined as those sites that users set as their home page. Some definitions of a portal include search engines such as Google and Bing even if few make these sites their home page. Portals such as Yahoo, Facebook, MSN, and AOL offer web search tools as well as an integrated package of content and services such as news, email, instant messaging, maps, calendars, shopping, music downloads, video streaming, and more all in one place. The portal business model now provides a destination site where users start their web searching and linger to read news, find entertainment, meet other people, and, of course, be exposed to advertising. Facebook is a different kind of portal based on social networking. Portals generate revenue primarily by attracting very large audiences, charging advertisers for display ad placement (similar to traditional newspapers), collecting referral fees for steering customers to other sites, and charging for premium services. Although there are hundreds of portal/search engine sites, the top portals (Yahoo, MSN, and AOL) gather more than 90 percent of the Internet's U.S. portal traffic because of their superior brand recognition.

E-tailer

Online retail stores, often called **e-tailers**, come in all sizes, from giant Amazon with estimated 2020 retail sales revenues of more than \$280 billion to tiny local stores that have websites. An e-tailer is similar to the typical brick-and-mortar

storefront, except that customers only need to connect to the Internet to check their inventory and place an order. Altogether, online retail (the sale of physical goods online) will generate about \$3.9 trillion in revenues worldwide in 2020. The value proposition of e-tailers is to provide convenient, low-cost shopping 24/7; large selections; and consumer choice. Some e-tailers, such as Tesco.com or Zara.com, referred to as bricks-and-clicks, are subsidiaries or divisions of existing physical stores and carry the same products. Others, however, operate only in the virtual world, without any ties to physical locations. Ashford.com and eVitamins.com are examples of this type of e-tailer. Several other variations of e-tailers—such as online versions of direct-mail catalogs, online malls, and manufacturer-direct online sales—also exist.

Content Provider

E-commerce has increasingly become a global content channel. *Content* is defined broadly to include all forms of intellectual property. **Intellectual property** refers to tangible and intangible products of the mind for which the creator claims a property right. Content providers distribute information content—such as digital video, music, photos, text, and artwork—over the web. The value proposition of online content providers is that consumers can conveniently find a wide range of content online and purchase this content inexpensively to be played or viewed on multiple computer devices or smartphones.

Providers do not have to be the creators of the content (although sometimes they are, like Disney.com) and are more likely to be Internet-based distributors of content produced and created by others. For example, Apple sells music tracks at its music store and streaming music service, but it does not create or commission new music.

The phenomenal popularity of Internet-connected mobile devices such as the iPhone and iPad has enabled new forms of digital content delivery from podcasting to mobile streaming. **Podcasting** is a method of publishing audio or video broadcasts through the Internet, allowing subscribing users to download audio or video files onto their personal computers, smartphones, tablets, or portable music players. **Streaming** is a publishing method for music and video files that flows a continuous stream of content to a user's device without being stored locally on the device.

Estimates vary, but total online content generated about \$60 billion in the United States in 2019, one of the fastest-growing e-commerce segments, growing at an estimated 18 percent annual rate.

Transaction Broker

Sites that process transactions for consumers normally handled in person, by phone, or by mail are transaction brokers. The largest industries using this model are financial services and travel services. The online transaction broker's primary value propositions are savings of money and time and providing an extraordinary inventory of financial products or travel packages in a single location. Online stockbrokers and travel booking services charge fees that are considerably less than traditional versions of these services. Fidelity and Expedia are examples of financial and travel service firms based on a transaction broker model.

Market Creator

Market creators build a digital environment in which buyers and sellers can meet, display products, search for products, and establish prices. The value proposition of online market creators is that they provide a platform where

sellers can easily display their wares and purchasers can buy directly from sellers. Online auction markets such as eBay and Priceline are good examples of the market creator business model. Another example is Amazon's Merchants platform (and similar programs at eBay), where merchants are allowed to set up stores on Amazon's website and sell goods at fixed prices to consumers. The so-called on-demand economy (mistakenly often referred to as the sharing economy), exemplified by Uber and Airbnb, is based on the idea of a market creator building a digital platform where supply meets demand; for instance, spare auto or room rental capacity finds individuals who want transportation or lodging. Deliveroo, profiled in the Interactive Session on Technology, is another example. Crowdsource funding markets such as Kickstarter.com bring together private equity investors and entrepreneurs in a funding marketplace.

Service Provider

Whereas e-tailers sell products online, service providers offer services online. Photo sharing and online sites for data backup and storage all use a service provider business model. Software is no longer a physical product with a disk in a box but, increasingly, software as a service (SaaS) that you subscribe to online rather than purchase from a retailer, such as Office 365. Google has led the way in developing online software service applications such as G Suite, Google Sites, Gmail, and online data storage services. Salesforce.com is a major provider of cloud-based software for customer management (see Chapters 5 and 9).

Community Provider (Social Networks)

Community providers are sites that create a digital online environment where people with similar interests can transact (buy and sell goods); share interests, photos, and videos; communicate with like-minded people; receive interest-related information; and even play out fantasies by adopting online personalities called *avatars*. Social networking sites Facebook, Pinterest, Instagram, LinkedIn, and Twitter and hundreds of other smaller, niche sites all offer users community-building tools and services. Social networking sites have been the fastest-growing websites in recent years, often doubling their audience size in a year.

E-commerce Revenue Models

A firm's **revenue model** describes how the firm will earn revenue, generate profits, and produce a superior return on investment. Although many e-commerce revenue models have been developed, most companies rely on one, or some combination, of the following six revenue models: advertising, sales, subscription, free/freemium, transaction fee, and affiliate.

Advertising Revenue Model

In the **advertising revenue model**, a website generates revenue by attracting a large audience of visitors who can then be exposed to advertisements. The advertising model is the most widely used revenue model in e-commerce, and arguably, without advertising revenues, the web would be a vastly different experience from what it is now because people would be asked to pay for access to content. Content on the web—everything from news to videos and opinions—is free to visitors because advertisers pay the production and distribution costs in return for the right to expose visitors to ads. Companies will spend an estimated \$340 billion on online advertising worldwide in 2020 (in the form of a paid message on a website, paid search listing, video, app, game, or other online medium, such as instant messaging), up 17 percent from 2019.

INTERACTIVE SESSION TECHNOLOGY

Deliveroo: Global Food Delivery App

Deliveroo is an on-demand, online food delivery platform that links hungry people looking for a meal with restaurants seeking to provide them, using bike riders/couriers to deliver those meals in a timely fashion. Deliveroo now operates in almost 800 cities and towns and works with an estimated 140,000 participating restaurants, using around 80,000 freelance riders/couriers. While Deliveroo started out in 2013 in the United Kingdom, it has spread rapidly and now operates in the Netherlands, France, Belgium, Ireland, Spain, Italy, Australia, Singapore, the United Arab Emirates, and Hong Kong.

Prior to the COVID-19 pandemic, consumers used Deliveroo to avoid the hassle of driving and waiting for food, but during the pandemic it has in many ways become an essential service. Deliveroo believes the pandemic has significantly accelerated consumer adoption of food delivery. Deliveroo enables restaurants to expand their business without building additional, expensive storefronts, and instead maximize their existing footprint and investment. It also provides an opportunity for restaurateurs to advertise their offerings on the app and launch promotional deals. For its riders/couriers, Deliveroo offers a flexible job that fits into their schedules. The net result, on paper, is a win-win for all parties.

What makes all this possible is a collection of technologies from databases to record in-coming orders, to a real-time dispatching system, to smart-phones, to cloud services such as Amazon Web Services (AWS). For instance, AWS enables Deliveroo to fast-track orders using a real-time dispatching and resource management algorithm based on Amazon SageMaker machine learning software that analyzes orders based on the location of riders, customers, and restaurants, and then calculates the most efficient way of dispatching orders and selecting riders. This system can also analyze past patterns of delivery and direct riders to areas of the city where they are most likely to be needed. This software enables riders to earn more (they are paid \$10 per delivery) in the same number of hours and customers to receive their meals more rapidly, saving minutes on each delivery. Deliveroo also uses Amazon SageMaker to recommend restaurants, products, and features to customers based on their past orders. AWS also helps Deliveroo to scale its operations, as well as specific features, to meet fluctuating demand, something that

became particularly important after the onset of the COVID-19 pandemic, which resulted in a tripling of the demand for food delivery. This flexibility also enabled Deliveroo to introduce new services such as grocery delivery during lockdown.

Like nearly all “gig-economy” companies, Deliveroo has not yet recorded an annual profit. Although its 2019 sales reached almost £772 million, its losses for the year also grew to £318 million, driven largely by ballooning administrative expenses, including technology. Deliveroo’s operations thus far have been primarily funded by venture capital. In May 2019, it raised an additional \$575 million by selling a 16 percent stake in the company to Amazon, an investment that raised anti-competitive concerns, but which was ultimately approved by the UK Competitions and Markets Authority in August 2020.

Deliveroo’s business model is based on paying drivers below market rates and on the absence of benefits which are common in most countries and considered a part of paid employment. Deliveroo accomplishes this by defining itself not as a food delivery service but rather as a digital platform used by self-employed independent contractors. Deliveroo makes money by collecting a commission from restaurants for each order and charging customers a delivery fee. It pays its contract riders \$10 a delivery. The average rider makes from \$10 to \$20 an hour, depending on the number of deliveries. In contrast, the average wage of paid couriers in Australian cities is \$23.50 an hour with benefits, including healthcare, insurance, pension, and legal protections offered by the government, which pumps the overall compensation by 33 percent to about \$30 an hour.

On-demand “gig economy” companies like Deliveroo face a number of ongoing lawsuits. For instance, a French court recently found Deliveroo guilty of “undeclared work,” ruling that paying its cyclists as independent contractors was an attempt to skirt labor laws. Deliveroo is also facing claims in Belgium that it should be paying payroll taxes for the thousands of Belgians riders delivering meals. In Australia, Deliveroo has been accused of violating the Fair Work Act. Lawyers describe Deliveroo contracts as “shams” and say that the firm fails to pay minimum rates as well as to deliver Work Cover Insurance, sick and maternity leave, and pension payments. The lawsuits also claim Deliveroo fails

to provide for safety training for riders and safety checks of bikes, resulting in numerous injuries to riders and pedestrians. The company claims it does not control workers, while the lawsuits and riders themselves claim Deliveroo exercises near complete control over riders by requiring uniforms, dispatching riders to restaurants and customers, tracking their performance, and disciplining those who do not meet its productivity requirements.

Does Deliveroo have a viable business model? In the past, it has had no trouble attracting riders to work for below minimum wages. But it is finding it increasingly difficult to defend the legal status of riders as contractors. As the global economy expands again and wages increase, Deliveroo may find its

future growth impaired by labor shortages and rising wages regardless of the result of the many lawsuits and court decisions.

Sources: AWS, "Deliveroo Finds Ingredients for Success with AWS," aws.amazon.com, accessed December 29, 2020; Tim Bradshaw, "Deliveroo's Losses Soared Before Its Pandemic Recovery," FT.com, December 21, 2020; Sam Shead, "Covid Has Accelerated the Adoption of Online Food Delivery by 2 to 3 Years, Deliveroo CEO Says," CNBC, December 3, 2020; Archie Mitchell, "Amazon Finally Wins Approval from Regulators to Gobble Up Minority Stake in Deliveroo," Marketwatch.com, August 5, 2020; France24, "France Faults Deliveroo in 'Undeclared Work' Lawsuit," France24.com, February 7, 2020; Campbell Kwan, "Deliveroo Faces Lawsuit for Allegedly Underpaying Food Delivery Riders," Zdnet.com, August 28, 2019; Ellie Donnelly, "Deliveroo Fast-tracks Orders Thanks to Real-time Algorithm," The Independent, August 10, 2017.

CASE STUDY QUESTIONS

1. Based on your reading of the chapter, what kind of business model is Deliveroo using? Is it different from or the same as Uber?
2. What technologies are used by Deliveroo to support its business model?
3. What's the difference between an employee and a contractor?
4. What risk factors might limit Deliveroo's growth in the future?

About \$246 billion of this will be for mobile ads. Mobile ads will account for over 72 percent of all digital advertising. In the past five years, advertisers have increased online spending while maintaining outlays on traditional channels such as radio and television (but cutting print ads). In 2020, online advertising will constitute over 55 percent of all advertising worldwide (eMarketer, 2020d, 2020e).

Websites with the largest viewership or that attract a highly specialized, differentiated viewership and are able to retain user attention (stickiness). As a result, they can charge higher advertising rates. Yahoo, for instance, derives nearly all its revenue from display ads (banner ads), video ads, and, to a lesser extent, search engine text ads. Google and Facebook derive well over 90 percent of their revenue from advertising, including selling keywords (AdWords), ad spaces (AdSense), and display ad spaces to advertisers.

Sales Revenue Model

In the **sales revenue model**, companies derive revenue by selling goods, information, or services to customers. Companies such as Amazon (which sells books, music, and other products), HM.com, and Zara.com all have sales revenue models. Content providers make money by charging for downloads or streaming of entire files such as music tracks (Apple Music and iTunes Store) or books or for downloading music and/or video streams (Hulu.com TV shows). Apple has pioneered and strengthened the acceptance of micropayments. **Micropayment systems** provide content providers with a cost-effective method for processing high volumes of very small monetary transactions (anywhere from 25 cents to \$5.00 per transaction). The largest micropayment system on the web has been Apple's iTunes Store, which has more than 1 billion customers worldwide who purchase individual music tracks for 99 cents and feature-length movies for various prices.

Subscription Revenue Model

In the **subscription revenue model**, a website offering content or services charges a subscription fee for access to some or all of its offerings on an ongoing basis. Content providers often use this revenue model. For instance, the online version of *Consumer Reports* provides access to premium content, such as detailed ratings, reviews, and recommendations, only to subscribers for a \$39.00 annual fee. Netflix is one of the most successful subscriber sites with over 180 million customers worldwide in 2020. To be successful, the subscription model requires the content to be perceived as differentiated, having high added value, and not readily available elsewhere or easily replicated. Other companies offering content or services online on a subscription basis include Match.com (dating services), Ancestry.com (genealogy research), and Microsoft Xbox Live.

Free/Freemium Revenue Model

In the **free/freemium revenue model**, firms offer basic services or content for free and charge a premium for advanced or special features. For example, Google offers free applications but charges for premium services. Pandora, the subscription radio service, offers a free service with limited play time and advertising and a premium service with unlimited play. The idea is to attract large audiences with free services and then convert some of this audience to pay a subscription for premium services. One problem with this model is converting people from being freeloaders into paying customers. "Free" can be a powerful model for losing money. None of the freemium music streaming sites have earned a profit to date. Nevertheless, they are finding that free service with ad revenue is more profitable than the paid subscriber part of their business.

Transaction Fee Revenue Model

In the **transaction fee revenue model**, a company receives a fee for enabling or executing a transaction. For example, eBay provides an online auction marketplace and receives a small transaction fee from a seller if the seller is successful in selling an item. The transaction revenue model enjoys wide acceptance in part because the true cost of using the platform is not immediately apparent to the user.

Online financial services, from banking to payment systems, rely on a transaction fee model. While online banking and services are dominated by large banks with millions of customers, start-up financial technology firms, also known as **FinTech** firms, have used IT innovatively to compete with banks for peer-to-peer (P2P) bill payment, money transfer, lending, crowd funding, financial advice, and account aggregation services. The largest growth in FinTech has involved P2P payment services, such as Venmo and Zelle (see the discussion of mobile payment app systems in section 10-5). FinTech firms are typically not profitable and are often bought out by larger financial service firms for their technology and customer base.

Affiliate Revenue Model

In the **affiliate revenue model**, websites (called *affiliate websites*) send visitors to other websites in return for a referral fee or percentage of the revenue from any resulting sales. Referral fees are also referred to as lead generation fees. For example, MyPoints makes money by connecting companies to potential customers by offering special deals to its members. When members take advantage of an offer and make a purchase, they earn points they can redeem for free products and services, and MyPoints receives a referral fee. Community feedback sites such as Yelp receive much of their revenue from steering potential

customers to websites where they make a purchase. Amazon uses affiliates that steer business to the Amazon website by placing the Amazon logo on their blogs. Personal blogs often contain display ads as part of affiliate programs. Some bloggers are paid directly by manufacturers, or receive free products, for speaking highly of products and providing links to sales channels.

10-3 | How has e-commerce transformed marketing?

Although e-commerce and the Internet have changed entire industries and enabled new business models, no industry has been more affected than marketing and marketing communications.

The Internet provides marketers with new ways of identifying and communicating with millions of potential customers at costs far lower than traditional media, including search engine marketing, data mining, recommender systems, and targeted email. The Internet enables **long tail marketing**. Before the Internet, reaching a large audience was expensive, and marketers had to focus on attracting the largest number of consumers with popular hit products, whether music, Hollywood movies, books, or cars. In contrast, the Internet allows marketers to find potential customers inexpensively for products where demand is low. For instance, the Internet makes it possible to sell independent music profitably to small audiences. There's always some demand for almost any product. Put a string of such long-tail sales together and you have a profitable business.

The Internet also provides new ways—often instantaneous and spontaneous—to gather information from customers, adjust product offerings, and increase customer value. Table 10.6 describes the leading marketing and advertising formats used in e-commerce.

Behavioral Targeting

Many e-commerce marketing firms use **behavioral targeting** techniques to increase the effectiveness of banners, rich media, and video ads. Behavioral targeting refers to tracking the clickstreams (history of clicking behavior) of individuals on thousands of websites to understand their interests and intentions and expose them to advertisements that are uniquely suited to their online behavior. Marketers and most researchers believe this more precise understanding of the customer leads to more efficient marketing (the firm pays for ads only to those shoppers who are most interested in their products) and larger sales and revenues. Unfortunately, behavioral targeting of millions of web users also leads to the invasion of personal privacy without user consent. When consumers lose trust in their web experience, they tend not to purchase anything. Backlash is growing against the aggressive uses of personal information as consumers seek out safer havens for purchasing and messaging. Snapchat offers disappearing messages, and even Facebook has retreated by making its default for new posts “for friends only.”

Behavioral targeting takes place at two levels: at individual websites or from within apps, and on various advertising networks that track users across thousands of websites. All websites collect data on visitor browser activity and store it in a database. They have tools to record the site that users visited prior to coming to the website, where these users go when they leave that site, the type of operating system they use, browser information, and even some location data. They also record the specific pages visited on the particular site, the time

TABLE 10.6 U.S. ONLINE AD SPENDING BY FORMATS (BILLIONS)

MARKETING FORMAT	2020 REVENUE	DESCRIPTION
Search engine	\$54.4	Text ads targeted at precisely what the customer is looking for at the moment of shopping and purchasing. Sales oriented.
Display ads	\$31.1	Banner ads (pop-ups and leave-behinds) with interactive features; increasingly behaviorally targeted to individual web activity. Brand development and sales. Includes social media and blog display ads.
Video	\$35.5	Fastest-growing format, engaging and entertaining; behaviorally targeted, interactive. Branding and sales.
Classified	\$2.1	Job, real estate, and services ads; interactive, rich media, and personalized to user searches. Sales and branding.
Rich media	\$5.6	Animations, games, and puzzles. Interactive, targeted, and entertaining. Branding orientation.
Lead generation	\$2.5	Marketing firms that gather sales and marketing leads online and then sell them to online marketers for a variety of campaign types. Sales or branding orientation.
Sponsorships	\$2.8	Online games, puzzles, contests, and coupon sites sponsored by firms to promote products. Sales orientation.
Email	\$0.49	Effective, targeted marketing tool with interactive and rich media potential. Sales oriented.

Source: Based on eMarketer, "U.S. Digital Ad Spending by Format," eMarketer, June 2020.

spent on each page of the site, the types of pages visited, and what the visitors purchased (see Figure 10.3). Firms analyze this information about customer interests and behavior to develop precise profiles of existing and potential customers. In addition, most major websites have hundreds of tracking programs on their home pages, which track your clickstream behavior across the web by following you from site to site and retarget ads to you by showing you the same ads on different sites. The leading online advertising network is Google's Marketing Platform.

This information enables firms to understand how well their website is working, create unique personalized web pages that display content or ads for products or services of special interest to each user, improve the customer's experience, and create additional value through a better understanding of the shopper (see Figure 10.4). By using personalization technology to modify the web pages presented to each customer, marketers achieve some of the benefits of using individual salespeople at dramatically lower costs. For instance, Land Rover might show a banner ad to women emphasizing safety and utility, whereas men might receive ads emphasizing power and ruggedness.

It's a short step from ad networks to programmatic ad buying. Ad networks create real-time bidding platforms (RTB) where marketers bid in an automated environment for highly targeted slots available from web publishers. Here, ad platforms can predict how many targeted individuals will view the ads, and ad buyers can estimate how much this exposure is worth to them.

FIGURE 10.3 WEBSITE VISITOR TRACKING

E-commerce websites and advertising platforms like Google Marketing Platform have tools to track a shopper's every step through an online store and then across the web as shoppers move from site to site. Close examination of customer behavior at a website selling women's clothing shows what the store might learn at each step and what actions it could take to increase sales.

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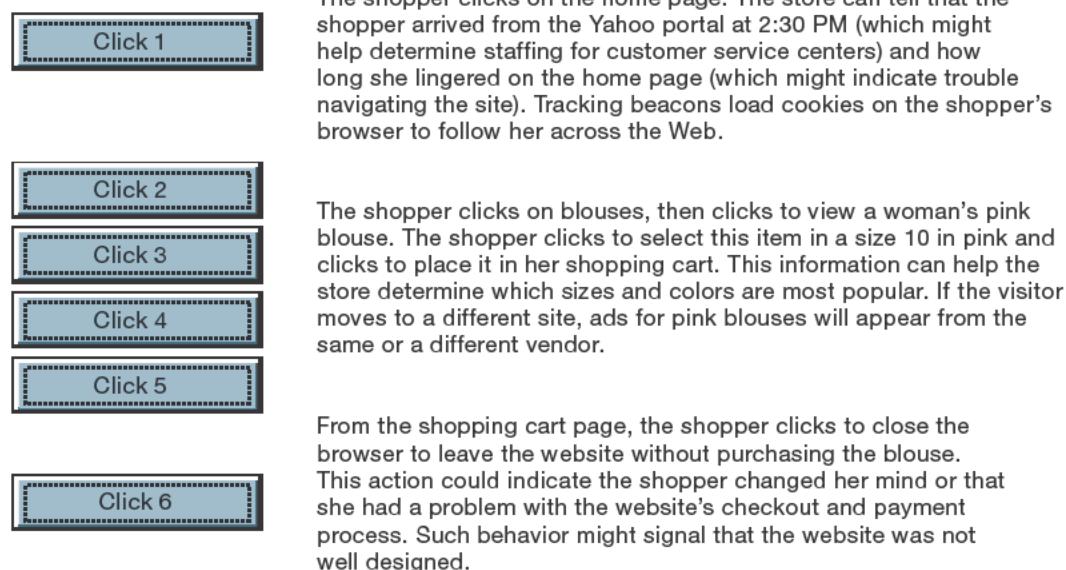


FIGURE 10.4 WEBSITE PERSONALIZATION

Firms can create unique personalized web pages that display content or ads for products or services of special interest to individual users, improving the customer experience and creating additional value.



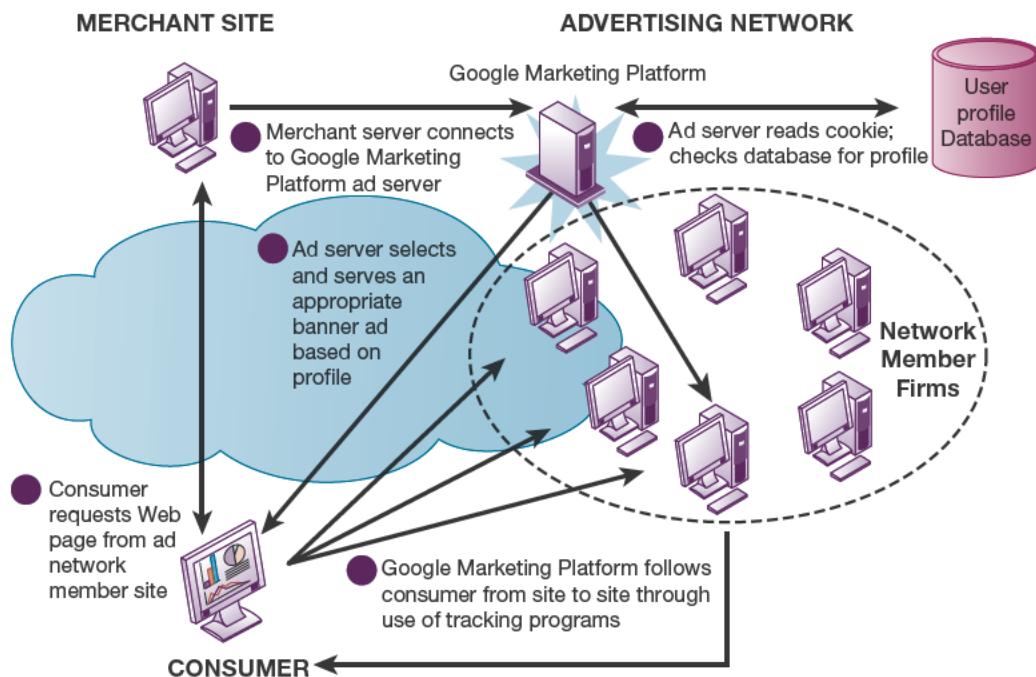
What if you are a large national advertising company or global manufacturer trying to reach millions of consumers? With millions of websites, working with each one would be impractical. Advertising networks solve this problem by creating a network of several thousand of the most popular websites millions of people visit, tracking the behavior of these users across the entire network, building profiles of each user, and then selling these profiles to advertisers in a real-time bidding environment. Popular websites download dozens of web-tracking cookies, bugs, and beacons, which report user online behavior to remote servers without the users' knowledge. Looking for young, single consumers with college degrees, living in the UK, in the 18–34 age range who are interested in purchasing a hybrid car? Advertising networks can identify and deliver thousands of people who fit this profile and expose them to ads for hybrid cars as they move from one website to another. Estimates vary, but behaviorally targeted ads are generally 10 times more likely to produce a consumer response than a randomly chosen banner or video ad (see Figure 10.5). So-called advertising exchanges use this same technology to auction access to people with specific profiles to advertisers in a few milliseconds. In 2019, about 73 percent of U.S. online display ads were targeted ads developed by programmatic ad buys, and the rest depended on the context of the pages shoppers visited—the estimated demographics of visitors, or on so-called blast-and-scatter advertising—which is placed randomly on any available page with minimal targeting, such as time of day or season.

It's another short step to **native advertising**. Native advertising involves placing ads in social network newsfeeds or within traditional editorial content, such as a newspaper article. This is also referred to as organic advertising, where content and advertising are in close proximity or are integrated together.

Two-thirds (68 percent) of U.S. Internet users disapprove of search engines and websites tracking their online behavior to aim targeted ads at them. A

FIGURE 10.5 HOW AN ADVERTISING NETWORK WORKS

Advertising networks and their use of tracking programs have become controversial among privacy advocates because of their ability to track individual consumers across the Internet.



majority of Americans want a Do Not Track option in browsers that will stop websites from collecting information about their online behavior. More than 50 percent are very concerned about the wealth of personal data online; 86 percent have taken steps to mask their online behavior; and 25 percent of web users use ad-blocking software (Rainie, 2016; eMarketer, 2019a).

Social E-commerce and Social Network Marketing

One of the fastest-growing media for branding and marketing is social media. Companies will spend an estimated \$88 billion worldwide in 2020 using social networks such as Facebook, Instagram, Pinterest, Twitter, Snapchat, and LinkedIn to reach millions of consumers who spend hours a day on social sites (eMarketer, 2020g, 2020h). Expenditures for social media marketing are much smaller than for television, magazines, and even newspapers, but this will change in the future. Social networks in the offline world are collections of people who voluntarily communicate with one another over an extended period of time. Online social networks, along with other sites with social components, are websites that enable users to communicate with one another, form group and individual relationships, and share interests, values, and ideas.

Social e-commerce is commerce based on the idea of the digital **social graph**, a mapping of all significant online social relationships. The social graph is synonymous with the idea of a social network used to describe offline relationships. You can map your own social graph (network) by drawing lines from yourself to the 10 closest people you know. If they know one another, draw lines between these people. If you are ambitious, ask these 10 friends to list and draw in the names of the 10 people closest to them. What emerges from this exercise is a preliminary map of your social network. Now imagine if everyone on the Internet did the same and posted the results to a large database with a website. Ultimately, you would end up with Facebook or a site like it.

According to small world theory, you are only six links away from any other person on earth. If you entered your personal address book, which has, say, 100 names in it, in a list and sent it to your friends, and they in turn entered 50 new names of their friends, and so on, five times, the social network created would encompass 31 billion people! The social graph is therefore a collection of millions of personal social graphs (and all the people in them).

If you understand the interconnectedness of people, you will see just how important this concept is to e-commerce: The products and services you buy will influence the decisions of your friends, and their decisions will in turn influence you. If you are a marketer trying to build and strengthen a brand, you can take advantage of the fact that people are enmeshed in social networks, share interests and values, and communicate and influence one another. As a marketer, your target audience is not a million isolated people watching a TV show but the social network of people who watch the show and the viewers' personal networks. Moreover, online social networks are where the largest Internet audiences are located. Table 10.7 describes the features of social commerce that are driving its growth.

Facebook, with over 80 percent of all social marketing revenue in the United States and 220 million monthly U.S. visitors in 2020 (comScore, 2020), receives most of the public attention given to social networking. The other top social sites are also growing, though at slower rates than in the past. Twitter has over 150 million active users, with stronger offshore growth than in the United States. LinkedIn has over 107 million. Pinterest hit the top 30 in terms of monthly unique visitors, with over 100 million. According to analysts, 13.5% percent of

TABLE 10.7 FEATURES OF SOCIAL COMMERCE

SOCIAL COMMERCE FEATURE	DESCRIPTION
Newsfeed	A stream of notifications from friends and advertisers that social users find on their home pages.
Timelines	A stream of photos and events in the past that create a personal history for users, one that can be shared with friends.
Social sign-on	Websites allow users to sign into their sites through their social network pages on Facebook or another social site. This allows websites to receive valuable social profile information from Facebook and use it in their own marketing efforts.
Collaborative shopping	An environment where consumers can share their shopping experiences with one another by viewing products, chatting, or texting. Friends can chat online about brands, products, and services.
Network notification	An environment where consumers can share their approval (or disapproval) of products, services, or content or share their geolocation, perhaps a restaurant or club, with friends. Facebook's ubiquitous "like" button is an example, as are Twitter's tweets and followers.
Social search (recommendations)	An environment where consumers can ask their friends for advice on purchases of products, services, and content. Although Google can help you find things, social search can help you evaluate the quality of things by listening to the evaluations of your friends or their friends. For instance, Amazon's social recommender system can use your Facebook social profile to recommend products.

the total time spent online in the United States was spent on social network sites (almost an hour a day), and social networking is one of the most common online activities (eMarketer, 2019b).

At **social shopping** sites such as Pinterest you can swap shopping ideas with friends. Facebook offers the "like" button to let your friends know you admire a product, service, or content and, in some cases, purchase something online. Facebook processes around 3.2 billion likes and comments a day worldwide. Online communities are also ideal venues to employ viral marketing techniques. Online viral marketing is like traditional word-of-mouth marketing except that word can spread across an online community at the speed of light and go much further geographically than a small network of friends.

The Wisdom of Crowds

Creating sites where thousands, even millions, of people can interact offers business firms new ways to market and advertise and to discover who likes (or hates) their products. Some argue that, in a phenomenon called the **wisdom of crowds**, large numbers of people can make better decisions about a wide range of topics or products than a single person or even a small committee of experts.

Obviously, this is not always the case, but it can happen in interesting ways. In marketing, the wisdom of crowds concept suggests that firms should consult with thousands of their customers first as a way of establishing a relationship with them and, second, to understand better how their products and services are used and appreciated (or rejected). Actively soliciting the comments of your

INTERACTIVE SESSION MANAGEMENT

Engaging “Socially” with Customers

Facebook, Instagram, Twitter, Snapchat, and other social tools create myriad opportunities to engage consumers, amplify product messages, discover trends and influencers, build brand awareness, and take action on customer requests and recommendations. Social media monitoring helps marketers and business owners understand more about buyers' likes, dislikes, and complaints concerning products, additional products or product modifications customers want, and how people are talking about a brand (positive or negative sentiment).

Instagram is one of the fastest-growing social networking platforms, with more than one billion active monthly followers, and is especially popular with younger Internet users. It is a powerful tool for business, enabling brands to get quick messages and photos to target audiences, engage with them, and build closer relationships. Users can interact with other Instagram users by following them, being followed by them, commenting, “liking,” tagging, and private messaging. Instagram has about 25 million registered business accounts and 1 million monthly active advertisers who use sponsored ads to reach more people on this platform. Instagram generated \$20 billion in ad revenue in 2019.

With over 86 million followers, Nike is one of the most popular Instagram business brands. Nike posts a mix of content, including celebrity-endorsed and lifestyle-based performance shots using still imagery, animated imagery, and video to define “moments.” Like many other companies, Nike has learned that its followers are not just buying their products, they are buying the lifestyle associated with those products. Nike continually promotes its products, but it does so via lifestyle-related storytelling.

Nike's mission statement is “To bring inspiration and innovation to every athlete in the world,” amateur or professional. The Nike brand reflects the belief that people can achieve more by believing in more, and that average people can be empowered to feel like full-fledged athletes if they “Just do it.” Many Nike Instagram posts inspiring followers to make a jump shot or run on the beach evoke this emotive motivation, earning the brand up to 500,000 “likes” per post.

Instagram is one of many social media tools used by NBC Sports to engage with its viewers. NBC Sports has 20 million primetime viewers nightly. Instead of asking people to watch its games, as it had in the past, NBC Sports urged them to engage in conversations about games at the moment they were happening live when it covered the PyeongChang Winter Olympics in 2018. Rather than pushing news, NBC Sports wants to know how people *feel* about the news. When an ad or piece of news is released, NBC Sports wants viewers to engage in spirited social debates using its social platforms. Through social listening and analysis tools, NBC Sports is able to see in real time which ads resonated with customers.

NBC Sports uses Oracle's Customer Experience Social Cloud, a cloud-based software service that enables businesses to listen, track, analyze, and make decisions based on “consumer chatter.” If a topic is heavily discussed, NBC Sports includes it in more of the content it shares. If something doesn't generate much buzz, the company shies away from it.

NBC Sports has found that different social media platforms attract different audiences, and that a piece of content might not work for every platform or every member of its audience. For example, Instagram appeals to a young audience, whereas Facebook appeals to an older following. To adapt content to different audiences, NBC Sports uses Facebook to post more in-depth stories about what's trending in sports. NBC Sports has over 50 channels for connecting with viewers socially on Instagram, Facebook, Twitter, Vine, Snapchat, and Pinterest.

Although engaging with customers via social media has benefited many companies, not all have achieved the results they hoped for. Lush UK, noted for its vegan and animal cruelty-free, all-natural face, bath, and body products, environmentally friendly packaging, and captivating Instagram posts, decided in the spring of 2019 to close its social media accounts. Lush claimed that social media was actually inhibiting its ability to engage with fans. Lush had massive followings on Instagram (570,000 followers), Twitter (200,000 followers), and Facebook (400,000 followers).

In an Instagram post, Lush stated that it was tired of catering to constant social media algorithm changes

to keep in front of followers. The company did not want to pay to appear in newsfeeds, nor did it want to limit conversations to a few places. Instead it preferred to open up conversations with customers via live chat on its website, email, and telephone. "Social media is making it harder and harder for us to talk to each other directly....We want social to be more about passions and less about likes," Lush stated.

Experts note that companies have recently had to struggle more to get in front of audiences because many social media platforms have stopped ordering news feeds chronologically in favor of algorithms that order content by "relevancy." Many businesses have been frustrated with their posts not being shown to users. They suspect the social media

platforms are making these changes to encourage more brands to pay for ads as a way of increasing impressions (number of times an ad is served).

Did Lush make the right decision? Will ignoring social media work for Lush? How much value is social media really driving? Can Lush succeed in creating a meaningful community outside social media? Many companies are watching closely for answers.

Sources: Brian Peters, "Nike's Secret to Success on Instagram Building an Engaged Community," buffer.com, accessed March 28, 2020; www.nbcsports.com, accessed March 28, 2020; "Nike," www.trackalytics.com, accessed March 28, 2020; Iris Hearn, "Lush Is Quitting Social Media Due to Frustrations over 'Fighting with Algorithms,'" Impact, April 11, 2019; and Genna Lepore, "What You Can Learn about Social Media Marketing from NBC Sports Unique Approach," Impact, March 19, 2019.

CASE STUDY QUESTIONS

1. Assess the management, organization, and technology issues for using social media technology to engage with customers.
2. What are the advantages and disadvantages of using social media for advertising, brand building, market research, and customer service?
3. Give an example of a business decision in this case study that was facilitated by using social media to interact with customers.
4. Should all companies use social media technology for customer service and marketing? Why or why not? What kinds of companies are best suited to use these platforms?

customers builds trust and sends the message to your customers that you care about what they are thinking and that you need their advice.

Beyond merely soliciting advice, firms can be actively helped in solving some business problems by using **crowdsourcing**. For instance, BMW launched a crowdsourcing project to enlist the aid of customers in designing an urban vehicle for 2025. Kickstarter.com is arguably one of the most famous e-commerce crowdfunding sites where visitors invest in start-up companies. Other examples include Caterpillar working with customers to design better machinery, IKEA for designing furniture, Lego Ideas for developing new toys and games, and Pepsico using Super Bowl viewers to build an online video.

Marketing through social media is still in its early stages, and companies are experimenting in hopes of finding a winning formula. Social interactions and customer sentiment are not always easy to manage, presenting new challenges for companies eager to protect their brands. The Interactive Session on Management provides specific examples of companies' social marketing efforts using Facebook and Instagram.

10-4 How has e-commerce affected business-to-business transactions?

Trade between business firms (business-to-business commerce, or B2B) represents a huge marketplace. The total amount of B2B trade in the United States in 2020 is estimated to be about \$14.5 trillion, with B2B e-commerce (online B2B)

contributing about \$6.7 trillion of that amount (U.S. Bureau of the Census, 2019; authors' estimates). By 2022, B2B e-commerce is expected to grow to about \$7.3 trillion in the United States.

The process of conducting trade among business firms is complex and requires considerable human intervention; therefore, it consumes significant resources. Some firms estimate that each corporate purchase order for support products costs them, on average, at least \$100 in administrative overhead, including processing paper, approving purchase decisions, using the telephone and fax machines to search for products and arrange for purchases, arranging for shipping, and receiving the goods. Across the economy, this adds up to trillions of dollars spent annually for procurement processes that could be automated. If even just a portion of interfirm trade were automated and parts of the entire procurement process were assisted by the Internet, literally trillions of dollars might be released for more productive uses, consumer prices potentially would fall, productivity would increase, and the economic wealth of the nation would expand. This is the promise of B2B e-commerce. The challenge of B2B e-commerce is changing existing patterns and systems of procurement and designing and implementing new Internet and cloud-based B2B solutions.

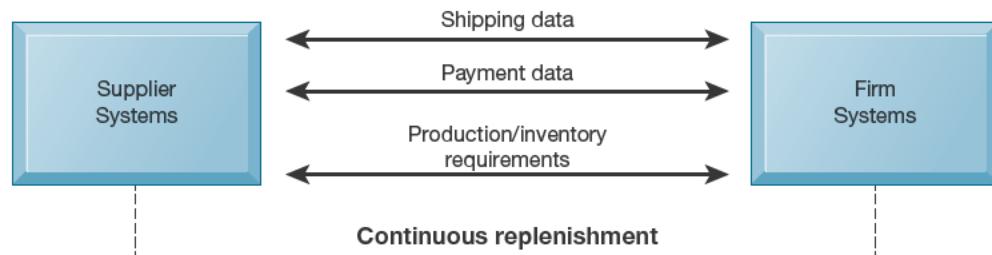
Electronic Data Interchange (EDI)

B2B e-commerce refers to the commercial transactions that occur among business firms. Increasingly, these transactions are flowing through a variety of Internet-enabled mechanisms. About 80 percent of online B2B e-commerce in the United States is still based on proprietary systems for **Electronic Data Interchange (EDI)**. EDI enables the computer-to-computer exchange between two organizations of standard transactions such as invoices, bills of lading, shipment schedules, or purchase orders. Transactions are automatically transmitted from one information system to another through a network, eliminating the printing and handling of paper at one end and the inputting of data at the other. Each major industry in the United States and much of the rest of the world has EDI standards that define the structure and information fields of electronic transactions for that industry.

EDI originally automated the exchange of documents such as purchase orders, invoices, and shipping notices. Although many companies still use EDI for document automation, firms engaged in just-in-time inventory replenishment and continuous production use EDI as a system for continuous replenishment. Suppliers have online access to selected parts of the purchasing firm's production and delivery schedules and automatically ship materials and goods to meet prespecified targets without intervention by firm purchasing agents (see Figure 10.6).

FIGURE 10.6 ELECTRONIC DATA INTERCHANGE (EDI)

Companies use EDI to automate transactions for B2B e-commerce and continuous inventory replenishment. Suppliers can automatically send data about shipments to purchasing firms. The purchasing firms can use EDI to provide production and inventory requirements and payment data to suppliers.



Although many organizations still use private networks for EDI, they are increasingly web-enabled because Internet technology provides a much more flexible and low-cost platform for linking to other firms. Businesses can extend digital technology to a wider range of activities and broaden their circle of trading partners.

Procurement, for example, involves not only purchasing goods and materials but also sourcing, negotiating with suppliers, paying for goods, and making delivery arrangements. Businesses can now use the Internet to locate the lowest-cost supplier, search online catalogs of supplier products, negotiate with suppliers, place orders, make payments, and arrange transportation. They are not limited to partners linked by traditional EDI networks.

New Ways of B2B Buying and Selling

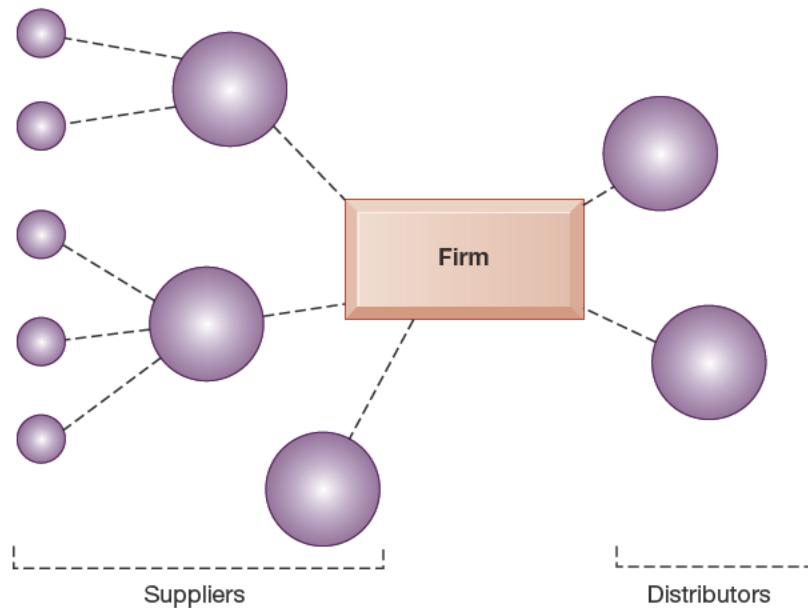
The Internet and web technology enable businesses to create electronic storefronts for selling to other businesses using the same techniques as used for B2C commerce. Alternatively, businesses can use Internet technology to create extranets or electronic marketplaces for linking to other businesses for purchase and sale transactions.

Private industrial networks typically consist of a large firm using a secure website to link to its suppliers and other key business partners (see Figure 10.7). The buyer owns the network, and it permits the firm and designated suppliers, distributors, and other business partners to share product design and development, marketing, production scheduling, inventory management, and unstructured communication, including graphics and email. Another term for a private industrial network is a **private exchange**.

An example is VW Group Supply, which links the Volkswagen Group and its suppliers. VW Group Supply handles 90 percent of all global purchasing for Volkswagen, including all automotive and parts components.

FIGURE 10.7 A PRIVATE INDUSTRIAL NETWORK

A private industrial network, also known as a private exchange, links a firm to its suppliers, distributors, and other key business partners for efficient supply chain management and other collaborative commerce activities.



Net marketplaces, which are sometimes called e-hubs, provide a single, digital marketplace based on Internet technology for many buyers and sellers (see Figure 10.8). They are industry-owned or operate as independent intermediaries between buyers and sellers. Net marketplaces generate revenue from purchase and sale transactions and other services provided to clients. Participants in Net marketplaces can establish prices through online negotiations, auctions, or requests for quotations, or they can use fixed prices.

There are many types of Net marketplaces and ways of classifying them. Some sell direct goods and some sell indirect goods. **Direct goods** are goods used in a production process, such as sheet steel for auto body production. **Indirect goods** are all other goods not directly involved in the production process, such as office supplies or products for maintenance and repair. Some Net marketplaces support contractual purchasing based on long-term relationships with designated suppliers, and others support short-term spot purchasing, where goods are purchased based on immediate needs, often from many suppliers.

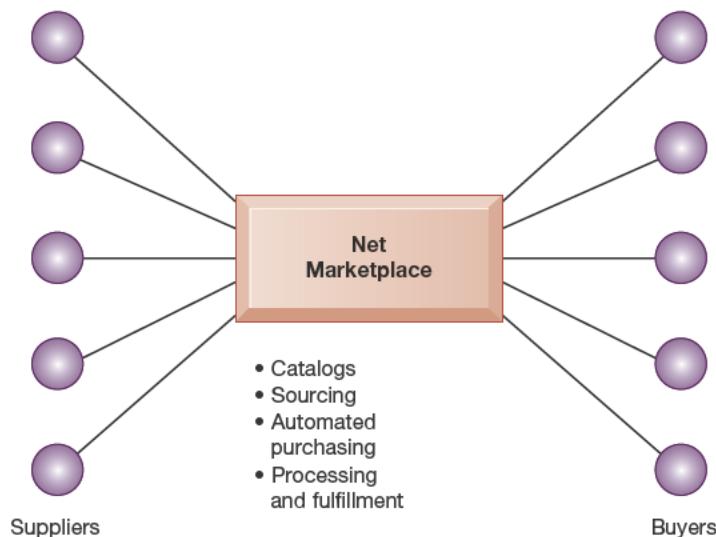
Some Net marketplaces serve vertical markets for specific industries, such as automobiles, telecommunications, or machine tools, whereas others serve horizontal markets for goods and services that can be found in many industries, such as office equipment or transportation.

Exostar is an example of an industry-owned Net marketplace, focusing on long-term contract purchasing relationships and on providing common networks and computing platforms for reducing supply chain inefficiencies. This aerospace and defense industry-sponsored Net marketplace was founded jointly by BAE Systems, Boeing, Lockheed Martin, Raytheon, and Rolls-Royce plc to connect these companies to their suppliers and facilitate collaboration. More than 125,000 trading partners in the commercial, military, and government sectors use Exostar's sourcing, e-procurement, and collaboration tools for both direct and indirect goods.

Exchanges are independently owned third-party Net marketplaces that connect thousands of suppliers and buyers for spot purchasing. Many exchanges provide vertical markets for a single industry, such as food, electronics, or

FIGURE 10.8 A NET MARKETPLACE

Net marketplaces are online marketplaces where multiple buyers can purchase from multiple sellers.



industrial equipment, and they primarily deal with direct inputs. For example, Go2Paper enables a spot market for paper, board, and craft among buyers and sellers in the paper industries from more than 75 countries.

Exchanges proliferated during the early years of e-commerce, but many have failed. Suppliers were reluctant to participate because the exchanges encouraged competitive bidding that drove prices down and did not offer any long-term relationships with buyers or services to make lowering prices worthwhile. Many essential direct purchases are not conducted on a spot basis because they require contracts and consideration of issues such as delivery timing, customization, and quality of products.

10-5 What is the role of m-commerce in business, and what are the most important m-commerce applications?

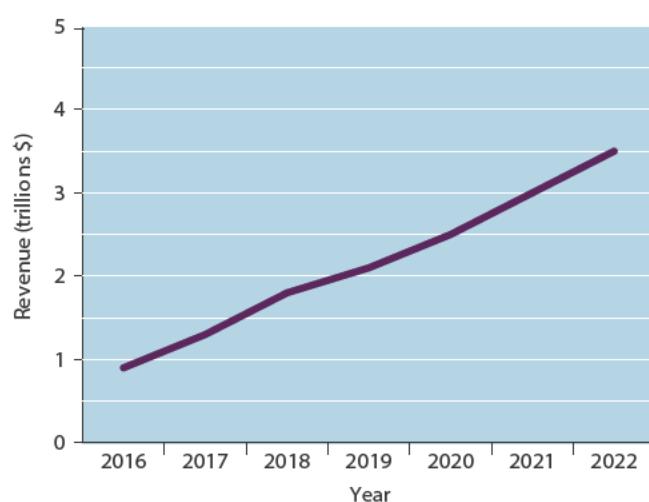
In 2020, retail m-commerce worldwide will account for 65 percent of all retail e-commerce, with about \$2.54 trillion in annual revenues. Retail m-commerce is the fastest-growing form of e-commerce, expanding at a rate of more than 15 percent a year, and it is estimated that it will grow to \$4 trillion worldwide by 2023 (see Figure 10.9) (eMarketer, 2020b).

The main areas of growth in mobile e-commerce are mass market retailing such as Amazon; sales of digital content such as music, TV shows, movies, and e-books; and in-app sales to mobile devices. On-demand firms such as Uber and Airbnb are location-based services, and examples of mobile commerce as well. Larger mobile screens and more-convenient payment procedures also play a role in the expansion of m-commerce.

FIGURE 10.9 MOBILE RETAIL COMMERCE REVENUES WORLDWIDE

Mobile e-commerce is the fastest-growing type of B2C e-commerce. By 2021, m-commerce retail sales are expected to account for over 66 percent of total e-commerce retail sales.

Sources: Data from eMarketer. "Retail Mcommerce Sales, by County." (September 2020).



Location-Based Services and Applications

Location-based services include geosocial, geoadvertising, and geoinformation services. Seventy-four percent of smartphone owners use location-based services. What ties these activities together and is the foundation for mobile commerce is the global positioning system (GPS)-enabled map services available on smartphones. A **geosocial service** can tell you where your friends are meeting. **Geoadvertising services** can tell you where to find the nearest Italian restaurant, and **geoinformation services** can tell you the price of a house you are looking at or about special exhibits at a museum you are passing. In 2020, the fastest-growing and most popular location-based services are on-demand economy firms such as Uber, Lyft, Airbnb, and hundreds more that provide services to users in local areas and are based on the user's location (or, in the case of Airbnb, the user's intended travel location).

Waze is an example of a popular, social geoinformation service. Waze is a GPS-based map and navigational app for smartphones, now owned by Google. Waze locates the user's car on a digital map using GPS and, like other navigation programs, collects information on the user's speed and direction continuously. What makes Waze different is that it collects traffic information from users who submit accident reports, speed traps, landmarks, street fairs, protests, and even addresses. Waze uses this information to come up with suggested alternative routes, travel times, and warnings and can even make recommendations for gas stations along the way. The Waze app is used extensively by Uber and Lyft drivers and more than 130 million other drivers in the United States.

Foursquare and new offerings by Facebook and Google are examples of geo-social services. Geosocial services help you find friends, or your friends to find you, by checking in to the service and announcing your presence in a restaurant or other place. Your friends are instantly notified.

Foursquare provides a location-based social networking service to over 55 million registered individual users, who can connect with friends, update their location, and provide reviews and tips for enjoying a location. Points are awarded for checking in at designated venues. Users choose to post their check-ins on their accounts on Twitter, Facebook, or both. Users also earn badges by checking in at locations with certain tags, for check-in frequency, or for the time of check-in.

Connecting people to local merchants in the form of geoadvertising is the economic foundation for mobile commerce. Geoadvertising sends ads to users based on their GPS locations. Smartphones report their locations back to Google and Apple. Merchants buy access to these consumers when they come within range of a merchant. For instance, Kiehl Stores, a cosmetics retailer, sent special offers and announcements to customers who came within 100 yards of their store.

Other Mobile Commerce Services

Banks and credit card companies have developed services that let customers manage their accounts from their mobile devices. In the UK, HSBC and NatWest customers can use their cell phones to check account balances, transfer funds, and pay bills. Apple Pay for the iPhone and Apple Watch, along with other Android and Windows smartphone apps, allow users to charge items to their credit card accounts with a swipe of their phone. (See our Learning Track on e-commerce payment systems.)

The mobile advertising market is the fastest-growing online ad platform, racking up an estimated \$246 billion in ad revenue worldwide in 2020 and forecast to grow at an average of almost 15 percent over the next several years (eMarketer, 2020e). Ads eventually move to where the eyeballs are, and increasingly

that means mobile devices. Facebook/Instagram is the largest mobile advertising market worldwide, generating over \$75 billion from mobile ads (95 percent of its total ad revenue), with Google (including YouTube) just behind at \$73 billion (about 68 percent of its total digital ad business). Google displays ads linked to mobile phone searches; ads are embedded in games, videos, and other mobile applications.

Shopkick is a mobile application that enables retailers such as Best Buy, Sports Authority, and Macy's to offer coupons to people when they walk into their stores. The Shopkick app automatically recognizes when the user has entered a partner retail store and offers a new virtual currency called kickbucks, which can be redeemed for store gift cards.

Forty seven percent of top U.S. retailers now have m-commerce websites—simplified versions of their websites that enable shoppers to use cell phones to shop and place orders. Virtually all large traditional and online retailers such as Sephora, Home Depot, Amazon, and Walmart have apps for m-commerce sales.

Mobile App Payment Systems

Many of the current FinTech applications are mobile app payment systems, which use mobile apps to replace credit cards and traditional banking services. There are three main types of mobile payment apps (see Table 10.8). Near-field

TABLE 10.8 TYPES OF MOBILE APP PAYMENT SYSTEMS

TYPE OF MOBILE APP PAYMENT SYSTEM	DESCRIPTION	EXAMPLES
Near Field Communication (NFC)	Uses near field communication (NFC) chips in both payers' mobile devices and merchants' point-of-sale (POS) reader devices. When close together and activated, these NFC chips exchange encrypted data to complete a payment. Can be used with many different merchants if they use NFC readers and software for accepting payments.	Apple Pay, Google Pay, Samsung Pay
QR Code	Uses a two-dimensional barcode in which information is encoded to perform contactless transactions using a code-scanning and generation app on a smartphone and a compatible merchant device. After a merchant enters the payment amount, the customer opens an app that displays a QR code generated for the transaction. The merchant scans the code, and the payment amount is deducted from the customer's mobile wallet. Alternatively, the customer opens the app and scans a QR code displayed by the merchant, enabling the app to identify the merchant. The customer then supplies the amount and completes the payment.	Tesco, Walmart, Dunkin Donuts
Peer-to-peer (P2P) payment system	Allows individuals to transfer funds from their bank accounts to other accounts on the same platform via the Internet. P2P users establish a secure account with a trusted third-party vendor, designating their bank account or credit card account to send and accept funds. Using the third-party app, users can send money to another person or to a merchant's account. Users are generally identified by their email address or mobile phone number.	Venmo, Zelle

communication (NFC)-driven systems enable NFC-enabled smartphones and other mobile devices to make contactless payments by communicating with a NFC-enabled reader at a merchant's point-of-sale (POS) terminal in close physical proximity. (Review the discussion of radio-frequency identification [RFID] and near field communication [NFC] in Chapter 7.) Apple Pay and Google Pay are examples. QR Code payment systems, such as Walmart Pay, use a contactless payment method where a payment is performed by scanning a two-dimensional barcode called a QR (Quick Response) code using a mobile app on the payer's smartphone. Peer-to-peer (P2P) payment systems such as Venmo or Zelle are used for transferring money among individuals who have installed a proprietary app.

10-6 What issues must be addressed when building an e-commerce presence?

Building a successful e-commerce presence requires a keen understanding of business, technology, and social issues as well as a systematic approach. Today, an e-commerce presence is not just a corporate website but also includes a social network site on Facebook/Instagram, a Twitter feed, and smartphone apps where customers can access your services. Developing and coordinating all these customer venues can be difficult. A complete treatment of the topic is beyond the scope of this text, and students should consult books devoted to just this topic (Laudon and Traver, 2020). The two most important management challenges in building a successful e-commerce presence are (1) developing a clear understanding of your business objectives and (2) knowing how to choose the right technology to achieve those objectives.

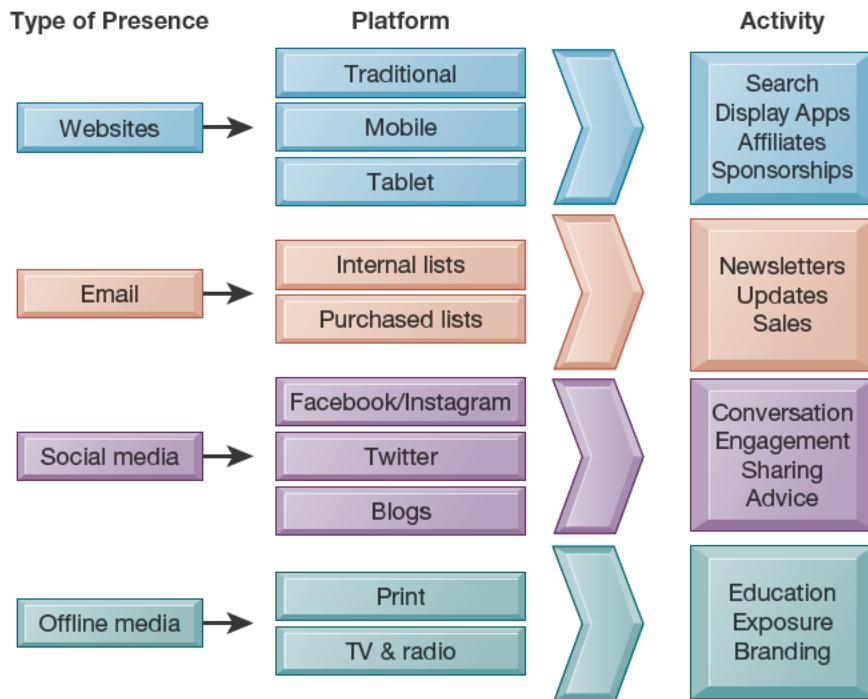
Develop an E-commerce Presence Map

E-commerce has moved from being a PC-centric activity on the web to a mobile and tablet-based activity. Currently, a majority of Internet users in the United States use smartphones and tablets to shop for goods and services, look up prices, enjoy entertainment, and access social sites, less so to make purchases. Your potential customers use these various devices at different times during the day and involve themselves in different conversations, depending on what they are doing—touching base with friends, tweeting, or reading a blog. Each of these is a touch point where you can meet the customer, and you have to think about how you develop a presence in these different virtual places. Figure 10.10 provides a roadmap to the platforms and related activities you will need to think about when developing your e-commerce presence.

Figure 10.10 illustrates four kinds of e-commerce presence: websites, email, social media, and offline media. You must address different platforms for each of these types. For instance, in the case of website presence, there are three platforms: traditional desktop, tablets, and smartphones, each with different capabilities. Moreover, for each type of e-commerce presence, there are related activities you will need to consider. For instance, in the case of websites, you will want to engage in search engine marketing, display ads, affiliate programs, and sponsorships. Offline media, the fourth type of e-commerce presence, is included here because many firms use multiplatform or integrated marketing by which print ads refer customers to websites.

FIGURE 10.10 E-COMMERCE PRESENCE MAP

An e-commerce presence requires firms to consider the four types of presence, with specific platforms and activities associated with each.



Develop a Timeline: Milestones

Where would you like to be a year from now? It's very helpful for you to have a rough idea of the time frame for developing your e-commerce presence when you begin. You should break your project down into a small number of phases that could be completed within a specified time. Table 10.9 illustrates a one-year timeline for the development of an e-commerce presence for a start-up company devoted to fashions for teenagers. You can also find more detail about developing an e-commerce website in the Learning Tracks for this chapter.

TABLE 10.9 E-COMMERCE PRESENCE TIMELINE

PHASE	ACTIVITY	MILESTONE
Phase 1: Planning	Envision web presence; determine personnel.	Web mission statement
Phase 2: Website development	Acquire content; develop a site design; arrange for hosting the site.	Website plan
Phase 3: Web implementation	Develop keywords and metatags; focus on search engine optimization; identify potential sponsors.	A functional website
Phase 4: Social media plan	Identify appropriate social platforms and content for your products and services.	A social media plan
Phase 5: Social media implementation	Develop Facebook/Instagram, Twitter, and Pinterest presence.	Functioning social media presence
Phase 6: Mobile plan	Develop a mobile plan; consider options for porting your website to smartphones.	A mobile media plan



10-7 How will MIS help my career?

Here is how Chapter 10 and this text can help you find a job as a junior e-commerce data analyst.

The Company

SportsFantasy Empire, a technology company that creates digital sports competitions, is looking for a recent college graduate to fill a junior e-commerce data analyst position. SportsFantasy Empire offers players the opportunity to compete through web and mobile devices in fantasy sports contests for cash prizes. The company was founded in 2014 and is headquartered in London, with additional offices in Sydney, San Francisco, and New York.

Job Description

The junior e-commerce data analyst will work with SportsFantasy Empire's analytics team to analyze large volumes of data to derive business insights about the company's games and customers that will increase revenue. Job responsibilities include:

- Setting up contest sizing that defines the user experience and business efficiency.
- Optimizing acquisition spending and marketing strategies to drive growth.
- Identifying ways to improve customer gameplay through on-site changes.
- Measuring how new features or site changes are driving changes in customer behavior.
- Developing standard reporting for key business results, including reports on contest performance, player activity, segment performance, and key player performance.

Job Requirements

- Bachelor's degree in engineering, mathematics, business, or a related field
- E-commerce data analytics experience desirable
- Knowledge of statistics
- Demonstrated history of independently developing new insights from data
- Experience with model building, SQL, SAS, or other programming language desirable
- Strong communication and organizational skills
- Avid fantasy sports player a plus

Interview Questions

1. Do you play fantasy sports? How often? Have you ever worked with data about fantasy sports? Why do you think you would be a good fit for this job?
2. What is your background in statistics? What courses did you take? Have you had any job experience where you had to use statistics?
3. Have you ever analyzed data about website performance or online customer behavior?

4. What do you know about the cost of acquiring a customer through social media channels (i.e., measuring the average customer acquisition cost on social networks; acquisition vs. retention costs)?
5. How would you propose working with our nontechnical teams in telling a story about customer data insights so that they are able to drive customer engagement and loyalty and execute more effectively?
6. What is your proficiency level with SQL or SAS and site analytics tools? Have you ever used these tools on the job? What did you do with them?
7. Can you give an example of a problem you solved using data analytics? Did you do any writing and analysis? Can you provide examples?

Author Tips

1. Review this chapter and also the discussion of search and search engine marketing in Chapter 7. To qualify for this job, you should also have taken course work in statistics. Course work or on-the-job training in SQL and SAS also would be helpful.
2. Use the web to do more research on the company. Try to find out more about its strategy, competitors, and business challenges. Additionally, review the company's social media channels from the past 12 months. Are there any trends you can identify or certain themes the social media channels seem to focus on?
3. Be prepared to talk about SportsFantasy Empire's games as well as the games offered by competitors to show you are familiar with the industry. Inquire about some of the ways the company fine-tunes its online presence. Be prepared to give an example of how you think a fantasy game could improve its online presence.
4. Use the web to find examples of data analytics used by fantasy sports companies.

REVIEW SUMMARY

10-1 What are the unique features of e-commerce, digital markets, and digital goods?

E-commerce involves digitally enabled commercial transactions between and among organizations and individuals. Unique features of e-commerce technology include ubiquity, global reach, universal technology standards, richness, interactivity, information density, capabilities for personalization and customization, and social technology. E-commerce is becoming increasingly social, mobile, and local.

Digital markets are said to be more transparent than traditional markets, with reduced information asymmetry, search costs, transaction costs, and menu costs along with the ability to change prices dynamically based on market conditions. Digital goods, such as music, video, software, and books, can be delivered over a digital network. Once a digital product has been produced, the cost of delivering that product digitally is extremely low.

10-2 What are the principal e-commerce business and revenue models?

E-commerce business models are e-tailers, transaction brokers, market creators, content providers, community providers, service providers, and portals. The principal e-commerce revenue models are advertising, sales, subscription, free/freemium, transaction fee, and affiliate.

10-3 How has e-commerce transformed marketing?

The Internet provides marketers with new ways of identifying and communicating with millions of potential customers at costs far lower than traditional media. Crowdsourcing using the wisdom of crowds helps companies learn from customers to improve product offerings and increase customer value. Behavioral targeting techniques increase the effectiveness of banner, rich media, and video ads. Social commerce uses social networks and social network sites to improve targeting of products and services.

10-4 How has e-commerce affected business-to-business transactions?

B2B e-commerce generates efficiencies by enabling companies to locate suppliers, solicit bids, place orders, and track shipments in transit electronically. Net marketplaces provide a single, digital marketplace for many buyers and sellers. Private industrial networks link a firm with its suppliers and other strategic business partners to develop highly efficient and responsive supply chains.

10-5 What is the role of m-commerce in business, and what are the most important m-commerce applications?

M-commerce is especially well suited for location-based applications such as finding local hotels and restaurants, monitoring local traffic and weather, and providing personalized location-based marketing. Mobile phones and handhelds are being used for mobile bill payment, banking, securities trading, transportation schedule updates, and downloads of digital content such as music, games, and video clips. Mobile payment systems include technologies for near field communication, QR codes, and peer-to-peer payments. The GPS capabilities of smartphones make geoadvertising, geosocial, and geoinformation services possible.

10-6 What issues must be addressed when building an e-commerce presence?

Building a successful e-commerce presence requires a clear understanding of the business objectives to be achieved and selection of the right platforms, activities, and timeline to achieve those objectives. An e-commerce presence includes not only a corporate website but also a presence on Facebook, Instagram, Twitter, and other social networking sites and smartphone apps.

Key Terms

- Advertising revenue model, 418*
Affiliate revenue model, 421
Behavioral targeting, 422
Business-to-business (B2B), 415
Business-to-consumer (B2C), 415
Community providers, 418
Consumer-to-consumer (C2C), 415
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MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

- 10-1 What are the unique features of e-commerce, digital markets, and digital goods?**
- Explain the term “eyeballs” and why it is no longer an effective way of engaging potential customers.
 - Identify two areas of traditional media that are losing ground to online competitors.
 - Distinguish between the terms marketplace and marketspace.
- 10-2 What are the principal e-commerce business and revenue models?**
- Explain why portals are more than just gateways.
 - Explain the value proposition of e-tailers.
 - Explain the importance of micropayment systems.
- 10-3 How has e-commerce transformed marketing?**
- Identify the two places where behavioral targeting takes place.
 - How can online businesses take advantage of interconnectedness?
- 10-4 How has e-commerce affected business-to-business transactions?**
- Define electronic data interchange and explain its continuing importance.
 - Define and describe private industrial networks and how they are used.
- 10-5 What is the role of m-commerce in business, and what are the most important m-commerce applications?**
- List and describe important types of m-commerce services and applications.
 - List and describe three types of mobile app payment systems.
- 10-6 What issues must be addressed when building an e-commerce presence?**
- List and describe the four types of e-commerce presence and the platforms and activities associated with each.

Discussion Questions

- 10-7** How does the Internet change consumer and supplier relationships?
MyLab MIS
- 10-8** The Internet may not make corporations obsolete, but the corporations will have to change their business models. Do you agree? Why or why not?
MyLab MIS
- 10-9** How have social technologies changed e-commerce?
MyLab MIS

Hands-On MIS Projects

The projects in this section give you hands-on experience developing e-commerce strategies for businesses, using spreadsheet software to research the profitability of an e-commerce company, and using web tools to research and evaluate e-commerce hosting services. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 10-10** Columbiana is a small, independent island in the Caribbean that has many historical buildings, forts, and other sites along with rainforests and striking mountains. A few first-class hotels and several dozen less-expensive accommodations lie along its beautiful white-sand beaches. The major airlines have regular flights to Columbiana, as do several small airlines. Columbiana's government wants to increase tourism and develop new markets for the country's tropical agricultural products. How can an e-commerce presence help? What Internet business model would be appropriate? What functions should the e-commerce presence perform?
- 10-11** Nelly, Gina Tricot, and H&M are all Swedish clothing retail brands. Examine each of their websites and compare them. How do they differ from each other in terms of tone, approach, overall concept, market segmentation, value proposition (quality and pricing), revenue model, and market strategy? Discuss how some of the topics brought up in this chapter may enhance their businesses.

Improving Decision Making: Using Spreadsheet Software to Analyze a Dot-com Business

Software skills: Spreadsheet downloading, formatting, and formulas

Business skills: Financial statement analysis

- 10-12** Pick one e-commerce company on the Internet—for example, Ashford, Apple, or eBay. Study the web pages that describe the company and explain its purpose and structure. Use the web to find articles that comment on the company. Then visit the Securities and Exchange Commission's website at www.sec.gov to access the company's 10-K (annual report) form showing income statements and balance sheets. Select only the sections of the 10-K form containing the desired portions of financial statements that you need to examine and download them into your spreadsheet. (MyLab MIS provides more detailed instructions on how to download this 10-K data into a spreadsheet.) Create simplified spreadsheets of the company's balance sheets and income statements for the past three years.
- Is the company a dot-com success, borderline business, or failure? What information provides the basis of your decision? Why? When answering these questions, pay special attention to the company's three-year trends in revenues, costs of sales, gross margins, operating expenses, and net margins.
 - Prepare an overhead presentation (with a minimum of five slides), including appropriate spreadsheets or charts, and present your work to your professor and classmates.

Achieving Operational Excellence: Evaluating E-commerce Hosting Services

Software skills: Web browser software

Business skills: Evaluating e-commerce hosting services

- 10-13** This project will help develop your Internet skills in evaluating commercial services for hosting an e-commerce site for a small start-up company.
 You would like to set up a website to sell towels, linens, pottery, and tableware from Portugal and are examining services for hosting small business Internet storefronts. Your website should be able

to take secure credit card payments and calculate shipping costs and taxes. Initially, you would like to display photos and descriptions of 40 products. Visit Wix, GoDaddy, and iPage and compare the range of e-commerce hosting services they offer to small businesses, their capabilities, and their costs. Examine the tools they provide for creating an e-commerce site. Compare these services and decide which you would use if you were actually establishing a web store. Write a brief report indicating your choice and explaining the strengths and weaknesses of each service.

Collaboration and Teamwork Project

Performing a Competitive Analysis of E-commerce Sites

- 10-14** Form a group with three or four of your classmates. Select two businesses that are competitors in the same industry and that use their websites for electronic commerce. Visit these websites. You might compare, for example, the websites for Pandora and Spotify, Amazon and BarnesandNoble.com, or E*Trade and TD Ameritrade. Prepare an evaluation of each business's website in terms of its functions, user-friendliness, and ability to support the company's business strategy. Which website does a better job? Why? Can you make some recommendations to improve these websites? If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

An iDEAL Solution to the Single Online EU Market

CASE STUDY

In January 2020, Eurostat, the statistical agency of the European Union, published some interesting data on Internet use and online shopping, and one of the findings was that the European Union is very diverse in terms of behavior. In Romania, for instance, only 19 percent of the respondents had purchased a product online in the 12 months leading up to the date of the research. In Denmark, this percentage was much higher, at 86 percent. The research also found that online shopping has been increasing steadily, mostly among younger consumers (the 16–24 and 25–54 age groups). The most popular category of products purchased online were clothes and sports goods, followed by travel and holiday accommodation.

But is the European Union one market online too? Eurostat found that the percentage of people buying goods from other EU states is not very high—just 35 percent. This percentage has been increasing since 2012, when it was 25 percent, but as these statistics show, it has not done so very rapidly. So what's standing in the way?

One serious issue is that some companies just do not want to sell their goods to customers in other EU countries. A good example is the travel industry. Companies that sell flight tickets like to segment their markets by country. The reason is commercial. A Dutch consumer organization, for instance, found that flight tickets are cheaper in Germany than in the Netherlands even if the passenger flies through Schiphol Airport.

The extent to which the European market for travel products is still segmented was investigated by the Dutch website VPNgids. The website's staff twice booked the same trip online—a return ticket from New York to Kuala Lumpur with an airline from the Middle East and 15 nights in a hotel in Kuala Lumpur. The first time, the staff used a Dutch IP address; the second time, a Romanian one. To make sure that the time of booking did not play a role in determining the result, the bookings were made with just a five-minute gap between them.

The price differences were staggering. The hotel was €172 cheaper when using a Romanian IP address than when it was using a Dutch one—€1033 instead of €1205. The difference in price turned out to be even

bigger with regard to the flight ticket; the Romanian ticket was €935, whereas the Dutch one was an astonishing €3914.48. By using a Romanian IP address, the staff of the website noted, savings of over €3000 were achievable.

The location of the IP address was the most important factor determining price differences between bookings. Consumer websites often give readers special advice to make sure that travel companies will not increase prices: Book flights during the evening, as prices go down at that time; and avoid looking at the same travel itinerary several times while using the same computer, as that gives the impression that the reader is really interested in buying tickets. However, according to VPNgids, none of that advice is really useful—the only thing that results in real savings is changing one's IP address.

Another problem for prospective shoppers across borders is customer care. An online store in Bulgaria, for instance, may want to sell goods to people in the United Kingdom, but if there is a problem, they need people who can answer questions in English. Customers may also be resistant to buying goods from other EU countries for another reason: if they don't like the product, they can send it back, but they would have to pay for the shipment costs.

And then there is, of course, the issue of fraud. In many countries, customers have to use their credit cards to pay for their purchases, and sometimes, more money is deducted from the account than was agreed on. To counter such abuse, many banks advise customers to open a special account for potentially "problematic" purchases, specifying a limit to the amount of money that can be deducted. Financial companies like PayPal also have procedures in place for customers to dispute payments.

The Netherlands has been very successful in developing a safe and reliable payment system for online shopping in the form of the iDEAL system. The name of this payment system, which was created in 2005, is intended to be interpreted in many ways; one could read it as a "deal" made on the Internet (ideal), "I deal" in English, and idéal (meaning ideal) in French. While opinion is divided in the Netherlands about whether the system really is "ideal," it is certainly easy. When buying online, customers in the Netherlands have

iDEAL as an optional payment method; they can click on it and then choose their bank, upon which they are immediately directed to its website. If they agree to a payment, they need to confirm it on the website by using a code that is sent to their mobile phone. When this code is verified, the bank deducts the amount from the checking account of the customer and sends a message to the online shop that the payment has been made.

There were several reasons why the iDEAL system was devised. One was that Dutch consumers are very cautious, and online retailers and banks felt that they would only shop online if a safe and easy payment system was provided. Another problem was that in the Netherlands (unlike, for instance, the United States) people do not use credit cards very often; they rely on debit cards instead, and this is what iDEAL is linked with. A third reason for the creation of the system is the large number of banks in the Netherlands—if every bank had created its own payment system, it would have made it very difficult to shop online.

iDEAL has been a big success in the first ten years of its existence, growing from 4 million total transactions in 2006, the year it launched, to over 650 million in 2019—an astounding figure given that the population of the Netherlands is around 17 million—and the average amount per transaction that year was around €82. During the COVID-19 crisis, iDEAL proved its vitality; in August 2020, the number of payments through the payment system was 35 percent higher than that in August 2019.

The iDEAL system has proven so successful that websites outside the Netherlands that are frequented by Dutch customers (like Amazon.de and websites in Belgium) offer iDEAL as a payment method.

Critics, however, see significant disadvantages. Consumers may feel more secure when they use iDEAL, but in practice they are less protected while using it than they would be if they used a credit card instead. Additionally, payment through iDEAL is more or less definitive; consumers can't approach their banks to claim their money back. (Compare this to some credit cards, which automatically insure purchases made for 120 days and immediately return the money to the consumer if there is a problem). Another downside that is especially relevant for online shops is that the system is expensive: every transaction through iDEAL costs 40–50 eurocents, and it takes several days before they receive the actual payment.

Will the Dutch iDEAL system become a prototype in the development of Europe-wide payment systems? The Dutch are not the only people who use debit rather than credit cards; in Germany, the most populous country in the European Union, only 34 percent of consumers regularly use credit cards while shopping. Will a European iDEAL system develop, or will payment systems like PayPal become more and more important?

The European Commission would certainly like to transform Europe into one market, and the Internet is a major part of this endeavor. The fact that many countries in the European Union use the same currency should be a powerful impetus to online shopping. To make online shopping more reliable, the European Union adopted the European directive "Buying Online" in 2014, and several basic rights were given Europe-wide validity to make things easier for European consumers. Products must now be delivered within 30 days. Every consumer now has the right to send a product back to the online store within two weeks and have their money refunded within 30 days. For its part, the online shop is also obliged by the directive to provide the customer with detailed information about, for instance, the price of the product and how delivery will take place.

As part of its Digital Single Market Strategy, new rules were implemented across the European Union in December 2018 to end unjustified geoblocking practiced by online sellers. Geoblocking involves restrictions based on the place of residence of the consumer, such as being re-routed back to a country-specific website or having to use a specific mode of payment (debit or credit card) when purchasing products from a certain country. The new rules ensure that online sellers treat all EU consumers equally, irrespective of their nationality. The rules have also addressed the issue of cross-border parcel delivery prices, which are usually about three to five times higher than domestic delivery prices. Delivery prices have not been capped, but businesses are now required to disclose their prices for the consumers to compare. The European Commission's website is also expected to have a webpage dedicated to standard parcel delivery prices, which consumers may consult before making a purchase.

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CASE STUDY QUESTIONS

10-15 Douglas is a perfume shop that has branches in many European countries. Go to their European website (www.douglas.eu) and choose a country. Now choose a perfume and look at the online Douglas shops in other European countries. Is there a price difference? Would you buy your perfume in the

online shop of another country? What problems might you experience?

10-15 You are thinking of opening an online shop in the Netherlands. Would you include iDEAL as a payment option? What factors would you take into consideration before taking a decision?

10-15 The world is, of course, bigger than the European Union. Does the legislation of the European Union give the same rights to those who buy online from within the European Union as opposed to those who live in the European Union but buy online from, let's say, a shop in China?

Case contributed by Bernard Bouwman

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11

Managing Knowledge and Artificial Intelligence

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 11-1** What is the role of knowledge management systems in business?
- 11-2** What are artificial intelligence (AI) and machine learning? How do businesses use AI?
- 11-3** What types of systems are used for enterprise-wide knowledge management, and how do they provide value for businesses?
- 11-4** What are the major types of knowledge work systems, and how do they provide value for firms?
- 11-5** How will MIS help my career?

CHAPTER CASES

- Artificial Intelligence Beats Radiologists in Reading Mammograms
- Do You Know Who Is Using Your Face?
- Will AI Kill Jobs?
- Are Self-Driving Cars Ready for the Road?

VIDEO CASES

- How IBM's Watson Became a Jeopardy Champion
- Alfresco: Open Source Document Management and Collaboration

MyLab MIS

Discussion Questions: 11-5, 11-6, 11-7; Hands-On MIS Projects: 11-8, 11-9, 11-10, 11-11;
eText with Conceptual Animations

Artificial Intelligence Beats Radiologists in Reading Mammograms

According to the American Cancer Society 268,600 new cases of invasive breast cancer and 41,760 deaths from breast cancer were predicted among women in the United States in 2019. Globally, there are about 2 million new breast cancer cases and over half a million deaths each year. That makes breast cancer a leading source of death among women.

The leading tool for detecting breast cancer has been mammography, in which X rays are used to locate and diagnose tumors in the breast. In the United States, about 33 million screening mammograms are performed each year. Although mammograms have helped with early cancer detection, the test misses 20 percent of breast cancers due to false negatives, and also tags 7–12 percent as false positives. A false negative is when cancer is present, but a mammogram is misread as normal. A false positive is when no cancer is present, but a mammogram is misread as abnormal. Mammograms could be a better screening tool if they were made more accurate.

A new system for reading mammograms using AI (artificial intelligence) technology has been recently developed, and it is proving to read X-ray images better than radiologists. A team of researchers from Google Health, Northwestern University in Chicago, and Britain's Cancer Research Imperial Centre and Royal Surrey County Hospital designed the computer model to read breast X-ray images. Computers can be trained to recognize patterns and interpret images, and the team designed an algorithm and taught the model using X-ray images from many thousands of women who had known breast cancer diagnoses. The new system performed better than human radiologists. On scans from the United States, the system was able to reduce false



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negatives by 9.4 percent and false positives by 5.7 percent. On mammograms from Britain, the system reduced false negatives by 2.7 percent and false positives by 1.2 percent.

The research team used mammograms from about 76,000 women in Britain and 15,000 in the United States whose diagnoses were already known to train computers to recognize breast cancer. They then tested the computers using images from about 25,000 other women in the UK and 3,000 in the United States and compared their system's performance with that of the radiologists who had originally read the mammograms. The mammograms had been taken in the past and their outcomes were known, so the researchers knew whether the radiologists' initial diagnoses were correct. The team found that the new AI-based system was more accurate than the radiologists.

Another test, in which the AI system and six radiologists in the United States analyzed 500 mammograms, also showed that the AI system outperformed the humans. However, there were some instances where the AI system missed a cancer that all six radiologists found.

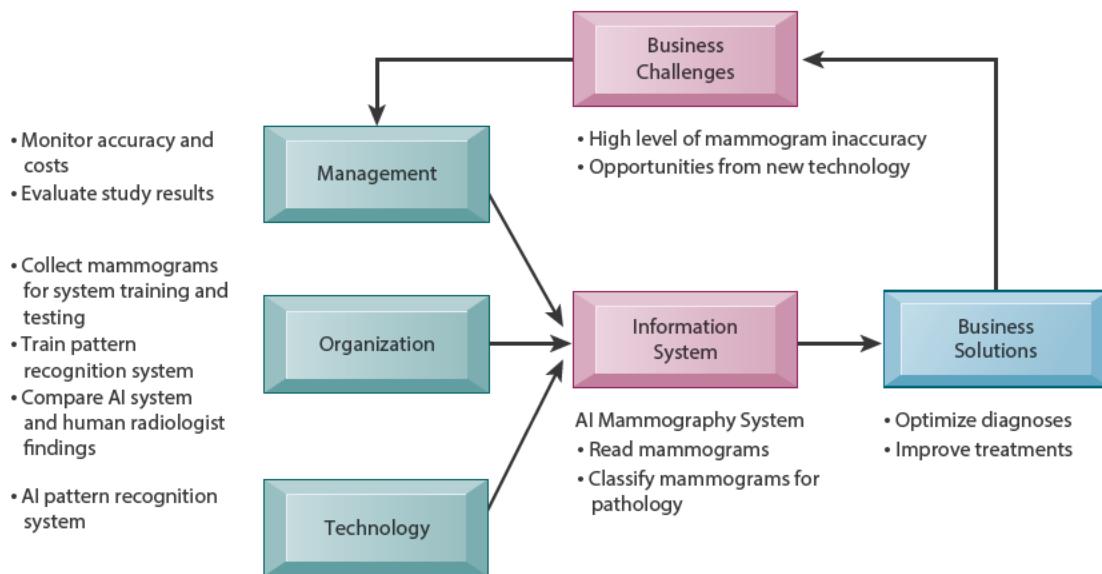
The new system for reading mammograms is not yet ready for widespread clinical use. The researchers want to validate the tool in real-world settings, where it will be used by radiologists as part of their routine practice reading mammograms.

Sources: Denise Grady, "A.I. Is Learning to Read Mammograms," *New York Times*, January 1, 2020; Karina Lichtenstein, "A.I. Better at Reading Mammograms Than Radiologists," MedicineNet Health News, January 7, 2020; and American Cancer Society, "Breast Cancer Facts and Figures, 2019–2020," 2019.

Use of artificial intelligence techniques such as pattern recognition systems to improve the accuracy of mammograms shows how organizational performance can benefit by using technology to facilitate the acquisition and application of knowledge. Facilitating access to knowledge, using knowledge tools to create and utilize new knowledge, and using that knowledge to improve business processes are vital to success and survival for both private business firms and public organizations.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. Mammography has proved a useful breast cancer-detection tool, but mammogram interpretation by human radiologists has had a high level of inaccuracy. Radiologists reading the mammograms missed 20 percent of breast cancers due to false negatives, and also identified 7–12 percent as abnormal when no cancer was present. AI techniques such as pattern recognition were able to increase mammogram accuracy so that the computer system produced more accurate mammogram readings than human radiologists.

Here are some questions to think about: How did using artificial intelligence improve the accuracy of mammograms? What is the potential impact on the way radiologists analyze mammograms and make diagnoses?



11-1 What is the role of knowledge management systems in business?

Knowledge management and collaboration systems are among the fastest-growing areas of corporate and government software investment. The past decade has shown an explosive growth in research on knowledge and knowledge management in the economics, management, and information systems fields.

Knowledge management and collaboration are closely related. Knowledge that cannot be communicated and shared with others is nearly useless. Knowledge becomes useful and actionable when shared throughout the firm. We have already described the major tools for collaboration and social business in Chapter 2. In this chapter, we will focus on knowledge management systems and be mindful that communicating and sharing knowledge are becoming increasingly important.

We live in an information economy in which the major source of wealth and prosperity is the production and distribution of information and knowledge. Knowledge management has become an important theme at many large business firms as managers realize that much of their firm's value depends on the firm's ability to create and manage knowledge. Studies have found that a substantial part of a firm's stock market value is related to its intangible assets, of which knowledge is one important component, along with brands, reputations, and unique business processes. Well-executed knowledge-based projects have been known to produce extraordinary returns on investment, although the impacts of knowledge-based investments are difficult to measure (Gu and Lev, 2001).

Important Dimensions of Knowledge

There is an important distinction between data, information, knowledge, and wisdom. Chapter 1 defines **data** as flows of events or transactions captured by an organization's systems that are useful for transacting but little else. To turn data into useful *information*, a firm must expend resources to organize data into categories of understanding, such as monthly, daily, regional, or store-based reports of total sales. To transform information into **knowledge**, a firm must

expend additional resources to discover patterns, rules, and contexts where the knowledge works. Finally, **wisdom** is thought to be the collective and individual experience of applying knowledge to the solution of problems. Wisdom involves where, when, and how to apply knowledge.

Knowledge is both an individual attribute and a collective attribute of the firm. Knowledge is a cognitive, even a physiological, event that takes place inside people's heads. It is also stored in libraries and records, shared in lectures, and stored by firms in the form of business processes and employee know-how. Knowledge residing in the minds of employees that has not been documented is called **tacit knowledge**, whereas knowledge that has been documented is called **explicit knowledge**. Knowledge can reside in email, voice mail, graphics, and unstructured documents as well as structured documents. Knowledge is generally believed to have a location, either in the minds of humans or in specific business processes. Knowledge is "sticky" and not universally applicable or easily moved. Finally, knowledge is thought to be situational and contextual. For example, you must know when to perform a procedure as well as how to perform it. Table 11.1 reviews these dimensions of knowledge.

We can see that knowledge is a different kind of firm asset from, say, buildings and financial assets; that knowledge is a complex phenomenon; and that there are many aspects to the process of managing knowledge. We can also recognize that knowledge-based core competencies of firms—the two or three things that an organization does best—are key organizational assets. Knowing how to do things effectively and efficiently in ways that other organizations cannot duplicate is a primary source of profit and competitive advantage that cannot be purchased easily by competitors in the marketplace.

For instance, having a unique build-to-order production system constitutes a form of knowledge and perhaps a unique asset that other firms cannot copy easily. With knowledge, firms become more efficient and effective in their use of scarce resources. Without knowledge, firms become less efficient and less effective in their use of resources and ultimately fail.

TABLE 11.1 IMPORTANT DIMENSIONS OF KNOWLEDGE

KNOWLEDGE IS A FIRM ASSET

Knowledge is an intangible asset.

The transformation of data into useful information and knowledge requires organizational resources.

Knowledge is not subject to the law of diminishing returns as are physical assets but instead experiences network effects because its value increases as more people share it.

KNOWLEDGE HAS DIFFERENT FORMS

Knowledge can be either tacit or explicit (codified).

Knowledge involves know-how, craft, and skill.

Knowledge involves knowing how to follow procedures.

Knowledge involves knowing why, not simply when, things happen (causality).

KNOWLEDGE HAS A LOCATION

Knowledge is a cognitive event involving mental models and maps of individuals.

There is both a social and an individual basis of knowledge.

Knowledge is "sticky" (hard to move), situated (enmeshed in a firm's culture), and contextual (works only in certain situations).

KNOWLEDGE IS SITUATIONAL

Knowledge is conditional; knowing when to apply a procedure is just as important as knowing the procedure (conditional).

Knowledge is related to context; you must know how to use a certain tool and under what circumstances.

Organizational Learning and Knowledge Management

Like humans, organizations create and gather knowledge using a variety of organizational learning mechanisms. Through collection of data, careful measurement of planned activities, trial and error (experimentation), and feedback from customers and the environment in general, organizations gain experience. Organizations that learn adjust their behavior to reflect that learning by creating new business processes and by changing patterns of management decision making. This process of change is called **organizational learning**. Arguably, organizations that can sense and respond to their environments rapidly will survive longer than organizations that have poor learning mechanisms.

The Knowledge Management Value Chain

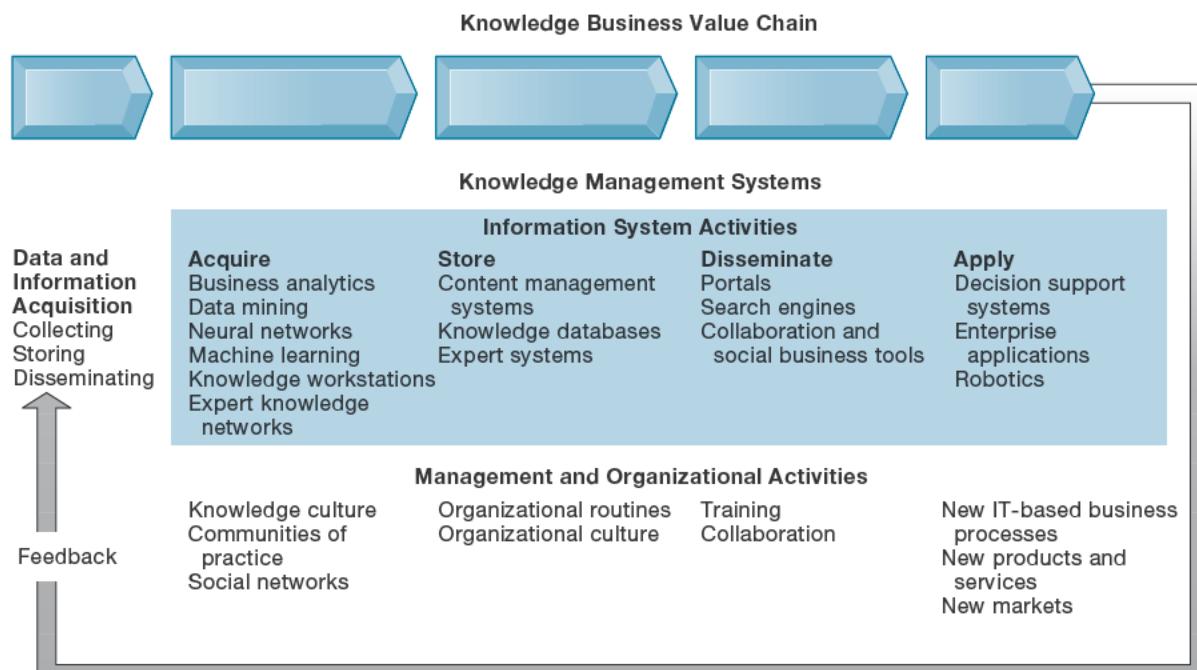
Knowledge management refers to the set of business processes developed in an organization to create, store, transfer, and apply knowledge. Knowledge management increases the ability of the organization to learn from its environment and to incorporate knowledge into its business processes. Figure 11.1 illustrates the value-adding steps in the knowledge management value chain. Each stage in the value chain adds value to raw data and information as they are transformed into usable knowledge.

In Figure 11.1, information systems activities are separated from related management and organizational activities, with information systems activities on the top of the graphic and organizational and management activities below. One apt slogan of the knowledge management field is “Effective knowledge management is 80 percent managerial and organizational and 20 percent technological.”

In Chapter 1, we define *organizational and management capital* as the set of business processes, culture, and behavior required to obtain value from

FIGURE 11.1 THE KNOWLEDGE MANAGEMENT VALUE CHAIN

Knowledge management today involves both information systems activities and a host of enabling management and organizational activities.



investments in information systems. In the case of knowledge management, as with other information systems investments, supportive values, structures, and behavior patterns must be built to maximize the return on investment in knowledge management projects. In Figure 11.1, the management and organizational activities in the lower half of the diagram represent the investment in organizational capital required to obtain substantial returns on the information technology (IT) investments and systems shown in the top half of the diagram.

Knowledge Acquisition

Organizations acquire knowledge in a number of ways, depending on the type of knowledge they seek. The first knowledge management systems sought to build corporate repositories of documents, reports, presentations, and best practices. These efforts have been extended to include unstructured documents (such as email). In other cases, organizations acquire knowledge by developing online expert networks so that employees can “find the expert” in the company who is personally knowledgeable.

In still other cases, firms must acquire new knowledge by discovering patterns in corporate data via machine learning (including neural networks, genetic algorithms, natural language processing, and other AI techniques), or by using knowledge workstations where engineers can discover new knowledge. These various efforts are described throughout this chapter. A coherent and organized knowledge system also requires business analytics using data from the firm's transaction processing systems that track sales, payments, inventory, customers, and other vital areas as well as data from external sources such as news feeds, industry reports, legal opinions, scientific research, and government statistics (See Chapter 12).

Knowledge Storage

Once they are discovered, documents, patterns, and expert rules must be stored so they can be retrieved and used by employees. Knowledge storage generally involves the creation of a database. Document management systems that digitize, index, and tag documents according to a coherent framework are large databases adept at storing collections of documents. Expert systems also help corporations preserve the knowledge that is acquired by incorporating that knowledge into organizational processes and culture. Each of these is discussed later in this chapter and in the following chapter.

Management must support the development of planned knowledge storage systems, encourage the development of corporate-wide schemas for indexing documents, and reward employees for taking the time to update and store documents properly. For instance, it would reward the sales force for submitting names of prospects to a shared corporate database of prospects where all sales personnel can identify each prospect and review the stored knowledge.

Knowledge Dissemination

Portals, email, instant messaging, wikis, social business tools, and search engine technology have added to an existing array of collaboration tools for sharing calendars, documents, data, and graphics (see Chapter 2). Contemporary technology has created a deluge of information and knowledge. How can managers and employees discover, in a sea of information and knowledge, that which is really important for their decisions and their work? Here, training programs, informal networks, and shared management experience communicated through a supportive culture help managers focus their attention on what is important.

Knowledge Application

Regardless of what type of knowledge management system is involved, knowledge that is not shared and applied to the practical problems facing firms and managers does not add business value. To provide a return on investment, organizational knowledge must become a systematic part of management decision making and become situated in systems for decision support (described in Chapter 12). Ultimately, new knowledge must be built into a firm's business processes and key application systems, including enterprise applications for managing crucial internal business processes and relationships with customers and suppliers. Management supports this process by creating—based on new knowledge—new business practices, new products and services, and new markets for the firm.

Building Organizational and Management Capital: Collaboration, Communities of Practice, and Office Environments

In addition to the activities we have just described, managers can help by developing new organizational roles and responsibilities for the acquisition of knowledge, including the creation of chief knowledge officer executive positions, dedicated staff positions (knowledge managers), and communities of practice.

Communities of practice (COPs) are informal social networks of professionals and employees within and outside the firm who have similar work-related activities and interests. The activities of these communities include self-education and group education, conferences, online newsletters, and day-to-day sharing of experiences and techniques to solve specific work problems. Many organizations, such as IBM, the U.S. Federal Highway Administration, and the World Bank, have encouraged the development of thousands of online communities of practice. These communities of practice depend greatly on software environments that enable collaboration and communication.

COPs can make it easier for people to reuse knowledge by pointing community members to useful documents, creating document repositories, and filtering information for newcomers. COPs' members act as facilitators, encouraging contributions and discussion. COPs can also reduce the learning curve for new employees by providing contacts with subject matter experts and access to a community's established methods and tools. Finally, COPs can act as a spawning ground for new ideas, techniques, and decision-making behavior.

Types of Knowledge Management Systems

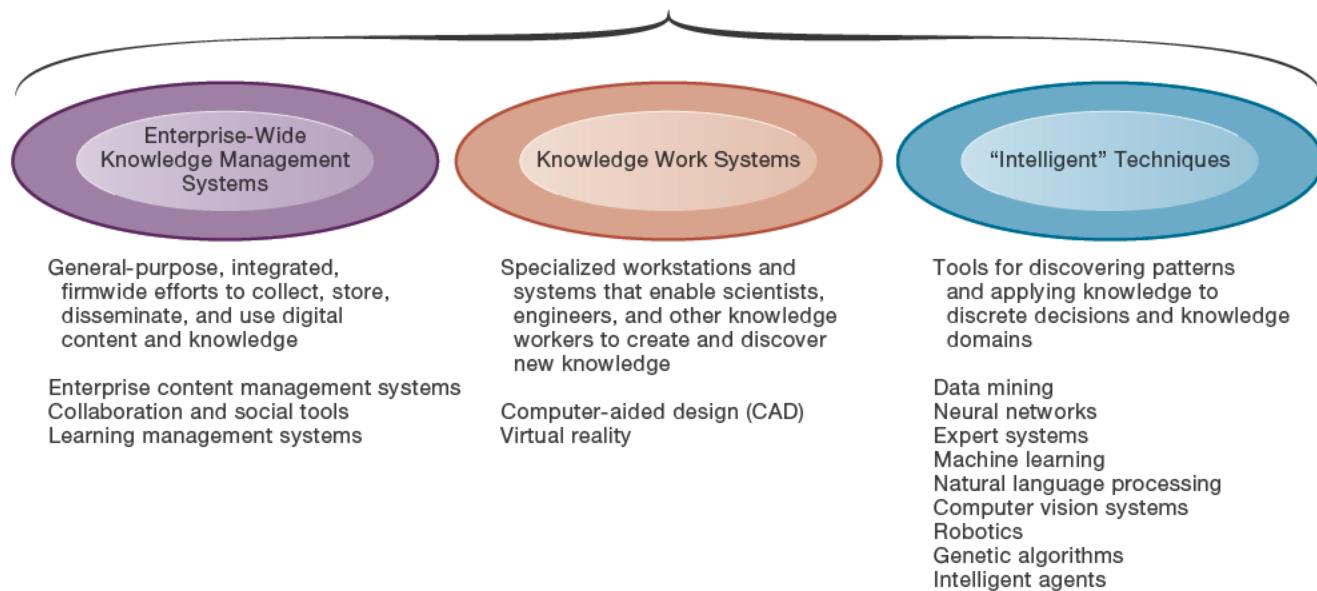
There are essentially three major types of knowledge management systems: enterprise-wide knowledge management systems, knowledge work systems, and "intelligent" techniques. Figure 11.2 shows the knowledge management systems applications for each of these major categories.

Enterprise-wide knowledge management systems are general-purpose firmwide efforts to collect, store, distribute, and apply digital content and knowledge. These systems include capabilities for searching for information, storing both structured and unstructured data, and locating employee expertise within the firm. They also include supporting technologies such as portals, search engines, collaboration and social business tools, and learning management systems.

The development of powerful networked workstations and software for assisting engineers and scientists in the discovery of new knowledge has led to the creation of knowledge work systems such as computer-aided design (CAD),

FIGURE 11.2 MAJOR TYPES OF KNOWLEDGE MANAGEMENT SYSTEMS

There are three major categories of knowledge management systems, and each can be broken down further into more specialized types of knowledge management systems.



visualization, simulation, and virtual reality systems. **Knowledge work systems (KWS)** are specialized systems built for engineers, scientists, and other knowledge workers charged with discovering and creating new knowledge for a company. We discuss knowledge work applications in detail in Section 11-4.

Knowledge management also includes a diverse group of “intelligent” techniques, such as data mining, expert systems, machine learning, neural networks, natural language processing, computer vision systems, robotics, genetic algorithms, and intelligent agents. These techniques have different objectives, from a focus on discovering knowledge (data mining and neural networks) to distilling knowledge in the form of rules for a computer program (expert systems) to discovering optimal solutions for problems (genetic algorithms). Section 11-2 provides more detail about these “intelligent” techniques.

11-2 What are artificial intelligence (AI) and machine learning? How do businesses use AI?

“Intelligent” techniques are often described as **artificial intelligence (AI)**. There are many definitions of artificial intelligence. In the most ambitious vision, AI involves the attempt to build computer systems that think and act like humans. Humans see, hear, and communicate with natural languages, make decisions, plan for the future, achieve goals, perceive patterns in their environments, and learn, among many other capabilities. Humans also love, hate, and choose what objectives they want to pursue. These are the foundations of what is called “human intelligence” and what is called “common sense” or generalized intelligence.

So far the “Grand Vision” of AI remains a distant dream: there are no computer programs that have demonstrated generalized human intelligence or common sense. Human intelligence is vastly more complex than the most

sophisticated computer programs and covers a broader range of activities than is currently possible with “intelligent” computer systems and devices.

A narrow definition of artificial intelligence is far more realistic and useful. Stripped of all the hyperbole, artificial intelligence programs are like all computer programs: They take data input from the environment, process that data, and produce outputs. AI programs differ from traditional software programs in the techniques and technologies they use to input and process data. AI systems today can perform many tasks that would be impossible for humans to accomplish, and can equal or come close to humans in tasks such as interpreting CT scans, recognizing faces and voices, playing games like chess or Go, or besting human experts in certain well-defined tasks. In many industries they are transforming how business is done, where people are employed, and how they do their jobs.

Evolution of AI

In the last decade, significant progress has been made within this limited vision of AI. The major forces driving the rapid evolution of AI are the development of Big Data databases generated by the Internet, e-commerce, the Internet of Things, and social media. Secondary drivers include the drastic reduction in the cost of computer processing and the growth in the power of processors. And finally, the growth of AI has relied on the refinement of algorithms by tens of thousands of AI software engineers and university AI research centers, along with significant investment from business and governments. There have been few fundamental conceptual breakthroughs in AI in this period, or in understanding how humans think. Many of the algorithms and statistical techniques were developed decades earlier but could not be implemented and refined on such a large scale as is currently possible.

Progress has been significant: Image recognition programs have gone from 25 percent error rates down to less than 3 percent in 2018; natural language speech recognition errors have dropped from 15 percent to 5 percent; and in translation among common languages, Google's Translate program achieves about 85 percent accuracy compared to humans (Technology Quarterly, 2017; Hirschberg and Manning, 2016). These advances have made possible personal assistants like Siri (Apple), Alexa (Amazon), and Cortana (Microsoft), as well as speech-activated systems in automobiles.

In a famous 1950 paper, computer scientist Alan Turing defined an artificially intelligent computer program as one that a human could have a conversation with and not be able to tell it was a computer (Turing, 1950). We still cannot have a genuine conversation with a computer AI system because it has no genuine understanding of the world, no common sense, and does not truly understand humans. Nevertheless, AI systems can be enormously helpful to humans and business firms.

Major Types of AI

Artificial intelligence is a family of programming techniques and technologies, each of which has advantages in select applications. Table 11.2 describes the major types of AI: expert systems, machine learning, neural networks, deep learning, genetic algorithms, natural language processing, computer vision systems, robotics, and intelligent agents. Let's take a look at each type of AI and understand how it is used by businesses and other organizations.

TABLE 11.2 MAJOR TYPES OF AI TECHNIQUES

Expert systems	Represent the knowledge of experts as a set of rules that can be programmed so that a computer can assist human decision makers.
Machine learning	Software that can identify patterns in very large databases without explicit programming although with significant human training.
Neural networks and deep learning	Loosely based on human neurons, algorithms that can be trained to classify objects into known categories based on data inputs. Deep learning uses multiple layers of neural networks to reveal the underlying patterns in data, and in some limited cases identify patterns without human training.
Genetic algorithms	Algorithms based loosely on evolutionary natural selection and mutation, commonly used to generate high-quality solutions to optimization and search problems.
Natural language processing	Algorithms that make it possible for a computer to understand and analyze natural human language.
Computer vision systems	Systems that can view and extract information from real-world images.
Robotics	Use of machines that can substitute for human movements as well as computer systems for their control and information processing.
Intelligent agents	Software agents that use built-in or learned knowledge to perform specific tasks or services for an individual.

Expert Systems

Expert systems were developed in the 1970s and were the first large-scale applications of AI in business and other organizations. They account for an estimated 20 percent of all AI systems today. Expert systems capture the knowledge of individual experts in an organization through in-depth interviews, and represent that knowledge as sets of rules. These rules are then converted into computer code in the form of IF-THEN rules. Such programs are often used to develop apps that walk users through a process of decision making.

Expert systems provide benefits such as improved decisions, reduced errors, reduced costs, reduced training time, and better quality and service. They have been used in applications for making decisions about granting credit and for diagnosing equipment problems, as well as in medical diagnostics, legal research, civil engineering, building maintenance, drawing up building plans, and educational technology (personalized learning and responsive testing) (Maor, 2003; Mishra, 2016). For instance, if you were the project manager of a 14-story office building and were given the task of configuring the building's air conditioning system, which has hundreds of parts and subassemblies, an expert system could walk you through the process by asking a series of questions, producing an order to suppliers, and providing an overall cost estimate for the project, all in a matter of hours rather than weeks. See Figure 11.3 for an expert system for credit granting.

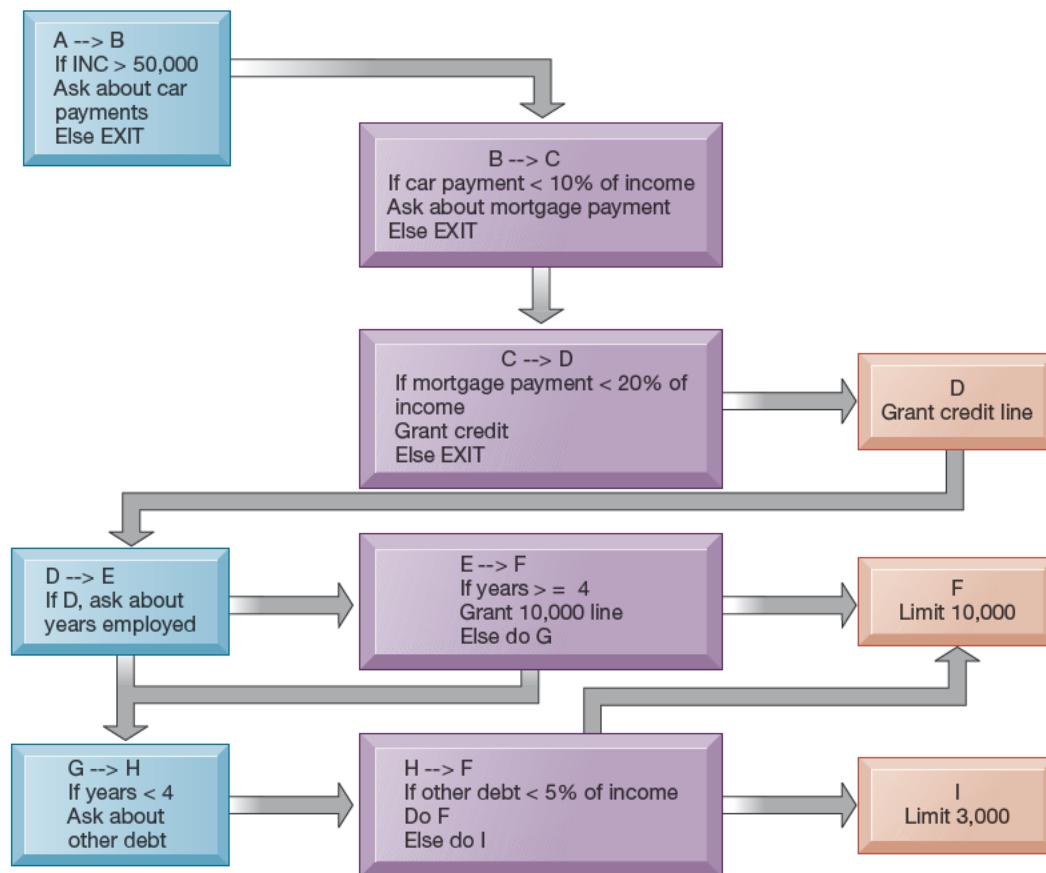
How Expert Systems Work

Expert systems model human knowledge as a set of rules that collectively are called the **knowledge base**. Expert systems can have from a handful to many thousands of rules, depending on the complexity of the decision-making problem. The strategy used to search through the collection of rules and formulate conclusions is called the **inference engine**. The inference engine works by searching through the rules and firing those rules that are triggered by facts the user gathers and enters.

Expert systems have a number of limitations, the most important of which is that even experts can't explain how they make decisions: they know more than they can say. People drive cars, for instance, but are challenged to say how they do it. The knowledge base can become chaotic as the number of rules can reach into the thousands. In rapidly changing environments, say medical

FIGURE 11.3 RULES IN AN EXPERT SYSTEM

An expert system contains a number of rules to be followed. The rules are interconnected, the number of outcomes is known in advance and is limited, there are multiple paths to the same outcome, and the system can consider multiple rules at a single time. The rules illustrated are for simple credit-granting expert systems.



diagnosis, the rules change and need to be continually updated. Expert systems are not useful for dealing with unstructured problems that managers and employees typically encounter, and do not use real-time data to guide their decisions. Expert systems do not scale well to the kinds of very large data sets produced by the Internet and the Internet of Things (IoT), and they are expensive to build. For these reasons, expert system development has slowed to small domains of expert knowledge such as automobile diagnosis.

Machine Learning

More than 75 percent of AI development today involves some kind of **machine learning (ML)** accomplished by neural networks, deep learning networks, and genetic algorithms, with the main focus on finding patterns in data, and classifying data inputs into known (and unknown) outputs. Machine learning is based on an entirely different AI paradigm than expert systems. In machine learning there are no experts, and there is no effort to write computer code for rules reflecting an expert's understanding. Instead, ML begins with very large data sets with tens to hundreds of millions of data points and automatically finds patterns and relationships by analyzing a large set of examples and making a statistical inference. Table 11.3 provides some examples of how leading business firms are using various types of machine learning.

TABLE 11.3 EXAMPLES OF MACHINE LEARNING

WellsFargo	Aiera system reads and analyzes a half-million documents daily for 1,600 stocks, and produces buy and sell calls for 550 stocks followed by their wealth management unit.
Netflix	Recommender system based on video similarity algorithm uses statistical and machine learning to develop a personalized selection of videos for each of its 167 million subscribers worldwide.
Schindler Group	Monitors over one million elevators and walkways using GE's Predix operating system and machine learning to make predictions about needed maintenance.
PayPal	Uses machine learning algorithms to identify patterns of fraud for 300 million customers who generate four billion transactions annually.

Facebook has 250 billion monthly active users who spend an average of 37 minutes on site daily. The firm displays an estimated 1 billion ads monthly to this audience, and it decides which ads to show each person in less than one second. For each person, Facebook bases this decision on the prior behavior of its users, including information shared (posts, comments, Likes), the activity of their social network friends, background information supplied to Facebook (age, gender, location, devices used), information supplied by advertisers (email address, prior purchases), and user activity on apps and other websites that Facebook can track. Facebook uses ML to identify patterns in the dataset, and to estimate the probability that any specific user will click on a particular ad based on the patterns of behavior they have identified. At the end of this process is a simple show ad/no show ad result.

The current response rate (click rate) to Facebook ads is about 0.1 percent, roughly four times that of an untargeted display ad although not as good as targeted email campaigns (about 3 percent), or Google Search ads (about 2 percent). All of the very large Internet consumer firms, including Amazon, Alphabet's Google, Microsoft, Alibaba, Tencent, Netflix, and Baidu, use similar ML algorithms. Obviously, no human or group of humans could achieve these results given the enormous database size, the speed of transactions, or the complexity of working in real time. The benefits of ML illustrated by this brief example come down to an extraordinary ability to recognize patterns at the scale of millions of people in a matter of seconds, and classify objects into discrete categories.

Supervised and Unsupervised Learning

Nearly all machine learning today involves **supervised learning**, in which the system is "trained" by providing specific examples of desired inputs and outputs identified by humans in advance. A very large database is developed, say ten million photos posted on the Internet, and then split into two sections, one a development database and the other a test database. Humans select a target, let's say to identify all photos that contain a car image. Humans feed a large collection of verified pictures that contain a car image into a neural network (described below) that proceeds iteratively through the development database in millions of cycles, until eventually the system can identify photos with a car. The machine learning system is then tested using the test database to ensure the algorithms can achieve the same results with different photos. In many cases, but not all, machine learning can come close to or equal human efforts, but on a very much larger scale. Over time, with tweaking by programmers, and by making the database even bigger, using ever larger computing systems, the system will improve its performance, and in that sense, can learn. Supervised learning is one technique used to develop autonomous vehicles that need to be able to recognize objects around them, such as people, other cars, buildings, and lines on the pavement to guide them (see the chapter-ending case study).

In **unsupervised learning**, the same procedures are followed, but humans do not feed the system examples. Instead, the system is asked to process the development database and report whatever patterns it finds. For instance, in a seminal research effort often referred to “The Cat Paper,” researchers collected 10 million YouTube photos from videos and built an ML system that could detect human faces without labeling or “teaching” the machine with verified human face photos (Le et al., 2011). Researchers developed a brute force neural network computer system composed of 1,000 machines with 16,000 core processors loaned by Google. The systems processors had a total of 1 billion connections to one another, creating a very large network that imitated on a small scale the neurons and synapses (connections) of a human brain. The result was a system that could detect human faces in photos, as well as cat faces and human bodies. The system was then tested on 22,000 object images on ImageNet (a large online visual database), and achieved a 16 percent accuracy rate. In principle then, it is possible to create machine learning systems that can “teach themselves” about the world without human intervention. But there’s a long way to go: we wouldn’t want to use autonomous cars that were guided by systems with a 16 percent accuracy rate! Nevertheless, this research was a 75 percent improvement over previous efforts.

To put this in perspective, a one-year-old human baby can recognize faces, cats, tables, doors, windows, and hundreds of other objects it has been exposed to, and continuously catalogs new experiences that it seeks out by itself for recognition in the future. But babies have a huge computational advantage over our biggest ML research systems. The human adult brain has an estimated 86 billion neurons, each with thousands of connections to other neurons (synapses), and over 100 trillion total connections in its network (brain). Modern *homo sapiens* have been programmed (by nature) for an estimated 300,000 years, and their predecessors for 2.5 million years. For these reasons, machine learning is applicable today in a very limited number of situations where there are very large databases and computing facilities, most desired outcomes are already defined by humans, the output is binary (0,1), and where there is a very talented and large group of software and system engineers working on the problem.

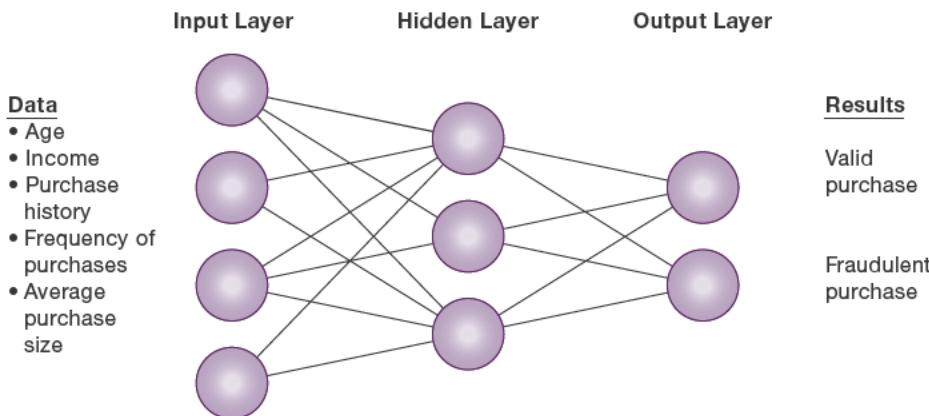
Neural Networks

A neural network is composed of interconnected units called neurons. Each neuron can take data from other neurons, and transfer data to other neurons in the system. The artificial neurons are not biological physical entities as in the human brain, but instead are software programs and mathematical models that perform the input and output function of neurons. The strength of the connections (weight) can be controlled by researchers using a Learning Rule, an algorithm that systematically alters the strength of the connections among the neurons to produce the final desired output that could be identifying a picture of a cancer tumor, fraudulent credit card transactions, or suspicious telephone calling patterns.

Neural networks find patterns and relationships in very large amounts of data that would be too complicated and difficult for a human being to analyze by using machine learning algorithms and computational models that are loosely based on how the biological human brain is thought to operate. Neural networks are **pattern detection programs**. Neural networks learn patterns from large quantities of data by sifting through the data, and ultimately finding pathways through the network of thousands of neurons. Some pathways are more successful than others in their ability to identify objects like cars, animals,

FIGURE 11.4 HOW A NEURAL NETWORK WORKS

A neural network uses rules it “learns” from patterns in data to construct a hidden layer of logic. The hidden layer then processes inputs, classifying them based on the experience of the model. In this example, the neural network has been trained to distinguish between valid and fraudulent credit card purchases.



faces, and voices. There may be millions of pathways through the data. An algorithm (the Learning Rule mentioned above) identifies these successful paths, and strengthens the connection among neurons in these pathways. This process is repeated thousands or millions of times until only the most successful pathways are identified. The Learning Rule identifies the best or optimal pathways through the data. At some point, after millions of pathways are analyzed, the process stops when an acceptable level of pattern recognition is reached, for instance, successfully identifying cancer tumors about as well as humans, or even better than humans.

Figure 11.4 represents one type of neural network comprising an input layer, a processing layer, and an output layer. Humans train the network by feeding it a set of outcomes they want the machine to learn. For instance, if the objective is to build a system that can identify patterns in fraudulent credit card purchases, the system is trained using actual examples of fraudulent transactions. The data set may be composed of a million examples of fraudulent transactions. The data set is divided into two segments: a training data set, and a test data set. The training data set is used to train the system. After millions of test runs, the program hopefully will identify the best path through the data. To verify the accuracy of the system, it is then used on the test data set, which the system has not analyzed before. If successful, the system will be tested on new data sets. The neural network in Figure 11.4 has learned how to identify a likely fraudulent credit card purchase.

Neural network applications in medicine, science, and business address problems in pattern classification, prediction, and control and optimization. In medicine, neural network applications are used for screening patients for coronary artery disease, for diagnosing epilepsy and Alzheimer's disease, and for performing pattern recognition of pathology images, including certain cancers, as described in the chapter-opening case. The financial industry uses neural networks to discern patterns in vast pools of data that might help investment firms predict the performance of equities, corporate bond ratings, or corporate bankruptcies. Visa International uses a neural network to help detect credit card fraud by monitoring all Visa transactions for sudden changes in the buying patterns of cardholders. Table 11.4 provides examples of neural networks, and the Interactive Session on Technology describes how neural networks are used for facial recognition.

INTERACTIVE SESSION TECHNOLOGY

Do You Know Who Is Using Your Face?

Facial recognition is an artificial intelligence application that can uniquely identify a person by analyzing patterns based on the person's facial textures and shape. Facial recognition systems can be used to identify people in photos, video, or real-time. A facial recognition system uses biometrics to map facial features from a photograph or video. It compares the information with a database of known faces to find a match. The face recognition system uses computer algorithms to highlight specific, distinctive details about a person's face, such as the distance between the eyes or the shape of the chin. (Some algorithms explicitly map the face, measuring the distances between the eyes, nose, and mouth and so on. Others map the face using more abstract features.) The system converts these details to a mathematical representation and compares them to data on other faces stored in a face recognition database. The data about a particular face is called a face template, and it can be compared to other templates on file. Facial recognition technology learns how to identify people by analyzing as many digital pictures as possible using neural networks, which are complex mathematical systems that require vast amounts of data to build pattern recognition.

Face recognition tools are now frequently used in routine policing. Police compare mugshots of arrestees to local, state, and federal face recognition databases. Law enforcement can query these mugshot databases to identify people in photos taken from social media, traffic cameras, and closed circuit television surveillance cameras in stores, parks, and other places. There are systems to compare faces in real-time with "hot lists" of people suspected of illegal activity. Face recognition has also been used in airports, border crossings, and events such as the Olympic games. The FBI spent more than a decade using such systems to compare driver's license and visa photos against the faces of suspected criminals.

Facial recognition systems can make products safer and more secure. For example, face authentication can ensure that only the right person gets access to sensitive information meant just for them. It can also be used for social good; there are nonprofits using facial recognition to combat trafficking of minors. However these systems also have limitations that can do harm as well.

Dozens of databases of people's faces are being compiled by companies and researchers, with many

of the images then being shared around the world. The databases are pulled together with images from social networks, photo websites, dating services like OkCupid, and cameras placed in restaurants and on college quads. While there is no precise count of the data sets, privacy activists have pinpointed repositories that were built by Microsoft, Stanford University, and others, with one holding over 10 million images while another had more than two million. Georgetown University has estimated that photos of nearly half of all U.S. adults have been entered into at least one face recognition database.

Tech giants like Facebook and Google are reputed to have amassed the largest facial data sets, which they do not distribute, according to research papers. But other companies and universities have widely shared their image troves with researchers, governments, and private enterprises in Australia, China, India, Singapore, and Switzerland for training artificial intelligence, according to academics, activists, and public papers.

Startup Clearview AI created a powerful facial recognition app that enables the user to take a picture of a person, upload it, and be able to view public photos of that person, along with links to where those photos appeared. The system uses a database of more than three billion images that Clearview claims to have scraped from Facebook, YouTube, Venmo, and millions of other websites. Federal and state law enforcement officers have used the Clearview app to help solve shoplifting, identity theft, credit card fraud, murder, and child sexual exploitation cases.

Companies and labs have gathered facial images for more than a decade, and image databases are an essential component of facial recognition technology. But people often have no idea that their faces are in them. And although names are typically not attached to the photos, individuals can be recognized because each face is unique to a person. There is no oversight of these facial recognition data repositories.

Privacy advocates worry that facial recognition systems are being misused. A database called Brainwash was created by Stanford University researchers in 2014. The researchers captured over 10,000 images using a camera located in San Francisco's Brainwash Café (now closed). It is unclear whether the patrons knew their images were being captured and used for research. The Stanford

researchers shared Brainwash with Chinese academics associated with the National University of Defense Technology and Megvii, an AI company that provided surveillance technology for racial profiling of China's Uighur Muslim population. Brainwash was removed from its original website in mid-2019.

Using eight cameras on campus to collect images, Duke University researchers gathered more than 2 million video frames with images of over 2,700 people. The database, called Duke MTMC, was reported to have been used to train AI systems in the United States, Japan, China, and elsewhere. The cameras were identified with signs, which gave a phone number or email for people to opt out.

Moreover, facial recognition systems are not entirely accurate. Face recognition systems have varying ability to identify people under challenging conditions such as poor lighting, low-quality image resolution, and suboptimal angle of view, which might occur if a photograph was taken from above looking down on an unknown person.

Facial recognition software is poor at identifying African Americans and other ethnic minorities as well as women and young people. A 2012 study co-authored by the FBI reported that accuracy rates were lower for Afro-Americans than for other demographics. Although the FBI claims that its facial recognition system can find the correct candidate in the top 50 profiles 85 percent of the time, that's only when the true candidate exists in its gallery. If the candidate is not in the gallery, the system may still come up with one or more potential matches, creating false positive results. Those identified could then be targeted as suspects for crimes they didn't commit.

Face recognition becomes less accurate as the number of people in the database increases. Many people around the world look alike. As the likelihood of similar faces goes up, matching accuracy goes down.

Sources: "Face Recognition," www.eff.org, accessed April 21, 2020; Kashmir Hill, "The Secretive Company that Might End Privacy as We Know It," *New York Times*, January 18, 2020; Cate Metz, "Facial Recognition Tech Is Growing Stronger, Thanks to Your Face," *New York Times*, July 13, 2019; www.ai.google.com, accessed April 21, 2020.

CASE STUDY QUESTIONS

1. Explain the key technologies used in facial recognition systems.
2. What are the benefits of using facial recognition systems? How do they help organizations improve

operations and decision making? What problems can they help solve?

3. Identify and describe the disadvantages of using facial recognition systems and facial databases.

TABLE 11.4 EXAMPLES OF NEURAL NETWORKS

FUNCTIONALITY	INPUTS	PROCESS	OUTPUTS/APPLICATION
Computer vision	Millions of digital images, videos, or sensors	Recognize patterns in images, and objects	Photo tagging; facial recognition; autonomous vehicles
Speech recognition	Digital soundtracks, voices	Recognize patterns and meaning in soundtracks and speech	Digital assistants, chatbots, help centers
Machine controls, diagnostics	Internet of Things: thousands of sensors	Identify operational status, patterns of failure	Preventive maintenance; quality control
Language translation	Millions of sentences in various languages	Identify patterns in multiple languages	Translate sentences from one language to another
Transaction analysis	Millions of loan applications, stock trades, phone calls	Identify patterns in financial and other transactions	Fraud control; theft of services; stock market predictions
Targeted online ads	Millions of browser histories	Identify clusters of consumers; preferences	Programmatic advertising

"Deep Learning" Neural Networks

"Deep learning" neural networks are more complex, with many layers of transformation of the input data to produce a target output. Collections of neurons are called nodes or layers. Deep learning networks are in their infancy, and are used almost exclusively for pattern detection on unlabeled data where the system is not told what to look for specifically but to simply discover patterns in the data. The system is expected to be self-taught. See Figure 11.5.

For instance, in our earlier example of unsupervised learning involving a machine learning system that could identify cats (The Cat Paper) and other objects without training, the system used was a deep learning network. It consisted of three layers of neural networks (layers 1, 2, and 3). Each of these layers has two levels of pattern detection (levels 1 and 2). Each level was developed to identify a low-level feature of the photos: layer 1 identified lines in the photos, and layer 2 identified circles. The result of the first layer may be blobs and fuzzy edges. Second and third layers refine the images emerging from the first layer, until at the end of the process the system can distinguish cats, dogs, and humans, although in this case not very well, with a 16 percent accuracy rate.

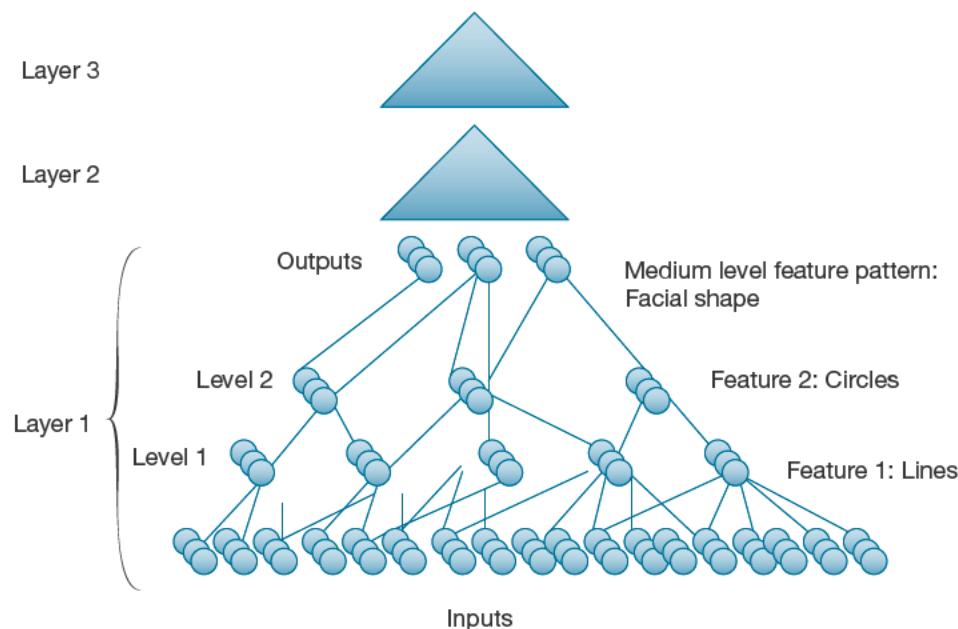
Many pundits believe deep learning networks come closer to the "Grand Vision" of AI where ML systems would be capable of learning like a human being. Others who work in ML and deep learning are more critical (Marcus, 2018; Pearl 2016).

Limitations of Neural Networks and Machine Learning

Neural networks have a number of limitations currently. They require very large data sets to identify patterns. There are often many patterns in large data sets that are nonsensical, and it takes humans to choose which patterns "make sense." Many patterns in large data sets are ephemeral: there may be a pattern in the stock market, or the performance of professional sports teams, but they do not last long. In many important decision situations there are no large data

FIGURE 11.5 A DEEP LEARNING NETWORK

Deep learning networks consist of many layers of neural networks working in a hierarchical fashion to detect patterns. Shown here is an expanded look at layer 1. Other layers have the same structure.



sets. Should you apply to College A or College B? Should we merge with another company? Answers to many important questions are difficult to specify or describe, only semistructured at best, and depend greatly on human assessments, judgments, and sentiments.

Neural networks, machine learning systems, and the people who work with them cannot explain how the system arrived at a particular solution. For instance, in the case of the IBM® Watson™ computer playing Jeopardy, researchers could not say exactly why Watson™ chose the answers it did, only that they were either right or wrong. Most real-world ML applications in business involve classifying digital objects into simple binary categories (yes or no; 0 or 1). But many of the significant problems facing managers, firms, and organizations do not have binary solutions. Neural networks may not perform well if their training covers too little or too much data. AI systems have no sense of ethics: they may recommend actions that are illegal or immoral. In most current applications, AI systems are best used as tools for relatively low-level decisions, aiding, but not substituting for managers.

Genetic Algorithms

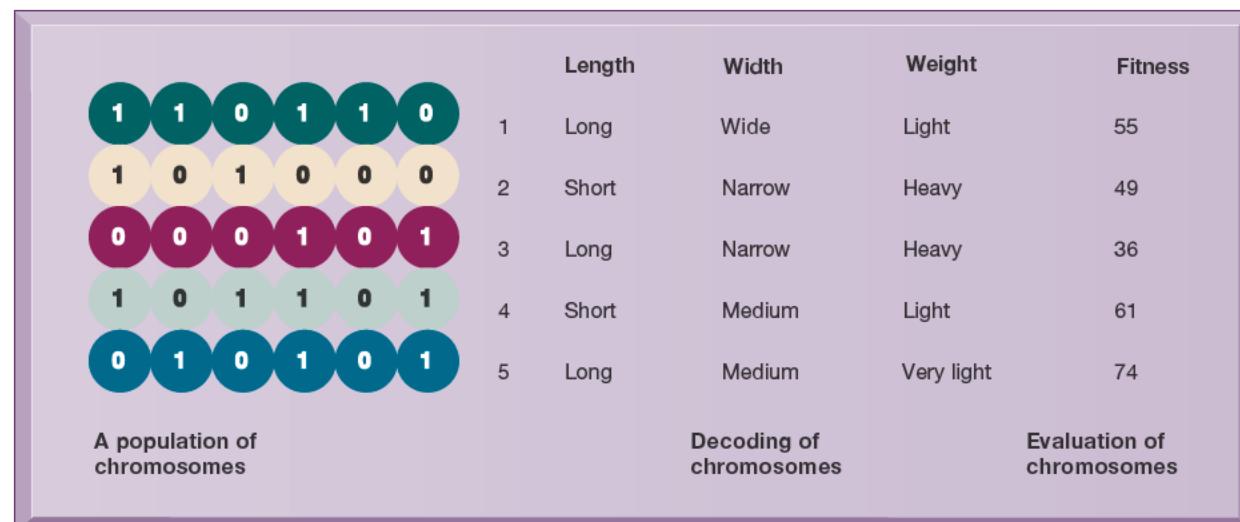
Genetic algorithms are another form of machine learning. Genetic algorithms are useful for finding the optimal solution for a specific problem by examining a very large number of alternative solutions for that problem. Their method of solving problems is based on ideas inspired by evolutionary biology such as inheritance, mutation, selection, and crossover (recombination).

A genetic algorithm works by searching a population of randomly generated strings of binary digits to identify the right string representing the best possible solution for the problem. As solutions alter and combine, the worst ones are discarded and the better ones survive to go on to produce even better solutions.

In Figure 11.6, each string corresponds to one of the variables in the problem. One applies a test for fitness, ranking the strings in the population according to their level of desirability as possible solutions. After the initial population is evaluated for fitness, the algorithm then produces the next generation of

FIGURE 11.6 THE COMPONENTS OF A GENETIC ALGORITHM

This example illustrates an initial population of "chromosomes," each representing a different solution. The genetic algorithm uses an iterative process to refine the initial solutions so that the better ones, those with the higher fitness, are more likely to emerge as the best solution.



strings, consisting of strings that survived the fitness test plus offspring strings produced from mating pairs of strings, and tests their fitness. The process continues until a solution is reached.

Genetic algorithms are used to solve problems that are very dynamic and complex, involving hundreds or thousands of variables or formulas. The problem must be one whose range of possible solutions can be represented genetically and for which criteria can be established for evaluating fitness. Genetic algorithms expedite the solution because they can evaluate many solution alternatives quickly to find the best one. For example, General Electric engineers used genetic algorithms to help optimize the design for jet turbine aircraft engines, in which each design change required changes in up to 100 variables. The supply chain management software from JDA software uses genetic algorithms to optimize production-scheduling models, incorporating hundreds of thousands of details about customer orders, material and resource availability, manufacturing and distribution capability, and delivery dates.

Natural Language Processing, Computer Vision Systems, and Robotics

Other important AI techniques include natural language processing, computer vision systems, and robotics.

Natural Language Processing

Human language is not always precise. It is often ambiguous, and meanings of words can depend on complex variables such as slang, regional dialects, and social context. **Natural language processing (NLP)** makes it possible for a computer to understand and analyze natural language—language that human beings instinctively use, not language specially formatted to be understood by computers. NLP algorithms are typically based on machine learning, including deep learning, which can learn how to identify a speaker's intent from many examples. You can see natural language processing at work in leading search engines such as Google, spam filtering systems, and text mining sentiment analysis (discussed in Chapter 6).

Tokyo-based Mizuho Bank employs advanced speech recognition technology, IBM® Watson™ content analytics software, and a cloud services infrastructure to improve contact center agents' interactions with customers. After converting the customer's speech to textual data, the solution applies natural language processing algorithms based on machine learning analysis of interactions with thousands of customers. The system learns more and more from each customer interaction so that it can eventually infer the customer's specific needs or goals at each point of the conversation. It then formulates the optimal response, which is delivered in real time as a prompt on the agent's screen. By helping contact center agents more efficiently sense and respond to customer needs, this solution reduced the average duration of customer interactions by more than 6 percent (IBM, 2020).

Computer Vision Systems

Computer vision systems deal with how computers can emulate the human visual system to view and extract information from real-world images. Such systems incorporate image processing, pattern recognition, and image understanding. An example is Facebook's facial recognition tool called DeepFace, which is nearly as accurate as the human brain in recognizing a face. DeepFace helps Facebook improve the accuracy of Facebook's existing facial recognition capabilities to ensure

that every photo of a Facebook user is connected to that person's Facebook account. Computer vision systems are also used in autonomous vehicles such as drones and self-driving cars (see the chapter-ending case), industrial machine vision systems (e.g., inspecting bottles), military applications, and robotic tools.

In health care, computer vision technology is being used for tumor evaluations. For instance, Amsterdam University Medical Center (AUMC), one of Europe's largest academic oncology centers, is using SAS Visual Data Mining and Machine Learning tools to increase the speed and accuracy of chemotherapy response assessments. Tumors used to be manually evaluated using computerized tomography (CT) scans after treatment. How a tumor reacts to treatment determines whether lifesaving surgery is possible or if a different chemotherapy regimen is necessary. Prior evaluation methods conducted by humans were limited to what doctors could see. AUMC's new computer vision technology capabilities for automatic segmentation help doctors to quickly identify changes in the shape and size of tumors and note their color. The AI models show total tumor volume and a 3D representation of each tumor, allowing doctors to more accurately determine whether lifesaving surgery is viable or if a different treatment strategy should be chosen (Amsterdam UMC, 2021).

Robotics

Robotics deals with the design, construction, operation, and use of movable machines that can substitute for humans along with computer systems for their control, sensory feedback, and information processing. Robots cannot substitute entirely for people but are programmed to perform a specific series of actions automatically. They are often used in dangerous environments (such as bomb detection and deactivation and recently for delivering medical supplies to coronavirus-contaminated locations), manufacturing processes, military operations (drones), and medical procedures (surgical robots).

The most widespread use of robotic technology has been in manufacturing. For example, automobile assembly lines employ robots to do heavy lifting, welding, applying glue, and painting. People still do most of the final assembly of cars, especially when installing small parts or wiring that needs to be guided into place. A Renault SA plant in Cleon, France, now uses robots from Universal Robots AS of Denmark to drive screws into engines, especially those that go into places people find hard to access. The robots verify that parts are properly fastened and check to make sure the correct part is being used. The Renault robots are also capable of working in proximity to people and slowing down or stopping to avoid hurting them.

Growing use of robotic systems, along with other technologies described in this chapter and this text has kindled widespread fears that automation is taking away people's jobs. The Interactive Session on Organizations explores this topic.

Intelligent Agents

Intelligent agents are software programs that work in the background without direct human intervention to carry out specific tasks for an individual user, business process, or software application. The agent uses a limited built-in or learned knowledge base to accomplish tasks or make decisions on the user's behalf, such as deleting junk email, scheduling appointments, or finding the cheapest airfare to California.

There are many intelligent agent applications today in operating systems, application software, email systems, mobile computing software, and network tools. Of special interest to business are intelligent agent bots that search for information on the Internet. Chapter 7 describes how shopping bots help

INTERACTIVE SESSION ORGANIZATIONS

Will AI Kill Jobs?

Artificial intelligence (AI) is causing a paradigm shift, just as the World Wide Web did before it. A wide range of industries are employing AI to perform a variety of tasks, including customer service, technical support, advertising and medical diagnosis. AI can perform these services efficiently, effectively, and around the clock; it can execute not only routine duties that follow standard procedures but, increasingly, also tasks that require judgment. Some AI-powered applications can even be trained to respond to situations with flexibility.

Supplemented with other technologies, such as big data and cloud computing, AI is expected to be the next big thing that helps enterprises create value and reduce costs. An Edelman Ltd. survey found that 91 percent of tech executives and 84 percent of the general public believe that AI will be at the center of the next technology revolution.

While AI is beneficial to businesses, some worry that the technology threatens job stability. In a survey of 2,092 people by the Swiss Broadcasting Corporation, two-thirds believed that the emergence of AI would impact jobs in the future. Among the respondents, only 9 percent of the farmers and a quarter of senior executives were confident that their jobs would not be affected by AI. In their most conservative simulation, McKinsey & Company forecast that a third of work activities would be replaced by technology by 2030, forcing 3–14 percent of the global workforce, or 75 million to 375 million employees, to change occupations. A recent Deloitte Analytics poll found that as many as 75 percent of the executives surveyed believe that AI will transform their organization within the next three years. In another study conducted in 32 countries, the Organization for Economic Cooperation and Development (OECD) estimated that only about 14 percent of jobs are at high risk (that is, they have more than 70 percent probability) of being automated. That said, the number of job losses forecast by the OECD—around 66 million—is still significant.

However, it may be too early to be pessimistic about the job market in the era of AI. Technological breakthroughs do not necessarily mean job losses. The invention of ATMs did not make bank tellers redundant overnight; we still queue in banks today

to settle certain transactions. Rather than ending the bank tellers' role, ATMs have freed them from monotonous, repetitive errands to focus on useful, dynamic challenges. Therefore, one could argue that AI is eliminating tasks, not jobs. McKinsey & Company estimated that 60 percent of current jobs involve technically automatable activities constituting over 30 percent of the jobs' activities. Moreover, many AI applications are designed to facilitate individuals in doing their jobs rather than replacing them completely. For example, customer service-related AI initiatives are designed to provide the first line of service by answering simple enquiries from customers in the same way that human customer representatives do—but difficult cases still need human intervention. Although some AI applications are smart enough to write news feeds or computer programs, the aim is to free public relation officers and programmers from simple but dull tasks to work on more sophisticated, high-value ones. Human-machine collaboration is expected to generate optimal results.

McKinsey & Company's study of historical data also found that while new waves of technology have indeed killed some jobs on one hand, they have also created new ones on the other. Advancements in technology have resulted in temporary job losses, but in the long term, they have created new openings to be filled by individuals who have equipped themselves with the right skillsets to thrive alongside technological progress. In the Edelman survey, 68 percent of the tech executives and 60 percent of the general population agreed that AI may lead to job losses initially but will produce more jobs eventually. McKinsey & Company posits that AI will generate 50 million jobs by 2030, creating vacancies we cannot yet foresee.

The OECD and McKinsey & Company note that the number of jobs affected by AI will vary by country and by industry. Those who work in farms or factories are at high risk, but some positions in the service sector may also be replaced by AI. These jobs require a relatively low level of education; the higher the level of education required for an occupation, the more secure it is against the threat of AI substitutes. McKinsey & Company has estimated

that if there is rapid adoption of automation, up to 375 million workers globally (approximately 14 percent of the global workforce) may have to change occupations and adopt new skills. The studies by the OECD and McKinsey & Company have both found that appropriate training will help workers switch to other career paths. However, not all workers are lucky enough to get the necessary training, and even if they do, they may not earn the same wage after changing jobs.

The OECD study also found a U-shape relationship between automation and age, with the age group of 30-to-35-year-olds surprisingly being the most likely to lose a job due to AI, rather than those in the older generation. Fortunately, young people are usually better at keeping up with technological progress than their senior counterparts. After six decades of IT-driven automation, which early on was predicted by "experts" to lead to massive unemployment, the most interesting question is, why did employment

and jobs expand so rapidly despite intensive application of IT?

Sources: Beena Ammanath, David Jarvis, and Susanne Hupfer, "Thriving in the Era of Pervasive AI: Deloitte's State of AI in the Enterprise," 3rd edition, www2.deloitte.com, July 14, 2020; Gil Press, "Is AI Going to Be A Jobs Killer? New Reports about the Future of Work," *Forbes*, July 15, 2019; Edelman, "2019 Edelman AI Survey Results Report," www.edelman.com, March 2019; Dun & Bradstreet, "Artificial Intelligence Is Creating Jobs, Dun & Bradstreet Survey Finds," www.prnewswire.com. January 8, 2019; "Two-Thirds of Swiss See Artificial Intelligence as Job Threat," SWI, www.swissinfo.ch, November 21, 2018; Mark Knickrehm, H. James Wilson and Paul R. Daugherty, "Collaborative Intelligence: Humans and AI Are Joining Forces," *Harvard Business Review*, July-August 2018, pp. 114-123; "How Will AI Change Work? Here Are 5 Schools of Thought," *Harvard Business Review*, January 24, 2018; Ljubica Nedelkoska and Glenda Quintini, "Automation, Skills Use and Training," *OECD Social, Employment and Migration Working Papers*, No. 202, OECD Publishing, Paris (2018); McKinsey & Company, *Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation*, 2017.

CASE STUDY QUESTIONS

1. What are the various views on the impact of AI on jobs? What do you think will happen in your country?
2. Some people think that AI does not kill jobs but transforms business models. Do you agree? Why or why not?
3. How would AI potentially add more jobs than it eliminates?

Case contributed by Joyce Chan, City University of Hong Kong

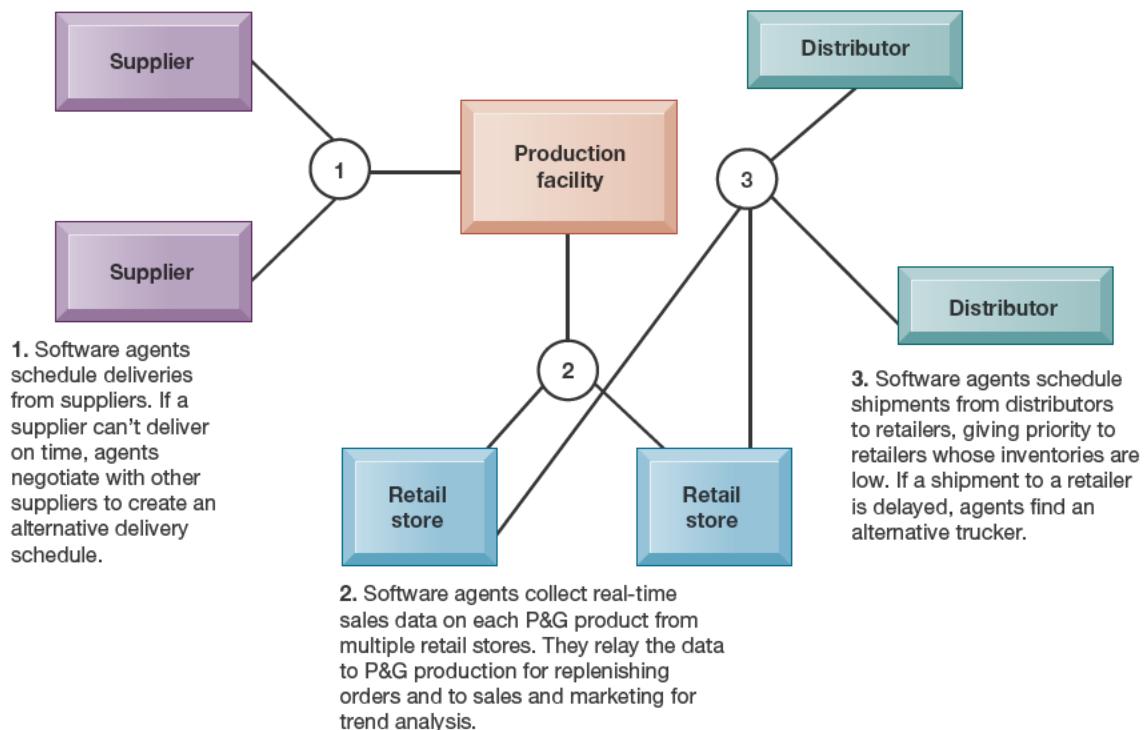
consumers find products they want and assist them in comparing prices and other features.

Although some software agents are programmed to follow a simple set of rules, others are capable of learning from experience and adjusting their behavior using machine learning and natural language processing. Siri, a virtual assistant application on Apple's iPhone and iPad, is an example. Siri uses natural language processing to answer questions, make recommendations, and perform actions. The software adapts to the user's individual preferences over time and personalizes results, performing tasks such as getting directions, scheduling appointments, and sending messages. Similar products include Microsoft's Cortana and Amazon's Alexa.

Chatbots (chatterbots) are software agents designed to simulate a conversation with one or more human users via textual or auditory methods. They try to understand what you type or say and respond by answering questions or executing tasks. They provide automated conversations that allow users to do things like check the weather, manage personal finances, shop online, and receive help when they have questions for customer service. For example, UK package delivery firm Hermes created a chatbot called Holly to help its call center handle customer service inquiries. The chatbot helps customers track shipments, change delivery orders, update account preferences, and handle other essential tasks quickly (Baum, 2019). Facebook has integrated chatbots into its Messenger messaging app so that an outside company with a Facebook brand page can interact

FIGURE 11.7 INTELLIGENT AGENTS IN P&G'S SUPPLY CHAIN NETWORK

Intelligent agents are helping Procter & Gamble shorten the replenishment cycles for products such as a box of Tide.



with Facebook users through the chat program. Today's chatbots perform very basic functions. As chatbots become more technologically advanced, people will increasingly use these "conversational agents" for interacting with IT systems.

Procter & Gamble (P&G) used intelligent agent technology to make its supply chain more efficient (see Figure 11.7). It modeled a complex supply chain as a group of semiautonomous agents representing individual supply chain components such as trucks, production facilities, distributors, and retail stores. The behavior of each agent is programmed to follow rules that mimic actual behavior, such as "order an item when it is out of stock." Simulations using the agents enable the company to perform what-if analyses on inventory levels, in-store stockouts, and transportation costs.

Using intelligent agent models, P&G discovered that trucks should often be dispatched before being fully loaded. Although transportation costs would be higher using partially loaded trucks, the simulation showed that retail store stockouts would occur less often, thus reducing the number of lost sales, which would more than make up for the higher distribution costs. Agent-based modeling has saved P&G \$300 million annually on an investment of less than 1 percent of that amount.

11-3 What types of systems are used for enterprise-wide knowledge management, and how do they provide value for businesses?

Firms must deal with at least three kinds of knowledge. Some knowledge exists within the firm in the form of structured text documents (reports and presentations). Decision makers also need knowledge that is semistructured, such as email, voice mail, chat room exchanges, videos, digital pictures, brochures, or

bulletin board postings. In still other cases, there is no formal or digital information of any kind, and the knowledge resides in the heads of employees. Much of this knowledge is tacit knowledge that is rarely written down. Enterprise-wide knowledge management systems deal with all three types of knowledge.

Enterprise Content Management Systems

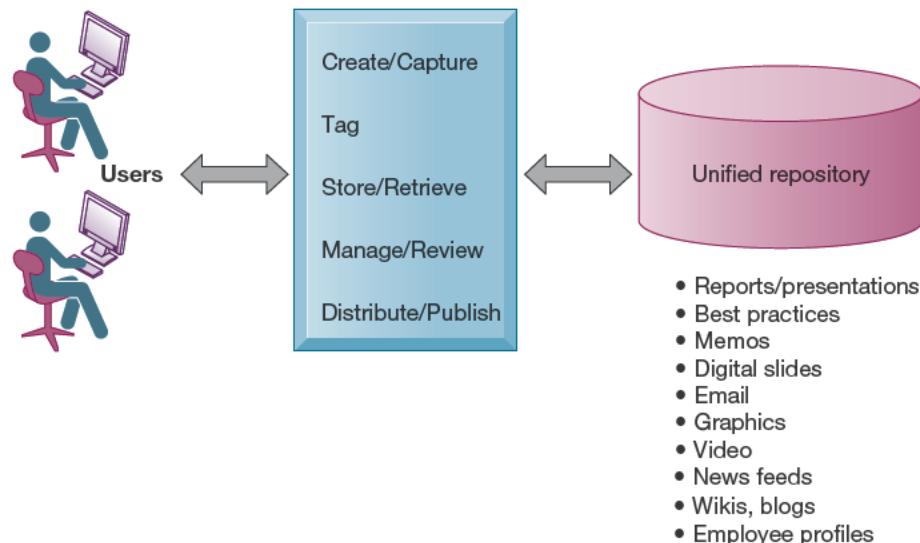
Businesses today need to organize and manage both structured and semistructured knowledge assets. **Structured knowledge** is explicit knowledge that exists in formal documents as well as in formal rules that organizations derive by observing experts and their decision-making behaviors. But according to experts, at least 80 percent of an organization's business content is semistructured or unstructured—information in folders, messages, memos, proposals, emails, graphics, electronic slide presentations, and even videos created in different formats and stored in many locations.

Enterprise content management (ECM) systems help organizations manage both types of information. They have capabilities for knowledge capture, storage, retrieval, distribution, and preservation to help firms improve their business processes and decisions. Such systems include corporate repositories of documents, reports, presentations, and best practices, as well as capabilities for collecting and organizing semistructured knowledge such as email (see Figure 11.8). Major enterprise content management systems also enable users to access external sources of information, such as news feeds and research, and to communicate via email, chat/instant messaging, discussion groups, and videoconferencing. They are starting to incorporate blogs, wikis, and other enterprise social networking tools. Open Text Corporation, IBM, and Oracle are leading vendors of enterprise content management software.

A key problem in managing knowledge is the creation of an appropriate classification scheme, or **taxonomy**, to organize information into meaningful

FIGURE 11.8 AN ENTERPRISE CONTENT MANAGEMENT SYSTEM

An enterprise content management system has capabilities for classifying, organizing, and managing structured and semistructured knowledge and making it available throughout the enterprise.



categories so that it can be easily accessed. Once the categories for classifying knowledge have been created, each knowledge object needs to be “tagged,” or classified, so that it can be easily retrieved. Enterprise content management systems have capabilities for tagging, interfacing with corporate databases and content repositories, and creating enterprise knowledge portals that provide a single point of access to information resources.

Firms may also have special needs for storing and managing unstructured digital data such as photographs, graphic images, video, and audio content. For example, Coca-Cola must keep track of all the images of the Coca-Cola brand that have been created in the past at all of the company's worldwide offices to prevent both redundant work and variation from a standard brand image. **Digital asset management systems** help companies classify, store, and distribute these digital objects.

Locating and Sharing Expertise

Some of the knowledge businesses need is not in the form of a digital document but instead resides in the memory of individual experts in the firm. Contemporary enterprise content management systems, along with the systems for collaboration and social business introduced in Chapter 2, have capabilities for locating experts and tapping their knowledge. These include online directories of corporate experts and their profiles with details about their job experience, projects, publications, and educational degrees, and repositories of expert-generated content. Specialized search tools make it easier for employees to find the appropriate expert in a company. For knowledge resources outside the firm, social networking and social business tools enable users to bookmark web pages of interest, tag these bookmarks with keywords, and share the tags and web page links with other people.

Learning Management Systems

Companies need ways to keep track of and manage employee learning and to integrate it more fully into their knowledge management and other corporate systems. A **learning management system (LMS)** provides tools for the management, delivery, tracking, and assessment of various types of employee learning and training. Contemporary LMS support multiple modes of learning, including downloadable videos, web-based classes, live instruction in classes or online, and group learning in online forums and chat sessions. The LMS consolidates mixed-media training, automates the selection and administration of courses, assembles and delivers learning content, and measures learning effectiveness.

Businesses run their own LMS, but they are also turning to publicly available **massive open online courses (MOOCs)** to educate their employees. A MOOC is an online course made available via the web to very large numbers of participants and enables learners to collaborate with each other, watch videos, and participate in threaded discussion groups. Firms such as Microsoft, AT&T, and Tenaris have developed their own MOOCs, while others such as Bank of America and Qualcomm are adapting publicly available MOOCs aligned with their core competencies. While in the future, MOOCs are expected to play a larger role in corporate training, in Europe they are currently primarily focused on expanding access to university courses. Europe has one of the highest concentrations of students in the world taking MOOC courses (EADTU, 2018).

11-4 What are the major types of knowledge work systems, and how do they provide value for firms?

The enterprise-wide knowledge systems we have just described provide a wide range of capabilities that can be used by many if not all the workers and groups in an organization. Firms also have specialized systems for knowledge workers to help them create new knowledge and to ensure that this knowledge is properly integrated into the business.

Knowledge Workers and Knowledge Work

Knowledge workers, which we introduced in Chapter 1, include researchers, designers, architects, scientists, and engineers who primarily create knowledge and information for the organization. Knowledge workers usually have high levels of education and memberships in professional organizations and are often asked to exercise independent judgment as a routine aspect of their work. For example, knowledge workers create new products or find ways of improving existing ones. Knowledge workers perform key roles that are critical to the organization and to the managers who work within the organization.

Requirements of Knowledge Work Systems

Most knowledge workers rely on systems such as word processors, email, videoconferencing, collaboration, and scheduling systems, which are designed to increase worker productivity in the office. However, knowledge workers also require highly specialized knowledge work systems with powerful graphics, analytical tools, and communications and document management capabilities.

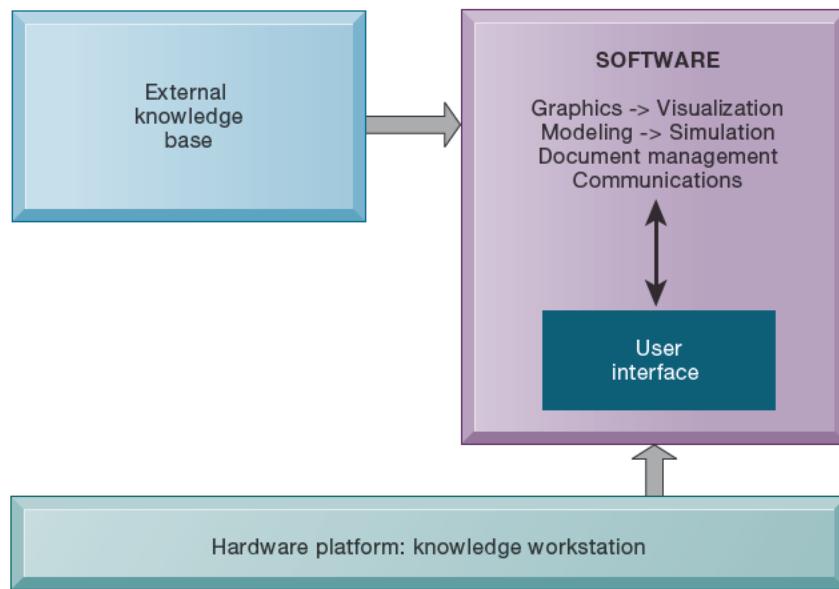
These systems require sufficient computing power to handle the sophisticated graphics or complex calculations necessary for such knowledge workers as scientific researchers, engineers, and product designers. Because knowledge workers need knowledge from the external world, these systems also must give the worker quick and easy access to external databases. They typically feature user-friendly interfaces that enable users to perform needed tasks without having to spend a great deal of time learning how to use the system. Knowledge workers are highly paid—wasting a knowledge worker's time is simply too expensive. Figure 11.9 summarizes the requirements of knowledge work systems.

Examples of Knowledge Work Systems

Major knowledge work applications include CAD systems and virtual reality systems for simulation and modeling. **Computer-aided design (CAD)** automates the creation and revision of designs, using computers and sophisticated graphics software. Using a more traditional physical design methodology, each design modification requires a mold to be made and a prototype to be tested physically. That process must be repeated many times, which is very expensive and time-consuming. Using a CAD workstation, the designer need only make a physical prototype toward the end of the design process because the design can be easily tested and changed on the computer. The ability of CAD software to provide design specifications for the tooling and manufacturing processes also saves a great deal of time and money while producing a manufacturing process with far fewer problems.

FIGURE 11.9 REQUIREMENTS OF KNOWLEDGE WORK SYSTEMS

Knowledge work systems require strong links to external knowledge bases in addition to specialized hardware and software.



For example, Ford Motor Company used a computer simulation to create an engine cylinder to come up with the most efficient design possible. Engineers altered that design to account for manufacturing constraints and tested the revised design virtually in models that used decades of data on material properties and engine performance. Ford then created the mold to make a real part that could be bolted onto an engine for further testing. The entire process took days instead of months and cost thousands of dollars instead of millions.

CAD systems can supply data for **3-D printing**, also known as additive manufacturing, which uses machines to make solid objects, layer by layer, from specifications in a digital file. Unlike traditional techniques, by which objects are cut or drilled from molds, resulting in wasted materials, 3-D printing lets workers model an object on a computer and print it out with plastic, metal, or composite materials. 3-D printing is currently used for prototyping, custom manufacturing, and fashioning items with small production runs. Today's 3-D printers can handle materials including plastic, titanium, and human cartilage and produce fully functional components including batteries, transistors, prosthetic devices, LEDs, and other complex mechanisms, and there are now 3-D printing services that run over the cloud.

Virtual reality (VR) systems have visualization, rendering, and simulation capabilities that go far beyond those of conventional CAD systems. They use interactive graphics software to create computer-generated simulations that are so close to reality that users almost believe they are participating in a real-world situation. In many virtual reality systems, the user dons special clothing, headgear, and equipment, depending on the application. The clothing contains sensors that record the user's movements and immediately transmit that information back to the computer. For instance, to walk through a virtual reality simulation of a house, you would need garb that monitors the movement of your feet, hands, and head. You also would need goggles containing video screens and sometimes audio attachments and feeling gloves so that you can be immersed in the computer feedback.

Volkswagen Group has been experimenting with virtual reality to speed up vehicle design and development and to identify potentially costly design problems earlier in the development cycle. Volkswagen has been able to cut out costly physical prototypes and replace them with immersive, 360-degree views of digitally constructed interior and exterior components of a vehicle using virtual reality HTC Vive headsets. Virtual components of a car, including interior and exterior parts such as buttons, lights, or consoles, can be switched out and replaced easily with a few lines of software code during the design process.

Augmented reality (AR) is a related technology for enhancing visualization by overlaying digital data and images onto a physical real-world environment. The digital technology provides additional information to enhance the perception of reality, making the surrounding real world of the user more interactive and meaningful. The yellow first-down markers shown on televised football games are examples of augmented reality as are medical procedures like image-guided surgery, where data acquired from computerized tomography (CT) and magnetic resonance imaging (MRI) scans or from ultrasound imaging are superimposed on the patient in the operating room. Other industries where AR has caught on include military training, engineering design, robotics, and consumer design. For example, Newport News Shipbuilding, which designs and builds U.S. Navy aircraft carriers, uses AR to inspect a ship near the end of the manufacturing process. By seeing the final design superimposed on the ship, engineers have reduced inspection time by 96 percent—from 36 hours to only 90 minutes (Porter and Heppelmann, 2017).



11-5 How will MIS help my career?

Here is how Chapter 11 and this book will help you find an entry-level job as a sales assistant for an AI company.

The Company

RMD Technology, an artificial intelligence company based in Stockholm, Sweden, is looking for an entry-level sales assistant. RazzleDazzle specializes in computer vision technology, seeking to unlock the value of visual content produced daily across diverse data sets to solve problems for a variety of industries, including advertising and professional sports.

Position Description

The sales assistant will work closely with the sales team on planning and staging events, database management, administrative tasks, and account research to support sales and marketing objectives. Job responsibilities include:

- Using Salesforce.com for lead generation collection, data entry, and maintenance
- Using Excel to update sales team resources
- Scheduling meetings and taking meeting notes
- Assisting with research on sales accounts and new event ideas and locations
- Assisting sales with client meeting preparation
- Assembling promotional materials

Job Requirements

- Recent college graduate.
- Bachelor's degree in marketing, MIS, finance, or liberal arts.
- Strong interest in learning the business and industry.
- Knowledge of Microsoft Office essential.
- Attention to detail, effective communication skills, enthusiastic attitude, and the ability to thrive in a fast-paced environment.

Interview Questions

- What do you know about our company and about computer vision systems? Have you ever done any work with AI technology?
- Have you ever worked with Salesforce.com? How have you used the software?
- What is your proficiency level with Microsoft Office tools? What work have you done with Excel spreadsheets?
- Can you provide samples of your writing to demonstrate your communication skills and sense of detail?

Author Tips

- Review the section of this chapter on AI and use the web to find out more about computer vision systems.
- Use the web and LinkedIn to find out more about this company, its products, services, and competitors, and the way it operates. Think about what it needs to support its sales team and how you could specifically contribute.
- Learn what you can about Salesforce.com, with attention to how it handles lead generation, data entry, and maintenance.
- Inquire exactly how you would be using Excel in this job. Describe some of the Excel work you have done and perhaps bring samples with you to the interview.

REVIEW SUMMARY

11-1 What is the role of knowledge management systems in business?

Knowledge management is a set of processes to create, store, transfer, and apply knowledge in the organization. Much of a firm's value depends on its ability to create and manage knowledge. Knowledge management promotes organizational learning by increasing the ability of the organization to learn from its environment and to incorporate knowledge into its business processes. There are three major types of knowledge management systems: enterprise-wide knowledge management systems, knowledge work systems, and "intelligent" techniques.

11-2 What are artificial intelligence (AI) and machine learning? How do businesses use AI?

AI involves the attempt to build computer systems that try to think and act like humans. At present, artificial intelligence lacks the flexibility, breadth, and generality of human intelligence, but it can be used to capture, codify, and extend organizational knowledge.

Expert systems capture tacit knowledge from a limited domain of human expertise and express that knowledge in the form of rules. Machine learning software can learn from previous data and examples. It can identify patterns in very large databases without explicit programming, although with significant human training.

Neural networks consist of hardware and software that attempt to mimic the thought processes of the human brain. Neural networks are notable for their ability to learn on their own with some training, and to recognize patterns that cannot be easily identified by humans. Deep learning neural networks use multiple layers of neural networks to reveal the underlying patterns in data, and in some limited cases identify patterns without human training.

Genetic algorithms develop solutions to particular problems using genetically based processes such as fitness, crossover, and mutation. Genetic algorithms are useful for solving problems involving optimization where many alternatives or variables must be evaluated to generate an optimal solution.

Intelligent agents are software programs with built-in or learned knowledge bases that carry out specific tasks for an individual user, business process, or software application. Intelligent agents can be programmed to navigate through large amounts of data to locate useful information and in some cases act on that information on behalf of the user. Chatbots are software agents designed to simulate a conversation with one or more human users via textual or auditory methods.

Natural language processing technology makes it possible for a machine to understand human language and to process that information. Computer vision systems deal with how computers can view and extract information from real-world images. Robotics deals with the design, construction, operation, and use of movable machines that can substitute for some human actions.

11-3 What types of systems are used for enterprise-wide knowledge management, and how do they provide value for businesses?

Enterprise-wide knowledge management systems are firmwide efforts to collect, store, distribute, and apply digital content and knowledge. Enterprise content management systems provide databases and tools for organizing and storing structured documents and tools for organizing and storing semistructured knowledge, such as email or rich media. Often these systems include group collaboration tools, portals to simplify information access, search tools, tools for locating experts, and tools for classifying information based on a taxonomy that is appropriate for the organization. Learning management systems provide tools for the management, delivery, tracking, and assessment of various types of employee learning and training.

11-4 What are the major types of knowledge work systems, and how do they provide value for firms?

Knowledge work systems (KWS) support the creation of new knowledge and its integration into the organization. KWS require easy access to an external knowledge base; powerful computer hardware that can support software with intensive graphics, analysis, document management, and communications capabilities; and a user-friendly interface. KWS include computer-aided design (CAD) systems, augmented reality applications, and virtual reality systems, which create interactive simulations that behave like the real world, with intensive graphics and powerful modeling capabilities.

Key Terms

- 3-D printing*, 475
Artificial intelligence (AI), 456
Augmented reality (AR), 476
Chatbot, 470
Communities of practice (COPs), 455
Computer-aided design (CAD), 474
Computer vision systems, 467
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“Deep learning”, 465
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Wisdom, 452

MyLab MIS

To complete the problems with the MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

- 11-1 What is the role of knowledge management systems in business?**
- Identify the key differences between tacit and explicit knowledge.
 - Describe the process of organizational learning.
 - How can an organization store the knowledge that they have created or acquired?
 - Identify the type of workers that would value knowledge work systems.
- 11-2 What are artificial intelligence (AI) and machine learning? How do businesses use AI?**
- Define artificial intelligence (AI) and the major AI techniques.
 - Define an expert system, describe how it works, and explain its value to business.
 - Define machine learning, explain how it works, and give some examples of the kinds of problems it can solve.
 - Define neural networks and deep learning neural networks, describing how they work and how they benefit organizations.
 - Define and describe genetic algorithms and intelligent agents. Explain how each works and the kinds of problems for which each is suited.
- 11-3 What types of systems are used for enterprise-wide knowledge management, and how do they provide value for businesses?**
- Define and describe the various types of enterprise-wide knowledge management systems and explain how they provide value for businesses.
 - Describe the role of the following in facilitating knowledge management: taxonomies, MOOCs, and learning management systems.
- 11-4 What are the major types of knowledge work systems, and how do they provide value for firms?**
- List and describe the three key roles performed by knowledge workers that are crucial to an organization.
 - Explain why it is imperative that knowledge workers have immediate access to the external world.

Discussion Questions

- 11-5** Knowledge management is a business process, not a technology. Discuss.
MyLab MIS
- 11-6** Describe various ways that knowledge management systems could help firms with sales and marketing or with manufacturing and production.
MyLab MIS
- 11-7** Compare artificial intelligence to human intelligence. How “intelligent” is artificial intelligence today?
MyLab MIS

Hands-On MIS Projects

The projects in this section give you hands-on experience designing a knowledge portal, identifying opportunities for knowledge management, creating a simple expert system, and using intelligent agents to research products for sale on the web. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 11-8** U.S. Pharma Corporation is headquartered in New Jersey but has research sites in Germany, France, the United Kingdom, Switzerland, and Australia. Research and development of new pharmaceuticals is key to ongoing profits, and U.S. Pharma researches and tests thousands of possible drugs. The company's researchers need to share information with others within and outside the company, including the U.S. Food and Drug Administration, the World Health Organization, and the International Federation of Pharmaceutical Manufacturers & Associations. Also critical is access to health information sites, such as the U.S. National Library of Medicine, and to industry conferences and professional journals. Design a knowledge portal for U.S. Pharma's researchers. Include in your design specifications relevant internal systems and databases, external sources of information, and internal and external communication and collaboration tools. Design a home page for your portal.
- 11-9** Canadian Tire is one of Canada's largest companies, with 58,000 employees and 1,686 stores and gas bars (gas stations) across Canada selling sports, leisure, home products, apparel, and financial services as well as automotive and petroleum products. The retail outlets are independently owned and operated. Canadian Tire has been using daily mailings and thick product catalogs to inform its dealers about new products, merchandise setups, best practices, product ordering, and problem resolution, and it is looking for a better way to provide employees with human resources and administrative documents. Describe the problems created by this way of doing business and how knowledge management systems might help.

Improving Decision Making: Building a Simple Expert System for Retirement Planning

Software skills: Spreadsheet formulas and IF function or expert system tool

Business skills: Benefits eligibility determination

- 11-10** Expert systems typically use a large number of rules. This project has been simplified to reduce the number of rules, but it will give you experience working with a series of rules to develop an application. When employees at your company retire, they are given cash bonuses. These cash bonuses are based on the length of employment and the retiree's age. To receive a bonus, an employee must be at least 50 years of age and have worked for the company for at least five years. The following table summarizes the criteria for determining bonuses.

LENGTH OF EMPLOYMENT	BONUS
<5 years	No bonus
5–10 years	20 percent of current annual salary
11–15 years	30 percent of current annual salary
16–20 years	40 percent of current annual salary
21–25 years	50 percent of current annual salary
26 or more years	100 percent of current annual salary

Using the information provided, build a simple expert system. Find a demonstration copy of an expert system software tool on the web that you can download. Alternatively, use your spreadsheet software to build the expert system. (If you are using spreadsheet software, we suggest using the IF function so you can see how rules are created.)

Improving Decision Making: Using Intelligent Agents for Comparison Shopping

Software skills: Web browser and shopping bot software

Business skills: Product evaluation and selection

- 11-11** This project will give you experience using shopping bots to search online for products, find product information, and find the best prices and vendors. Select a digital camera you might want to purchase, such as the Canon PowerShot SX540-HS or the Olympus Tough TG-6. Visit MySimon, Bizrate, and Google Shopping to do price comparisons for you. Evaluate these shopping sites in terms of their ease of use, number of offerings, speed in obtaining information, thoroughness of information offered about the product and seller, and price selection. Which site or sites would you use, and why? Which camera would you select, and why? How helpful were these sites for making your decision?

Collaboration and Teamwork Project

Rating Enterprise Content Management Systems

- 11-12** With a group of classmates, select two enterprise content management (ECM) products, such as those from Oracle, OpenText, and IBM. Compare their features and capabilities. To prepare your analysis, use articles from computer magazines and the websites of the ECM software vendors. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Are Self-Driving Cars Ready for the Road?

CASE STUDY

Will cars really be able to drive themselves without human operators? Should they? And are they good business investments? Everyone is searching for answers.

Autonomous vehicle technology has reached a point where no automaker can ignore it. Every major auto maker is racing to develop and perfect autonomous vehicles, believing that the market for them could one day reach trillions of dollars. Companies such as Ford, General Motors, Nissan, Mercedes, Tesla, and others have invested billions in autonomous technology research and development. GM bought a self-driving car startup called Cruise. Ride-hailing companies like Uber and Lyft believe driverless cars that eliminate labor costs are key to their long-term profitability. (A study conducted by UBS shows that the cost per mile of a self-driving “robo-taxi” will be about 80 percent less than that of a traditional taxi.) Cars that drive themselves have been on the road in select locations in California, Arizona, Michigan, Paris, London, Singapore, and Beijing. Marketing firm ABI predicts that roughly 8 million vehicles with some level of self-driving capabilities will be shipped in 2025. In December 2018, Waymo, a subsidiary of Google Alphabet, launched a commercial self-driving taxi service called “Waymo One” in the Phoenix metropolitan area.

A car that is supposed to take over driving from a human requires a powerful computer system that must process and analyze large amounts of data generated by myriad sensors, cameras, and other devices to control and adjust steering, accelerating, and braking in response to real-time conditions. Key technologies include:

Sensors: Self-driving cars are loaded with sensors of many different types. Sensors on car wheels measure the car’s velocity as it drives and moves through traffic. Ultrasonic sensors measure and track positions of line curbs, sidewalks, and objects close to the car.

Cameras: Cameras are needed for spotting things like lane lines on the highway, speed signs, and traffic lights. Windshield-mounted cameras create a 3-D image of the road ahead. Cameras behind the rearview mirror focus on lane markings. Infrared cameras pick up infrared beams emitted from headlamps to extend vision for night driving.

Lidars: Lidars are light detection and ranging devices that sit on top of most self-driving cars. A lidar fires out millions of laser beams every second, measuring how long they take to bounce back. The lidar takes in a 360-degree view of a car’s surroundings, identifying nearby objects with an accuracy up to 2 centimeters. Lidars are very expensive and not yet robust enough for a life of potholes, extreme temperatures, rain, or snow.

GPS: A global positioning system (GPS) pinpoints the car’s macro location, and is accurate to within 1.9 meters. Combined with reading from tachometers, gyroscopes, and altimeters, it provides initial positioning.

Radar: Radar bounces radio waves off objects to help see a car’s surroundings, including blind spots, and is especially helpful for spotting big metallic objects, such as other vehicles.

Computer: All the data generated by these technologies needs to be combined, analyzed, and turned into a robot-friendly picture of the world, with instructions on how to move through it, requiring almost supercomputer-like processing power. Its software features obstacle avoidance algorithms, predictive modeling, and “smart” object discrimination (for example, knowing the difference between a bicycle and a motorcycle) to help the vehicle follow traffic rules and navigate obstacles.

Machine Learning, Deep Learning, and Computer Vision Technology: The car’s computer system has to be “trained” using machine intelligence and deep learning to do things like detect lane lines and identify cyclists, by showing it millions of examples of the subject at hand. Because the world is too complex to write a rule for every possible scenario, cars must be able to “learn” from experience and figure out how to navigate on their own.

Maps: Before an autonomous car takes to the streets, its developers use cameras and lidars to map its territory in extreme detail. That information helps the car verify its sensor readings, and it is key for any vehicle to know its own location. Self-driving car companies are notorious for overhyping their progress. Should we believe them? At this point, the outlook for them is clouded.

In March 2018, a self-driving Uber Volvo XC90 operating in autonomous mode struck and killed a woman in Tempe, Arizona. Uber suspended autonomous vehicle testing for a period of time. Even before the accident, Uber's self-driving cars were having trouble driving through construction zones and next to tall vehicles like big truck rigs. Uber's drivers had to intervene far more frequently than drivers in other autonomous car projects.

The Uber accident raised questions about whether autonomous vehicles were even ready to be tested on public roads and how regulators should deal with this. Autonomous vehicle technology's defenders pointed out that nearly 40,000 people die on U.S. roads every year, and human error causes more than 90 percent of crashes. But no matter how quickly self-driving proliferates, it will be a long time before the robots can put a serious dent in those numbers and convince everyday folks that they're better off letting the cars do the driving. Uber has revised its approach to autonomous driving and plans to launch its self-driving cars in pockets of cities where weather, demand, and other conditions are most favorable. While proponents of self-driving cars like Tesla's Elon Musk envision a self-driving world where almost all traffic accidents would be eliminated, and older adults and those with disabilities could travel freely, most Americans think otherwise. A Pew Research Center survey found that most people did not want to ride in self-driving cars and were unsure if they would make roads more dangerous or safer. Eighty-seven percent wanted a person always behind the wheel, ready to take over if something went wrong.

There's still plenty that needs to be improved before self-driving vehicles could safely take to the road. Autonomous vehicles are not yet able to operate safely in all weather conditions. Heavy rain or snow can confuse current car radar and lidar systems—autonomous vehicles can't operate on their own in such weather conditions. These vehicles also have trouble when tree branches hang too low or bridges and roads have faint lane markings. On some roads, self-driving vehicles will have to make guidance decisions without the benefit of white lines or clear demarcations at the edge of the road, including Botts' Dots (small plastic markers that define lanes). Botts' Dots are not believed to be effective lane-marking for autonomous vehicles.

Computer vision systems are able to reliably recognize objects. What remains challenging is "scene understanding"—for example, the ability to determine

whether a bag on the road is empty or is hiding bricks or heavy objects inside. Although autonomous vehicle vision systems are now capable of picking out traffic lights reliably, they are not always able to make correct decisions if traffic lights are not working. This requires experience, intuition, and knowing how to cooperate among multiple vehicles. Autonomous vehicles must also be able to recognize a person moving alongside a road, determine whether that person is riding a bicycle, and predict how that person is likely to respond and behave. All of that is still difficult for an autonomous vehicle to do right now. Chaotic environments such as congested streets teeming with cars, pedestrians, and cyclists are especially difficult for self-driving cars to navigate.

Driving a car to merge into rapidly flowing lanes of traffic is an intricate task that often requires eye contact with oncoming drivers. How can autonomous vehicles communicate with humans and other machines to let them know what they want to do? Researchers are investigating whether electronic signs and car-to-car communication systems would solve this problem. There's also what's called the "trolley problem": In a situation where a crash is unavoidable, how does a robot car decide whom or what to hit? Should it hit the car coming up on its left or a tree on the side of the road?

Less advanced versions of autonomous vehicle technology are already on the market. No current production car in the United States can drive while you sleep, read, or tweet, but many systems can maintain following distance with the vehicle ahead or keep your car centered in its lane, even down to a stop in bumper-to-bumper traffic. In some cases these systems allow the "driver" behind the wheel to take hands off the wheel, provided that person keeps paying attention and is ready to take control if needed.

These less-advanced systems can't see things like stopped fire trucks or traffic lights. But humans haven't made good driving backups because their attention tends to wander. At least two Tesla drivers in the United States have died using the system. (One hit a truck in 2016, another hit a highway barrier in 2018.) There is what is called a "handoff problem." A semiautonomous car needs to be able to determine what its human "driver" is doing and how to get that person to take the wheel when needed.

And let's not forget security. A self-driving car is essentially a collection of networked computers and sensors linked wirelessly to the outside world, and it is no more secure than other networked systems. Keeping

systems safe from intruders who want to crash or weaponize cars may prove to be the greatest challenge confronting autonomous vehicles in the future.

A computer-driven car that can handle any situation as well as a human under all conditions is decades away at best. Researchers at Cleveland State University estimate that only 10 to 30 percent of all vehicles will be fully self-driving by 2030. PwC analysts estimate that 12 percent of all vehicles will be fully autonomous by then, but they will only work in geographically constrained areas under good weather conditions, as does Waymo's fleet of self-driving vans in Phoenix. Truly autonomous cars are still science fiction.

What is more likely is that self-driving technology will be incorporated into human-driven cars. Current auto models are being equipped with technologies such as advanced object recognition, radar-and-laser detection, some capability to take control of driving if the driver has made a mistake, and ultradetailed highway maps that were originally developed for self-driving vehicles. By 2022, nearly all new vehicles in the United States will have automatic emergency braking, which reduces rear-end crashes by 50 percent and crashes with injuries by 56 percent. Once emergency braking technology has been fully deployed, it could reduce fatalities and injuries from rear-end crashes by 80 percent. Human-driven vehicles with some level of self-driving technology will become safer at a rate that completely autonomous vehicles may have trouble matching. This makes the need for fully self-driving cars less compelling.

Many analysts expect the first deployment of self-driving technology will be robot taxi services operating in limited conditions and areas, so their operators can avoid particularly tricky intersections and make sure everything is mapped in fine detail.

The Boston Consulting Group predicts that 25 percent of all miles driven in the United States by 2030 may be by shared self-driving vehicles. To take a ride, you'd probably have to use predetermined pickup and drop-off points, so your car can always pull over safely and legally. The makers of self-driving cars will be figuring out how much to charge so they can recoup their research and development costs, but not so much as to dissuade potential riders. They'll struggle with regulators and insurance companies over what to do in the inevitable event of a crash.

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CASE STUDY QUESTIONS

- 11-13** What are the management, organizational, and technology challenges posed by self-driving car technology?
- 11-14** Are self-driving cars good business investments? Explain your answer.
- 11-15** What ethical and social issues are raised by self-driving car technology?
- 11-16** Will cars really be able to drive themselves without human operators? Should they?

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12

Enhancing Decision Making

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 12-1** What are the different types of decisions, and how does the decision-making process work?
- 12-2** How do information systems support the activities of managers and management decision making?
- 12-3** How do business intelligence and business analytics support decision making?
- 12-4** How do different decision-making constituencies in an organization use business intelligence?
- 12-5** How will MIS help my career?

CHAPTER CASES

- Eastspring: Targeted Enterprise System Building
- Predictive Maintenance in the Oil and Gas Industry
- GIS Help Land O'Lakes Manage Assets Strategically
- Should an Algorithm Make Our Decisions?

VIDEO CASES

- PSEG Leverages Big Data and Business Analytics Using GE's Predix Platform
- FreshDirect Uses Business Intelligence to Manage Its Online Grocery
- Business Intelligence Helps the Cincinnati Zoo Work Smarter

MyLab MIS

Discussion Questions: 12-5, 12-6, 12-7; Hands-On MIS Projects: 12-8, 12-9, 12-10, 12-11;
eText with Conceptual Animations

Eastspring: Targeted Enterprise System Building

Eastspring Investments is a company owned by Hong Kong-based Prudential Corporation Asia. Eastspring invests the money from premiums in securities to generate profits and support the policies of Prudential's customers. Originally founded in 1994 as Prudential Asset Management, it has around \$220 billion in various funds under management as of June 2020. Focusing on investments in Asia, it creates portfolios of stocks and bonds for institutional and retail investors as well as for the parent company. Eastspring is headquartered in Singapore and it operates in 11 markets across Asia, as well as having offices in North America and Europe.

When the company was launched in 1994, a significant amount of technology was introduced, including state-of-the-art trading systems and a specialized data management platform. A team of in-house developers purchased systems software and integrated the modified systems to existing legacy systems, and built other applications. By 2013 there were 30 key applications in the Singapore head office in addition to over 20 other applications and around 2,000 scheduled batch jobs. As the expansion plans progressed, it became increasingly obvious that the current technology had a number of systemic problems that seemed to be intractable. Both of the main systems were old, end-of-life versions, and upgrade projects during 2014 had stalled due to the complexity of the applications that had been built around the systems over the years to cater to Eastspring's business needs.

The company realized that the fundamental cause of the application's complexity was the locally specific business needs of the regional business units, such as the use of bespoke IT systems, country regulations, and diverse client reporting needs. To meet the company's growth demands, it was decided that the technology should be completely overhauled, but the underlying business process variations across the business units should be examined first. In 2015, all of the business processes were reviewed and a target operating model (TOM) created for the whole region along with a 3-year project plan. A strategic decision was made to acquire systems that had a breadth of services rather than just the best-in-breed, and



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to use off-the-shelf products for all processes, avoiding in-house development altogether. This required Eastspring to change its business processes to match those of the new enterprise software.

The business processes designed in the TOM were divided into critical, important, and unimportant: Critical process were those that give the company an edge over the competition, such as the portfolio management applications. Important processes were those that do not lead to a competitive advantage but must be performed correctly (trade settlement, for example). Unimportant processes are generally purely internal but still need to be performed, such as those related to human resources. It was decided that critical processes should be managed by an in-house team, important processes should be outsourced, and unimportant processes should use off-the-shelf products.

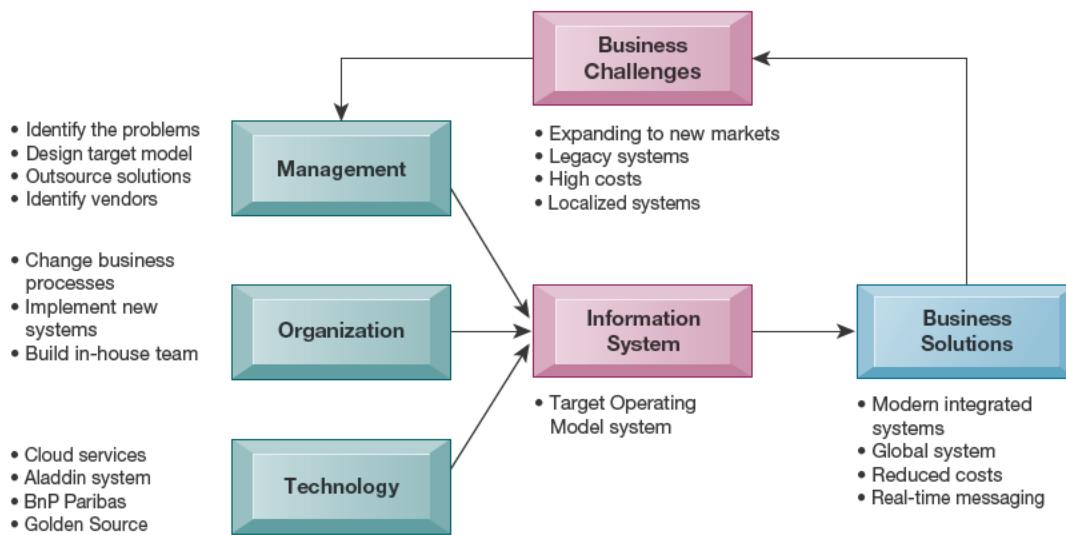
The important processes were split into three areas: portfolio and order management, data management, and middle and back-office processing. Three vendors for each area were finally selected: Aladdin from Blackrock for the portfolio and order management, GoldenSource for the data management platform, and BNP Paribas for the middle and back office processes.

The Aladdin system is a hosted service which includes the infrastructure, system administration, and interfacing with data providers and industry utilities. The system is interfaced through web services built on distributed application servers with a real-time messaging system. All of the vendor software runs in the cloud, reducing the need for in-house infrastructure and specialized teams. The first phases of the project have been successfully completed regionally and the project continues to roll out. For instance, the Aladdin system enabled Eastspring to switch from using Excel spreadsheets to generate risk reports and now enables Eastspring to develop a much more sophisticated understanding of the risk parameters for the various funds it is managing. Eastspring is now in 14 markets worldwide, including the United Kingdom, the United States, and Luxembourg. Funds under management have grown over 25 percent since 2013, and the future is looking very bright. According to reports, dividends on investments were down in the first half of 2020, but Southeast Asia is already witnessing early signs of a strong post-pandemic recovery.

Sources: Eastspring Investments website, www.eastspring.com, accessed January 12, 2021; Prudential, "We Do Life – Prudential plc Annual Report 2019," annualreports.com, March 10, 2020; "Eastspring Seeks to Nurture Growth with Better Data," Risk.net, November 6, 2019; "Prudential's Fund Arms to Use BlackRock's Aladdin Platform," Reuters, November 15, 2016. The author would also like to thank Brian Lyons, Eastspring Investments, and James Baker for their help in writing this case.

Case contributed by Paul Griffin, Singapore Management University

The chapter-opening case calls attention to important points raised by this chapter. Eastspring's business performance and ability to expand into new markets—regionally and globally—suffered because it was saddled with outdated legacy systems rendered too complex by the large number of local business units. Local systems and disparate processes made it difficult for different parts of the company to work together, take full advantage of new market opportunities, and pursue business goals. By moving to outsourced providers of industry-standard enterprise systems, Eastspring was able to redesign more efficient business processes across the region for a new business operating model, including fund management, trading, and sales. Eastspring's new technology



landscape is not only allowing the company to run its business more efficiently and effectively but also providing the functionality to support global expansion. However, to obtain these benefits from the enterprise services, Eastspring had to redesign its local and regional business processes as well as its legacy systems.

Here are some questions to think about: What problems did Eastspring solve by implementing a TOM? How did the new hosted services change the way Eastspring ran its business? What were the benefits of using hosted services for Eastspring?

12-1 What are the different types of decisions, and how does the decision-making process work?

Decision making in businesses used to be limited to management. Today, lower-level employees are responsible for some of these decisions, as information systems make information available to lower levels of the business. But what do we mean by better decision making? How does decision making take place in businesses and other organizations? Let's take a closer look.

Business Value of Improved Decision Making

What does it mean to the business to make better decisions? What is the monetary value of improved decision making? Table 12.1 attempts to measure the monetary value of improved decision making for a small U.S. manufacturing firm with \$280 million in annual revenue and 140 employees. The firm has identified a number of key decisions where new system investments might improve the quality of decision making. The table provides selected estimates of annual value (in the form of cost savings or increased revenue) from improved decision making in selected areas of the business.

TABLE 12.1 BUSINESS VALUE OF ENHANCED DECISION MAKING

EXAMPLE DECISION	DECISION MAKER	NUMBER OF ANNUAL DECISIONS	ESTIMATED VALUE TO FIRM OF A SINGLE IMPROVED DECISION	ANNUAL VALUE
Allocate support to most valuable customers	Accounts manager	12	\$100,000	\$1,200,000
Predict call center daily demand	Call center management	4	\$150,000	\$600,000
Decide parts inventory levels daily	Inventory manager	365	\$5,000	\$1,825,000
Identify competitive bids from major suppliers	Senior management	1	\$2,000,000	\$2,000,000
Schedule production to fill orders	Manufacturing manager	150	\$10,000	\$1,500,000
Allocate labor to complete a job	Production floor manager	100	\$4,000	\$400,000

We can see from Table 12.1 that decisions are made at all levels of the firm and that some of these decisions are common, routine, and numerous. Although the value of improving any single decision may be small, improving hundreds of thousands of “small” decisions adds up to a large annual value for the business.

Types of Decisions

Chapters 1 and 2 showed that there are different levels in an organization. Each of these levels has different information requirements for decision support and responsibility for different types of decisions (see Figure 12.1). Decisions are classified as structured, semistructured, and unstructured.

Unstructured decisions are those in which the decision maker must provide judgment, evaluation, and insight to solve the problem. Each of these decisions is novel, important, and nonroutine, and there is no well-understood or agreed-on procedure for making them.

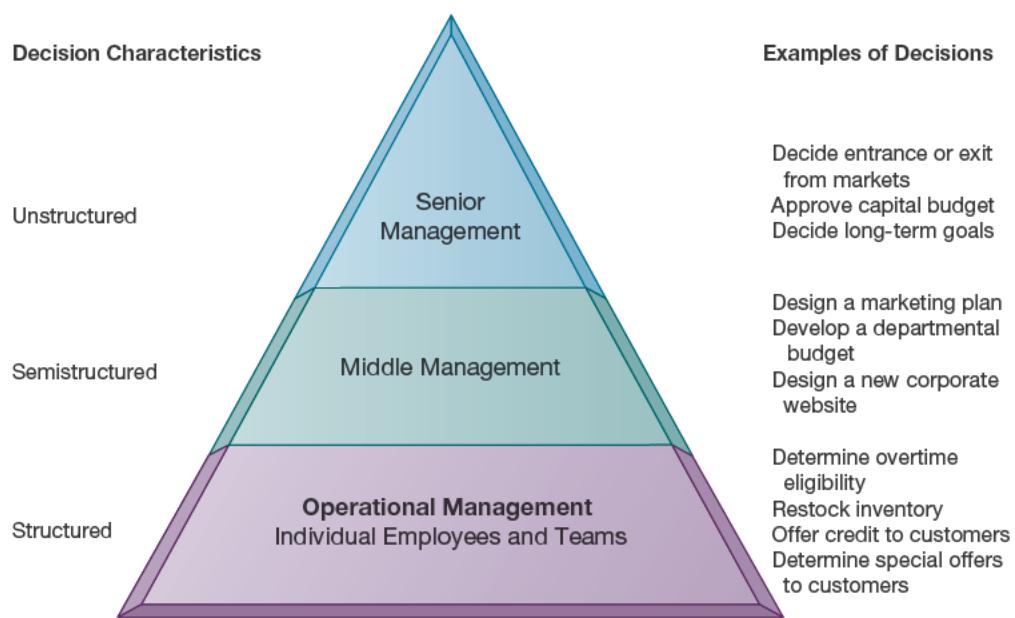
Structured decisions, by contrast, are repetitive and routine, and they involve a definite procedure for handling them so that they do not have to be treated each time as if they were new. Many decisions have elements of both types of decisions and are **semistructured**, where only part of the problem has a clear-cut answer provided by an accepted procedure. In general, structured decisions are more prevalent at lower organizational levels, whereas unstructured problems are more common at higher levels of the firm.

Senior executives face many unstructured decision situations, such as establishing the firm’s 5- or 10-year goals or deciding new markets to enter. Answering the question “Should we enter a new market?” would require access to news, government reports, and industry views as well as high-level summaries of firm performance. However, the answer would also require senior managers to use their own best judgment and poll other managers for their opinions.

Middle managers face more structured decision scenarios, but their decisions may include unstructured components. A typical middle-level management decision might be, “Why is the reported order fulfillment report showing a decline over the past six months at a distribution center in Stockholm?” This middle manager will obtain a report from the firm’s enterprise system or distribution management system on order activity and operational efficiency at the Minneapolis distribution center. This is the structured part of the decision. But

FIGURE 12.1 INFORMATION REQUIREMENTS OF KEY DECISION-MAKING GROUPS IN A FIRM

Senior managers, middle managers, operational managers, and employees have different types of decisions and information requirements.



before arriving at an answer, this middle manager will have to interview employees and gather more unstructured information from external sources about local economic conditions or sales trends.

Operational management and rank-and-file employees tend to make more structured decisions. For example, a supervisor on an assembly line has to decide whether an hourly paid worker is entitled to overtime pay. If the employee worked more than eight hours on a particular day, the supervisor would routinely grant overtime pay for any time beyond eight hours that was clocked on that day.

A sales account representative often has to make decisions about extending credit to customers by consulting the firm's customer database that contains credit information. If the customer met the firm's prespecified criteria for granting credit, the account representative would grant that customer credit to make a purchase. In both instances, the decisions are highly structured and are routinely made thousands of times each day in most large firms. The answer has been preprogrammed into the firm's payroll and accounts receivable systems.

The Decision-Making Process

Making a decision is a multistep process. Simon (1960) described four different stages in decision making: intelligence, design, choice, and implementation (see Figure 12.2).

Intelligence consists of discovering, identifying, and understanding the problems occurring in the organization—why a problem exists, where, and what effects it is having on the firm.

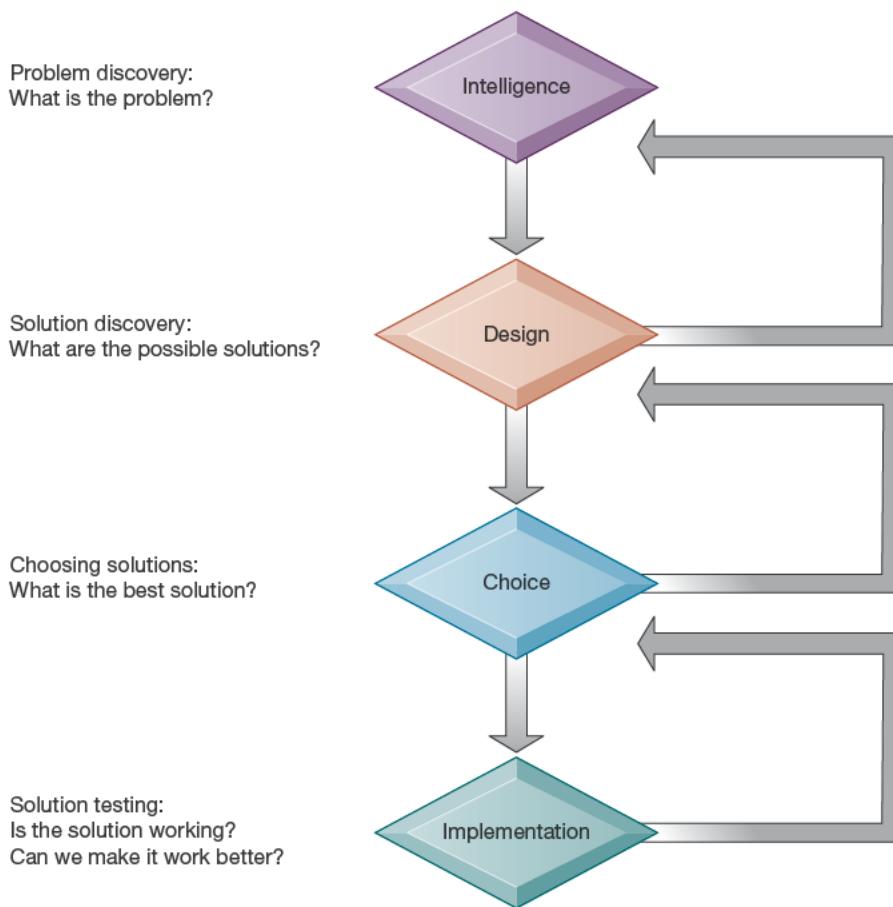
Design involves identifying and exploring various solutions to the problem.

Choice consists of choosing among solution alternatives.

Implementation involves making the chosen alternative work and continuing to monitor how well the solution is working.

FIGURE 12.2 STAGES IN DECISION MAKING

The decision-making process is broken down into four stages.



What happens if the solution you have chosen doesn't work? Figure 12.2 shows that you can return to an earlier stage in the decision-making process and repeat it if necessary. For instance, in the face of declining sales, a sales management team may decide to pay the sales force a higher commission for making more sales to spur on the sales effort. If this does not produce sales increases, managers would need to investigate whether the problem stems from poor product design, inadequate customer support, or a host of other causes that call for a different solution.

12-2 How do information systems support the activities of managers and management decision making?

The premise of this book and this chapter is that systems to support decision making produce better decision making by managers and employees, above-average returns on investment for the firm, and ultimately higher profitability. However, information systems cannot improve every decision taking place in an organization. Let's examine the role of managers and decision making in organizations to see why this is so.

Managerial Roles

Managers play key roles in organizations. Their responsibilities range from making decisions, to writing reports, to attending meetings, to arranging birthday parties. We are able to better understand managerial functions and roles by examining classical and contemporary models of managerial behavior.

The **classical model of management**, which describes what managers do, was largely unquestioned for more than 70 years after the 1920s. Henri Fayol and other early writers first described the five classical functions of managers as planning, organizing, coordinating, deciding, and controlling. This description of management activities dominated management thought for a long time, and it is still popular today.

The classical model describes formal managerial functions but does not address exactly what managers do when they plan, decide things, and control the work of others. For this, we must turn to the work of contemporary behavioral scientists who have studied managers in daily action. **Behavioral models** argue that the actual behavior of managers appears to be less systematic, more informal, less reflective, more reactive, and less well organized than the classical model would have us believe.

Observers find that managerial behavior actually has five attributes that differ greatly from the classical description. First, managers perform a great deal of work at an unrelenting pace — studies have found that managers engage in more than 600 different activities each day, with no break in their pace. There is never enough time to do everything for which a CEO is responsible (Porter and Nohria, 2018). Second, managerial activities are fragmented; most activities last for less than nine minutes, and only 10 percent of the activities exceed one hour in duration. Third, managers prefer current, specific, and ad hoc information (printed information often will be too old). Fourth, they prefer oral forms of communication to written forms because oral media provide greater flexibility, require less effort, and bring a faster response. Fifth, managers give high priority to maintaining a diverse and complex web of contacts that acts as an informal information system and helps them execute their personal agendas and short- and long-term goals.

Analyzing managers' day-to-day behavior, Henry Mintzberg found that it could be classified into 10 managerial roles (Mintzberg, 1971). **Managerial roles** are expectations of the activities that managers should perform in an organization. Mintzberg found that these managerial roles fell into three categories: interpersonal, informational, and decisional.

Interpersonal Roles

Managers act as figureheads for the organization when they represent their companies to the outside world and perform symbolic duties, such as giving out employee awards, in their **interpersonal role**. Managers act as leaders, attempting to motivate, counsel, and support subordinates. Managers also act as liaisons between various organizational levels; within each of these levels, they serve as liaisons among the members of the management team. Managers provide time and favors, which they expect to be returned.

Informational Roles

In their **informational role**, managers act as the nerve centers of their organizations, receiving the most concrete, up-to-date information and redistributing it to those who need to be aware of it. Managers are therefore information disseminators and spokespersons for their organizations.

TABLE 12.2 MANAGERIAL ROLES AND SUPPORTING INFORMATION SYSTEMS

ROLE	BEHAVIOR	SUPPORT SYSTEMS
INTERPERSONAL ROLES		
Figurehead		Telepresence systems
Leader	Interpersonal	Telepresence, social networks, Twitter
Liaison		Smartphones, social networks
INFORMATIONAL ROLES		
Nerve center		Management information systems, executive support system
Disseminator	Information processing	Texting, email, social networks
Spokesperson		Webinars, telepresence
DECISIONAL ROLES		
Entrepreneur	Decision making	None exist
Disturbance handler		None exist
Resource allocator		Business intelligence, decision-support system
Negotiator		None exist

Sources: Authors and Mintzberg, Henry. "Managerial Work: Analysis from Observation." *Management Science* 18 (October 1971).

Decisional Roles

Managers make decisions. In their **decisional role**, they act as entrepreneurs by initiating new kinds of activities, they handle disturbances arising in the organization, they allocate resources to staff members who need them, and they negotiate conflicts and mediate between conflicting groups.

Table 12.2, based on Mintzberg's role classifications, is one look at where systems can and cannot help managers. The table shows that information systems are now capable of supporting most, but not all, areas of managerial life.

Real-World Decision Making

We now see that information systems are not helpful for all managerial roles. And in those managerial roles where information systems might improve decisions, investments in information technology do not always produce positive results. There are three main reasons: information quality, management filters, and organizational culture (see Chapter 3).

Information Quality

High-quality decisions require high-quality information. Table 12.3 describes information quality dimensions that affect the quality of decisions.

If the output of information systems does not meet these quality criteria, decision making will suffer. Chapter 6 describes how corporate databases and files have varying levels of inaccuracy and incompleteness, which in turn will degrade the quality of decision making.

Management Filters

Even with timely, accurate information, managers often make bad decisions. Managers (like all human beings) absorb information through a series of filters to make sense of the world around them. Cognitive scientists, behavioral economists, and recently neuroeconomists have found that managers, like other humans, are

TABLE 12.3 INFORMATION QUALITY DIMENSIONS

QUALITY DIMENSION	DESCRIPTION
Accuracy	Do the data represent reality?
Integrity	Are the structure of data and relationships among the entities and attributes consistent?
Consistency	Are data elements consistently defined?
Completeness	Are all the necessary data present?
Validity	Do data values fall within defined ranges?
Timeliness	Are data available when needed?
Accessibility	Are the data accessible, comprehensible, and usable?

poor at assessing risk, and are risk averse; perceive patterns where none exist; and make decisions based on intuition, feelings, and the framing of the problem as opposed to empirical data (Kahneman, 2011; Tversky and Kahneman, 1986).

For instance, Wall Street firms such as Bear Stearns and Lehman Brothers imploded in 2008 because they underestimated the risk of their investments in complex mortgage securities, many of which were based on subprime loans that were more likely to default. The computer models they and other financial institutions used to manage risk were based on overly optimistic assumptions and overly simplistic data about what might go wrong. Management wanted to make sure that their firms' capital was not all tied up as a cushion against defaults from risky investments, preventing them from investing it to generate profits. So the designers of these risk management systems were encouraged to measure risks in a way that minimized their risk.

Organizational Inertia and Politics

Organizations are bureaucracies with limited capabilities and competencies for acting decisively. When environments change and businesses need to adopt new business models to survive, strong forces within organizations resist making decisions calling for major change. Decisions taken by a firm often represent a balancing of the firm's various interest groups rather than the best solution to the problem.

Studies of business restructuring find that firms tend to ignore poor performance until threatened by outside takeovers, and they systematically blame poor performance on external forces beyond their control—such as economic conditions (the economy), foreign competition, and rising prices—rather than blaming senior or middle management for poor business judgment. When the external business environment is positive and firm performance improves, managers typically credit themselves for the improved performance rather than the positive environment.

High-Velocity Automated Decision Making

Today, many decisions made by organizations are not made by managers—or any humans. For instance, when you enter a query into Google's search engine, Google has to decide which URLs to display in about half a second on average (500 milliseconds). High-frequency traders at electronic stock exchanges execute their trades within nanoseconds. Humans are eliminated from the decision chain because they are too slow.

In high-velocity decision environments, the intelligence, design, choice, and implementation parts of the decision-making process are captured by the software's algorithms. The humans who wrote the software have already identified

the problem, designed a method for finding a solution, defined a range of acceptable solutions, and implemented a solution. In these situations, organizations are making decisions faster than managers can monitor or control, and great care needs to be taken to ensure the proper operation of these systems to prevent significant harm.

12-3 How do business intelligence and business analytics support decision making?

Chapter 2 introduced you to the different types of systems used for supporting management decision making. At the foundation of all of these decision support systems are a business intelligence and business analytics infrastructure that supplies the data and the analytic tools for supporting decision making.

What Is Business Intelligence?

Business intelligence (BI) is a term used by hardware and software vendors and information technology consultants to describe the infrastructure for warehousing, integrating, reporting, and analyzing data that come from the business environment, including big data. The foundation infrastructure collects, stores, cleans, and makes relevant information available to managers. Think databases, data warehouses, data marts, Hadoop, and analytic platforms, which we described in Chapter 6. *Business analytics (BA)* is also a vendor-defined term that focuses more on tools and techniques for analyzing and understanding data. Think online analytical processing (OLAP), statistics, models, and data mining, which we also introduced in Chapter 6.

Business intelligence and analytics are essentially about integrating all the information streams produced by a firm into a single, coherent, enterprise-wide set of data and then using modeling, statistical analysis tools, and data mining tools to make sense out of all these data so managers can make better decisions and plans. For instance, Purdue College of Agriculture is using business intelligence and analytics to help farmers make some very fine-grained decisions about fertilizer levels, planting depth, and irrigation requirements for small sections of fields or individual plants.

It is important to remember that business intelligence and analytics are products defined by technology vendors and consulting firms. Leading providers of these products include Oracle, SAP, IBM, Microsoft, and SAS. A number of BI and BA products now have cloud and mobile versions.

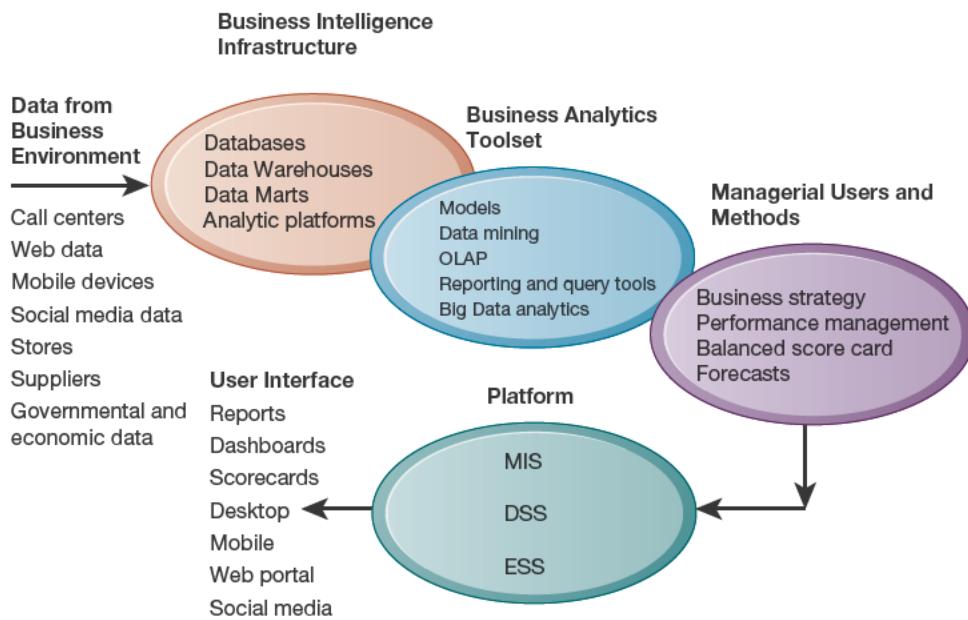
The Business Intelligence Environment

Figure 12.3 gives an overview of a business intelligence environment, highlighting the kinds of hardware, software, and management capabilities that the major vendors offer and that firms develop over time. There are six elements in this business intelligence environment:

- **Data from the business environment:** Businesses must deal with both structured and unstructured data from many different sources, including big data. The data need to be integrated and organized so that they can be analyzed and used by human decision makers.
- **Business intelligence infrastructure:** The underlying foundation of business intelligence is a powerful database system that captures all the relevant

FIGURE 12.3 BUSINESS INTELLIGENCE AND ANALYTICS FOR DECISION SUPPORT

Business intelligence and analytics require a strong database foundation, a set of analytic tools, and an involved management team that can ask intelligent questions and analyze data.



data to operate the business. The data may be stored in transactional databases or combined and integrated into an enterprise data warehouse or series of interrelated data marts.

- **Business analytics toolset:** A set of software tools are used to analyze data and produce reports, respond to questions posed by managers, and track the progress of the business using key indicators of performance.
- **Managerial users and methods:** Business intelligence hardware and software are only as intelligent as the human beings who use them. Managers impose order on the analysis of data using a variety of managerial methods that define strategic business goals and specify how progress will be measured. These include business performance management and balanced scorecard approaches focusing on key performance indicators and industry strategic analyses focusing on changes in the general business environment, with special attention to competitors. Without strong senior management oversight, business analytics can produce a great deal of information, reports, and online screens that focus on the wrong matters and divert attention from the real issues.
- **Delivery platform—MIS, DSS, ESS:** The results from business intelligence and analytics are delivered to managers and employees in a variety of ways, depending on what they need to know to perform their jobs. MIS, DSS, and ESS, which we introduced in Chapter 2, deliver information and knowledge to different people and levels in the firm—operational employees, middle managers, and senior executives. In the past, these systems could not share data and operated as independent systems. Today, one suite of hardware and software tools in the form of a business intelligence and analytics package is able to integrate all this information and bring it to managers' desktops or mobile platforms.
- **User interface:** Business people often learn quicker from a visual representation of data than from a dry report with columns and rows of information.

Data visualization tools facilitate creation of graphs, charts, dashboards, and maps to make it easier for users to obtain insights from data.



© Andriy Popov/123RF

Today's business analytics software suites feature **data visualization** tools, such as rich graphs, charts, dashboards, and maps. They also are able to deliver reports on mobile phones and tablets as well as on the firm's web portal. For example, Tableau Software enables nontechnical users to easily create and share customized interactive dashboards to provide business insights from a broad spectrum of data, including data from spreadsheets, corporate databases, and the web.

Business Intelligence and Analytics Capabilities

Business intelligence and analytics promise to deliver correct, nearly real-time information to decision makers, and the analytic tools help them quickly understand the information and take action. There are six analytic functionalities that BI systems deliver to achieve these ends:

- **Production reports:** These are predefined reports based on industry-specific requirements (see Table 12.4).
- **Parameterized reports:** Users enter several parameters as in a pivot table to filter data and isolate impacts of parameters. For instance, you might want to enter region and time of day to understand how sales of a product vary by region and time. If you were Starbucks, you might find that customers in the East buy most of their coffee in the morning, whereas in the Northwest

TABLE 12.4 EXAMPLES OF BUSINESS INTELLIGENCE PREDEFINED PRODUCTION REPORTS

BUSINESS FUNCTIONAL AREA	PRODUCTION REPORTS
Sales	Forecast sales; sales team performance; cross-selling; sales cycle times
Service/call center	Customer satisfaction; service cost; resolution rates; churn rates
Marketing	Campaign effectiveness; loyalty and attrition; market basket analysis
Procurement and support	Direct and indirect spending; off-contract purchases; supplier performance
Supply chain	Backlog; fulfillment status; order cycle time; bill of materials analysis
Financials	General ledger; accounts receivable and payable; cash flow; profitability
Human resources	Employee productivity; compensation; workforce demographics; retention

customers buy coffee throughout the day. This finding might lead to different marketing and ad campaigns in each region. (See the discussion of pivot tables in Section 12-4).

- **Dashboards/scorecards:** These are visual tools for presenting performance data defined by users.
- **Ad hoc query/search/report creation:** These allow users to create their own reports based on queries and searches.
- **Drill down:** This is the ability to move from a high-level summary to a more detailed view.
- **Forecasts, scenarios, models:** These include the ability to perform linear forecasting and what-if scenario analysis and analyze data using standard statistical tools.

Predictive Analytics

An important capability of business intelligence analytics is the ability to model future events and behaviors, such as the probability that a customer will respond to an offer to purchase a product. **Predictive analytics** use statistical analysis, data mining techniques, historical data, and assumptions about future conditions to predict future trends and behavior patterns. Variables that can be measured to predict future behavior are identified. For example, an insurance company might use variables such as age, gender, and driving record as predictors of driving safety when issuing auto insurance policies. A collection of such predictors is combined into a predictive model for forecasting future probabilities with an acceptable level of reliability.

FedEx has been using predictive analytics to develop models that predict how customers will respond to price changes and new services, which customers are most at risk of switching to competitors, and how much revenue will be generated by new storefront or drop-box locations. The accuracy rate of FedEx's predictive analytics system ranges from 65 to 90 percent.

Predictive analytics are being incorporated into numerous business intelligence applications for sales, marketing, finance, fraud detection, and health-care. One of the most well-known applications is credit scoring, which is used throughout the financial services industry. When you apply for a new credit card, scoring models process your credit history, loan application, and purchase data to determine your likelihood of making future credit payments on time. Healthcare insurers have been analyzing data for years to identify which patients are most likely to generate high costs.

Many companies employ predictive analytics to predict response to direct marketing campaigns. They are able to lower their marketing and sales costs by focusing their resources on customers who have been identified as more promising. For instance, Slack Technologies, which provides cloud-based team collaboration tools and services for 12 million active users in over 150 countries, uses predictive analytics to identify customers who are most likely to use its products very frequently and upgrade to its paid services.

Big Data Analytics

Predictive analytics are starting to use big data from both private and public sectors, including data from social media, customer transactions, and output from sensors and machines. In e-commerce, many online retailers have capabilities for making personalized online product recommendations to their website visitors to help stimulate purchases and guide their decisions about what

TABLE 12.5 WHAT BIG DATA ANALYTICS CAN DO

EHarmony	Online dating website analyzes personal and behavioral data on 10 million users to match couples based on features of compatibility found in thousands of successful relationships. Processes more than 3.5 million matches per day.
Barclays	Analyzes transactional big data to develop customized products for customers. For example, a "smart business" application for small and medium-sized businesses enables them to see patterns in anonymized data generated by the bank's other customers. A hairdresser in Birmingham could see what hairdressers in other locations are spending on electricity.
Hunch	Analyzes massive database with data from customer purchases, social networks, and signals from around the web to produce a "taste graph" that maps users with their predicted affinity to products, services, and websites. The taste graph includes predictions about 500 million people, 200 million objects (videos, gadgets, books), and 30 billion connections between people and objects. Helps eBay develop more finely customized recommendations on items to offer.
German World Cup Soccer Team	Analyzed very large amounts of video and numeric data about individual player and team performance on itself and competing teams and then used what it had learned to improve how it played and to capitalize on competitors' strengths and weaknesses. Superior use of big data analytics helped the team win the 2014 World Cup.

merchandise to stock. However, most of these product recommendations have been based on the behaviors of similar groups of customers, such as those with incomes under \$50,000 or whose ages are between 18 and 25 years. Now some retailers are starting to analyze the tremendous quantities of online and in-store customer data they collect along with social media data to make these recommendations more individualized. These efforts are translating into higher customer spending and customer retention rates. Table 12.5 provides examples of companies using big data analytics.

In the public sector, big data analytics have been driving the movement toward "smart cities," which make intensive use of digital technology to make better decisions about running cities and serving their residents. Public record-keeping has produced warehouses full of property transfers, tax records, corporate filings, environmental compliance audits, restaurant inspections, building maintenance reports, mass transit appraisals, crime data, health department stats, public education records, utility reviews, and more. Municipalities are adding more data captured through sensors, location data from mobile phones, and targeted smartphone apps. Predictive modeling programs now inform public policy decisions on utility management, transportation operation, healthcare delivery, and public safety. What's more, the ability to evaluate how changes in one service affect the operation and delivery of other services enables holistic problem solving that could only be dreamed of a generation ago.

Operational Intelligence and Analytics

Many decisions deal with how to run the business of these cities on a day-to-day basis. These are largely operational decisions, and this type of business activity monitoring is called **operational intelligence**. The Internet of Things is creating huge streams of data from web activities, smartphones, sensors, gauges, and monitoring devices that can be used for operational intelligence about activities inside and outside the organization. Software for operational intelligence and analytics enables organizations to analyze these streams of big data as they are generated in real time. The Interactive Session on Organizations describes how oil and gas companies are using operational intelligence for predictive maintenance, which can predict which pieces of equipment or infrastructure might shortly break down so that maintenance can be scheduled before failure occurs.

INTERACTIVE SESSION ORGANIZATIONS

Predictive Maintenance in the Oil and Gas Industry

In a number of industries, improving the productivity of existing assets by even a single percentage point can generate significant benefits. This is true of the oil and gas sector, which is deeply affected by unplanned downtime, when equipment cannot operate because of a malfunction. A single unproductive day on a platform can cost a liquefied natural gas (LNG) facility as much as \$25 million, and an average mid-sized LNG facility experiences about five down days a year. That's \$125 to \$150 million lost. Minimizing downtime is critical, especially considering declining revenues from lower energy prices. Big data analytics can help.

Sensors in oil fields and in oil and natural gas pipelines produce a vast amount of data that can be analyzed for predictive maintenance. McKinsey & Company estimates that a typical offshore production platform can have more than 40,000 data tags. Energy companies have been using oil field sensors to monitor real-time operations status, and now they are starting to use IoT data to predict equipment failure and address issues before they become costly problems. Physical inspection of equipment in remote locations is typically an expensive process. This lack of visibility can lead to equipment failure and costly unscheduled maintenance and nonproductive time, as well as oil spills, leakages, or accidents resulting from failing equipment.

Predictive maintenance tools evaluate the condition of operational equipment and predict its maintenance requirements in order to achieve optimum performance and prevent malfunction. They use automated condition monitoring and advanced data analytics to gather vital equipment statistics such as vibration, temperature, sound, and electric current, comparing them with historical records of similar equipment to detect signs of deterioration. The insights gained from predictive maintenance programs enable decision makers to schedule maintenance activities without disrupting routine production operations and to determine which repairs are the highest priority.

British oil and gas company BP worked with General Electric (GE) in 2015 to equip 650 of its thousands of oil wells with GE sensors linked to GE's Predix cloud platform. Predix provides services for developing and running IoT applications that

collect data from industrial sensors and analyze the data in the cloud, providing real-time information to schedule maintenance checks, improve machine efficiency, and reduce downtime. Each BP well was outfitted with 20 to 30 sensors to measure pressure and temperature, transmitting 500,000 data points to the Predix cloud every 15 seconds. BP hopes to use the data to predict well flows and the useful life of each well and ultimately to obtain an enterprise-wide view of its oil fields' performance.

The BP partnership with GE recently produced an application called Plant Operations Advisor (POA) that will further improve the efficiency, reliability, and safety of BP's oil and gas production operations. Plant Operations Advisor will prevent unplanned downtime by helping engineering teams respond quickly to problems as they occur in real time. BP first used Plant Operations Advisor to help manage the performance of one of its platforms in the Gulf of Mexico and will soon deploy this tool to other BP facilities around the world.

GE identified pipeline risk management as a major challenge for the oil and gas industry. There are 2 million miles of transmission pipe throughout the globe, moving liquid oil or gas from its point of extraction to refining, processing, or market. About 55 percent of transmission pipeline in the United States was installed before 1970. Pipeline spills are not frequent, but when they occur, they create serious economic and environmental damage as well as bad publicity for pipeline operators and energy companies. Pipeline operators are always anxious to know where their next rupture will be, but they typically lacked the data to measure pipeline fitness.

GE developed a pipeline-management software suite for accessing, managing, and integrating critical data for the safe management of pipelines, including a risk assessment tool to monitor aging infrastructure. GE's risk-assessment solution combines internal and external factors (such as flooding) to provide an accurate, up-to-the minute visual representation of where risk exists in a pipeline. This risk assessment tool enables pipeline operators to make real-time decisions about where field service crews should be deployed along the pipeline.

Weather has a sizable impact on risk for pipelines in areas prone to seismic activity, waterways, and

washouts. Checking weather patterns along thousands of miles of pipe for rain or flood zones, and integrating those data with other complex pipeline data sets is difficult to perform manually. But by bringing all relevant data together in one place, GE Predix gives pipeline operators easier access to information to help them address areas with the greatest potential impact.

Royal Dutch Shell PLC is using the Microsoft Azure cloud platform and the C3 IoT platform-as-a-service (PaaS) application development platform to monitor and predict where and when maintenance is needed for compressors, valves, and other equipment. Predictive maintenance applications built with these tools are moving into production. One handles equipment performing coal seam gas (gas collected from unmined

coal seams) production in Australia, while another helps detect anomalies in downstream valves. Shell is now trying to deploy predictive maintenance technology at tens and even hundreds of thousands of sites and over one million pieces of individual equipment.

Sources: www.ge.com, accessed April 20, 2020; "BP and GE Announce New Offshore Digital Technology with Plans to Deploy Globally," www.powergenadvancement.com, accessed April 12, 2020; "Predictive Maintenance Gains Greater Significance in Oil and Gas Industry," *Oil & Gas Engineering*, May 24, 2019; Caroline Donnelly, "AI and Machine Learning Help to Power Shell's Multi-Decade Digital Transition," *Computer Weekly Nordic*, November 2018–January 2019; Steven Norton, "Shell Announces Plans to Deploy Applications at Scale," *CIO Journal*, September 20, 2019; and Laura Winig, "GE's Big Bet on Data and Analytics," *MIT Sloan Management Review*, February 2016.

CASE STUDY QUESTIONS

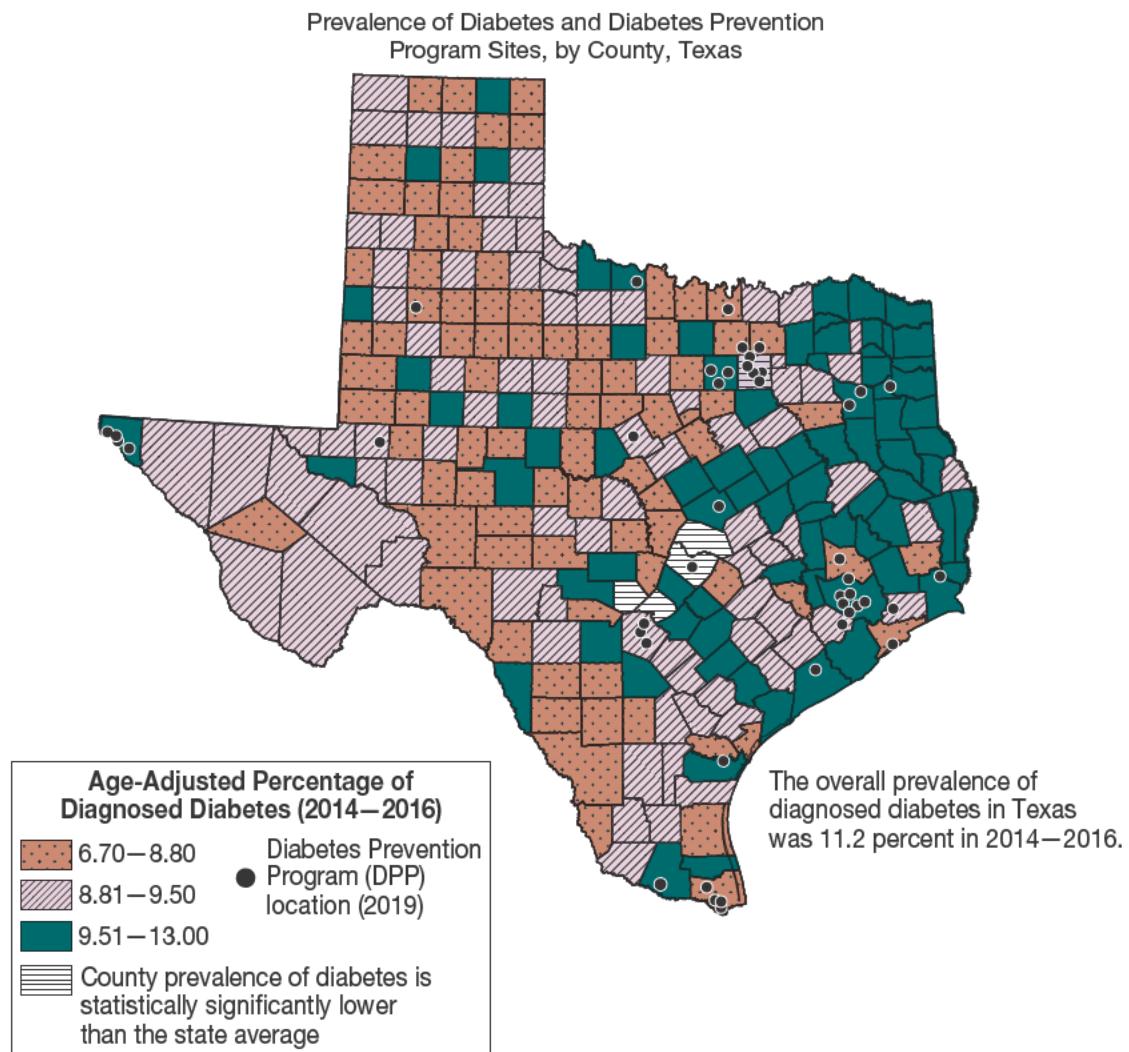
1. Why is predictive maintenance so important in the oil and gas industry? What problems does it solve?
2. What is the role of the Internet of Things (IoT) and Big Data analytics in predictive maintenance?
3. How did BP and Royal Dutch Shell's predictive maintenance applications change business operations and decision making?
4. Give an example of how predictive maintenance systems could be used in another industry.

Another example of operational intelligence is the use of data generated by sensors on trains and equipment by SNCF, which operates France's rail services, including France's high-speed rail network. The railway network consists of about 32,000 km (20,000 miles) of route and about 14,000 trains run daily. The sensors monitor data about train speed, engine and train car functioning, and track conditions. SNCF is able to analyze these data to reduce failures and improve the reliability of trains, signals and tracks. Engineers can connect to running trains in real time, enabling the company to figure out if a component is likely to fail, which could lead to a train being taken out of service (Zaremski, 2018; Venna, 2017).

Location Analytics and Geographic Information Systems

Decisions are also based on location data. BI analytics include **location analytics**, the ability to gain business insight from the location (geographic) component of data, including location data from mobile phones, output from sensors or scanning devices, and data from maps. For example, location analytics might help a marketer determine which people to target with mobile ads about nearby restaurants and stores or quantify the impact of mobile ads on in-store visits. Location analytics would help a utility company view and measure outages and their associated costs as related to customer location to help prioritize marketing, system upgrades, and customer service efforts. .

This map illustrates that the prevalence of diagnosed diabetes in the state of Texas in the United States is disproportionately concentrated in East Texas. Additionally, this map shows the need in East Texas for an increased number of Diabetes Prevention Programs (DPPs), which are community-based programs that provide evidence-based type 2 diabetes prevention education.



Geographic information systems (GIS) provide tools to help decision makers visualize problems that benefit from mapping. GIS software ties location data about the distribution of people or other resources to points, lines, and areas on a map. Some GIS have modeling capabilities for changing the data and automatically revising business scenarios.

GIS might be used to help state and local governments calculate response times to natural disasters and other emergencies, to help banks identify the best location for new branches or ATM terminals, or to help police forces pinpoint locations with the highest incidence of crime. Planners behind Singapore's Punggol Digital District are using a GIS to develop better designs for buildings and facilities. The GIS integrates, manages and analyzes a variety of data to provide designers and architects with more insights on a structure's location, orientation and construction materials. The GIS will enable planners behind the new district to visualize the impact of their designs on existing surroundings and landscape on a 3D map. This will help ensure that the infrastructure and amenities in the district will support the needs of the community (Tan, 2020). The Interactive Session on Management provides examples of other types of GIS applications used by Land O'Lakes to improve operations and planning.

INTERACTIVE SESSION MANAGEMENT

GIS Help Land O'Lakes Manage Assets Strategically

Land O'Lakes is a member-owned agricultural co-operative serving the dairy industry by working to improve the quality, consistency, marketing, and economies of its dairy products. It was founded in 1921 by 300 creameries and is based in Arden Hills, Minnesota. It is now one of the largest co-ops in the United States, with 3,667 members and nearly 10,000 employees. Land O'Lakes sales of dairy products, animal feed, and seed and crop protection products total \$15 billion per year. In 2019, the co-op produced \$187 million in returns for its members.

Land O'Lakes provides technical know-how, proprietary tools, and research-based solutions to help farmers become more productive and competitive. About seven years ago, the co-op formed a Strategic Asset Management (SAM) team to provide consulting services to its members. In the agricultural industry, efficiencies and profits are deeply affected by the distance between a farm and various assets, such as feed lots, grain elevators, or crop nutrient facilities. Existing storage facilities may be located in suboptimal areas for serving farms' current customers, and new facilities are not always built in the most strategic locations.

SAM often uses geographic information systems (GIS) when it consults about these issues. For example, GIS can show co-op members mapping and locational information about the trade areas for a project—where the trade area is located, where members' facilities are situated within the trade area, and where competitors are based. The GIS is able to show the geographic dynamics of the trade area analyzed by the SAM team and how they can be improved.

If Land O'Lakes has multiple facilities that are close together, the SAM team analyzes where the trade areas overlap. It also performs transportation analysis to determine how products are currently being delivered to Land O'Lakes customers and if there is a way to do so more efficiently. The SAM team can analyze the facilities customers are currently using compared to ones that are believed to be more appropriate for their use based on distance, functionality, and future growth. Sometimes GIS will be used for analyzing drive-time routes within specific trade territories as well as for route planning.

Additionally, the team uses GIS for field data collection. It frequently needs to analyze how co-op

members are operating their facilities. What are the capabilities of those facilities? How old are they? Can we expand those facilities? The SAM team uses Survey123 for ArcGIS to capture a comprehensive and consistent set of data about the facilities so it can answer these questions.

ArcGIS is a suite of GIS software products developed by ESRI (Environmental Systems Research Institute), an international supplier of geographic information systems that operate on desktop, server, and mobile platforms. These tools integrate, store, edit, analyze, and display geographic information for informing decision making. Survey123 for ArcGIS is a software tool for creating, sharing, and analyzing surveys and supports data collection via web and mobile devices.

The agricultural industry is affected by the consolidation of existing facilities and the construction of new ones. These changes can create trade area overlaps, gaps, and redundancies, which will impact efficiency and profitability. It is important to understand how much capacity an operation has and how much is needed to service existing and future customers. Before a co-op member builds new facilities, the SAM team evaluates the project based on the future needs of the marketplace and the potential return on investment. The assessment addresses factors such as the current feed business, customer needs, competitor capabilities, asset efficiency, financial performance, regulatory compliance, market trends, and project risk. GIS help the SAM team show co-op members the customer allocations for various facilities, such as two new mills.

The SAM team makes recommendations about how to change members' transportation or distribution models. Take, for instance, a member operating seven feed mills for hog producers. Two of the mills are old and are not worth spending money to improve them. With some investment, another mill could be operated for five more years before it needs to be replaced. The feed mill market is growing, so the mill owner should increase capacity as the market expands. The question is, where is the best place to put a new facility to replace the three that are outdated, a facility that can manufacture feed in a way that's more efficient and safer for employees, and

implement a tracking mechanism to meet today's consumer transparency demands? The SAM team will work to provide answers.

Land O'Lakes uses transportation studies to examine operating expenses and future transportation costs as part of its financial analysis for capital investment purposes. The SAM team will try to answer questions such as: How many miles do truck drivers have to travel today to reach distribution facilities? How many miles would they have to drive if a new transportation model were implemented to accommodate a different set of distribution facilities? Will the new transportation model produce cost savings, or will costs increase by building new facilities in different areas?

The SAM team's market analyses also examine the demand trends for Land O'Lakes products: Where is this demand coming from? How is that demand changing? What is driving the demand? How much growth has happened in the market historically? Where are the growth opportunities in the future? Who are the competitors and what is their impact on the market? The SAM team's work has benefited both day-to-day operations as well as long-term planning.

Sources: www.esri.com, accessed January 15, 2020; "2019 Land O'Lakes Inc. Annual Report," February 25, 2020; "As Agriculture Continually Transforms, Land O'Lakes Uses GIS to Manage Strategic Assets," *ArcNews*, Fall 2019; www.vault.com, accessed January 15, 2020.

CASE STUDY QUESTIONS

1. Why is geographic location data so important to Land O'Lakes? What categories of geographic information does Land O'Lakes use?
2. How did using GIS improve operations and decision making at Land O'Lakes?
3. Give examples of three decisions at Land O'Lakes that were improved by using GIS.

12-4 How do different decision-making constituencies in an organization use business intelligence?

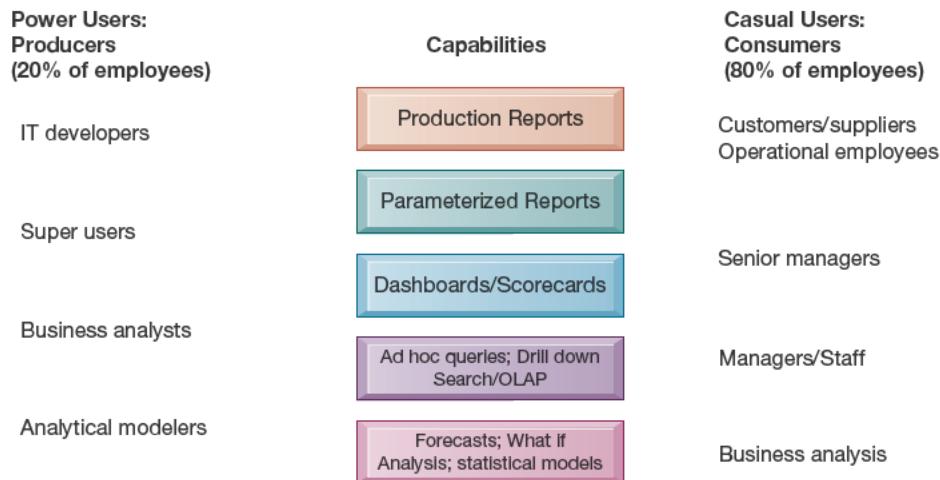
Earlier in this text and in this chapter, we described the different information constituencies in business firms—from senior managers to middle managers, analysts, and operational employees. This also holds true for BI and BA systems (see Figure 12.4). More than 80 percent of the audience for BI consists of casual users who rely largely on production reports. Senior executives tend to use BI to monitor firm activities using visual interfaces like dashboards and scorecards. Middle managers and analysts are much more likely to be immersed in the data and software, entering queries and slicing and dicing the data along different dimensions. Operational employees will, along with customers and suppliers, be looking mostly at prepackaged reports.

Decision Support for Operational and Middle Management

Operational and middle management are generally charged with monitoring the performance of key aspects of the business, ranging from the downtime of machines on a factory floor to the daily or even hourly sales at franchise food stores to the daily traffic at a company's website. Most of the decisions these

FIGURE 12.4 BUSINESS INTELLIGENCE USERS

Casual users are consumers of BI output, while intense power users are the producers of reports, new analyses, models, and forecasts.



managers make are fairly structured. Management information systems (MIS), which we introduced in Chapter 2, are typically used by middle managers to support this type of decision making. Increasingly, middle managers receive these reports online and are able to interactively query the data to find out why events are happening. Managers at this level often turn to exception reports, which highlight only exceptional conditions, such as when the sales quotas for a specific territory fall below an anticipated level or employees have exceeded their spending limits in a dental care plan. Table 12.6 provides some examples of MIS for business intelligence.

Support for Semistructured Decisions

Some managers are “super users” and keen business analysts who want to create their own reports and use more sophisticated analytics and models to find patterns in data, to model alternative business scenarios, or to test specific hypotheses. Decision-support systems (DSS) are the BI delivery platform for this category of users, with the ability to support semistructured decision making.

DSS rely more heavily on modeling than MIS, using mathematical or analytical models to perform what-if or other kinds of analysis. “What-if” analysis, working forward from known or assumed conditions, allows the user to vary certain values in test results to predict outcomes if changes occur in those values. What happens if we raise product prices by 5 percent or increase the advertising budget by \$1 million? **Sensitivity analysis** models ask what-if questions repeatedly to predict a range of outcomes when one or more variables are changed multiple times (see Figure 12.5). Backward sensitivity analysis helps

TABLE 12.6 EXAMPLES OF MIS APPLICATIONS

COMPANY	MIS APPLICATION
Plan International	Human resources MIS for this UK-headquartered company tracks the location, skills, and job experience of 10,000 workers located in over 70 countries and identifies who has the appropriate skills and experience to provide the necessary services for various types of emergencies.
Black & Veatch	Web-based MIS tracks construction costs for projects in over 22 countries worldwide.
Dubai Islamic Bank	MIS reports on customer eligibility for loans and guides management decisions about whether to approve or reject the loan application.

FIGURE 12.5 SENSITIVITY ANALYSIS

This figure displays the results of a sensitivity analysis of the effect of changing the sales price of a necktie and the cost per unit on the product's break-even point. It answers the question: What happens to the break-even point if the sales price and the cost to make each unit increase or decrease?

Total fixed costs	19000
Variable cost per unit	3
Average sales price	17
Contribution margin	14
Break-even point	1357
Variable Cost per Unit	
Sales Price	1357 2 3 4 5 6
14	1583 1727 1900 2111 2375
15	1462 1583 1727 1900 2111
16	1357 1462 1583 1727 1900
17	1267 1357 1462 1583 1727
18	1188 1267 1357 1462 1583

decision makers with goal seeking: If I want to sell 1 million product units next year, how much must I reduce the price of the product?

Chapter 6 described multidimensional data analysis and OLAP as key business intelligence technologies. Spreadsheets have a similar feature for multidimensional analysis called a **pivot table**, which manager "super users" and analysts employ to identify and understand patterns in business information that may be useful for semistructured decision making.

Figure 12.6 illustrates a Microsoft Excel pivot table that examines a large list of order transactions for a company selling online management training videos and books. It shows the relationship between two dimensions: the sales region and the source of contact (web banner ad or e-mail) for each customer order. It answers the question: Does the source of the customer make a difference in addition to region? The pivot table in this figure shows that most customers come from the West and that banner advertising produces most of the customers in all the regions.

FIGURE 12.6 A PIVOT TABLE THAT EXAMINES CUSTOMER REGIONAL DISTRIBUTION AND ADVERTISING SOURCE

In this pivot table, we are able to examine where an online training company's customers come from in terms of region and advertising source.

Courtesy of Microsoft Corporation

Region	Email	Web	Grand Total
East	24	77	101
North	28	64	92
South	33	73	106
West	57	154	211
Grand Total	142	368	510

One of the Hands-On MIS projects for this chapter asks you to use a pivot table to find answers to a number of other questions using the same list of transactions for the online training company as we used in this discussion. The complete Excel file for these transactions is available in MyLab MIS. We also provide a Learning Track on creating pivot tables using Excel.

In the past, much of this modeling was done with spreadsheets and small stand-alone databases. Today these capabilities are incorporated into large enterprise BI systems where they are able to analyze data from large corporate databases. BI analytics include tools for intensive modeling, some of which we described earlier. Such capabilities help Progressive Insurance identify the best customers for its products. Using widely available insurance industry data, Progressive defines small groups of customers, or “cells,” such as motorcycle riders age 30 or above with college educations, credit scores over a certain level, and no accidents. For each “cell,” Progressive performs a regression analysis to identify factors most closely correlated with the insurance losses that are typical for this group. It then sets prices for each cell and uses simulation software to test whether this pricing arrangement will enable the company to make a profit. These analytic techniques make it possible for Progressive to profitably insure customers in traditionally high-risk categories that other insurers would have rejected.

Decision Support for Senior Management: Balanced Scorecard and Enterprise Performance Management Methods

The purpose of executive support systems (ESS), introduced in Chapter 2, is to help C-level executive managers focus on the really important performance information that affects the overall profitability and success of the firm. There are two parts to developing ESS. First, you will need a methodology for understanding exactly what is “the really important performance information” for a specific firm that executives need, and second, you will need to develop systems capable of delivering this information to the right people in a timely fashion.

A leading methodology for understanding the really important information needed by a firm's executives is called the **balanced scorecard method** (Kaplan and Norton, 1992). The balanced scorecard is a framework for operationalizing a firm's strategic plan by focusing on measurable outcomes on four dimensions of firm performance: financial, business process, customer, and learning and growth (Figure 12.7).

Performance on each dimension is measured using **key performance indicators (KPIs)**, which are the measures proposed by senior management for understanding how well the firm is performing along any given dimension. For instance, one key indicator of how well an online retail firm is meeting its customer performance objectives is the average length of time required to deliver a package to a consumer. If your firm is a bank, one KPI of business process performance is the length of time required to perform a basic function like creating a new customer account.

The balanced scorecard framework is thought to be “balanced” because it causes managers to focus on more than just financial performance. In this view, financial performance is past history—the result of past actions—and managers should focus on the things they are able to influence today, such as business process efficiency, customer satisfaction, and employee training. Once a scorecard is developed by consultants and senior executives, the next step is

FIGURE 12.7 THE BALANCED SCORECARD FRAMEWORK

In the balanced scorecard framework, the firm's strategic objectives are operationalized along four dimensions: financial, business process, customer, and learning and growth. Each dimension is measured using several KPIs.



automating a flow of information to executives and other managers for each of the key performance indicators. Once these systems are implemented, they are often referred to as ESS.

Another closely related management methodology is **business performance management (BPM)**. Originally defined by an industry group in 2004 (led by companies that sell enterprise and database systems like Oracle, SAP, and IBM), BPM attempts to systematically translate a firm's strategies (e.g., differentiation, low-cost producer, market share growth, and scope of operation) into operational targets. Once the strategies and targets are identified, a set of KPIs are developed that measure progress toward the targets. The firm's performance is then measured with information drawn from the firm's enterprise database systems. BPM uses the same ideas as the balanced scorecard but with a stronger strategy flavor.

Corporate data for contemporary ESS are supplied by the firm's existing enterprise applications (enterprise resource planning, supply chain management, and customer relationship management). ESS also provide access to news services, financial market databases, economic information, and whatever other external data senior executives require. ESS also have significant drill-down capabilities if managers need more detailed views of data.

Well-designed ESS help senior executives monitor organizational performance, track activities of competitors, recognize changing market conditions, and identify problems and opportunities. Employees lower down in the corporate hierarchy also use these systems to monitor and measure business performance in their areas of responsibility. For these and other business intelligence systems to be truly useful, the information must be “actionable”—it must be readily available and also easy to use when making decisions. If users have difficulty identifying critical metrics within the reports they receive, employee productivity and business performance will suffer.



12-5 How will MIS help my career?

Here is how Chapter 12 and this text can help you find a job as an entry-level data analyst.

The Company

Western Well Health, a provider of private healthcare services for the Melbourne, Australia metropolitan area, is looking for an entry-level data analyst to perform data analysis and reporting for operational/clinical departments. The company's healthcare network includes several hospitals, six senior living communities, urgent care clinics, and home care and hospice services.

Position Description

The data analyst will be responsible for coordinating a variety of quality and performance measurement initiatives, including satisfaction survey programs, benchmarking and tracking quality of care, clinical outcome performance, and asset utilization. Job responsibilities include:

- Performing data analysis based on SAS data sets, MS Access databases, external websites, and business intelligence platforms to produce reports for key stakeholder groups and decision makers.
- Eliciting data and reporting requirements using interviews, document analysis, requirements workshops, site visits, use cases, data analysis, and workflow analysis.
- Working with staff on the design, maintenance, and distribution of reports and incorporation of reports into the balanced scorecard.
- Analyzing, testing, and modifying databases and reports as needed to meet end user specifications and quality assurance procedures.
- Assisting in enhancing business intelligence reporting tools, dashboards, and mobile BI to improve usability, increase user adoption, and streamline support.

Job Requirements

- Bachelor's degree in Information Systems or Statistics
- Knowledge of Microsoft Access, SQL, and business intelligence tools such as Business Objects, SAS BI, or Tableau
- Data management, analytics, and information system experience preferred
- Some knowledge of the healthcare business and medical record systems desirable
- Project management skills and/or experience desirable

Interview Questions

1. Have you worked with any business intelligence software? Which tools? What is your level of proficiency? Can you give examples of the kinds of data analysis work and reports you used these tools for?
2. In your experience with data analysis and business intelligence, did you ever work with tools that were not as user-friendly as they could have been? What would you have recommended to improve the tool(s) for users?

3. Have you ever developed an analytics report for users from scratch? What BI tools, or tools and data sets, did you use? Can you talk more about how you worked with users to elicit the information requirements for the report?
4. What do you know about the healthcare industry and electronic medical records? Have you ever worked with medical record systems and software? What work did you do with them?
5. Have you ever worked on a project team? What were your responsibilities? Did you play a leadership role?

Author Tips

1. Review the first two sections of this chapter on decision making and also Chapter 6 on data management and Chapter 13 on building systems and information requirements.
2. Use the web to do more research on the company. Try to find out more about its strategy, competitors, and business challenges. Additionally, look at the company's social media channels over the past 12 months. Are there any trends you can identify or certain themes the social media channels seem to focus on?
3. If you don't have experience with the BI software tools required for the job, use the web to learn more about these tools and how other healthcare companies are using them. Go to websites of major consulting companies such as McKinsey & Co., Boston Consulting Group, Bain & Co., and Accenture to read their research articles on how technology is changing the healthcare service industry.
4. Be prepared to bring samples of the querying/reporting work you have done in your course work and your Microsoft Access proficiency.

REVIEW SUMMARY

12-1 What are the different types of decisions, and how does the decision-making process work?

The different levels in an organization (strategic, management, operational) have different decision-making requirements. Decisions can be structured, semistructured, or unstructured, with structured decisions clustering at the operational level of the organization and unstructured decisions at the strategic level. Decision making can be performed by individuals or groups and includes employees as well as operational, middle, and senior managers. There are four stages in decision making: intelligence, design, choice, and implementation.

12-2 How do information systems support the activities of managers and management decision making?

Early classical models of managerial activities stress the functions of planning, organizing, coordinating, deciding, and controlling. Contemporary research looking at the actual behavior of managers has found that managers' real activities are highly fragmented, varied, and brief in duration and that managers shy away from making grand, sweeping policy decisions.

Information technology provides new tools for managers to carry out both their traditional and newer roles, enabling them to monitor, plan, and forecast with more precision and speed than ever before and to respond more rapidly to the changing business environment. Information systems have been most helpful to managers by providing support for their roles in disseminating information, providing liaisons between organizational levels, and allocating resources. However, information systems are less successful at supporting unstructured decisions. Where information systems are useful, information quality, management filters, and organizational culture can degrade decision making.

12-3 How do business intelligence and business analytics support decision making?

Business intelligence and analytics promise to deliver correct, nearly real-time information to decision makers, and analytic tools help them quickly understand the information and take action. A business intelligence environment consists of data from the business environment, the BI infrastructure, a BA toolset, managerial users and methods, a BI delivery platform (MIS, DSS, or ESS), and the user interface. There are six analytic functionalities that BI systems deliver to achieve these ends: predefined production reports, parameterized reports, dashboards and scorecards, ad hoc queries and searches, the ability to drill down to detailed views of data, and the ability to model scenarios and create forecasts. BI analytics are starting to handle big data. Predictive analytics, location analytics, and operational intelligence are important analytic capabilities.

12-4 How do different decision-making constituencies in an organization use business intelligence?

Operational and middle management are generally charged with monitoring the performance of their firm. Most of the decisions they make are fairly structured. Management information systems (MIS) producing routine production reports are typically used to support this type of decision making. For making unstructured decisions, middle managers and analysts will use decision-support systems (DSS) with powerful analytics and modeling tools, including spreadsheets and pivot tables. Senior executives making unstructured decisions use dashboards and visual interfaces displaying key performance information affecting the overall profitability, success, and strategy of the firm. The balanced scorecard and business performance management are two methodologies used in designing executive support systems (ESS).

Key Terms

Balanced scorecard method, 508

Behavioral models, 493

Business performance management (BPM), 509

Choice, 491

Classical model of management, 493

Data visualization, 498

Decisional role, 494

Design, 491

Geographic information systems (GIS), 503

Implementation, 491

Informational role, 493

Intelligence, 491

Interpersonal role, 493

Key performance indicators (KPIs), 508

Location analytics, 502
Managerial roles, 493
Operational intelligence, 500
Pivot table, 507
Predictive analytics, 499

Semistructured decisions, 490
Sensitivity analysis, 506
Structured decisions, 490
Unstructured decisions, 490

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

12-1 What are the different types of decisions, and how does the decision-making process work?

- List four structured decisions that a manager at the operational level in an organization is likely to have to make.
- According to the classical model of management, what are the five roles of management?
- Explain what is meant by the term management filter.

12-2 How do information systems support the activities of managers and management decision making?

- Describe the nature and value of a business analytics toolset.
- Explain how predictive analytics works and what it uses.

12-3 How do business intelligence and business analytics support decision making?

- Explain how management information systems and transaction processing systems interact.
- Distinguish between a production report and a parameterized report.
- List three different production reports that might be generated by a sales department.
- Explain how a business would use data from the Internet of Things.

12-4 How do different decision-making constituencies in an organization use business intelligence?

- List each of the major decision-making constituencies in an organization and describe the types of decisions each makes.
- Describe how MIS, DSS, or ESS provide decision support for each of these groups.
- Define and describe the balanced scorecard method and business performance management.

Discussion Questions

12-5 As a manager or user of information systems, what would you need to know to participate in the design and use of a DSS or an ESS? Why?

12-6 If businesses used DSS and ESS more widely, would managers and employees make better decisions? Why or why not?

12-7 How much can business intelligence and business analytics help companies refine their business strategy? Explain your answer.

Hands-On MIS Projects

The projects in this section give you hands-on experience identifying opportunities for DSS, using a spreadsheet pivot table to analyze sales data, and using online retirement planning tools for financial planning. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

12-8 Dealerships for Subaru and other automobile manufacturers keep records of the mileage of cars they sell and service. Mileage data are used to remind customers of when they need to schedule service appointments, but they are used for other purposes as well. What kinds of decisions does this piece of

data support at the local level and at the corporate level? What would happen if this piece of data were erroneous, for example, showing mileage of 130,000 instead of 30,000? How would it affect decision making? Assess its business impact.

- 12-9** Applebee's is one of the the largest casual dining chains in the world, with more than 1,700 locations throughout 19 countries. The menu features beef, chicken, and pork items as well as burgers, pasta, and seafood. Applebee's CEO wants to make the restaurant more profitable by developing menus that are tastier and contain more items that customers want and are willing to pay for despite rising costs for agricultural products. How might business intelligence help management implement this strategy? What pieces of data would Applebee's need to collect? What kinds of reports would be useful to help management make decisions on how to improve menus and profitability?

Improving Decision Making: Using Pivot Tables to Analyze Sales Data

Software skills: Pivot tables

Business skills: Analyzing sales data

- 12-10** This project gives you an opportunity to learn how to use Excel's PivotTable feature to analyze a database or data list. Use the data file for Online Management Training Inc. described earlier in the chapter. This is a list of the sales transactions at OMT for one day. You can find this spreadsheet file at MyLab MIS. Use Excel's PivotTable to help you answer the following questions:

- Where are the average purchases higher? The answer might tell managers where to focus marketing and sales resources, or pitch different messages to different regions.
- What form of payment is the most common? The answer could be used to emphasize in advertising the most preferred means of payment.
- Are there any times of day when purchases are most common? Do people buy more products while at work (likely during the day) or at home (likely in the evening)?
- What's the relationship between region, type of product purchased, and average sales price?
- We provide instructions on how to use Excel PivotTables in our Learning Tracks.

Improving Decision Making: Using a Web-Based DSS for Retirement Planning

Software skills: Internet-based software

Business skills: Financial planning

- 12-11** This project will help develop your skills in using web-based DSS for financial planning.

The websites for CNN Money and Kiplinger feature web-based DSS for financial planning and decision making. Select either site to plan for retirement. Use your chosen site to determine how much you need to save to have enough income for your retirement. Assume that you are 50 years old and single and plan to retire in 17 years. You have \$100,000 in savings. Your current annual income is \$85,000. Your goal is to be able to generate an annual retirement income of \$60,000, including Social Security payments.

Use the website you have selected to determine how much money you need to save to help you achieve your retirement goal. If you need to calculate your estimated Social Security payments, use the Quick Calculator at the Social Security Administration website.

Critique the site—its ease of use, its clarity, the value of any conclusions reached, and the extent to which the site helps investors understand their financial needs and the financial markets.

Collaboration and Teamwork Project

Investigating Data-Driven Analytics in Sports

- 12-12** With three or four of your classmates, select a sport, such as football, baseball, basketball, or soccer. Use the web to research how the sport uses data and analytics to improve team performance or increase ticket sales to events. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Should an Algorithm Make Our Decisions?

CASE STUDY

Darnell Gates of Philadelphia had been jailed for running a car into a house in 2013 and later for violently threatening his former domestic partner. When he was released in 2018, he was initially required to visit a probation officer once a week because he had been identified as "high risk" by a computer algorithm. Gates's probation office visits were eventually stretched to every two weeks and then once a month, but conversations with probation officers remained impersonal and perfunctory, with the officers rarely taking the time to understand Gates's rehabilitation. What Gates didn't know was that a computer algorithm developed by a University of Pennsylvania professor had made the "high risk" determination that governed his treatment.

This algorithm is one of many now being used to make decisions about people's lives in the United States and Europe. Predictive algorithms are being used to determine prison sentences, probation rules, and police patrols. It is often not clear how these automated systems are making their decisions. Many countries and states have few rules requiring disclosure of algorithms' formulae. And even if governments provide explanation of how the systems arrive at their decisions, the algorithms are often too difficult for a layperson to understand.

The Rotterdam city government has used such algorithms to identify risks for welfare and tax fraud. A program called System Risk Indication scans data from various government authorities to flag people who may be claiming unemployment benefits when they are working, or receiving a housing subsidy for living alone when they are actually living with several others. According to the Ministry of Social Affairs and Employment, which runs this program, data examined include income, education, property, rent, debt, car ownership, home address, and the welfare benefits received for housing, health care, and children. The algorithm produces "risk reports" on individuals who should be investigated. When the system was used most recently in Rotterdam, it produced 1,263 risk reports in two neighborhoods. People who are on the list are not told how the algorithm is making its decisions and whether they are on the register, nor are they shown ways to appeal. An October 2019 report by the United Nations

special rapporteur on extreme poverty criticized the Dutch system for creating a "digital welfare state" that turns crucial decisions about people's lives over to machines.

Rotterdam citizens, along with privacy rights groups, civil rights lawyers, and the largest national labor union rallied against System Risk Indication. A district court ordered an immediate halt to the risk algorithm's use. The court stated that the System Risk Indication program lacked privacy safeguards and that the government was insufficiently transparent about how it worked. The decision can be appealed.

Bristol, England is using an algorithm to compensate for tight budgets that reduced social services. A team that includes representatives from the police and children's services meets weekly to review results from an algorithm that tries to identify youths in the city who are most at risk for crime and children who are most in need. In 2019, Bristol introduced a software program that creates a risk score based on data extracted from police reports, social benefits, and other government records. The risk score takes into account crime, school attendance, and housing data, known ties to others with high risk scores, and whether a youth's parents were involved in a domestic incident. The scores fluctuate, depending on how recently a youth had an incident such as a school suspension.

There is evidence that Bristol's algorithm is identifying the right people, and there are human decision makers governing its use. Charlene Richardson and Desmond Brown, two city workers who are responsible for aiding young people flagged by the software, acknowledge that the computer doesn't always get it right, so they do not rely on it entirely. The city government has been open with the public about the program. The government has posted some details online and staged community events. However, opponents believe the program isn't fully transparent. Young people and their parents do not know if they are on the list, and have no way to contest their inclusion.

Studies of algorithms in credit scoring, hiring, policing, and health care have found that poorly designed algorithms can reinforce racial and gender

biases. According to Solon Barocas, an assistant professor at Cornell University and principal researcher at Microsoft Research, algorithms can appear to be very data-driven, but there are subjective decisions that go into setting up the problem in the first place.

For example, a study by Ziad Obermeyer, a health policy researcher at the University of California, Berkeley, and colleagues, published in October 2019 in the journal *Science*, examined an algorithm widely used in hospitals to establish priorities for patient care. The study found that black patients were less likely than white patients to receive extra medical help, despite being sicker. The algorithm has been used in the Impact Pro program from Optum, United Health Group's health services arm, to identify patients with heart disease, diabetes, and other chronic illnesses who could benefit from more attention from nurses, pharmacists, and case workers in managing their prescriptions, scheduling doctor visits, and monitoring their overall health.

The algorithm assigned healthier white patients the same ranking as black patients who had one more chronic illness as well as poorer laboratory results and vital signs. To identify people with the greatest medical needs, the algorithm looked at patients' medical histories and how much was spent treating them, and then predicted who was likely to have the highest costs in the future. The algorithm used costs to rank patients.

The algorithm wasn't intentionally racist—in fact, it specifically excluded race. Instead, to identify patients who would benefit from more medical support, the algorithm used a seemingly race-blind metric: how much patients would cost the health-care system in the future. But cost isn't a race-neutral measure of health-care need. Black patients incurred about \$1,800 less in medical costs per year than white patients with the same number of chronic conditions; thus the algorithm scored white patients as equally at risk of future health problems as black patients who had many more diseases.

When the researchers searched for the source of the scores, they discovered that Impact Pro was using bills and insurance payouts as indicators for a person's overall health. However, health care costs tend to be lower for black patients, regardless of their actual well-being. Compared with white patients, many black patients live farther from their hospitals, making it harder to visit them regularly. They also tend to have less flexible job schedules and more child care responsibilities.

As a result, black patients with the highest risk scores had higher numbers of serious chronic conditions than white patients with the same scores, including cancer and diabetes, the researchers reported. Compared with white patients with the same risk scores, black patients also had higher blood pressure and cholesterol levels, more severe diabetes, and worse kidney function.

By using medical records, laboratory results, and vital signs of the same set of patients, the researchers found that black patients were sicker than white patients who had a similar predicted cost. By revising the algorithm to predict the number of chronic illnesses that a patient will likely experience in a given year—rather than the cost of treating those illnesses—the researchers were able to reduce the racial disparity by 84 percent. When the researchers sent their results to Optum, it replicated their findings and committed to correcting its model.

Civil rights lawyers, labor unions, community organizers, and some government agencies are trying to find ways to push back against the growing dependence on automated systems that remove humans from the decision making process. Media Mobilizing Project in Philadelphia and MediaJustice in Oakland, California have compiled a nationwide database of prediction algorithms. Community Justice Exchange, a national organization supporting community organizers, has issued a guide advising organizers on how to confront the use of algorithms. Idaho passed a law in 2019 specifying that the methods and data used in bail algorithms should be publicly available so that the general public can understand how they work.

Concerns about biases have always been present whenever people make important decisions. What's new is the much larger scale at which we rely on algorithms in automated systems to help us decide, and even to take over the decision making for us. Algorithms are helpful in making predictions that will help guide decision makers, but decision making requires much more. Good decision making requires bringing together and reconciling multiple points of view and the ability to explain why a particular path was chosen.

As automated systems increasingly shift from predictions to decisions, focusing on the fairness of algorithms is not enough because their output is just one of the inputs for a human decision maker. One must also look at how human decision makers interpret and integrate the output from algorithms and under what conditions they would deviate from

an algorithmic recommendation. Which aspects of a decision process should be handled by an algorithm and which by a human decision maker to obtain fair and reliable outcomes?

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CASE STUDY QUESTIONS

- 12-13** What are the problems in using algorithms and automated systems for decision making?
- 12-14** What management, organizational, and technology factors have contributed to the problem?
- 12-15** Should automated systems be used to make decisions? Explain your answer.

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PART FOUR

Building and Managing Systems

CHAPTER 13

Building Information Systems

CHAPTER 15

Managing Global Systems

CHAPTER 14

Making the Business Case for
Information Systems and Managing
Projects

PART FOUR shows how to use the knowledge acquired in earlier chapters to analyze and design information system solutions to business problems. This part answers questions such as these: How can I develop a solution to an information system problem that provides genuine business benefits? How can the firm adjust to the changes introduced by the new system solution? What alternative approaches are available for building system solutions?

13

Building Information Systems

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 13-1** How does building new systems produce organizational change?
- 13-2** What are the core activities in the systems development process?
- 13-3** What are the principal methodologies for modeling and designing systems?
- 13-4** What are alternative methods for building information systems?
- 13-5** What are new approaches for system building in the digital firm era?
- 13-6** How will MIS help my career?

CHAPTER CASES

- Vinci Energies Builds a New Mobile Employee Time Sheet App
- Business Process Redesign at DP World
- McAfee Turns to Automated Software Testing
- Pick n Pay's Cloud Migration to Enhance Business Intelligence

VIDEO CASES

- IBM: Business Process Management in a SaaS Environment
- IBM Helps the City of Madrid with Real-Time BPM Software

Instructional Videos:

- BPM Business Process Management
- Customer Story
- Workflow Management Visualized

MyLab MIS

Discussion Questions: 13-6, 13-7, 13-8; Hands-On MIS Projects: 13-9, 13-10, 13-11, 13-12;
eText with Conceptual Animations

Vinci Energies Builds a New Mobile Employee Time Sheet App

Vinci Energies, part of the Vinci Group and headquartered in France, is a growing professional services company for the construction, energy, and information technology industries. It provides solutions for infrastructure, building, and information and communications technology (ICT), and develops and maintains efficient energy infrastructures. The company had 1,800 business units with over 82,000 employees in 55 countries and global revenue of 13.8 billion Euros (U.S. \$15 billion) in 2019.

Vinci had pursued a strong acquisition strategy, tripling in size between 2009 and 2019. Vinci moved all of its companies worldwide to a single instance of SAP S/4HANA, SAP's next generation of ERP software, so that the entire enterprise would operate on a common set of business processes. The company was able to migrate to the new SAP S/4HANA system in August 2018, and wanted additional applications created using the SAP platform.

What Vinci produces are actually services, so the business is entirely project-based, and each project has its own financial arrangements with clients. Every cost for the company (such as hours worked or equipment rental) is tied to a specific project, and a single employee might be working on multiple projects. If an employee in the field works on more than one project on a given day, that person might need to input 2 hours spent on one project and 4 hours 15 minutes spent on another. That person might also have to add equipment rental costs for one of these projects. Management uses this information to determine whether a project is earning or losing money for the business. Vinci Energies manages about 400,000 projects worldwide each year, each valued at about 20,000 to 25,000 Euros (U.S. \$22,000 to \$27,000).

Vinci's existing systems, which were heavily manual, made it very difficult and time-consuming to keep track of all these project costs. Employees working in the field (many of whom traveled to perform construction and maintenance at remote sites) would have to return to the office to enter project and time sheet data online into the SAP system. The company needed a new employee time sheet application that could capture worker time sheets as well as project costs and activities for multiple projects from any location. The time sheet and project data would be able to be viewed by other authorized users online.

Vinci undertook a pilot project using SAP Cloud Platform for this purpose. SAP Cloud Platform is an enterprise Platform-as-a-Service (PaaS), which lets



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organizations build, extend, and integrate business applications in the cloud. It has an intuitive user interface and simple development tools. Vinci developed an app called MOBITIME, using this tool within a seven-month period. Business and application users spent considerable time discussing business processes and data entry screen design to make sure the system had the correct functionality, the design was acceptable, and people were comfortable using the software.

MOBITIME is only available online, but employees can easily access it on tablets and mobile phones when they are in the field. They are able to enter time sheet data or other project costs using a single application, which transmits the data to update the new SAP S/4HANA system. MOBITIME's interface is easily navigable and allows employees to input all the data in one place. After transmission to the SAP S/4HANA system, the data can be viewed at the back office to help project managers keep track of their projects' various costs.

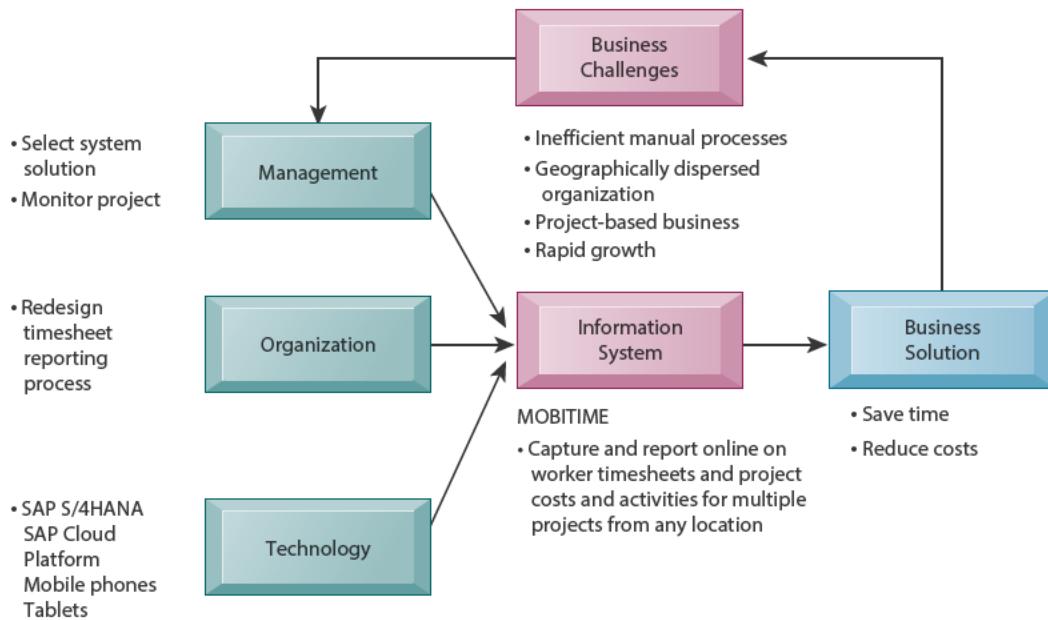
Sources: www.vinci.com, accessed April 8, 2020; Lauren Bonneau, "VINCI Energies Simplifies Employees' Lives with New Timesheet-Entry Application," SAPInsider, February 28, 2019; www.sap.com, accessed April 9, 2020; and Lauren Meyerhoff, "With an Aggressive Acquisition Strategy, Vinci Energies Triples Its Size In 10 Years," *Forbes*, September 5, 2019.

Vinci Energies's experience illustrates some of the steps required to design and build new information systems. Building a new system for mobile time sheet entry entailed analyzing the organization's problems with existing systems, assessing information requirements, selecting appropriate technology, and redesigning business processes and jobs. Management had to oversee the systems-building effort and evaluate benefits and costs. The information requirements were incorporated into the design of the new system, which represented a process of planned organizational change.

The chapter-opening case calls attention to important points raised by this case and this chapter. Vinci Energies was a far-flung business that had been growing very quickly over the past ten years. It had thousands of employees, many of whom worked remotely, and many thousands of projects to monitor, and there were other costs to track besides time worked on a project. Vinci's ability to keep track of projects and analyze project costs was hampered by inefficient manual processes, which raised costs and slowed down work, and limited the company's ability to quickly and thoroughly analyze its project data.

The solution was to implement a new app called MOBITIME that could be accessed online by employees in the field using tablets and mobile phones as well as in the back office. The app provides data entry and reporting for an employee's multiple projects with multiple types of costs. Vinci's information requirements were incorporated into the system design. The system was more user-friendly. The solution encompassed not just the application of new technology, but changes to corporate culture, business processes, and job functions.

Here are some questions to think about: How did MOBITIME meet Vinci Energies's information requirements? How much did the new system change the way Vinci ran its business?



13-1 How does building new systems produce organizational change?

Building a new information system is one kind of planned organizational change. The introduction of a new information system involves much more than new hardware and software. It also includes changes in jobs, skills, management, and organization. When we design a new information system, we are redesigning the organization. System builders must understand how a system will affect specific business processes and the organization as a whole.

Systems Development and Organizational Change

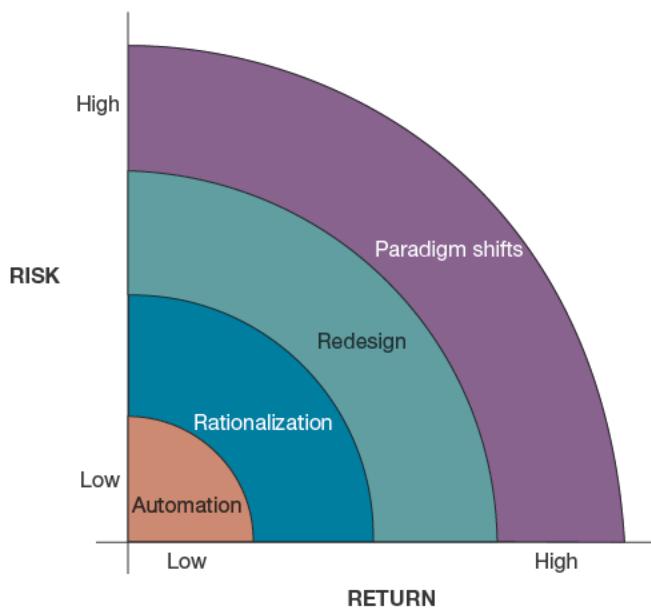
Information technology can promote various degrees of organizational change, ranging from incremental to far-reaching. Figure 13.1 shows four kinds of structural organizational change that are enabled by information technology: (1) automation, (2) rationalization, (3) business process redesign, and (4) paradigm shifts. Each carries different risks and rewards.

The most common form of IT-enabled organizational change is **automation**. The first applications of information technology involved assisting employees with performing their tasks more efficiently and effectively. Calculating paychecks and payroll registers, giving bank tellers instant access to customer deposit records, and developing a nationwide reservation network for airline ticket agents are all examples of early automation.

A deeper form of organizational change—one that follows quickly from early automation—is **rationalization of procedures**. Automation frequently reveals new bottlenecks in production and makes the existing arrangement of procedures and structures painfully cumbersome. Rationalization of procedures is the streamlining of standard operating procedures. For example, Vinci Energies's new system for processing employee time sheets is effective not only because it uses computer technology but also because the company simplified its business processes for this function. Fewer manual steps are required.

FIGURE 13.1 ORGANIZATIONAL CHANGE CARRIES RISKS AND REWARDS

The most common forms of organizational change are automation and rationalization. These relatively slow-moving and slow-changing strategies present modest returns but little risk. Faster and more comprehensive change—such as redesign and paradigm shifts—carries high rewards but offers substantial chances of failure.



Rationalization of procedures is often found in programs for making a series of continuous quality improvements in products, services, and operations, such as total quality management (TQM) and Six Sigma. **Total quality management (TQM)** makes achieving quality an end in itself and the responsibility of all people and functions within an organization. TQM derives from concepts developed by American quality experts such as W. Edwards Deming and Joseph Juran, but it was popularized by Japanese organizations. **Six Sigma** is a specific measure of quality, representing 3.4 defects per million opportunities. Most companies cannot achieve this level of quality but use six sigma as a goal for driving ongoing quality improvement programs.

A more powerful type of organizational change is **business process redesign**, in which business processes are analyzed, simplified, and redesigned. Business process redesign reorganizes workflows, combining steps to cut waste and eliminate repetitive, paper-intensive tasks. (Sometimes the new design eliminates jobs as well.) It is much more ambitious than rationalization of procedures, requiring a new vision of how the process is to be organized. The Interactive Session on Organizations presents another example.

Rationalizing procedures and redesigning business processes are limited to specific parts of a business. New information systems can ultimately affect the design of the entire organization by transforming how the organization carries out its business or even the nature of the business. For instance, the long-haul trucking and transportation firm Schneider National used new information systems to change its business model. Schneider created a new business managing logistics for other companies. This more radical form of business change is called a **paradigm shift**. A paradigm shift involves rethinking the nature of the business and the nature of the organization.

INTERACTIVE SESSION ORGANIZATIONS

Business Process Redesign at DP World

DP World is one of the leading port operators in the world, involved in marine and inland terminal operations while providing technology-driven solutions to clients. Headquartered in Dubai, it has 78 terminals and businesses in around 40 countries spread over 6 continents, with a market capitalization of around \$12 billion and revenue of \$8.5 billion.

DP World employs around 50,000 people and moves up to 174,000 containers every day. In 2019, it handled an equivalent of 71.2 million containers. DP World is growing aggressively and is always looking for ways to improve how it handles cargo. To do this, it has to incorporate technology, which today encompasses everything from middleware to the latest in blockchain applications.

Several processes at DP World used to be manual and paper-based, and therefore repetitive, time-consuming, and prone to errors. Managers had to spend time and resources on operational issues and ensure that their employees remained motivated while also resolving the problems that resulted from duplicated manual tasks.

In its search for ways to enhance its services, DP World (then known as Dubai Port Management) recognized that customer service could be vastly improved by reducing transaction time and making the process simpler. For instance, at the time, customers often had to submit multiple copies of the same documents or different versions of the same documents to several departments. This not only caused delays during the process but also unnecessarily duplicated it over the course of its life cycle.

Using IBM's WebSphere MQ technology, DP World created a centralized system that sends validated versions of documents to all related departments. IBM's WebSphere technology is a middleware product, which is an interface to communicate between different applications. IBM's WebSphere MQ technology is also extremely flexible, robust, and scalable, which meant DP World did not need to worry about changing the system anytime soon—after implementing it, it connected its three existing systems seamlessly using the middleware. The whole implementation simplified the overall system and significantly reduced the time it took to finish a process.

DP World has also partnered with Oracle to drive digital transformation across its business operations. Oracle's cloud applications (SaaS) are enabling DP World to standardize by redesigning business processes that include human resources, procurement, finance, and operations in an integrated technology platform. The objective is to create value for all stakeholders through intelligent logistics, with a focus on reducing cost and improving efficiency. This integrated technology platform incorporates AI, IoT, and blockchain technology.

Ports generate a huge amount of data, and AI's job is to use this data to transform port operations and make them more efficient. Robots are becoming increasingly more "intelligent" and flexible in their learning capabilities, and AI can help planners find optimal solutions for ideal stowage and to plan shipyards' layouts. Although DP World does not currently use physical robots, it does use AI-driven chatbots for various tasks. Another use is in fleet management; IoT can monitor the conditions and location of assets through sensors and send information about possible delays or damage to goods. It can also send temperature and humidity data for analysis and plan things accordingly across the process.

Use of blockchain is especially exciting for DP World. Blockchain is a distributed transaction database that uses encryption to identify participants and products as they move through the supply chain. Blockchain has enormous potential to transform port-related activities by making it possible to track petroleum products from the well all the way to the retailers throughout the world. The increasing complexity of port operations has led to less transparency in the whole process. Terrorism and illegal trade are prominent concerns, and this is where blockchain comes in: the highly secure and scalable system will be invaluable for tracking goods, contract exchanges, and payments.

DP World's management strongly believes that supply chain intelligence, blockchain, and AI will make the global supply chain quicker, more cost-effective, and more productive. They see blockchain in particular as a transformative technology offering the promise of innovation in goods visibility across

the supply chain. The whole idea is to add business value and differentiate DP World in the market, helping it to keep growing as a digitized global trade enabler. DP World is also implementing Oracle Fusion ERP as a platform to build consistency across its multiple geographies and has begun to deploy it across its various operations.

Sources: DP World website, www.dpworld.com, accessed January 13, 2021; Naushad Cherrayil, "DP World Deploys Disruptive Technologies to Rev Up Digital Transformation Journey," techrader.com, March 1, 2020;; Louise Tegner, "DP World Extends Strategic Collaboration with Oracle to Accelerate Global Digital Transformation in the Cloud," blog.oracle.com, May 21, 2018; James Dartnell, "The 5 Technologies That Will Transform DP World," TahawulTech.com, March 1, 2018; "DP World Jumps on the Digitization Bandwagon," [World Maritime News](https://WorldMaritimeNews.com), January 31, 2018; Matthew Southwell, "Dubai Ports and Customs Accelerates Import/Export with IBM," [Arabian Business](https://ArabianBusiness.com), February 25, 2002.

CASE STUDY QUESTIONS

1. What is business process redesign? Why might BPR fail in an organization?
2. Do you think the IBM WebSphere MQ technology adopted by DP World was a good solution? What advantages can you identify?
3. Do you think AI could have other uses in port operations?
4. Explain IoT technology and the possible problems that may arise in implementing it.
5. What are the four types of organizational change? Give an example of each type from this case.

Case contributed by Saadat Alhashmi, University of Sharjah

Paradigm shifts and business process redesign often fail because extensive organizational change is so difficult to orchestrate (see Chapter 14). Why, then, do so many corporations contemplate such radical change? Because the rewards are equally high (see Figure 13.1). In many instances, firms seeking paradigm shifts and pursuing reengineering strategies achieve stunning, order-of-magnitude increases in their returns on investment (or productivity). Some of these success stories, and some failure stories, are included throughout this book.

Business Process Redesign

Like DP World, described in the Interactive Session on Organizations, many businesses today are trying to use information technology to improve their business processes. Some of these systems entail incremental process change, but others require more far-reaching redesign of business processes. To deal with these changes, organizations are turning to business process management. **Business process management (BPM)** provides a variety of tools and methodologies to analyze existing processes, design new processes, and optimize those processes. BPM is never concluded because process improvement requires continual change. Companies practicing business process management go through the following steps:

1. **Identify processes for change:** One of the most important strategic decisions that a firm can make is not deciding how to use computers to improve business processes but understanding what business processes need improvement. When systems are used to strengthen the wrong business model or business processes, the business can become more efficient at doing what it should not do. As a result, the firm becomes vulnerable to competitors who may have discovered the right business model. Considerable time and cost

may also be spent improving business processes that have little impact on overall firm performance and revenue. Managers need to determine what business processes are the most important and how improving these processes will help business performance.

2. **Analyze existing processes:** Existing business processes should be modeled and documented, noting inputs, outputs, resources, and the sequence of activities. The process design team identifies redundant steps, paper-intensive tasks, bottlenecks, and other inefficiencies.
3. **Design the new process:** Once the existing process is mapped and measured in terms of time and cost, the process design team will try to improve the process by designing a new one. A new streamlined “to-be” process will be documented and modeled for comparison with the old process.
4. **Implement the new process:** Once the new process has been thoroughly modeled and analyzed, it must be translated into a new set of procedures and work rules. New information systems or enhancements to existing systems may have to be implemented to support the redesigned process. The new process and supporting systems are rolled out into the business organization. As the business starts using this process, problems are uncovered and addressed. Employees working with the process may recommend improvements.
5. **Continuous measurement:** Once a process has been implemented and optimized, it needs to be continually measured. Why? Processes may deteriorate over time as employees fall back on old methods, or they may lose their effectiveness if the business experiences other changes.

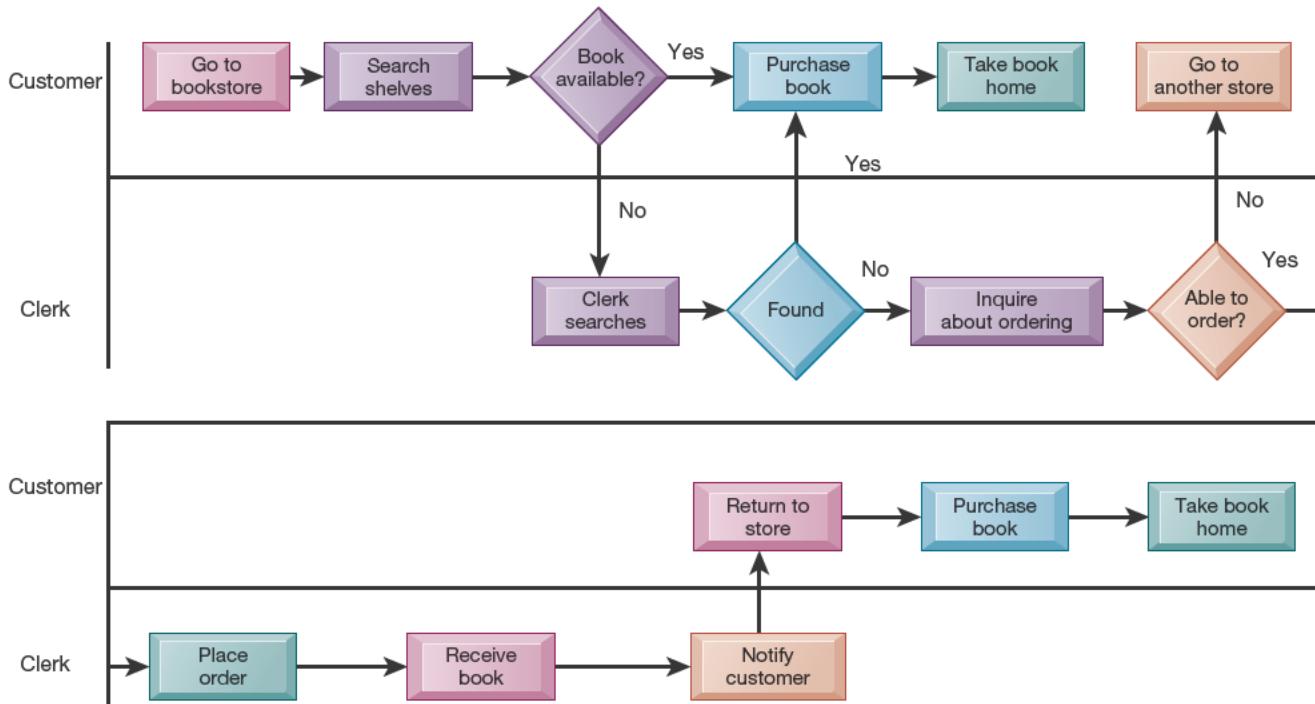
Figure 13.2 illustrates the “as-is” process for purchasing a book from a physical bookstore. Consider what happens when a customer visits a physical bookstore and searches its shelves for a book. If he or she finds the book, that person takes it to the checkout counter and pays for it via credit card, cash, or check. If the customer is unable to locate the book, he or she must ask a bookstore clerk to search the shelves or check the bookstore’s inventory records to see if it is in stock. If the clerk finds the book, the customer purchases it and leaves. If the book is not available locally, the clerk inquires about ordering it for the customer from the bookstore’s warehouse or from the book’s distributor or publisher. Once the ordered book arrives at the bookstore, a bookstore employee telephones the customer with this information. The customer would have to go to the bookstore again to pick up the book and pay for it. If the bookstore is unable to order the book for the customer, the customer would have to try another bookstore. You can see that this process has many steps and might require the customer to make multiple trips to the bookstore.

Figure 13.3 illustrates how the book-purchasing process can be redesigned by taking advantage of the Internet. The customer accesses an online bookstore over the Internet from his or her computer. He or she searches the bookstore’s online catalog for the book he or she wants. If the book is available, the customer orders the book online, supplying credit card and shipping address information, and the book is delivered to the customer’s home. If the online bookstore does not carry the book, the customer selects another online bookstore and searches for the book again. This process has far fewer steps than those for purchasing the book in a physical bookstore, requires much less effort on the part of the customer, and requires less sales staff for customer service. The new process is therefore much more efficient and time-saving.

The new process design needs to be justified by showing how much it reduces time and cost or enhances customer service and value. Management first measures the time and cost of the existing process as a baseline. In our example,

FIGURE 13.2 AS-IS BUSINESS PROCESS FOR PURCHASING A BOOK FROM A PHYSICAL BOOKSTORE

Purchasing a book from a physical bookstore requires many steps to be performed by both the seller and the customer.

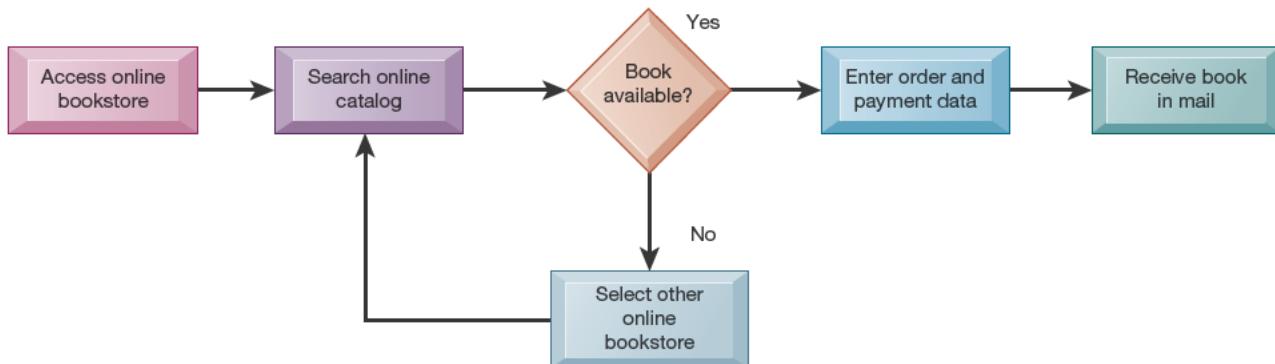


the time required for purchasing a book from a physical bookstore might range from 15 minutes (if the customer immediately finds what he or she wants) to 30 minutes if the book is in stock but has to be located by sales staff. If the book has to be ordered from another source, the process might take one or two weeks and another trip to the bookstore for the customer. If the customer lives far away from the bookstore, the time to travel to the bookstore would have to be factored in. The bookstore will have to pay the costs for maintaining a physical store and keeping the book in stock, for sales staff on site, and for shipment costs if the book has to be obtained from another location.

The new process for purchasing a book online might only take several minutes, although the customer might have to wait several days or a week to have

FIGURE 13.3 REDESIGNED PROCESS FOR PURCHASING A BOOK ONLINE

Using Internet technology makes it possible to redesign the process for purchasing a book so that it requires fewer steps and consumes fewer resources.



the book delivered and will have to pay a shipping charge. But the customer saves time and money by not having to travel to the bookstore or make additional visits to pick up the book. Booksellers' costs are lower because they do not have to pay for a physical store location or for local inventory.

Although many business process improvements are incremental and ongoing, there are occasions when more radical change must take place. Our example of a physical bookstore redesigning the book-purchasing process so that it can be carried out online is an example of this type of radical, far-reaching change. When properly implemented, business process redesign produces dramatic gains in productivity and efficiency and may even change the way the business is run. In some instances, it drives a "paradigm shift" that transforms the nature of the business itself.

This actually happened in book retailing when Amazon challenged traditional physical bookstores with its online retail model and Kindle e-book reader. By radically rethinking the way a book can be published, purchased, and sold, Amazon and other online bookstores have achieved remarkable efficiencies, cost reductions, and a whole new way of doing business.

BPM poses challenges. Executives report that the largest single barrier to successful business process change is organizational culture. Employees do not like unfamiliar routines and often try to resist change. This is especially true of projects where organizational changes are very ambitious and far-reaching. Managing change is neither simple nor intuitive, and companies committed to extensive process improvement need a good change management strategy (see Chapter 14).

Tools for Business Process Management

Many software firms provide tools for various aspects of BPM, including IBM, Oracle, and TIBCO. These tools help businesses identify and document processes requiring improvement, create models of improved processes, capture and enforce business rules for performing processes, and integrate existing systems to support new or redesigned processes. BPM software tools also provide analytics for verifying that process performance has been improved and for measuring the impact of process changes on key business performance indicators.

BT Group plc (formerly British Telecom) used Pegasystems BPM software to streamline customer-facing business processes. After BT acquired EE (formerly Everything Everywhere), a British mobile network operator and internet service provider, BT had to integrate information across two different organizations with disparate processes and technology tools. Pegasystems software helped BT connect customer data from multiple CRM systems to provide both customer service agents and users with a simple, streamlined decision-making process for customer interactions across multiple channels, reducing the need to switch between more than 100 applications (Pegasystems, 2021).

13-2 What are the core activities in the systems development process?

New information systems are an outgrowth of organizational problem solving. A new information system is built as a solution to some type of problem or set of problems the organization perceives it is facing. The problem may be one in which managers and employees realize that the organization is not performing

as well as expected or that the organization should take advantage of new opportunities to perform more successfully.

The activities that go into producing an information system solution to an organizational problem or opportunity are called **systems development**. Systems development is a structured kind of problem solved with distinct activities. These activities consist of systems analysis, systems design, programming, testing, conversion, and production and maintenance.

Figure 13.4 illustrates the systems development process. The systems development activities depicted usually take place in sequential order. But some of the activities may need to be repeated, and some may take place simultaneously depending on the approach to system building that is being employed (see Section 13-4).

Systems Analysis

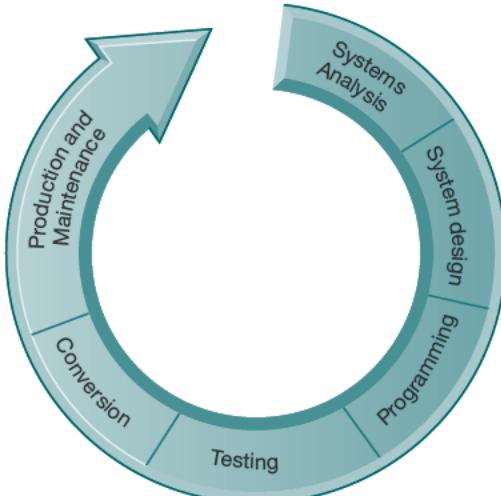
Systems analysis is the analysis of a problem that a firm tries to solve with an information system. It consists of defining the problem, identifying its causes, specifying the solution, and identifying the information requirements that must be met by a system solution.

The systems analyst creates a road map of the existing organization and systems, identifying the primary owners and users of data along with existing hardware and software. The systems analyst then details the problems of existing systems. By examining documents, work papers, and procedures, observing system operations, and interviewing key users of the systems, the analyst can identify the problem areas and objectives a solution would achieve. Often, the solution requires building a new information system or improving an existing one.

The systems analysis also includes a **feasibility study** to determine whether that solution is feasible, or achievable, from a financial, technical, and organizational standpoint. The feasibility study determines whether the proposed system is expected to be a good investment, whether the technology needed for the system is available and can be handled by the firm's information systems specialists, and whether the organization can handle the changes introduced by the system.

FIGURE 13.4 THE SYSTEMS DEVELOPMENT PROCESS

Building a system can be broken down into six core activities.



Normally, the systems analysis process identifies several alternative solutions that the organization can pursue and assesses the feasibility of each. A written systems proposal report describes the costs and benefits, and the advantages and disadvantages, of each alternative. It is up to management to determine which mix of costs, benefits, technical features, and organizational impacts represents the most desirable alternative.

Establishing Information Requirements

Perhaps the most challenging task of the systems analyst is to define the specific information requirements that must be met by the chosen system solution. At the most basic level, the **information requirements** of a new system involve identifying who needs what information, where, when, and how. Requirements analysis carefully defines the objectives of the new or modified system and develops a detailed description of the functions that the new system must perform. Faulty requirements analysis is a leading cause of systems failure and high systems development costs (see Chapter 14). A system designed around the wrong set of requirements will either have to be discarded because of poor performance or will need to undergo major modifications. Section 13-4 describes alternative approaches to eliciting requirements that help minimize this problem.

Some problems do not require an information system solution but instead need an adjustment in management, additional training, or refinement of existing organizational procedures. If the problem is information-related, systems analysis still may be required to diagnose the problem and arrive at the proper solution.

Systems Design

Systems analysis describes what a system should do to meet information requirements, and **systems design** shows how the system will fulfill this objective. The design of an information system is the overall plan or model for that system. Like the blueprint of a building or house, it consists of all the specifications that give the system its form and structure.

The systems designer details the system specifications that will deliver the functions identified during systems analysis. These specifications should address all of the managerial, organizational, and technological components of the system solution. Table 13.1 lists the types of specifications that would be produced during systems design.

Like houses or buildings, information systems may have many possible designs. Each design represents a unique blend of technical and organizational components. What makes one design superior to others is the ease and efficiency with which it fulfills user requirements within a specific set of technical, organizational, financial, and time constraints.

The Role of End Users

User information requirements drive the entire system-building effort. Users must have sufficient control over the design process to ensure that the system reflects their business priorities and information needs, not the biases of the technical staff. Working on design increases users' understanding and acceptance of the system. As we describe in Chapter 14, insufficient user involvement in the design effort is a major cause of system failure. However, some systems require more user participation in design than others, and Section 13-4 shows how alternative systems development methods address the user participation issue.

TABLE 13.1 SYSTEM DESIGN SPECIFICATIONS

OUTPUT	PROCESSING	DOCUMENTATION
Medium	Computations	Operations documentation
Content	Program modules	Systems documentation
Timing	Required reports	User documentation
INPUT	Timing	CONVERSION
Origins		Data conversion rules
Flow	What activities	Testing method
Data entry	Who performs them	Conversion strategy
USER INTERFACE	When	TRAINING
Simplicity	How	Training techniques
Efficiency	Where	Training modules
Logic		ORGANIZATIONAL CHANGES
Feedback	CONTROLS	Task redesign
Errors	Input controls (characters, limit, reasonableness)	Job design
DATABASE DESIGN	Processing controls (consistency, record counts)	Process design
Logical data model	Output controls (totals, samples of output)	Organization structure design
Volume and speed requirements	Procedural controls (passwords, special forms)	Reporting relationships
Record specifications		
	SECURITY	
	Access controls	
	Catastrophe plans	
	Audit trails	

Completing the Systems Development Process

The remaining steps in the systems development process translate the solution specifications established during systems analysis and design into a fully operational information system. These concluding steps consist of programming, testing, conversion, production, and maintenance.

Programming

During the **programming** stage, system specifications that were prepared during the design stage are translated into software program code. Today, many organizations no longer do their own programming for new systems. Instead, they purchase the software that meets the requirements for a new system from external sources such as software packages from a commercial software vendor, software services from a software service provider, or outsourcing firms that develop custom application software for their clients (see Section 13-4).

Testing

Exhaustive and thorough **testing** must be conducted to ascertain whether the system produces the right results. Testing answers the question: Will the system produce the desired results under known conditions? Some companies are starting to use cloud computing services for this work.

The amount of time needed to answer this question has been traditionally underrated in systems project planning (see Chapter 14). Testing is time-consuming: Test data must be carefully prepared, results reviewed, and corrections made in the system. In some instances, parts of the system may have to be redesigned. The risks resulting from glossing over this step are enormous. (See the Interactive Session on Technology on automated testing.)

Testing an information system can be broken down into three types of activities: unit testing, system testing, and acceptance testing. **Unit testing**, or program testing, consists of testing each program separately in the system. It is widely believed that the purpose of such testing is to guarantee that programs are error-free, but this goal is realistically impossible. Testing should be viewed instead as a means of locating errors in programs, by focusing on finding all the ways to make a program fail. Once they are pinpointed, problems can be corrected.

System testing tests the functioning of the information system as a whole. It tries to determine whether discrete modules will function together as planned and whether discrepancies exist between the way the system actually works and the way it was conceived. Among the areas examined are performance time, capacity for file storage and handling peak loads, recovery and restart capabilities, and manual procedures.

Acceptance testing provides the final certification that the system is ready to be used in a production setting. Systems tests are evaluated by users and reviewed by management. When all parties are satisfied that the new system meets their standards, the system is formally accepted for installation.

The systems development team works with users to devise a systematic test plan. The **test plan** includes all of the preparations for the series of tests we have just described.

Figure 13.5 shows an example of a test plan. The general condition being tested is a record change. The documentation consists of a series of test plan screens maintained on a database (perhaps a PC database) that is ideally suited to this kind of application.

Conversion

Conversion is the process of changing from the old system to the new system. Four main conversion strategies can be employed: the parallel strategy, the direct cutover strategy, the pilot study strategy, and the phased approach strategy.

In a **parallel strategy**, both the old system and its potential replacement are run together for a time until everyone is assured that the new one functions

FIGURE 13.5 A SAMPLE TEST PLAN TO TEST A RECORD CHANGE

When developing a test plan, it is imperative to include the various conditions to be tested, the requirements for each condition tested, and the expected results. Test plans require input from both end users and information systems specialists.

Procedure		Address and Maintenance "Record Change Series"		Test Series 2		
		Prepared by:	Date:	Version:		
Test Ref.	Condition Tested	Special Requirements	Expected Results	Output On	Next Screen	
2.0	Change records					
2.1	Change existing record	key field	Not allowed			
2.2	Change nonexistent record	Other fields	"Invalid key" message			
2.3	Change deleted record	Deleted record must be available	"Deleted" message			
2.4	Make second record	Change 2.1 above	OK if valid	Transaction file	V45	
2.5	Insert record		OK if valid	Transaction file	V45	
2.6	Abort during change	Abort 2.5	No change	Transaction file	V45	

correctly. This is the safest conversion approach because, in the event of errors or processing disruptions, the old system can still be used as a backup. However, this approach is very expensive, and additional staff or resources may be required to run the extra system.

The **direct cutover strategy** replaces the old system entirely with the new system on an appointed day. It is a very risky approach that can potentially be more costly than running two systems in parallel if serious problems with the new system are found. There is no other system to fall back on. Dislocations, disruptions, and the cost of corrections may be enormous.

The **pilot study strategy** introduces the new system to only a limited area of the organization, such as a single department or operating unit. When this pilot version is complete and working smoothly, it is installed throughout the rest of the organization, either simultaneously or in stages.

The **phased approach strategy** introduces the new system in stages, either by functions or by organizational units. If, for example, the system is introduced by function, a new payroll system might begin with hourly workers who are paid weekly, followed six months later by adding salaried employees (who are paid monthly) to the system. If the system is introduced by organizational unit, corporate headquarters might be converted first, followed by outlying operating units four months later.

Moving from an old system to a new one requires that end users be trained to use the new system. Detailed **documentation** showing how the system works from both a technical and end-user standpoint is finalized during conversion time for use in training and everyday operations. Lack of proper training and documentation contributes to system failure, so this portion of the systems development process is very important.

Production and Maintenance

After the new system is installed and conversion is complete, the system is said to be in **production**. During this stage, the system will be reviewed by both users and technical specialists to determine how well it has met its original objectives and to decide whether any revisions or modifications are in order. In

TABLE 13.2 SYSTEMS DEVELOPMENT

CORE ACTIVITY	DESCRIPTION
Systems analysis	Identify problem(s) Specify solutions Establish information requirements
Systems design	Create design specifications
Programming	Translate design specifications into program code
Testing	Perform unit testing Perform systems testing Perform acceptance testing
Conversion	Plan conversion Prepare documentation Train users and technical staff
Production and maintenance	Operate the system Evaluate the system Modify the system

some instances, a formal **post-implementation audit** document is prepared. After the system has been fine-tuned, it must be maintained while it is in production to correct errors, meet requirements, or improve processing efficiency. Changes in hardware, software, documentation, or procedures to a production system to correct errors, meet new requirements, or improve processing efficiency are termed **maintenance**. Routine maintenance consumes a large percentage of many firms' IT budgets, but could be reduced significantly through more up-to-date systems-building practices and technology. Table 13.2 summarizes the systems development activities.

13-3 What are the principal methodologies for modeling and designing systems?

There are alternative methodologies for modeling and designing systems. Structured methodologies and object-oriented development are the most prominent.

Structured Methodologies

Structured methodologies have been used to document, analyze, and design information systems for many decades. **Structured** refers to the fact that the techniques are step by step, with each step building on the previous one. Structured methodologies are top-down, progressing from the highest, most abstract level to the lowest level of detail—from the general to the specific.

Structured development methods are process-oriented, focusing primarily on modeling the processes, or actions that capture, store, manipulate, and distribute data as the data flow through a system. These methods separate data from processes. A separate programming procedure must be written every time someone wants to take an action on a particular piece of data. The procedures act on data that the program passes to them.

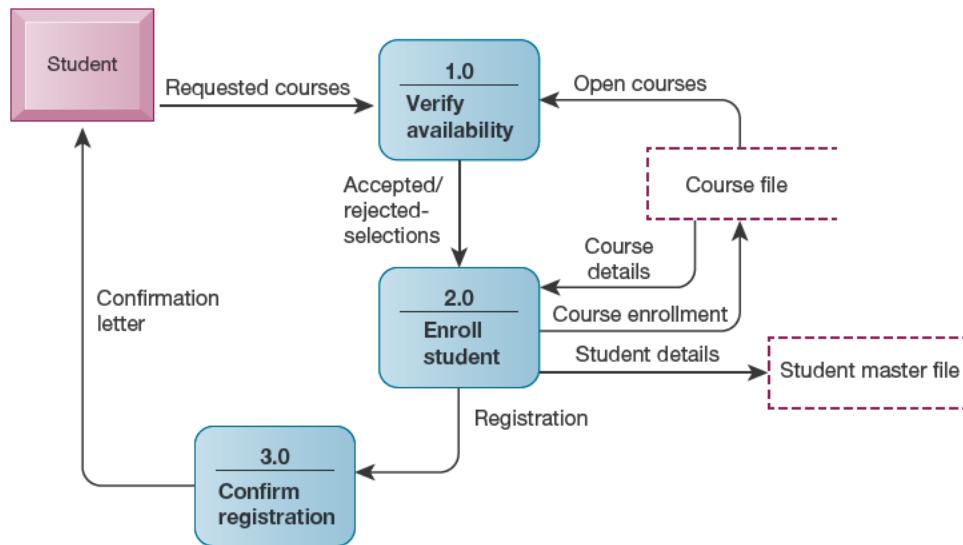
The primary tool for representing a system's component processes and the flow of data between them is the **data flow diagram (DFD)**. The data flow diagram offers a logical graphic model of information flow, partitioning a system into modules that show manageable levels of detail. It rigorously specifies the processes or transformations that occur within each module and the interfaces that exist between them.

Figure 13.6 shows a simple data flow diagram for a mail-in university course registration system. The rounded boxes represent processes, which portray the transformation of data. The square box represents an external entity, which is an originator or receiver of information located outside the boundaries of the system being modeled. The open rectangles represent data stores, which are either manual or automated inventories of data. The arrows represent data flows, which show the movement between processes, external entities, and data stores. They contain packets of data with the name or content of each data flow listed beside the arrow.

This data flow diagram shows that students submit registration forms with their name, their identification number, and the numbers of the courses they wish to take. In process 1.0, the system verifies that each course selected is still open by referencing the university's course file. The file distinguishes courses that are open from those that have been canceled or filled. Process 1.0 then determines which of the student's selections can be accepted or rejected. Process

FIGURE 13.6 DATA FLOW DIAGRAM FOR MAIL-IN UNIVERSITY REGISTRATION SYSTEM

The system has three processes: Verify availability (1.0), Enroll student (2.0), and Confirm registration (3.0). The name and content of each of the data flows appear adjacent to each arrow. There is one external entity in this system: the student. There are two data stores: the student master file and the course file.



2.0 enrolls the student in the courses for which he or she has been accepted. It updates the university's course file with the student's name and identification number and recalculates the class size. If maximum enrollment has been reached, the course number is flagged as closed. Process 2.0 also updates the university's student master file with information about new students or changes in address. Process 3.0 then sends each student applicant a confirmation of registration letter listing the courses for which he or she is registered and noting the course selections that could not be fulfilled.

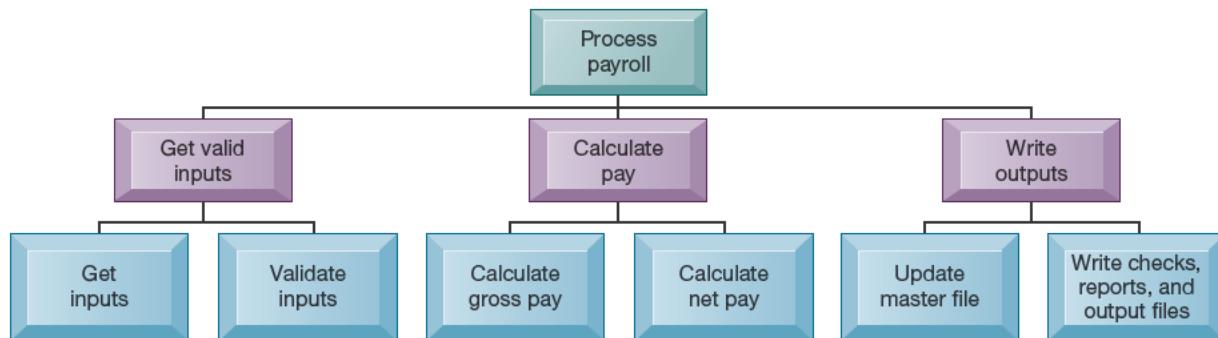
The diagrams can be used to depict higher-level processes as well as lower-level details. Through leveled data flow diagrams, a complex process can be broken down into successive levels of detail. An entire system can be divided into subsystems with a high-level data flow diagram. Each subsystem, in turn, can be divided into additional subsystems with second-level data flow diagrams, and the lower-level subsystems can be broken down again until the lowest level of detail has been reached.

Another tool for structured analysis is a data dictionary, which contains information about individual pieces of data and data groupings within a system (see Chapter 6). The data dictionary defines the contents of data flows and data stores so that systems builders understand exactly what pieces of data they contain. **Process specifications** describe the transformation occurring within the lowest level of the data flow diagrams. They express the logic for each process.

In structured methodology, software design is modeled using hierarchical structure charts. The **structure chart** is a top-down chart, showing each level of design, its relationship to other levels, and its place in the overall design structure. The design first considers the main function of a program or system, then breaks this function into subfunctions, and decomposes each subfunction until the lowest level of detail has been reached. Figure 13.7 shows a high-level structure chart for a payroll system. If a design has too many levels to fit onto one structure chart, it can be broken down further on more detailed structure charts. A structure chart may document one program, one system (a set of programs), or part of one program.

FIGURE 13.7 HIGH-LEVEL STRUCTURE CHART FOR A PAYROLL SYSTEM

This structure chart shows the highest or most abstract level of design for a payroll system, providing an overview of the entire system.



Object-Oriented Development

Structured methods are useful for modeling processes but do not handle the modeling of data well. They also treat data and processes as logically separate entities, whereas in the real world such separation seems unnatural. Different modeling conventions are used for analysis (the data flow diagram) and for design (the structure chart).

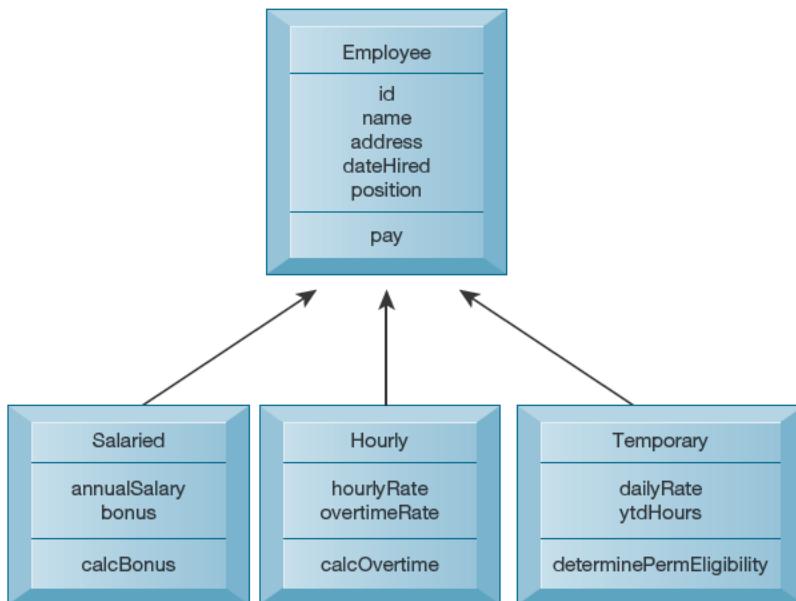
Object-oriented development addresses these issues. Object-oriented development uses the **object** as the basic unit of systems analysis and design. An object combines data and the specific processes that operate on those data. Data encapsulated in an object can be accessed and modified only by the operations, or methods, associated with that object. Instead of passing data to procedures, programs send a message for an object to perform an operation that is already embedded in it. The system is modeled as a collection of objects and the relationships among them. Because processing logic resides within objects rather than in separate software programs, objects must collaborate with each other to make the system work.

Object-oriented modeling is based on the concepts of *class* and *inheritance*. Objects belonging to a certain class, or general category of similar objects, have the features of that class. Classes of objects in turn can inherit all the structure and behaviors of a more general class and then add variables and behaviors unique to each object. New classes of objects are created by choosing an existing class and specifying how the new class differs from the existing class instead of starting from scratch each time.

We can see how class and inheritance work in Figure 13.8, which illustrates the relationships among classes concerning employees and how they are paid. Employee is the common ancestor, or superclass, for the other three classes. Salaried, Hourly, and Temporary are subclasses of Employee. The class name is in the top compartment, the attributes for each class are in the middle portion of each box, and the list of operations is in the bottom portion of each box. The features that are shared by all employees (ID, name, address, date hired, position, and pay) are stored in the Employee superclass, whereas each subclass stores features that are specific to that particular type of employee. Specific to hourly employees, for example, are their hourly rates and overtime rates. A solid line from the subclass to the superclass is a generalization path showing that the subclasses Salaried, Hourly, and Temporary have common features that can be generalized into the superclass Employee.

FIGURE 13.8 CLASS AND INHERITANCE

This figure illustrates how classes inherit the common features of their superclass.



Object-oriented development is more iterative and incremental than traditional structured development. During analysis, systems builders document the functional requirements of the system, specifying its most important properties and what the proposed system must do. Interactions between the system and its users are analyzed to identify objects, which include both data and processes. The object-oriented design phase describes how the objects will behave and how they will interact with one another. Similar objects are grouped together to form a class, and classes are grouped into hierarchies in which a subclass inherits the attributes and methods from its superclass.

The information system is implemented by translating the design into program code, reusing classes that are already available in a library of reusable software objects, and adding new ones created during the object-oriented design phase. Implementation may also involve the creation of an object-oriented database. The resulting system must be thoroughly tested and evaluated.

Because objects are reusable, object-oriented development could potentially reduce the time and cost of writing software because organizations can reuse software objects that have already been created as building blocks for other applications. New systems can be created by using some existing objects, changing others, and adding a few new objects. Object-oriented frameworks have been developed to provide reusable, semicomplete applications that the organization can further customize into finished applications.

13-4 What are alternative methods for building information systems?

Systems differ in terms of their size and technological complexity and in terms of the organizational problems they are meant to solve. A number of systems-building approaches have been developed to deal with these differences. This section describes these alternative methods: the traditional systems life cycle,

prototyping, application software packages and cloud software services, and outsourcing.

Traditional Systems Life Cycle

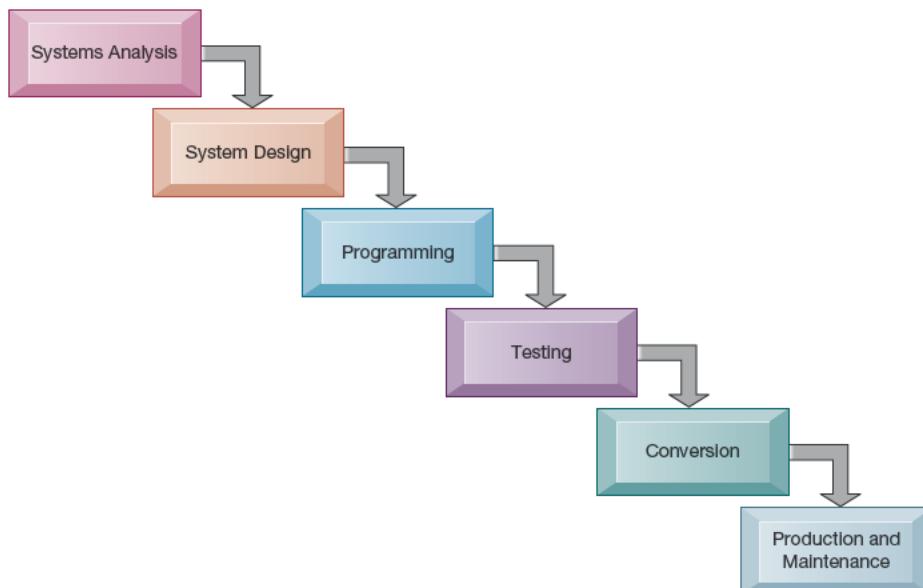
The **systems life cycle** is the oldest method for building information systems. The life cycle methodology is a phased approach to building a system, dividing systems development into formal stages, as illustrated in Figure 13.9. Systems development specialists have different opinions on how to partition the systems-building stages, but they roughly correspond to the stages of systems development we have just described.

The systems life cycle methodology maintains a formal division of labor between end users and information systems specialists. Technical specialists, such as systems analysts and programmers, are responsible for much of the systems analysis, design, and implementation work; end users are limited to providing information requirements and reviewing the technical staff's work. The life cycle also emphasizes formal specifications and paperwork, so many documents are generated during the course of a systems project.

The systems life cycle is still used for building large, complex systems that require a rigorous and formal requirements analysis, predefined specifications, and tight controls over the system-building process. However, the systems life cycle approach can be costly, time-consuming, and inflexible. Although systems builders can go back and forth among stages in the life cycle, the systems life cycle is predominantly a "waterfall" approach in which tasks in one stage are completed before work for the next stage begins. Activities can be repeated, but volumes of new documents must be generated and steps retraced if requirements and specifications need to be revised. This encourages freezing of specifications relatively early in the development process. The life cycle approach is also not suitable for many small desktop systems, which tend to be less structured and more individualized.

FIGURE 13.9 THE TRADITIONAL SYSTEMS DEVELOPMENT LIFE CYCLE

The systems development life cycle partitions systems development into formal stages, with each stage requiring completion before the next stage can begin.



Prototyping

Prototyping consists of building an experimental system rapidly and inexpensively for end users to evaluate. By interacting with the prototype, users can get a better idea of their information requirements. The prototype endorsed by the users can be used as a template to create the final system.

The **prototype** is a working version of an information system or part of the system, but it is meant to be only a preliminary model. Once operational, the prototype will be further refined until it conforms precisely to users' requirements. Once the design has been finalized, the prototype can be converted to a polished production system.

The process of building a preliminary design, trying it out, refining it, and trying again has been called an **iterative** process of systems development because the steps required to build a system can be repeated over and over again. Prototyping is more explicitly iterative than the conventional life cycle, and it actively promotes system design changes. It has been said that prototyping replaces unplanned rework with planned iteration, with each version more accurately reflecting users' requirements.

Steps in Prototyping

Figure 13.10 shows a four-step model of the prototyping process, which consists of the following:

- Step 1:** *Identify the user's basic requirements.* The systems designer (usually an information systems specialist) works with the user only long enough to capture the user's basic information needs.
- Step 2:** *Develop an initial prototype.* The systems designer creates a working prototype quickly, using tools for rapidly generating software.
- Step 3:** *Use the prototype.* The user is encouraged to work with the system to determine how well the prototype meets his or her needs and to make suggestions for improving the prototype.
- Step 4:** *Revise and enhance the prototype.* The system builder notes all changes the user requests and refines the prototype accordingly. After the prototype has been revised, the cycle returns to Step 3. Steps 3 and 4 are repeated until the user is satisfied.

When no more iterations are required, the approved prototype then becomes an operational prototype that furnishes the final specifications for the application. Sometimes the prototype is adopted as the production version of the system.

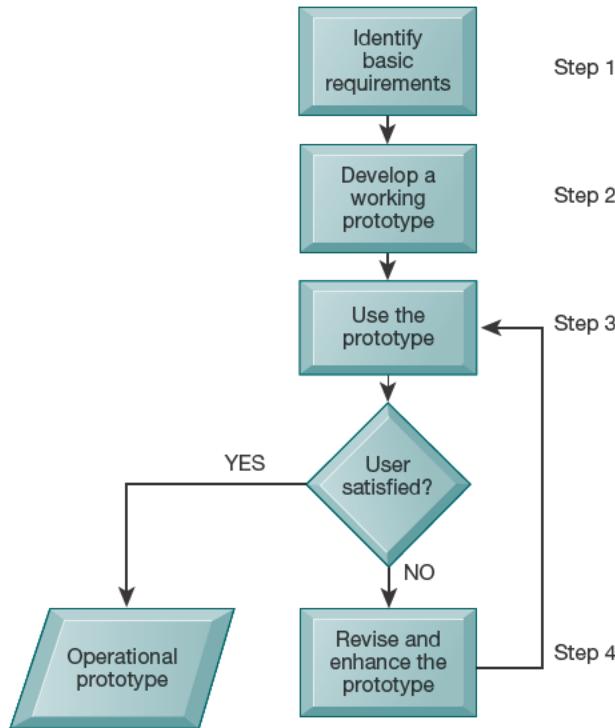
Advantages and Disadvantages of Prototyping

Prototyping is most useful when there is some uncertainty about requirements or design solutions and is often used for designing an information system's **end-user interface** (the part of the system with which end users interact, such as online display and data entry screens, reports, or web pages). Because prototyping encourages intense end-user involvement throughout the systems development life cycle, it is more likely to produce systems that fulfill user requirements.

However, rapid prototyping can gloss over essential steps in systems development. If the completed prototype works reasonably well, management may not see the need for reprogramming, redesign, or full documentation and testing to build a polished production system. Some of these hastily constructed systems may not easily accommodate large quantities of data or a large number of users in a production environment.

FIGURE 13.10 THE PROTOTYPING PROCESS

The process of developing a prototype can be broken down into four steps. Because a prototype can be developed quickly and inexpensively, systems builders can go through several iterations, repeating steps 3 and 4, to refine and enhance the prototype before arriving at the final operational one.



Application Software Packages, Software Services, and Outsourcing

Chapter 5 points out that much of today's software is not developed in-house but is purchased from external sources. Firms can rent the software from an online software service provider, they can purchase the software from a commercial vendor as a package to run in-house, or they can have a custom application developed by an outside outsourcing firm.

Application Software Packages and Cloud Software Services

Today many systems are based on commercially available application software packages or cloud software as a service (SaaS). For example, companies can choose to implement Oracle enterprise resource planning, supply chain management, or human capital management software in-house or pay to use this software running on the Oracle Cloud platform. Microsoft Office desktop productivity software comes in both desktop and cloud (Office 365) versions. Many applications are common to all business organizations—for example, payroll, accounts receivable, general ledger, or inventory control. For such universal functions with standard processes that do not change a great deal over time, a more generic system will fulfill the requirements of many organizations.

If a commercial software package or cloud software service can fulfill most of an organization's requirements, the company does not have to write its own software. The company can save time and money by using the prewritten, predesigned, pretested software programs from the software vendor. Package and SaaS vendors supply much of the ongoing maintenance and support for the system,

including enhancements to keep the system in line with ongoing technical and business developments. When a package or SaaS solution is pursued, end users will be responsible for supplying the business information requirements for the system, and information systems specialists will provide technical requirements.

If an organization has unique requirements that the package does not meet, these tools include capabilities for customization. **Customization** features allow a commercial software package or cloud-based software to be modified to meet an organization's unique requirements without destroying the integrity of the software. If a great deal of customization is required, additional programming and customization work may become so expensive and time-consuming that they negate many of the advantages of software packages and services.

When a system is developed using an application software package or a cloud software service, systems analysis will include a formal evaluation of the software package or service in which both end users and information systems specialists will participate. The most important evaluation criteria are the functions provided by the software, flexibility, user-friendliness, hardware requirements, database requirements, installation and maintenance efforts, documentation, vendor quality, and cost. The package or software service evaluation process often is based on a **request for proposal (RFP)**, which is a detailed list of questions submitted to software vendors.

When software from an external source is selected, the organization no longer has total control over the systems design process. Instead of tailoring the systems design specifications directly to user requirements, the design effort will consist of trying to mold user requirements to conform to the features of the package or software service. If the organization's requirements conflict with the way the package or software service works and this software cannot be customized, the organization will have to adapt to the package or software service and change its procedures.

Outsourcing

If a firm does not want to use its internal resources to build or operate information systems, it can outsource the work to an external organization that specializes in providing these services. Cloud computing and software as a service (SaaS) providers, which we described in Chapter 5, are one form of outsourcing. Subscribing companies use the software and computer hardware provided by the service as the technical platform for their systems. In another form of outsourcing, a company could hire an external vendor to design and create the software for its system, but that company would operate the system on its own computers. The outsourcing vendor might be domestic or in another country.

Domestic outsourcing is driven primarily by the fact that outsourcing firms possess skills, resources, and assets that their clients do not have. Installing a new supply chain management system in a very large company might require hiring an additional 30 to 50 people with specific expertise in supply chain management software licensed from a vendor. Rather than hire permanent new employees, most of whom would need extensive training in the new software, and then release them after the new system is built, it makes more sense, and is often less expensive, to outsource this work for a 12-month period.

In the case of **offshore outsourcing**, the decision is much more cost-driven. A skilled programmer in India or Russia earns about \$10,000–\$30,000 per year compared with about \$60,000 or more per year for a comparable programmer in the United States. The Internet and low-cost communications technology have drastically reduced the expense and difficulty of coordinating the work of global teams in offshore locations. In addition to cost savings, many offshore outsourcing firms

offer world-class technology assets and skills. Wage inflation outside the United States has recently eroded some of these advantages, and some jobs have moved back to the United States. Firms generally do not outsource the conception, systems analysis, and design of IT systems to offshore firms, but often do outsource programming, testing, maintenance, and daily operation of IT systems.

A firm is most likely to benefit from outsourcing if it takes the time to evaluate all the risks and to make sure outsourcing is appropriate for its particular needs. Any company that outsources its applications must thoroughly understand the project, including its requirements, method of implementation, anticipated benefits, cost components, and metrics for measuring performance.

Many firms underestimate costs for identifying and evaluating vendors of information technology services, for transitioning to a new vendor, for improving internal software development methods to match those of outsourcing vendors, and for monitoring vendors to make sure they are fulfilling their contractual obligations. Companies will need to allocate resources for documenting requirements, sending out RFPs, handling travel expenses, negotiating contracts, and project management. Experts claim it takes from three months to a full year to fully transfer work to an offshore partner and make sure the vendor thoroughly understands your business.

Outsourcing offshore incurs additional costs for coping with cultural differences that drain productivity and dealing with human resources issues, such as terminating or relocating domestic employees. All of these hidden costs undercut some of the anticipated benefits from outsourcing. Firms should be especially cautious when using an outsourcer to develop or to operate applications that give it some type of competitive advantage.

General Motors Corporation (GM) at one point had outsourced 90 percent of its IT services, including its data centers and application development. The company later decided to bring most of its IT infrastructure in-house. Lowering costs is important, but GM's primary reason for cutting back outsourcing was to take back control of its information systems, which it believes were preventing the company from responding quickly to competitive opportunities. Figure 13.11 shows best- and worst-case scenarios for the total cost of an offshore

FIGURE 13.11 TOTAL COST OF OFFSHORE OUTSOURCING

If a firm spends \$10 million on offshore outsourcing contracts, that company will actually spend 15.2 percent in extra costs even in the best-case scenario. In the worst-case scenario, where there is a dramatic drop in productivity along with exceptionally high transition and layoff costs, a firm can expect to pay up to 57 percent in extra costs on top of the \$10 million outlay for an offshore contract.

TOTAL COST OF OFFSHORE OUTSOURCING				
Cost of outsourcing contract	\$10,000,000			
Hidden Costs	Best Case	Additional Cost (\$)	Worst Case	Additional Cost (\$)
1. Vendor selection	.02%	20,000	2%	200,000
2. Transition costs	2%	200,000	3%	300,000
3. Layoffs & retention	3%	300,000	5%	500,000
4. Lost productivity/cultural issues	3%	300,000	27%	2,700,000
5. Improving development processes	1%	100,000	10%	1,000,000
6. Managing the contract	6%	600,000	10%	1,000,000
Total additional costs		1,520,000		5,700,000
	Outstanding Contract (\$)	Additional Cost (\$)	Total Cost (\$)	Additional Cost
Total cost of outsourcing (TCO) best case	10,000,000	1,520,000	11,520,000	15.2%
Total cost of outsourcing (TCO) worst case	10,000,000	5,700,000	15,700,000	57.0%

outsourcing project. It shows how much hidden costs affect the total project cost. The best case reflects the lowest estimates for additional costs, and the worst case reflects the highest estimates for these costs. As you can see, hidden costs increase the total cost of an offshore outsourcing project by an extra 15 to 57 percent. Even with these extra costs, many firms will benefit from offshore outsourcing if they manage the work well.

13-5 What are new approaches for system building in the digital firm era?

Technologies and business conditions are changing so rapidly that companies are adopting shorter, more informal systems development processes, including those for mobile applications. In addition to using software packages and online software services, businesses are relying more heavily on fast-cycle techniques such as rapid application development, joint application design, agile development, automated software testing, and low-code no-code development.

Rapid Application Development (RAD), Agile Development, Automated Software Testing, and DevOps

The term **rapid application development (RAD)** refers to the process of creating workable systems in a very short period of time with some flexibility to adapt as a project evolves. RAD includes the use of visual programming and other tools for building graphical user interfaces, iterative prototyping of key system elements, automation of program code generation, and close teamwork among end users and information systems specialists. Simple systems often can be assembled from prebuilt components. The process does not have to be sequential, and key parts of development can occur simultaneously.

Sometimes a technique called **joint application design (JAD)** is used to accelerate the generation of information requirements and to develop the initial systems design. JAD brings end users and information systems specialists together in an interactive session to discuss the system's design. Properly prepared and facilitated, JAD sessions can significantly speed up the design phase and involve users at an intense level.

Agile development focuses on rapid delivery of working software by breaking a large project into a series of small subprojects that are completed in short periods of time using iteration, continuous feedback, and ongoing user involvement. Iterations, called sprints, are short time frames that typically last from 1–4 weeks. Each mini-project is worked on by a cross-functional team (consisting of programmers, testers, a user representative, and other people required by the project) and regularly released to the client. Improvement or addition of new functionality takes place within the next iteration as developers clarify requirements.

Features to be developed are assigned to the sprints on a priority basis, with the “critical path” through the program developed first. This makes it possible for a bare-bones but functioning version of a program to be demonstrated early on. As additional features are developed, the code is added to the code already developed, a process known as “continuous integration.”

Testing occurs early and often throughout the entire development process. Agile methods emphasize face-to-face communication, encouraging people to

collaborate and make decisions quickly and effectively, rapid and flexible response to change, and the production of working software rather than elaborate documentation. Instead of a separate testing phase, as in the traditional waterfall approach, testing occurs continuously in agile development during each sprint, and testing is encouraged. This often means that more development time will be spent on testing than when using traditional approaches.

Although essential, continuous testing can be very time-consuming, especially since developing test scripts, executing test steps, and evaluating the results used to be largely manual. Automated testing tools are now available to meet this need. Automated testing tools perform examinations of the software, report outcomes, and compare results with earlier test runs. The Interactive Session on Technology shows how automated testing helped security software company McAfee use an agile methodology in its projects.

DevOps builds on agile development principles as an organizational strategy to create a culture and environment that further promote rapid and agile development practices. *DevOps* stands for “development and operations” and emphasizes close collaboration between the software developers who create applications and the IT operational staff who run and maintain the applications. Traditionally, in a large enterprise, an application development team would be in charge of gathering business requirements for an application, designing the application, and writing and testing the software. The operations team would run and maintain the software once it was put into production. Problems arise when the development team is unaware of operational issues that prevent the software from working as expected, requiring additional time and rework to fix the software.

DevOps tries to change this relationship by promoting better and more frequent communication and collaboration between systems development and operations groups and a fast and stable workflow throughout the entire application development life cycle. With this type of organizational change along with agile techniques, standardized processes, and more powerful automated software creation and testing tools, it is possible to build, test, and release applications more rapidly and more frequently. For example, DevOps helps developers at Netflix make hundreds of software changes each day.

Low-Code and No-Code Development

Low-code development is a software development approach that enables the delivery of applications faster and with minimal hand-coding using visual modeling in a graphical interface to assemble and configure applications. Such tools may produce entirely operational applications or require a small amount of additional coding. Low-code development platforms reduce the amount of hand-coding for creating workable software, so that business applications can be created more rapidly by a wider range of people (including business end users in some instances), not just those with formal programming skills.

No-code development tools are even easier for non-IT business people to use. Everything the software vendor thinks the user needs to create an app is already built into the tool, with no coding required. However, many no-code tools were built to solve a simple business problem and have very limited functionality. For example, Verite, a global nonprofit trying to eliminate human rights abuses in global supply chains, has a no-code application for processing client expense reports (Preimesberger, 2019). No-code applications are also difficult to customize. Another downside is that these tools make it possible for business users to create their own applications without proper management oversight by the IT department, creating security, compliance, and integration problems, as well as substandard systems.

INTERACTIVE SESSION TECHNOLOGY

McAfee Turns to Automated Software Testing

McAfee is a privately held company that sells security software to nearly 69,000 enterprise customers and more than 500 million individuals in 189 countries. You or your company may be using a McAfee product for combating malware, identity theft, and privacy invasion.

McAfee used a single global instance of SAP ERP 5.0 to run all of its back-end finance, controlling, accounting, materials management, and order fulfillment processes. It also has other non-SAP systems, which are integrated for processes involving sales, licensing, and customer service from an order-to-cash perspective. (Order-to-cash refers to the set of business processes for receiving, processing, and paying for customer orders.) The SAP ERP system, however, is the single source of information for McAfee's revenues and bookings. McAfee is a primarily partner-based organization that works through many resellers and distributors, and it needs to ensure that these partners can quickly and easily enter orders into the SAP system.

McAfee has been trying to juggle multiple systems projects. It has been trying to migrate to SAP S/4HANA (SAP's next generation of ERP software) and also to implement SAP Revenue Accounting and Reporting, which required updating McAfee's accounting codes to conform to new revenue recognition standards. This project had consumed most of McAfee's IT resources in 2018. The business had also been spun off from its parent company and had to separate its IT systems. Updates had to be released, tested, and confirmed to be working properly. McAfee's IT staff had to manage all of these projects without increasing headcount. At the same time, McAfee was adopting an agile methodology for all of its IT projects. In contrast to the traditional waterfall methodology, in which a project manager oversees individuals who are each dedicated to quality assurance, testing system functionality, and user acceptance testing, McAfee switched to an agile sprint cycle in which all members of a development team collaborate on incremental development of smaller pieces of software, which are released each sprint cycle every two weeks. With an agile methodology, software modules are constantly being created, tested, demonstrated for feedback, and revised with shorter time frames than the waterfall approach.

McAfee had to deal with approximately 40 systems for handling lead-to-order, order-to-cash, and source-to-pay processes that are actively worked on and enhanced.

According to Mouli Subrahmanayan, IT Director at McAfee India, "there are moving parts all over."

One way to do more, faster, was to automate testing. McAfee had traditionally used manual processes for software testing, which could not easily handle an increased amount of testing. Whenever a system was changed or enhanced with a new feature, McAfee's IT staff had to ensure that the updated systems performed as expected and fix any problems before the system went into production.

It was very difficult to use manual processes to keep up with the testing because so many changes had to be made within a very short period of time. Manually creating test scenarios for end-to-end processes, such as order-to-cash, took a long time and was very costly.

McAfee's increased testing needs were also driven by other application changes that required testing as well. For example, McAfee replaced its custom-developed system for configure, price, and quote (CPQ) processes (for configuring product pricing and generating quotes) with a third-party non-SAP system. The company needed to test the end-to-end scenario to ensure that quotes created for sales were properly converted into orders in the SAP ERP system and then fulfilled seamlessly. The testing had to create and test end-of-quarter volumes of 60,000 orders and validate the loads in the supporting non-SAP applications, such as for invoicing, licensing, and analytics. The testing had to show that everything in that chain of events could handle that transaction volume and the systems behaved as they should.

To complete a very large amount of testing in a short time period, McAfee opted for automated testing. Automated testing would allow time for agile development teams to focus on each scenario and ensure that back-end systems were working as expected to complete customer orders. McAfee's 13-member automation team consisted of automation engineers and business analysts, who were charged with selecting the automated testing product for the company. Automated testing software vendors had to use hands-on demonstrations to show that their tool could handle SAP testing and business process automation and that it was easy to use.

McAfee selected Worksoft Certify because it was the framework for SAP testing that came prebuilt within the software and its testing framework could be applied

to areas beyond the company's on-premises SAP system, including new custom applications. Worksoft Certify is an industry-leading test automation solution for enterprise applications including SAP, Workday, Salesforce.com, Oracle, and web apps. It is designed to test complex business processes that span multiple applications, and it is code-free. The tool models an application under test as a series of pages containing GUI (graphical user interface) objects and test steps, performing actions against those objects. It creates and stores automated test steps in a relational database without a single software script or program. People who lack software coding skills can use the tool.

By the end of 2017, McAfee started putting its automated testing system into production. The company now uses Worksoft Certify for testing and for business process automation in its SAP environment. Manual

tasks such as performing regular checks on the health of the SAP system are automated, as is the testing of changes to the system. That includes performance testing to test heavy processing loads. For example, McAfee was able to test how the SAP system processed a volume of 60,000 orders with 250,000 line items.

McAfee saved nearly 2,500 hours of manual effort through testing and business process automation, equivalent to \$200,000, and the need for application maintenance is at an all-time low.

Sources: www.worksoft.com, accessed April 7, 2020; Lauren Bonneau, "McAfee Saves 2500 Hours of Manual Effort with Test and Business Process Automation on Its Journey to SAP S/4HANA," *SAPInsider*, April 1, 2019; www.mcafee.com, accessed April 7, 2020.

CASE STUDY QUESTIONS

1. Why would a company such as McAfee benefit from automated software testing?
2. What management, organization, and technology factors did McAfee address in moving to automated software testing?
3. Was Worksoft Certify a good solution for McAfee? Why or why not?
4. How did automated software testing change the way McAfee ran its business?

Mobile Application Development: Designing for a Multiscreen World

Today, employees and customers expect, and even demand, to be able to use a mobile device of their choice to obtain information or perform a transaction anywhere and at any time. To meet these needs, companies will need to develop mobile websites, mobile web apps, and native apps as well as traditional information systems.

Once an organization decides to develop mobile apps, it has to make some important choices, including the technology it will use to implement these apps (whether to write a native app or mobile web app) and what to do about a mobile website. A **mobile website** is a version of a regular website that is scaled down in content and navigation for easy access and search on a small mobile screen. (Access Amazon's website from your computer and then from your smartphone to see the difference from a regular website.)

A **mobile web app** is an Internet-enabled app with specific functionality for mobile devices. Users access mobile web apps through their mobile device's web browser. The web app resides primarily on a server, is accessed via the Internet, and doesn't need to be installed on the device. The same application can be used by most devices that can surf the web, regardless of their brand.

A **native app** is a standalone application designed to run on a specific platform and device. The native app is installed directly on a mobile device. Native apps can connect to the Internet to download and upload data, and they can also operate on these data even when not connected to the Internet. For example, an e-book reading app such as Kindle software can download a book from

the Internet, disconnect from the Internet, and present the book for reading. Native mobile apps provide fast performance and a high degree of reliability. They are also able to take advantage of a mobile device's particular capabilities, such as its camera or touch features. However, native apps are expensive to develop because multiple versions of an app must be programmed for different mobile operating systems and hardware.

Developing applications for mobile platforms is quite different from development for PCs and their much larger screens. The reduced size of mobile devices makes using fingers and multitouch gestures much easier than typing and using keyboards. Mobile apps need to be optimized for the specific tasks they are to perform, they should not try to carry out too many tasks, and they should be designed for usability. The user experience for mobile interaction is fundamentally different from using a desktop or laptop PC. Saving resources—bandwidth, screen space, memory, processing, data entry, and user gestures—is a top priority.

When a full website created for the desktop shrinks to the size of a smartphone screen, it is difficult for the user to navigate through the site. The user must continually zoom in and out and scroll to find relevant material. Therefore, companies need to design websites specifically for mobile interfaces and create multiple mobile sites to meet the needs of smartphones, tablets, and desktop browsers. This equates to at least three sites with separate content, maintenance, and costs. Currently, websites know what device you are using because your browser will send this information to the server when you log on. Based on this information, the server will deliver the appropriate screen.

One solution to the problem of having multiple websites is to use **responsive web design**. Responsive web design enables websites to change layouts automatically according to the visitor's screen resolution, whether on a desktop, laptop, tablet, or smartphone. Responsive design uses tools such as flexible grid-based layouts, flexible images, and media queries to optimize the design for different viewing contexts. This eliminates the need for separate design and development work for each new device. HTML5, which we introduced in Chapter 5, is also used for mobile application development because it can support cross-platform mobile applications.



13-6 How will MIS help my career?

Here is how Chapter 13 and this book can help you find a job as an entry-level junior business systems analyst.

The Company

ST Consultants, an Oslo-based professional technology services firm, provides staffing and information technology consulting services and has an open position for an entry-level junior business systems analyst. The company provides business and technology consultants to more than 150 firms in financial services, healthcare, communications, transportation, energy, consumer goods, and technology, helping them implement business and technology initiatives cost-effectively.

Position Description

A junior business systems analyst is expected to work in project teams throughout all phases of the software development life cycle, including defining business requirements, developing detailed design specifications, and working with

application developers to build or enhance systems and business processes. Before undertaking assignments, new business systems analysts receive training in the background they will need to succeed in their assignments. The first assignment is to work on a contract basis for a startup data analytics company serving mid-sized organizations. The junior business systems analyst would work with a team of data scientists to help clients integrate data sources, cleanse and organize messy data, and improve understanding of patterns and trends.

Job Requirements

- Upcoming or recent college graduate, with BA in Management Information Systems, Finance, Psychology, or related field
- 3 to 6-plus months of corporate work or internship experience, including experience working with a project team
- Strong understanding of technology and systems, and business process improvement
- Strong analytical, communication, and problem-solving skills
- Ability to work comfortably in a team environment
- Knowledge and understanding of the software development life cycle and business process improvement
- Knowledge of MS Office applications
- Exposure to SQL desirable but not required

Interview Questions

1. What information systems courses have you taken, including MIS, database, data analytics, and systems development? Can you write SQL queries?
2. Have you worked on any systems development projects? If so, what exactly did you do? What systems development practices did you use?
3. Have you worked on any other kinds of projects, and what role did you play? Do you have samples of the writing or output you produced for these projects?
4. Which Microsoft Office tools have you used? What kinds of problems have you used these tools to solve?
5. Have you any experience with agile software development?

Author Tips

1. Review the discussion of business processes in Chapter 2 and Chapter 13 and the Chapter 14 discussion of IT project management and implementation. Be prepared to talk about any systems development experience you have had, including analyzing or redesigning business processes. Also be prepared to discuss contemporary systems development practices.
2. Inquire about how you would be using SQL and Microsoft Office tools for the job and what skills you would be expected to demonstrate. Bring samples of the work you have done with this software. Express interest in learning more about these tools to fulfill your job assignments.
3. Bring samples of your writing demonstrating your analytical and business application skills and project experience.

REVIEW SUMMARY

13-1 How does building new systems produce organizational change?

Building a new information system is a form of planned organizational change. Four kinds of technology-enabled change are (1) automation, (2) rationalization of procedures, (3) business process redesign, and (4) paradigm shift, with far-reaching changes carrying the greatest risks and rewards. Many organizations are using business process management to redesign workflows and business processes in the hope of achieving dramatic productivity breakthroughs. Business process management is also useful for promoting total quality management (TQM), Six Sigma, and other initiatives for incremental process improvement.

13-2 What are the core activities in the systems development process?

The core activities in systems development are systems analysis, systems design, programming, testing, conversion, production, and maintenance. Systems analysis is the study and analysis of problems of existing systems and the identification of requirements for their solutions. Systems design provides the specifications for an information system solution, showing how its technical and organizational components fit together.

13-3 What are the principal methodologies for modeling and designing systems?

The two principal methodologies for modeling and designing information systems are structured methodologies and object-oriented development. Structured methodologies focus on modeling processes and data separately. The data flow diagram is the principal tool for structured analysis, and the structure chart is the principal tool for representing structured software design. Object-oriented development models a system as a collection of objects that combine processes and data. Object-oriented modeling is based on the concepts of class and inheritance.

13-4 What are alternative methods for building information systems?

The oldest method for building systems is the systems life cycle, which requires that information systems be developed in formal stages. The stages must proceed sequentially and have defined outputs; each requires formal approval before the next stage can commence. The systems life cycle is useful for large projects that need formal specifications and tight management control over each stage of systems building, but it is very rigid and costly.

Prototyping consists of building an experimental system rapidly and inexpensively for end users to interact with and evaluate. Prototyping encourages end-user involvement in systems development and iteration of design until specifications are captured accurately. The rapid creation of prototypes can result in systems that have not been completely tested or documented or that are technically inadequate for a production environment.

Using a software package or online software services (SaaS) reduces the amount of design, programming, testing, installation, and maintenance work required to build a system. Application software packages or SaaS are helpful if a firm does not have the internal information systems staff or financial resources to custom develop a system. To meet an organization's unique requirements, packages may require extensive modifications that can substantially raise development costs.

Outsourcing consists of using an external vendor to build (or operate) a firm's information systems instead of the organization's internal information systems staff. Outsourcing can save application development costs or enable firms to develop applications without an internal information systems staff. However, firms risk losing control over their information systems and becoming too dependent on external vendors. Outsourcing also entails hidden costs, especially when the work is sent offshore.

13-5 What are new approaches for system building in the digital firm era?

Rapid application development (RAD) uses object-oriented software, visual programming, prototyping, and tools for very rapid creation of systems. Agile development breaks a large project into a series of small subprojects that are completed in short periods of time using iteration and continuous feedback. Automated testing tools speed up testing and improve quality by automating tasks that were previously manual. Low-code and no-code development tools enable people with minimal or no programming skills to create workable systems in a short period of time. DevOps emphasizes

close collaboration between the software developers who create applications and the IT operational staff who run and maintain the applications. Mobile application development must pay attention to simplicity, usability, and the need to optimize tasks for tiny screens.

Key Terms

- | | |
|------------------------------------------------|--------------------------------------------------|
| <i>Acceptance testing</i> , 533 | <i>Parallel strategy</i> , 533 |
| <i>Agile development</i> , 544 | <i>Phased approach strategy</i> , 534 |
| <i>Automation</i> , 523 | <i>Pilot study strategy</i> , 534 |
| <i>Business process management (BPM)</i> , 526 | <i>Post-implementation audit</i> , 535 |
| <i>Business process redesign</i> , 524 | <i>Process specifications</i> , 536 |
| <i>Conversion</i> , 533 | <i>Production</i> , 534 |
| <i>Customization</i> , 542 | <i>Programming</i> , 532 |
| <i>Data flow diagram (DFD)</i> , 535 | <i>Prototype</i> , 540 |
| <i>DevOps</i> , 545 | <i>Prototyping</i> , 540 |
| <i>Direct cutover strategy</i> , 534 | <i>Rapid application development (RAD)</i> , 544 |
| <i>Documentation</i> , 534 | <i>Rationalization of procedures</i> , 523 |
| <i>End-user interface</i> , 540 | <i>Request for proposal (RFP)</i> , 542 |
| <i>Feasibility study</i> , 530 | <i>Responsive web design</i> , 548 |
| <i>Information requirements</i> , 531 | <i>Six Sigma</i> , 524 |
| <i>Iterative</i> , 540 | <i>Structure chart</i> , 536 |
| <i>Joint application design (JAD)</i> , 544 | <i>Structured</i> , 535 |
| <i>Low-code development</i> , 545 | <i>System testing</i> , 533 |
| <i>Maintenance</i> , 535 | <i>Systems analysis</i> , 530 |
| <i>Mobile web app</i> , 547 | <i>Systems design</i> , 531 |
| <i>Mobile website</i> , 547 | <i>Systems development</i> , 530 |
| <i>Native app</i> , 547 | <i>Systems life cycle</i> , 539 |
| <i>No-code development</i> , 545 | <i>Test plan</i> , 533 |
| <i>Object</i> , 537 | <i>Testing</i> , 532 |
| <i>Object-oriented development</i> , 537 | <i>Total quality management (TQM)</i> , 524 |
| <i>Offshore outsourcing</i> , 542 | <i>Unit testing</i> , 533 |
| <i>Paradigm shift</i> , 524 | |

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

- 13-1 How does building new systems produce organizational change?**
 - Explain why rationalization of procedures is essential after automation in organizational change.
 - Define the term paradigm shift, and explain why it often fails.

- 13-2 What are the core activities in the systems development process?**
 - Explain why a systems analysis will often incorporate a feasibility study.
 - Explain the role of a systems designer and their work related to systems analysis.
 - Explain the role of the programming phase of a system development process. Who provides this service?

- 13-3 What are the principal methodologies for modeling and designing systems?**
 - Compare object-oriented and traditional structured approaches for modeling and designing systems.

- 13-4 What are alternative methods for building information systems?**
 - Define the traditional systems life cycle. Describe its advantages and disadvantages for systems building.
 - Define information system prototyping. Describe its benefits and limitations. List and describe the steps in the prototyping process.

- Define an application software package. Explain the advantages and disadvantages of developing information systems based on software packages.
- Describe the advantages and disadvantages of using outsourcing for building information systems.
- Define rapid application development (RAD), agile development, automated software testing, low-code and no-code development, and DevOps and explain how they can improve system building.
- Explain the features of mobile application development and responsive web design.

13-5 What are new approaches for system building in the digital firm era?

Discussion Questions

13-6 Why is selecting a systems development approach an important business decision? Who should participate in the selection process?

13-7 Some have said that the best way to reduce systems development costs is to use application software packages, SaaS,

or user-friendly tools. Do you agree? Why or why not?

13-8 Why is it so important to understand how a business process works when trying to develop a new information system?

Hands-On MIS Projects

The projects in this section give you hands-on experience analyzing business processes, designing and building a customer system for auto sales, and analyzing website information requirements.

Management Decision Problems

13-9 For an additional fee, a customer purchasing an appliance, such as a washing machine from Appliance Warehouse, with headquarters in Auckland New Zealand, can purchase a three-year service contract. The contract provides free repair service and parts for the specified appliance using an authorized service provider. When a person with a service contract needs to repair an appliance, such as a washing machine, he or she calls the Repairs & Parts department to schedule an appointment. The department makes the appointment and gives the caller the date and approximate time of the appointment. The repair technician arrives during the designated time frame and diagnoses the problem. If the problem is caused by a faulty part, the technician either replaces the part if he or she is carrying the part or orders the replacement part. If the part is not in stock, a technician orders the part and gives the customer an approximate time when the part will arrive. The part is shipped directly to the customer. After the part has arrived, the customer must call to schedule a second appointment for a repair technician to replace the ordered part. This process is very lengthy. It may take two weeks to schedule the first repair visit, another two weeks to order and receive the required part, and another week to schedule a second repair visit after the ordered part has been received.

- Diagram the existing process.
- What is the impact of the existing process on operational efficiency and customer relationships?
- What changes could be made to make this process more efficient? How could information systems support these changes? Diagram the improved process.

13-10 Management at your agricultural chemicals corporation has been dissatisfied with production planning. Production plans are created using best guesses of demand for each product, which are based on how much of each product has been ordered in the past. If a customer places an unexpected order or requests a change to an existing order after it has been placed, there is no way to adjust production plans. The company may have to tell customers it can't fill their orders, or it may run up extra costs maintaining additional inventory to prevent stock-outs.

At the end of each month, orders are totaled and manually keyed into the company's production planning system. Data from the past month's production and inventory systems are manually entered into the firm's order management system. Analysts from the sales department and from the production department analyze the data from their respective systems to determine what the sales targets and production targets should be for the next month. These estimates are usually different. The analysts then get together at a high-level planning meeting to revise the production and sales targets to take into account senior management's goals for market share, revenues, and profits. The outcome of the meeting is a finalized production master schedule.

The entire production planning process takes 17 business days to complete. Nine of these days are required to enter and validate the data. The remaining days are spent developing and reconciling the production and sales targets and finalizing the production master schedule.

- Draw a diagram of the existing production planning process.
- Analyze the problems this process creates for the company.
- How could an enterprise system solve these problems? In what ways could it lower costs? Diagram what the production planning process might look like if the company implemented enterprise software.

Improving Decision Making: Using Database Software to Design a Customer System for Auto Sales

Software skills: Database design, querying, reporting, and forms

Business skills: Sales lead and customer analysis

- 13-11** This project requires you to perform a systems analysis and then design a system solution using database software.

Ace Auto Dealers specializes in selling new vehicles from Subaru in Portland, Oregon. The company advertises in local newspapers and is listed as an authorized dealer on the Subaru website and other major websites for auto buyers. The company benefits from a good local word-of-mouth reputation and name recognition.

Ace does not believe it has enough information about its customers. It cannot easily determine which prospects have made auto purchases, nor can it identify which customer touch points have produced the greatest number of sales leads or actual sales so it can focus advertising and marketing more on the channels that generate the most revenue. Are purchasers discovering Ace from newspaper ads, from word of mouth, or from the web?

Prepare a systems analysis report detailing Ace's problem and a system solution that can be implemented using PC database management software. Then use database software to develop a simple system solution. In MyLab MIS, you will find more information about Ace and its information requirements to help you develop the solution.

Achieving Operational Excellence: Analyzing Website Design and Information Requirements

Software skills: Web browser software

Business skills: Information requirements analysis, website design

- 13-12** Visit the website of your choice and explore it thoroughly. Prepare a report analyzing the various functions provided by that website and its information requirements. Your report should answer these questions: What functions does the website perform? What data does it use? What are its inputs, outputs, and processes? What are some of its other design specifications? Does the website link to any internal systems or systems of other organizations? What value does this website provide the firm?

Collaboration and Teamwork Project

Preparing Website Design Specifications

- 13-13** With three or four of your classmates, select a system described in this text that uses the web. Review the website for the system you select. Use what you have learned from the website and the description in this book to prepare a report describing some of the design specifications for the system you select. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Pick n Pay's Cloud Migration to Enhance Business Intelligence

CASE STUDY

Pick n Pay is a retail business founded in 1967 by Raymond Ackerman, who started with four small stores in Cape Town, South Africa. Since then, the business has grown and expanded to become the second-largest retailer in South Africa, with stores in Namibia, Botswana, Zambia, Mozambique, Mauritius, Eswatini, and Lesotho. Pick n Pay provides a wide range of products, including food, clothing, alcoholic beverages, pharmaceuticals, hardware, and other general merchandise. The stores also provide value-added services such as third-party bill payments, financial services such as cash transfers and withdrawals, and social grant payments. Pick n Pay has the largest online grocery business in Africa.

The retail space is highly competitive, operating in an unpredictable market where trends change rapidly. To manage customer expectations, retailers need to ensure that they have the right product at the right time for the right price. The incremental loss of market share over several years prompted Pick n Pay to launch a long-term recovery plan in 2014 that supported its core values, which include consumer rights, business efficiency, sustainability and customer value, and innovation. Its IT team was required to support the business vision with systems and solutions that would enhance data capabilities, business agility, and customer experience. Back in 2009, Pick n Pay had replaced its legacy in-house system with a fully integrated ERP solution from SAP. Since then, Pick n Pay has worked in partnership with SAP to update, streamline, and automate its technology.

By the end of 2017, however, the Business Intelligence (BI) team had started to face several challenges with the existing infrastructure. They faced dire constraints from their physical, on-premises data centers, which could no longer support the requirements of the business. Retail business intelligence is a technology-driven process that translates raw data into relevant insights to promote improved decision-making—it has become a key attribute of retail competitiveness. Pick n Pay had three different data warehouse platforms due to historical decisions made based on their capabilities at the time. For their BI to function optimally, Pick n Pay required a single platform for all transactional data, from core retail transactions from sales in

stores to stock, margin, and inventory management. The design also had to be geared for future innovations such as machine learning, AI, and cognitive computing.

The Pick n Pay BI team discussed their future infrastructure requirements with their existing partner, SAP. At the time, the BI team at Pick n Pay was using SAP BW 4HANA on their platform along with BusinessObjects Analytics. The migration of IT applications and data to the cloud was largely unexplored by most South African organizations at the time, and the team carefully weighed the potential advantages and disadvantages. The analysis discovered that on-premises approaches to infrastructure hosting were more expensive, as administering a data center was not the core business of a retail organization. Infrastructure as a Service (IaaS) presented a potential solution, as it allows outsourcing of computer infrastructure such as hardware, storage, servers, and data center space over the Internet. This would allow the company to scale when it had to and reap the attendant financial benefits. (See Chapter 5).

The IT team found a range of aspects that had to be reviewed and weighed before selecting a cloud provider. These evaluations included costs, networks, resourcing, skills required from the partner, ways of working, and processes used for backups and restoring of data. Furthermore, user experience, security issues, and formulation of a disaster recovery process had to be considered. For a big enterprise with several large systems, cloud migration is a complex endeavor requiring a paradigm shift from multiple users.

The team identified Amazon Web Services (AWS) as the best strategic partner to work with for their cloud migration. AWS has been collaborating with SAP since 2011 to facilitate the deployment and migration of their SAP applications to AWS, and SAP has in turn certified AWS for a vast majority of SAP applications. According to Andrew Mayes, Pick n Pay's GM for Business Intelligence and Data Science, the dynamic nature of the cloud drove their decision to partner with AWS as infrastructure can be immediately acquired when needed. The advantages of the cloud-first approach and on-demand allocation provided by AWS along with the promise of efficient

and smarter utilization of existing hardware further cemented their decision.

Pick n Pay worked with SAP and AWS to determine the requirements for the project. The initial challenge was migration of localized data to the cloud. The team relied on the expertise of AWS with complex tasks such as the delivery, operation, and capacity planning of a server and storage infrastructure. Pick n Pay implemented the AWS Elastic Compute Cloud (EC2) on GP2 (General Purpose SSD) storage, which had been used earlier. Virtual machines on AWS EC2, also known as instances, have many advantages, such as scalability (one can choose instances with more RAM, CPUs, etc.), pay-per-use, and the freedom to choose different platforms or operating systems. The team selected Amazon Virtual Private Cloud (Amazon VPC), which provides a virtual, dedicated network as opposed to a public network, and Amazon CloudWatch, which measures and monitors data.

The project went live at the end of 2018 with the transition of all users to the cloud and decommissioning of the legacy platforms. The project delivered on expectations but incurred some cost overruns, mainly due to the lack of experience in putting the correct controls in place. AWS was a new product for Pick n Pay that required a different way of thinking about several concepts, including disaster recovery, security, and appreciation of the networking components, especially in the context of SAP applications. Pick n Pay depended on AWS to provide the required skills for the migration, as these skill sets were lacking within the company's team and the South African market. The project thus highlighted the importance of collaboration with implementation partners to provide training on necessary skills; this involves a careful review of the available skills prior to the launch of such a project to enable the project team to develop a thorough service level agreement (SLA) with the cloud partner. When working with a cloud partner, internal training and cloud skills development should be a priority to ensure effective integration. AWS had to provide the expertise

and training to help to grow the knowledge base of the Pick n Pay team during the migration; the training and certification were provided in an online and face-to-face environment. The team at Pick n Pay found that a formal process was also necessary for recruitment of the specific skills needed for a cloud environment as well as for the skills development of internal resources.

The cloud implementation achieved the objectives of the project to reduce cost and improve efficiency in the business. The real benefit, however, was the agility of the cloud environment to facilitate innovations such as enhanced data science, AI, and machine learning capabilities. This has enabled Pick n Pay to improve its customer loyalty program and facilitate targeted promotions and personalized discounts, intelligent digital sourcing and supply chain solutions, and multi-channel retailing.

Sources: Amazon Web Services website, aws.amazon.com, accessed October 15, 2020; Alex Bekker, "How to Get the Big Win with Retail Business Intelligence," www.scnsoft.com, accessed October 12, 2020; UCS Solutions, "Pick n Pay Implements World Competitive Solution," www.itweb.co.za, accessed October 12, 2020; Katy Gibson, "Pick n Paycuts Costs with Personalised Loyalty," www.sap.com, accessed October 9, 2020; Robin-Leigh Chetty, "Pick n Pay on Why It Chose to Migrate the AWS Infrastructure," www.hxt.co.za, accessed October 9, 2020; Pick n Pay website, www.pnp.co.za, accessed October 1, 2020; James de Villiers, "Amazon Web Services Open Data Centres in South Africa in 2020," www.businessinsider.co.za, accessed October 1, 2020.

CASE STUDY QUESTIONS

- 13-14** What problem did the company face from technology and organizational perspectives and what impact did this have on the business?
- 13-15** What solutions did Pick n Pay explore? Explain the process followed to identify the initial requirements.
- 13-16** Do you think the company made the right decision by outsourcing to AWS? Explain your answer.
- 13-17** What challenges did Pick n Pay experience during the system implementation?
- 13-18** What were the benefits of the project for Pick n Pay?

*Case contributed by Carolien van den Berg,
University of the Western Cape*

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14

Making the Business Case for Information Systems and Managing Projects

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 14-1** How should managers build a business case for the acquisition and development of new information systems?
- 14-2** What are the objectives of project management, and why is it so essential in developing information systems?
- 14-3** What are the principal risk factors in information systems projects?
- 14-4** How can project risks be managed?
- 14-5** How will MIS help my career?

CHAPTER CASES

- Al-Asasyah Implements a Modern ERP Solution
- Sauder Woodworking Gets ERP Implementation Right
- Arup Moves Project Management to the Cloud
- Pennsylvania's Unemployment Compensation Modernization System: Unfinished Business

VIDEO CASES

- NASA Project Management Challenges

MyLab MIS

Discussion Questions: 14-5, 14-6, 14-7; Hands-On MIS Projects: 14-8, 14-9, 14-10, 14-11;
eText with Conceptual Animations

Al-Asasyah Implements a Modern ERP Solution

Al-Asasyah, also operating as Basic Electronics Company Ltd., is a Saudi company that specializes in selling electronic products and electrical appliances. Since 1961, the company has been expanding and diversifying into new branches of business, including biomedical equipment and security systems. It is currently an exclusive agent in the Kingdom of Saudi Arabia for many leading international brands. The company has around 1,000 employees across many distribution facilities and after-sale service centers spread throughout the Kingdom. The total working capital of the company is around SAR 120 million (over \$32 million) and the total storage space at its warehouses exceeds 150,000 square meters.

Al-Asasyah used to have five main legacy systems, and its fast-growing business led to serious problems with accuracy, consistency, and accessibility of data. The different databases and file formats prevented the systems from providing effective communication among the different sites of the company. Attempts to remodel the systems to communicate the data appeared expensive and sometimes not feasible. As the legacy systems were unable to support direct, online communication with customers, partners, and suppliers, they were essentially incapable of maintaining any modern business model that would support the rapidly expanding company.

In 2014, Al-Asasyah acknowledged the seriousness of the problem, and a decision was made to replace the old systems with a new ERP solution. The company believed that implementation of an ERP system would be a challenging project to manage, so an internal team was formed to take on this responsibility. This team included managers with good knowledge of the company business processes, staff experienced in the old systems, and representatives from the different operational units of the company. At the pre-initiation phase of the project, the team set a number of constraints upon the selection of the ERP company to implement the solution, scrutinizing its history, successes and failures, cultural familiarity, etc. The team finally decided to adopt the SajayaERP solution. Sajaya is a software development and consulting firm in Saudi Arabia.

At the initiation phase, the company's internal team and the SajayaERP implementation team determined the scope, the outline plan, and a rough estimation of the cost of the project. Afterwards, the team developed a detailed plan that included a comprehensive implementation schedule, control and monitoring processes, change management model, and a more accurate cost estimation. The plan also included a detailed description



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of the company business processes and policies, system interface, the customizations needed, and report requirements.

The team decided to implement the execution phase through a number of sub-phases. First, a prototype of the system was run for three months in a small facility with a small number of transactions to allow more control over the testing and evaluation process. Second and third prototypes were then run at other sectors of the company. These consecutive runs enabled users from different departments of the company to get familiar with the main features of the system and freely evaluate it based on their own experience.

After the system passed the evaluation and testing stage, the final phase of execution focused on transferring the data from the legacy systems to the new one. The procedure was carefully designed, and the data was locked from changes for 10 weeks. All the changes that occurred to the data during this period of time were identified and then finally transferred to the ERP system. The whole system was then run for the first time and the old legacy systems were switched to a view-mode to be used for comparisons only. The old systems were finally switched off.

The whole project took eight months to complete. Al-Asasyah announced that it has seen the benefits of the project across all sectors of the company, and it credited the practical and effective project management as one of the main reasons for the successful implementation of the ERP system.

Sources: Basic Electronics Company Ltd. website, www.al-asasyah.com, accessed January 13, 2021; Sajaya.com Case Study, www.sajaya.com accessed December 18, 2018.

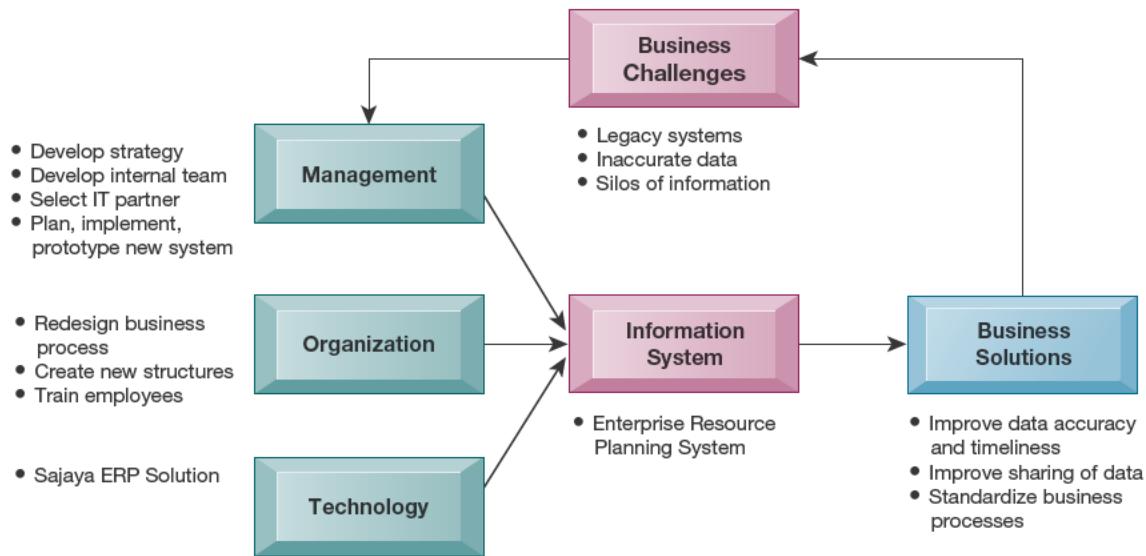
Case contributed by Yasser Mohamed Ibrahim Sabri, Cairo University

One of the principal challenges posed by information systems is ensuring they deliver genuine business benefits. There is a very high failure rate among information systems projects because organizations assess their business value incorrectly or because firms fail to manage the organizational change surrounding the introduction of new technology. Projects to build or improve information systems require special managerial and organizational techniques to make them effective.

The management at Al-Asasyah realized this when it undertook its project to implement a new modern ERP system. The new technology involved changes to important business processes as well as new software. Al-Asasyah succeeded because its management clearly understood that strong project management and attention to the execution details were essential to success.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. Al-Asasyah's rapid growth and antiquated legacy systems called for more automated, state-of-the art solutions that could quickly consolidate data from the different remotely distributed sectors of the company. Outdated legacy systems made the entire business process inefficient, preventing effective communication among the different operational units of the company. The management wisely assembled a project team composed of end users with good business knowledge, carefully implemented the project's plan, and worked closely with the specialist team from SajayaERP. The new system was implemented in manageable phases where users were carefully and systematically trained.

Here are some questions to think about: Why was this project successful? Why was it important to pay particular attention to project execution?



14-1 How should managers build a business case for the acquisition and development of new information systems?

One of the principal challenges posed by information systems is ensuring they deliver genuine business benefits. There is a very high failure rate among information systems projects because organizations have incorrectly assessed their business value or because firms have failed to manage the organizational change surrounding the introduction of new technology. Projects to build or improve information systems require special managerial and organizational techniques to make them effective.

Companies typically are presented with many alternatives for solving problems and improving their performance, including the development of new information systems or enhancement of existing ones. There are far more ideas for systems projects than there are resources. Your company will need to select the systems projects investments that promise the greatest benefit to the business. And you will need to make the business case for why the solution you select provides the greatest value to the firm compared to other solutions.

A **business case** is a proposal to management seeking approval for an investment. The business case for an IT investment describes the problem facing the organization that can be solved by investing in a proposed system solution. It provides an analysis of all the costs, benefits, and risks associated with that investment and the justification for that proposed course of action. The business case describes the rationale for proceeding with an investment, and shows how the investment supports the firm's strategic goals and business objectives and how it fits in with the overall information systems plan of the firm. It also provides the information necessary to make an informed decision about whether to proceed with the investment and in what form. The business case explains how this investment will provide value for the business, and identifies any risks that could negatively affect outcomes. The business case identifies alternative solutions, along with the deciding factors for selecting the preferred option.

FIGURE 14.1 FACTORS TO CONSIDER IN MAKING THE BUSINESS CASE

There are seven factors that should be addressed when making the business case for a new information system.



A good business case will also describe how the proposed solution may require changes in organizational culture, systems, processes, and jobs.

Figure 14.1 summarizes the seven major factors that are used in making the business case for a specific new system. (Review the discussion of business drivers of information systems in Chapter 1.) These factors are: (1) long-term strategic (lowering production costs, differentiation of products and services, increasing the scope of the firm [e.g., global expansion,] and matching or exceeding competitor capabilities); (2) improved decision making; (3) customer and supplier relationships; (4) survival (required by the market); (5) new products and services; (6) financial rationale; and (7) fitting with the long-term IT plan of the firm. Smaller systems that focus on a single problem will focus on just a few of these elements, such as “improved decision making,” “customer relationships,” and “lowering costs,” whereas larger system projects may well include all of these factors in making the business case.

The Information Systems Plan

In order to identify the information systems projects that will deliver the most business value, organizations need a corporate-wide **information systems plan** that supports their overall business plan, with strategic systems incorporated into top-level planning. The IS firm plan is developed by the Chief Information Officer, and is approved annually by the CEO and often the Board of Directors. The plan serves as a road map indicating the direction of systems development

TABLE 14.1 INFORMATION SYSTEMS PLAN

1.	Purpose of the Plan Overview of plan contents Current business organization and future organization Key business processes
2.	Strategic Business Plan Rationale Current situation Current business organization Changing environments Major goals of the business plan Firm's strategic plan
3.	Current Systems Major systems supporting business functions and processes Current infrastructure capabilities Hardware Software Database Networking and Internet Cloud services Difficulties meeting business requirements Anticipated future demands
4.	New Developments New system projects Project descriptions Business rationale Applications' role in strategy New infrastructure capabilities required Hardware Software Database Networking and Internet Cloud services
5.	Management Strategy Acquisition plans Organizational realignment Management controls Major training initiatives Human Resources strategy
6.	Implementation of the Plan Anticipated difficulties in implementation Progress reports and milestones

(the purpose of the plan), the rationale, the state of current systems, new developments to consider, the management strategy, the implementation plan, and the budget (see Table 14.1). Without a comprehensive firm-wide IS plan, it is difficult, if not impossible to evaluate the worth of proposals for developing specific individual systems. You cannot make the case for a specific new system without understanding the larger context of all the many systems in the firm.

The plan contains a statement of corporate goals and specifies how information technology will support the attainment of those goals. It explains how general goals will be achieved by specific systems projects. It identifies specific target dates and milestones that can be used later to evaluate the plan's progress in terms of how many objectives were actually attained in the time frame specified in the plan. The plan indicates the key management decisions, technology, and required organizational change.

In order to plan effectively, firms will need to inventory and document all of their information system applications, IT infrastructure components, and long- and short-term information requirements. For projects in which benefits involve improved decision making, managers should try to identify the decision improvements that would provide the greatest additional value to the firm (see Chapter 12). They should then develop a set of metrics to quantify the value of more timely and precise information on the outcome of the decision.

The plan should describe organizational changes, including management and employee training requirements; changes in business processes; and changes in authority, structure, or management practice. When you are making the business case for a new information system project, you show how the proposed system fits into that plan.

Portfolio Analysis

Once strategic analyses have determined the overall direction of systems development, **portfolio analysis** can be used to evaluate alternative systems projects. Portfolio analysis inventories all of the organization's information systems projects and assets, including infrastructure, outsourcing contracts, and licenses. This portfolio of information systems investments can be described as having a certain profile of risk and benefit to the firm (see Figure 14.2) similar to a financial portfolio.

Each information systems project carries its own set of risks and benefits. (Section 14-3 describes the factors that increase the risks of systems projects.) Firms would try to improve the return on their portfolios of IT assets by balancing the risk and return from their systems investments. Although there is no ideal profile for all firms, information-intensive industries (e.g., finance) should have a few high-risk, high-benefit projects to ensure that they stay current with technology. Firms in non-information-intensive industries should focus on high-benefit, low-risk projects.

FIGURE 14.2 A SYSTEM PORTFOLIO

Companies should examine their portfolio of projects in terms of potential benefits and likely risks. Certain kinds of projects should be avoided altogether and others developed rapidly. There is no ideal mix. Companies in different industries have different profiles.

		Project Risk	
		High	Low
Potential Benefits to Firm	High	Cautiously examine	Identify and develop
	Low	Avoid	Routine projects

Most desirable, of course, are systems with high benefit and low risk. These promise early returns and low risks. Second, high-benefit, high-risk systems should be examined; low-benefit, high-risk systems should be totally avoided; and low-benefit, low-risk systems should be reexamined for the possibility of rebuilding and replacing them with more desirable systems having higher benefits. By using portfolio analysis, management can determine the optimal mix of investment risk and reward for their firms, balancing riskier high-reward projects with safer lower-reward ones. Firms where portfolio analysis is aligned with business strategy have been found to have a superior return on their IT assets, better alignment of IT investments with business objectives, and better organization-wide coordination of IT investments.

Scoring Models

A **scoring model** is useful for selecting projects where many criteria must be considered. It assigns weights to various features of a system and then calculates the weighted totals. Using Table 14.2, the firm must decide among two alternative enterprise resource planning (ERP) systems. The first column lists the criteria that decision makers will use to evaluate the systems. These criteria are usually the result of lengthy discussions among the decision-making group. Often the most important outcome of a scoring model is not the score but agreement on the criteria used to judge a system.

Table 14.2 shows that this particular company attaches the most importance to capabilities for sales order processing, inventory management, and warehousing. The second column in Table 14.2 lists the weights that decision makers attached to the decision criteria. Columns 3 and 5 show the percentage of requirements for each function that each alternative ERP system can provide. Each vendor's score can be calculated by multiplying the percentage of

TABLE 14.2 EXAMPLE OF A SCORING MODEL FOR AN ERP SYSTEM

CRITERIA	WEIGHT	ERP SYSTEM A %	ERP SYSTEM A SCORE	ERP SYSTEM B %	ERP SYSTEM B SCORE
1.0 Order Processing					
1.1 Online order entry	4	67	268	73	292
1.2 Online pricing	4	81	324	87	348
1.3 Inventory check	4	72	288	81	324
1.4 Customer credit check	3	66	198	59	177
1.5 Invoicing	4	73	292	82	328
Total Order Processing			1,370		1,469
2.0 Inventory Management					
2.1 Production forecasting	3	72	216	76	228
2.2 Production planning	4	79	316	81	324
2.3 Inventory control	4	68	272	80	320
2.4 Reports	3	71	213	69	207
Total Inventory Management			1,017		1,079
3.0 Warehousing					
3.1 Receiving	2	71	142	75	150
3.2 Picking/packing	3	77	231	82	246
3.3 Shipping	4	92	368	89	356
Total Warehousing			741		752
Grand Total			3,128		3,300

requirements met for each function by the weight attached to that function. ERP System B has the highest total score.

Determining Solution Costs and Benefits

As we pointed out earlier, the business case for a system solution includes an assessment of whether each solution represents a good investment for the company.

Even if a systems project supports a firm's strategic goals and meets user information requirements, it needs to be a good investment for the firm. The value of systems from a financial perspective essentially revolves around the issue of return on invested capital. Does a particular information system investment produce sufficient returns to justify its costs?

Information System Costs and Benefits

Table 14.3 lists some of the more common costs and benefits of systems. **Tangible benefits** can be quantified and assigned a monetary value. **Intangible benefits**, such as more efficient customer service or enhanced decision making,

TABLE 14.3 COSTS AND BENEFITS OF INFORMATION SYSTEMS

COSTS
Hardware
Networking
Software
Services
Personnel
TANGIBLE BENEFITS (COST SAVINGS)
Increased productivity
Lower operational costs
Reduced workforce
Lower computer expenses
Lower outside vendor costs
Lower clerical and professional costs
Reduced rate of growth in expenses
Reduced facility costs
INTANGIBLE BENEFITS
Improved asset utilization
Improved resource control
Improved organizational planning
Increased organizational flexibility
More timely information
Improved customer experience
Increased organizational learning
Legal requirements attained
Enhanced employee goodwill
Increased job satisfaction
Improved decision making
Improved operations
Higher client satisfaction
Better corporate image

cannot be immediately quantified but may lead to quantifiable gains in the long run. Transaction and clerical systems that displace labor and save space always produce more measurable, tangible benefits than management information systems, decision-support systems, and systems for collaborative work (see Chapter 2). For instance, when BDO Canada switched from a homegrown project management tool to Microsoft Project Online, tangible benefits were increased productivity and lower operational costs resulting from streamlining the project management process. Intangible benefits included more timely and complete information, along with improved decision making.

Chapter 5 introduced the concept of total cost of ownership (TCO), which is designed to identify and measure the components of information technology expenditures beyond the initial cost of purchasing and installing hardware and software. TCO analysis, however, provides only part of the information needed to evaluate an information technology investment because it typically does not deal with benefits, cost categories such as complexity costs, and “soft” and strategic factors discussed later in this section.

Capital Budgeting for Information Systems

To determine the benefits of a particular project, you'll need to calculate all of its costs and all of its benefits. Obviously, a project where costs exceed benefits should be rejected. But even if the benefits outweigh the costs, additional financial analysis is required to determine whether the project represents a good return on the firm's invested capital. **Capital budgeting** models are one of several techniques used to measure the value of investing in long-term capital investment projects.

Capital budgeting methods rely on measures of cash flows into and out of the firm; capital projects generate those cash flows. The investment cost for information systems projects is an immediate cash outflow caused by expenditures for hardware, software, and labor. In subsequent years, the investment may cause additional cash outflows that will be balanced by cash inflows resulting from the investment. Cash inflows take the form of increased sales of more products (for reasons such as new products, higher quality, or increasing market share) or reduced costs in production and operations. The difference between cash outflows and cash inflows is used for calculating the financial worth of an investment. Once the cash flows have been established, several alternative methods are available for comparing different projects and deciding about the investment.

The principal capital budgeting models for evaluating IT projects are the payback method, the accounting rate of return on investment (ROI), net present value (NPV), and the internal rate of return (IRR). Figure 14.3 illustrates part of the capital budgeting analysis for a mobile online ordering system. You can find out more about how these capital budgeting models are used to justify information system investments in the Learning Tracks for this chapter.

Limitations of Financial Models

The traditional focus on the financial and technical aspects of an information system tends to overlook the social and organizational dimensions of information systems that may affect the true costs and benefits of the investment. Many companies' information systems investment decisions do not adequately consider costs from organizational disruptions created by a new system, such as the cost to train end users, the impact that users' learning curves for a new system have on productivity, or the time managers need to spend overseeing new system-related changes. Intangible benefits such as more timely decisions from a new system or enhanced employee learning and expertise may also be overlooked in a traditional financial analysis.

FIGURE 14.3 CAPITAL BUDGETING FOR AN INFORMATION SYSTEM INVESTMENT

This spreadsheet illustrates a simplified capital budgeting analysis for a mobile sales ordering system.

Courtesy of Microsoft Corporation.

A	B	C	D	E	F	G	H
1	Estimated Costs & Benefits - Mobile Online Ordering System						
2	Year	0	1	2	3	4	5
3		2019	2020	2021	2022	2023	2024
4	Costs						
5	Hardware						
6	50 iPads @ \$500	\$25,000					
7	Cloud IaaS	\$4,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
8	Networking	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500
9	Software						
10	Mobile ordering app	\$35,000					
11	Integration with ERP	\$25,000					
12	Human Resources						
13	Business Staff	\$10,000					
14	IT Staff + Consultants	\$45,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
15	Training	\$7,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
16	Maintenance and Support						
17	Annual Costs	\$1,52,500	\$11,500	\$11,500	\$11,500	\$11,500	\$11,500
18	Total Costs	\$2,10,000					
19	Benefits						
20	Reduced labor costs		\$52,000	\$52,000	\$52,000	\$52,000	\$52,000
21	Reduced errors and returns		\$70,000	\$70,000	\$70,000	\$70,000	\$70,000
22	Annual Net Cash Flow	-\$1,52,500	\$1,10,500	\$1,10,500	\$1,10,500	\$1,10,500	\$1,10,500
23	Total Benefits	\$4,00,000					
24							
25	Net Present Value	\$2,68,407					
26	ROI	4.1%					
27	Internal Rate of Return	17.0%					

14-2 What are the objectives of project management, and why is it so essential in developing information systems?

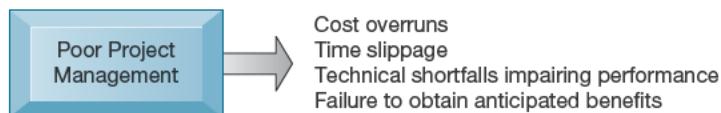
There is a very high failure rate among information systems projects. In nearly every organization, information systems projects take much more time and money to implement than originally anticipated, or the completed system does not work properly. When an information system does not meet expectations or costs too much to develop, companies may not realize any benefit from their information system investment, and the system may not be able to solve the problems for which it was intended. The development of a new system must be carefully managed and orchestrated, and the way a project is executed is likely to be the most important factor influencing its outcome. That's why it's essential to have some knowledge about managing information systems projects and the reasons why they succeed or fail.

Runaway Projects and System Failure

How badly are projects managed? On average, private sector projects are underestimated by half in terms of budget and time required to deliver the complete system promised in the system plan. Many projects are delivered with missing functionality (promised for delivery in later versions). A joint study by McKinsey and Oxford University found that large software projects on average run 66 percent over budget and 33 percent over schedule. Over 50 percent of businesses surveyed by cloud project portfolio management provider Innotas had experienced IT project failure within the previous twelve months (Florentine, 2016).

FIGURE 14.4 CONSEQUENCES OF POOR PROJECT MANAGEMENT

Without proper management, a systems development project takes longer to complete and most often exceeds the allocated budget. The resulting information system may not be able to demonstrate any benefits to the organization.



As illustrated in Figure 14.4 a systems development project without proper management will most likely suffer these consequences:

- Costs that vastly exceed budgets
- Unexpected time slippage
- Technical performance that is less than expected
- Failure to obtain anticipated benefits

The systems produced by failed information projects are often not used in the way they were intended or are not used at all. Users often have to develop parallel manual systems to make these systems work.

The actual design of the system may fail to capture essential business requirements or improve organizational performance. Information may not be provided quickly enough to be helpful, it may be in a format that is impossible to digest and use, or it may represent the wrong pieces of data.

The way in which nontechnical business users must interact with the system may be excessively complicated and discouraging. A system may be designed with a poor user interface. The **user interface** is the part of the system with which end users interact. For example, an online input form or data entry screen may be so poorly arranged that no one wants to submit data or request information. System outputs may be displayed in a format that is too difficult to comprehend. For example, the U.S. Navy had installed a new touch-screen navigation system on its John S. McCain destroyer with a design that was so confusing that the sailors using it accidentally guided the McCain into an oil tanker in the Singapore Strait on Aug. 21 2017 (Miller et. al, 2020).

Websites may discourage visitors from exploring further if the web pages are cluttered and poorly arranged, if users cannot easily find the information they are seeking, or if it takes too long to access and display the web page on the user's computer.

Additionally, the data in the system may have a high level of inaccuracy or inconsistency. The information in certain fields may be erroneous or ambiguous, or it may not be organized properly for business purposes. Information required for a specific business function may be inaccessible because the data are incomplete.

Project Management Objectives

A **project** is a planned series of related activities for achieving a specific business objective. Information systems projects include the development of new information systems, enhancement of existing systems, or upgrade or replacement of the firm's information technology (IT) infrastructure.

Project management refers to the application of knowledge, skills, tools, and techniques to achieve specific targets within specified budget and time constraints. Project management activities include planning the work, assessing risk, estimating resources required to accomplish the work, organizing the

work, acquiring human and material resources, assigning tasks, directing activities, controlling project execution, reporting progress, and analyzing the results. As in other areas of business, project management for information systems must deal with five major variables: scope, time, cost, quality, and risk.

Scope defines what work is or is not included in a project. For example, the scope of a project for a new order processing system might be to include new modules for inputting orders and transmitting them to production and accounting but not any changes to related accounts receivable, manufacturing, distribution, or inventory control systems. Project management defines all the work required to complete a project successfully and should ensure that the scope of a project does not expand beyond what was originally intended.

Time is the amount of time required to complete the project. Project management typically establishes the amount of time required to complete major components of a project. Each of these components is further broken down into activities and tasks. Project management tries to determine the time required to complete each task and establish a schedule for completing the work.

Cost is based on the time to complete a project multiplied by the cost of human resources required to complete the project. Information systems project costs also include the cost of hardware, software, and work space. Project management develops a budget for the project and monitors ongoing project expenses.

Quality is an indicator of how well the end result of a project satisfies the objectives specified by management. The quality of information systems projects usually boils down to improved organizational performance and decision making. Quality also considers the accuracy and timeliness of information produced by the new system and ease of use.

Risk refers to potential problems that would threaten the success of a project. These potential problems might prevent a project from achieving its objectives by increasing time and cost, lowering the quality of project outputs, or preventing the project from being completed altogether. Section 14.4 describes the most important risk factors for information systems.

14-3 What are the principal risk factors in information systems projects?

We have already introduced the topic of information systems risks and risk assessment in Chapter 8. In this chapter, we describe the specific risks to information systems projects and show what can be done to manage them effectively.

Dimensions of Project Risk

Systems differ dramatically in their size, scope, level of complexity, and organizational and technical components. Some systems development projects are more likely to create the problems we have described earlier or to suffer delays because they carry a much higher level of risk than others. The level of project risk is influenced by project size, project structure, and the level of technical expertise of the information systems staff and project team.

- *Project size.* The larger the project—as indicated by the dollars spent, the size of the implementation staff, the time allocated for implementation, and the number of organizational units affected—the greater the risk. Very large-scale systems projects have a failure rate that is 50 to 75 percent

higher than that for other projects because such projects are complex and difficult to control. The organizational complexity of the system—how many units and groups use it and how much it influences business processes—contributes to the complexity of large-scale systems projects just as much as technical characteristics, such as the number of lines of program code, length of project, and budget. In addition, there are few reliable techniques for estimating the time and cost to develop large-scale information systems.

- *Project structure.* Some projects are more highly structured than others. Their requirements are clear and straightforward, so outputs and processes can be easily defined. Users know exactly what they want and what the system should do; there is almost no possibility of the users changing their minds. Such projects run a much lower risk than those with relatively undefined, fluid, and constantly changing requirements; with outputs that cannot be fixed easily because they are subject to users' changing ideas; or with users who cannot agree on what they want.
- *Experience with technology.* The project risk rises if the project team and the information system staff lack the required technical expertise. If the team is unfamiliar with the hardware, system software, application software, or database management system proposed for the project, it is highly likely that the project will experience technical problems or take more time to complete because of the need to master new skills.

Although the difficulty of the technology is one risk factor in information systems projects, the other factors are primarily organizational, dealing with the complexity of information requirements, the scope of the project, and how many parts of the organization will be affected by a new information system.

Change Management and the Concept of Implementation

The introduction or alteration of an information system has a powerful behavioral and organizational impact. Changes in the way that information is defined, accessed, and used to manage the organization's resources often lead to new distributions of authority and power. This internal organizational change breeds resistance and opposition and can lead to the demise of an otherwise good system.

A very large percentage of information systems projects stumble because the process of organizational change surrounding system building was not properly addressed. Successful system building requires careful **change management**.

The Concept of Implementation

To manage the organizational change surrounding the introduction of a new information system effectively, you must examine the process of implementation. **Implementation** refers to all organizational activities working toward the adoption, management, and routinization of an innovation, such as a new information system. In the implementation process, the systems analyst is a **change agent**. The analyst not only develops technical solutions but also redefines the configurations, interactions, job activities, and power relationships of various organizational groups. The analyst is the catalyst for the entire change process and is responsible for ensuring that all parties involved accept the changes created by a new system. The change agent communicates with users, mediates between competing interest groups, and ensures that the organizational adjustment to such changes is complete.

The Role of End Users

System implementation generally benefits from high levels of user involvement and management support. User participation in the design and operation of information systems has several positive results. First, if users are heavily involved in systems design, they have more opportunities to mold the system according to their priorities and business requirements and more opportunities to control the outcome. Second, they are more likely to react positively to the completed system because they have been active participants in the change process. Incorporating user knowledge and expertise leads to better solutions.

The relationship between users and information systems specialists has traditionally been a problem area for information systems implementation efforts. Users and information systems specialists tend to have different backgrounds, interests, and priorities. This is referred to as the **user-designer communications gap**. These differences lead to divergent organizational loyalties, approaches to problem solving, and vocabularies.

Information systems specialists, for example, often have a highly technical, or machine, orientation to problem solving. They look for elegant and sophisticated technical solutions in which hardware and software efficiency is optimized at the expense of ease of use or organizational effectiveness. Users prefer systems that are oriented toward solving business problems or facilitating organizational tasks. Often the orientations of both groups are so at odds that they appear to speak in different tongues.

These differences are illustrated in Table 14.4, which depicts the typical concerns of end users and technical specialists (information systems designers) regarding the development of a new information system. Communication problems between end users and designers are a major reason why user requirements are not properly incorporated into information systems and why users are driven out of the implementation process.

Systems development projects run a very high risk of failure when there is a pronounced gap between users and technical specialists and when these groups continue to pursue different goals. Under such conditions, users are often driven away from the project. Because they cannot comprehend what the technicians are saying, users conclude that the entire project is best left in the hands of the information specialists alone.

Management Support and Commitment

If an information systems project has the backing and commitment of management at various levels, it is more likely to be perceived positively by both users and the technical information services staff. Both groups will believe that their participation in the development process will receive higher-level attention and priority. They will be recognized and rewarded for the time and effort they devote to implementation. Management backing also ensures that a systems

TABLE 14.4 THE USER-DESIGNER COMMUNICATIONS GAP

USER CONCERNs	DESIGNER CONCERNs
Will the system deliver the information we need for our work?	What demands will this system put on our servers?
Can we access the data on our smartphones, tablets, and PCs?	What kind of programming demands will this place on our group?
What new procedures do we need to enter data into the system?	Where will the data be stored? What's the most efficient way to store them?
How will the operation of the system change employees' daily routines?	What technologies should we use to secure the data?

project receives sufficient funding and resources to be successful. Furthermore, to be enforced effectively, all the changes in work habits and procedures and any organizational realignments associated with a new system depend on management backing. If a manager considers a new system a priority, the system will more likely be treated that way by his or her subordinates. According to the Project Management Institute, executive sponsors who are actively engaged is the leading factor in project success (Kloppenborg and Tesch, 2015; Project Management Institute, 2017).

Change Management Challenges for Business Process Management, Enterprise Applications, and Mergers and Acquisitions

Given the challenges of innovation and implementation, it is not surprising to find a very high failure rate among enterprise application and business process management projects which require extensive organizational change and which may require replacing old technologies and legacy systems that are deeply rooted in many interrelated business processes. A number of studies have indicated that 70 percent of all far-reaching business process management projects fail to deliver promised benefits. Likewise, a high percentage of enterprise applications fail to be fully implemented or to meet the goals of their users even after three years of work.

Many enterprise application and ambitious business process management projects have been undermined by poor implementation and change management practices that failed to address employees' concerns about change. Dealing with fear and anxiety throughout the organization, overcoming resistance by key managers, and changing job functions, career paths, and recruitment practices have posed greater threats to business process management than the difficulties companies faced visualizing and designing breakthrough changes to business processes. All of the enterprise applications require tighter coordination among different functional groups as well as extensive business process change (see Chapter 9).

Projects related to mergers and acquisitions have a similar failure rate. Mergers and acquisitions are deeply affected by the organizational characteristics of the merging companies as well as by their IT infrastructures. Combining the information systems of two different companies usually requires considerable organizational change and complex systems projects to manage. If the integration is not properly managed, firms can emerge with a tangled hodgepodge of inherited legacy systems built by aggregating the systems of one firm after another. Without a successful systems integration, the benefits anticipated from the merger cannot be realized, or worse, the merged entity cannot execute its business processes effectively.

14-4 How can project risks be managed?

Various project management, requirements gathering, and planning methodologies have been developed for specific categories of implementation problems. Strategies have also been devised for ensuring that users play appropriate roles throughout the implementation period and for managing the organizational change process. Not all aspects of the implementation process can be easily controlled or planned. However, anticipating potential implementation problems and applying appropriate corrective strategies can increase the chances for system success.

The first step in managing project risk involves identifying the nature and level of risk confronting the project. Implementers can then handle each project with the tools and risk management approaches geared to its level of risk. Not all risks are identifiable in advance, but with skillful project management, most are. Frequent communication and a culture of collaboration will help project teams adapt to unforeseen problems that arise (Browning and Ramasesh, 2015; Laufer et al., 2015; McFarlan, 1981).

Managing Technical Complexity

Projects with challenging and complex technology to master benefit from **internal integration tools**. The success of such projects depends on how well their technical complexity can be managed. Project leaders need both heavy technical and administrative experience. They must be able to anticipate problems and develop smooth working relationships among a predominantly technical team. The team should be under the leadership of a manager with a strong technical and project management background, and team members should be highly experienced. Team meetings should take place frequently. Essential technical skills or expertise not available internally should be secured from outside the organization.

Formal Planning and Control Tools

Large projects benefit from appropriate use of **formal planning tools** and **formal control tools** for documenting and monitoring project plans. The two most commonly used methods for documenting project plans are Gantt charts and PERT charts. A **Gantt chart** lists project activities and their corresponding start and completion dates. The Gantt chart visually represents the timing and duration of different tasks in a development project as well as their human resource requirements (see Figure 14.5). It shows each task as a horizontal bar whose length is proportional to the time required to complete it.

Although Gantt charts show when project activities begin and end, they don't depict task dependencies, how one task is affected if another is behind schedule, or how tasks should be ordered. That is where **PERT charts** are useful. *PERT* stands for "Program Evaluation and Review Technique," a methodology developed by the U.S. Navy during the 1950s to manage the Polaris submarine missile program. A PERT chart graphically depicts project tasks and their interrelationships. The PERT chart lists the specific activities that make up a project and the activities that must be completed before a specific activity can start, as illustrated in Figure 14.6.

The PERT chart portrays a project as a network diagram consisting of numbered nodes (either circles or rectangles) representing project tasks. Each node is numbered and shows the task, its duration, the starting date, and the completion date. The direction of the arrows on the lines indicates the sequence of tasks and shows which activities must be completed before the commencement of another activity. In Figure 14.6, the tasks in nodes 2, 3, and 4 are not dependent on each other and can be undertaken simultaneously, but each is dependent on completion of the first task. PERT charts for complex projects can be difficult to interpret, and project managers often use both techniques.

These project management techniques can help managers identify bottlenecks and determine the impact that problems will have on project completion times. They can also help systems developers partition projects into smaller, more manageable segments with defined, measurable business results. Standard control techniques can successfully chart the progress of the project against budgets and target dates, so deviations from the plan can be spotted.

FIGURE 14.5 A GANTT CHART

The Gantt chart in this figure shows the task, person-days, and initials of each responsible person as well as the start and finish dates for each task. The resource summary provides a good manager with the total person-days for each month and for each person working on the project to manage the project successfully. The project described here is a data administration project.

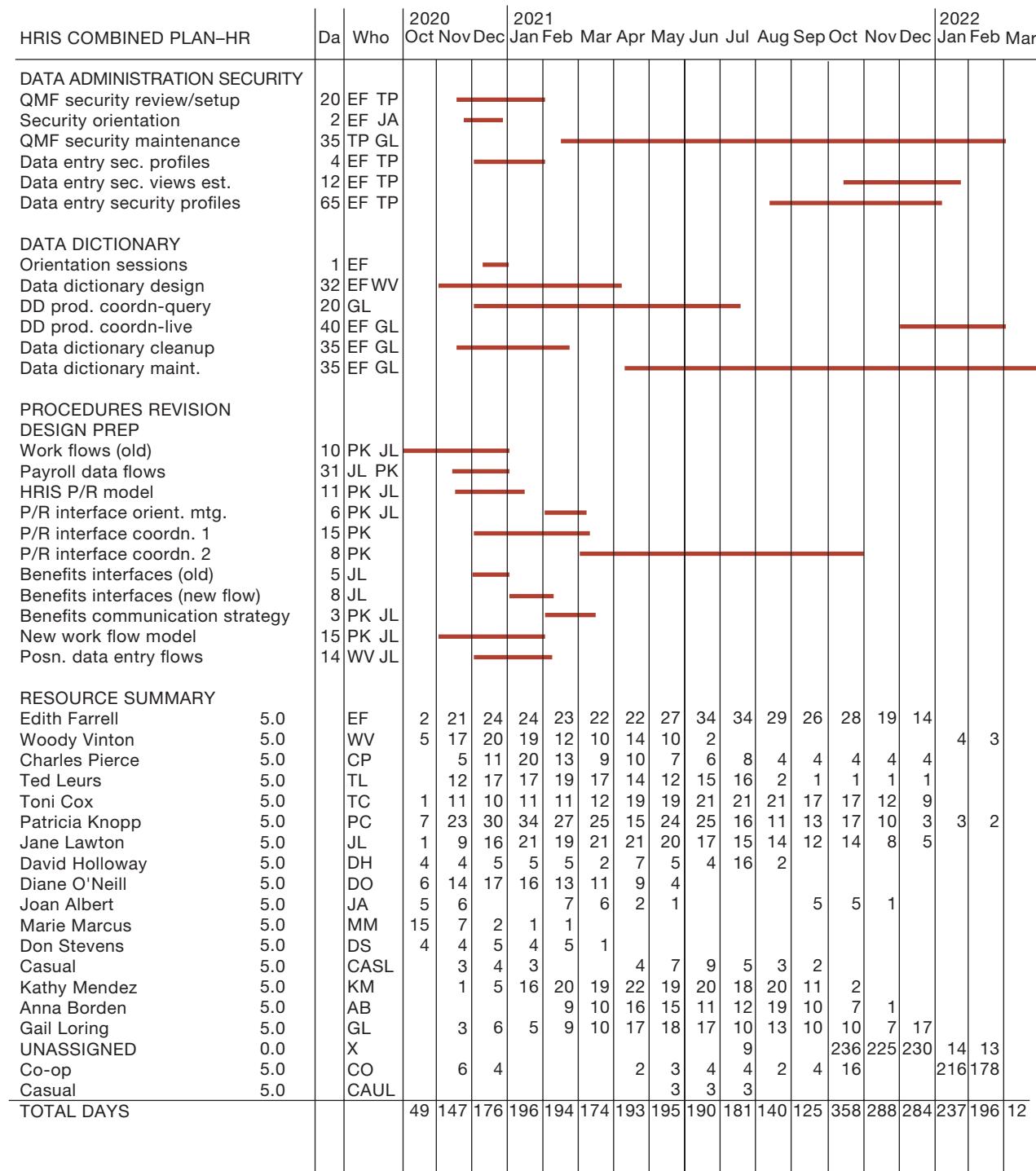
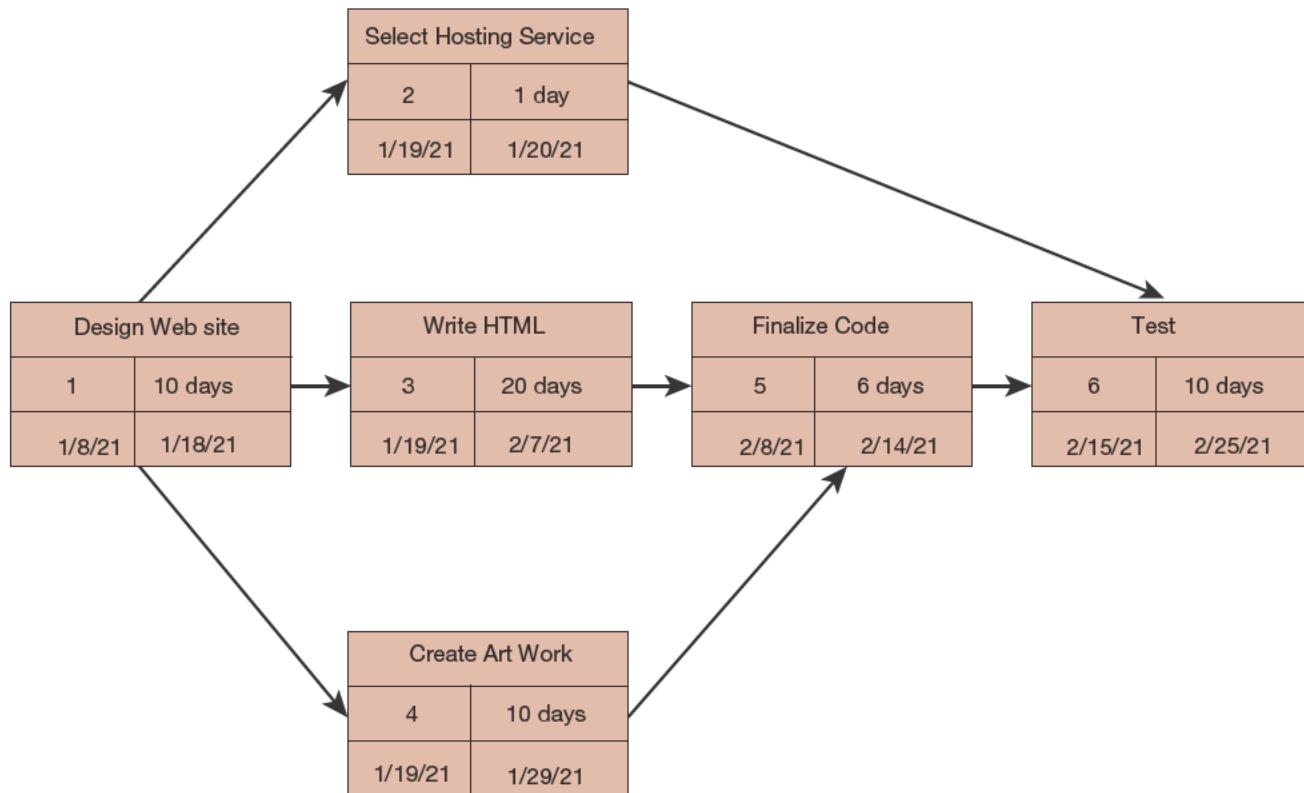


FIGURE 14.6 A PERT CHART

This is a simplified PERT chart for creating a small website. It shows the ordering of project tasks and the relationship of a task with preceding and succeeding tasks.



Increasing User Involvement and Overcoming User Resistance

Projects with relatively little structure and many undefined requirements must involve users fully at all stages. Users must be mobilized to support one of many possible design options and to remain committed to a single design. **External integration tools** consist of ways to link the work of the implementation team to users at all organizational levels. For instance, users can become active members of the project team, take on leadership roles, and take charge of installation and training. The implementation team can demonstrate its responsiveness to users, promptly answering questions, incorporating user feedback, and showing their willingness to help.

Participation in implementation activities may not be enough to overcome the problem of user resistance to organizational change. Different users may be affected by the system in different ways. Whereas some users may welcome a new system because it brings changes they perceive as beneficial to them, others may resist these changes because they believe the shifts are detrimental to their interests.

If the use of a system is voluntary, users may choose to avoid it; if use is mandatory, resistance will take the form of increased error rates, disruptions, turnover, and even sabotage. Therefore, the implementation strategy must not only encourage user participation and involvement, but it must also address the issue of counterimplementation. **Counterimplementation** is a deliberate strategy to thwart the implementation of an information system or an innovation in an organization.

Strategies to overcome user resistance include user participation (to elicit commitment as well as to improve design), user education and training, management edicts and policies, and better incentives for users who cooperate. The new system can be made more user-friendly by improving the end-user interface. Users will be more cooperative if organizational problems are solved prior to introducing the new system.

Designing for the Organization

Because the purpose of a new system is to improve the organization's performance, information systems projects must explicitly address the ways in which the organization will change when the new system is installed, including installation of mobile and web applications. In addition to procedural changes, transformations in job functions, organizational structure, power relationships, and the work environment should be carefully planned.

Areas where users interface with the system require special attention, with sensitivity to ergonomics issues. **Ergonomics** refers to the interaction of people and machines in the work environment. It considers the design of jobs, health issues, and the end-user interface of information systems. Table 14.5 lists the organizational dimensions that must be addressed when planning and implementing information systems.

Although systems analysis and design activities are supposed to include an organizational impact analysis, this area has traditionally been neglected. An **organizational impact analysis** explains how a proposed system will affect organizational structure, attitudes, decision making, and operations. To integrate information systems successfully with the organization, thorough and fully documented organizational impact assessments must be given more attention in the development effort.

Sociotechnical Design

One way of addressing human and organizational issues is to incorporate **sociotechnical design** practices into information systems projects. Designers set forth separate sets of technical and social design solutions. The social design plans explore different workgroup structures, allocation of tasks, and the design of individual jobs. The proposed technical solutions are compared with the proposed social solutions. The solution that best meets both social and technical objectives is selected for the final design. The resulting sociotechnical design is expected to produce an information system that blends technical efficiency with sensitivity to organizational and human needs, leading to higher job satisfaction and productivity.

You can see some of these project management strategies at work in the Interactive Session on Management, which describes how Sauder Woodworking implemented a new state-of-the-art ERP system.

TABLE 14.5 ORGANIZATIONAL FACTORS IN SYSTEMS PLANNING AND IMPLEMENTATION

Employee participation and involvement
Job design
Standards and performance monitoring
Ergonomics (including equipment, user interfaces, and the work environment)
Employee grievance resolution procedures
Health and safety
Government regulatory compliance

INTERACTIVE SESSION MANAGEMENT

Sauder Woodworking Gets ERP Implementation Right

Sauder Woodworking is North America's leading producer of ready-to-assemble furniture, and one of the top five U.S. residential furniture manufacturers. 90 percent of Sauder furniture is manufactured in Archbold, Ohio, where the company was founded in 1934. (Sauder also sources furniture from a network of global suppliers.) Its Ohio facility has 4-million-square-foot floor space housing high-tech furniture-making equipment from around the world and 2,000 employees. The company offers nearly 50 furniture collections. Furniture-making requires skilled design, artistry, and attention to detail, and Sauder has historically excelled in these areas.

Sauder started using SAP ERP Central Component (ECC) software for enterprise resource planning (ERP) in 2004. ECC provides modules covering a full range of industry applications, including finance, logistics, HR, product planning, and customer service, linked together into a single, customizable system run on a database of the user's choice. As a modular system, SAP ECC is designed so that organizations can use the pieces they need, configured in a way that makes sense for their business. Sauder used a phased implementation approach, starting with the modules for order-to-cash (business processes for receiving and processing customer orders). Sauder finished implementing all the main SAP ECC modules by 2015.

By that time, SAP had released SAP S/4HANA, a more leading-edge version of its ERP system that features in-memory computing (see Chapter 6). Sauder management had to decide whether to optimize the SAP modules it had already implemented on premises or whether to switch to S/4HANA to take advantage of its new functionality. Switching to the newest version of SAP ERP software would require more work than sticking with Sauder's existing system. Management opted for an on-premises version of SAP S/4HANA so that it could implement the new S/4HANA suite on its own timeline rather than wait and then be pressured to change software when SAP withdrew support for the older ECC system.

Another decision was whether to go greenfield (a completely new implementation) or brownfield (converting the existing system to the new one). A greenfield implementation would require installing

a clean installation of the ERP system, then importing all the relevant data. A brownfield implementation would entail converting the existing system to the new one, using the data from the ECC system. Sauder opted for the brownfield approach. A key factor in the decision to go brownfield was the number of employees (2,000) who would be impacted by having to deal with an entirely new system. They might have trouble learning the system or resist working with the system because it was so unfamiliar. Sauder didn't want to have to deal with a lot of change management.

Sauder was quite familiar with SAP software, which was the company's business processing engine. Sauder's SAP system supported over 1,600 users conducting business transactions with the software, including those for finance, supply chain management, and shop floor interactions with SAP. In 2018, Sauder's SAP system processed 1,624,169 shipments, 1,661,225 sales orders, 14,438,089 warehouse moves, 894,664 production receipts, and 1,624,684 invoices.

There were challenges: To minimize business disruptions, management wanted the SAP ECC system converted to SAP S/4HANA within 72 hours, a very narrow time frame for a project of this scope. There was no room for error. At the same time Sauder began transitioning to SAP S/4HANA, it also made major changes to its IT infrastructure. The company migrated off legacy IBM iSeries systems to a new platform based on Dell servers and storage area networks (SANs) in a VMware virtual environment (see Chapter 5). A SAN is a network of storage devices that can be accessed by multiple servers or computers, providing a shared pool of storage space. Sauder's IT staff had to learn how to support these new technologies, but was fortunately assisted by Symmetry consultants. Symmetry helps firms manage complex SAP implementations on a global scale. Symmetry had provided services to Sauder for over 12 years, and understood the nature of its business and technology environment.

The system was successfully converted within the 72-hour downtime window, including conversion of the production planning and detailed scheduling functionality of the SAP® Advanced Planning and Optimization component within SAP S/4HANA.

The cut over to the new S/4HANA system went very smoothly, with minimal disruption to the business, and the project was delivered on time and within budget.

The company plans to optimize its use of the S/4HANA system in phases, starting with finance functions. Running on SAP S/4HANA has positioned

Sauder Woodworking better for achieving its strategic goals.

Sources: Eric Kavanah, "Measure Twice, Cut Once: Getting a Modern ERP Deployment Right," *eWeek*, February 11, 2020; "SAP S/4HANA Migration Case Study: Sauder Woodworking," [symmetrycorp.com](#), accessed May 9, 2020; and "Sauder Woodworking," [itelligence.com](#), accessed May 8, 2020.

CASE STUDY QUESTIONS

1. Why is an ERP system so important for Sauder Woodworking? Why did Sauder want to switch to a newer ERP system?
2. Was SAP S/4HANA a good choice for Sauder? Why or why not?
3. Were there any risks in this project? How did Sauder deal with them?

Project Management Software Tools

Commercial software tools that automate many aspects of project management facilitate the project management process. Project management software typically features capabilities for defining and ordering tasks, assigning resources to tasks, establishing starting and ending dates to tasks, tracking progress at both individual and team levels, and facilitating modifications to tasks and resources. Many automate the creation of Gantt and PERT charts and provide communication, collaboration, and social tools.

Some of these tools are large sophisticated programs for managing very large projects, dispersed work groups, and enterprise functions. These high-end tools can manage very large numbers of tasks and activities and complex relationships. The most widely used project management tool today is Microsoft Project, but there are also lower-cost tools for smaller projects and small businesses. Many project management applications are now cloud-based to enable project team members to access project management tools and their data wherever they are working. The chapter-opening case and Interactive Session on Technology describe some capabilities of cloud-based Microsoft Project Online.

While project management software helps organizations track individual projects, the resources allocated to them, and their costs, **project portfolio management** software helps organizations manage portfolios of projects and dependencies among them. Project portfolio management software helps managers compare proposals and projects against budgets and resource capacity levels to determine the optimal mix and sequencing of projects that best achieves the organization's strategic goals.

INTERACTIVE SESSION TECHNOLOGY

Arup Moves Project Management to the Cloud

Arup Group Limited is a multinational professional services firm headquartered in London that provides engineering, design, planning, project management, and consulting services for all aspects of structures and environments of human construction. Founded in 1946, Arup now has over 16,000 staff based in 96 offices across 40 countries throughout the globe. The company defines itself as one where professionals of diverse disciplines—engineers, planners, designers, financial experts, consulting specialists, and sustainability professionals—can work together to deliver projects and services of greater quality than by working in isolation. Arup has worked on projects in over 160 countries, including the Pompidou Center in Paris, the Sydney Opera House, and the high-speed railway between London and Paris.

Arup is an intensive user of information technology in all aspects of its work, including working with clients, designing buildings, running structural simulations, and coordinating projects. Its management wants to ensure that Arup's information systems group is working on all the right IT projects for furthering the business and is doing so in the right way. Arup's systems have to be stable, leading edge, and available at all times, with employees able to access the information they need at any time and any place.

Until recently Arup's IT staff relied on Microsoft Excel spreadsheets or Microsoft Word documents as their project management tools. Reports were sporadic and in diverse formats, collaboration was very limited, project delivery styles were inconsistent, and there was no central visibility into what was happening with each project. Arup set up a Global IT Portfolio Management Office to oversee its entire portfolio of IT projects, but it was hampered by having to manually create reports using spreadsheets and email updates from regional offices.

Working with Program Framework consultants who specialize in project portfolio management, Arup decided to adopt Microsoft Project Online to improve project management. Project Online is Microsoft's cloud-based project management tool, and it helps organizations efficiently plan projects, track status, and collaborate with others from any location and any device. Members of Arup's global workforce have immediate access to project data at any time wherever they are working. The cloud solution also makes it possible to report on projects

using live data, with the system able to tie in to other processes such as service and change management. Program Framework consultants helped Arup implement Project Online and train employees. They also developed a customized Project and Program Status Reporting capability for Project Online.

In the past, Arup's Global IT Portfolio Management Office had to spend 40 hours per month compiling reports manually. By the time it created a status report, the report was already out of date. Project Online gives Arup instant views into the status of all of its IT projects. Regional employees can view their own portfolios of projects, while Arup's Global IT Portfolio Management Office has immediate views of all global projects. Arup's management can examine and classify projects throughout the entire enterprise based on their red, green, and amber status indicators. (Red designates projects with critical status, while amber designates those at risk.) The ability to see Arup's entire project portfolio gives management better insight into project delivery. The Global IT Portfolio Management Office can obtain key project status summaries, and highlight reporting of individual projects where it can drill down for further detail, enabling it to make better decisions based on up-to-date data. Project Online has become essential for supporting a common approach to Arup's project management across the globe. There is less duplication of effort and more strategic value in Arup's overall project portfolio.

Project Online is part of Microsoft's cloud-based Office 365 software suite, so it works seamlessly with other Microsoft productivity and communication tools such as OneDrive for Business (cloud storage), Skype for Business (voice, video, chat), Yammer (enterprise social networking), and Visual Studio Team Foundation Server, which Arup uses for software development projects. Arup also plans to implement additional Project Online capabilities for demand and capacity planning, portfolio prioritization, and portfolio balancing. Users can easily copy information from Project and paste it into Office applications like PowerPoint and Word.

Arup uses Project Online for its IT Project Pipeline, a central repository of ideas for future development. Each idea recorded in the Pipeline requires that the initiator furnish information such as project description, budget, and resource needs.

Arup's Global IT Portfolio Management Office sends this information to Arup's management committee members to review and prioritize for new initiatives.

When ideas are approved, their Project Pipeline information can easily be transferred to active projects. It only takes a few minutes for Project Pipeline to create a project or program within Project Online. Each has its own Project Details Pages, which include a built-in schedule template and a connected Microsoft SharePoint Server site with document repository and status reporting. This capability saves Arup's Global IT Portfolio Management Office manager Carolyn Bundey several days of work for each new project, creating significant time savings for an annual portfolio of approximately 180 IT projects.

Several years ago, Project Online had about 150 users, but Arup is thinking about providing the tool for all of its employees. Arup licenses three different versions of Project Online. Project managers, owners, and administrators use Project Online with Project Professional for Office 365, enabling them to create and edit project plans inside or outside a web browser. Arup executives use Project Online to review project status. Project team members can view assignments or collaborate with other team members using the lower-cost Project Lite version.

Sources: "Engineering Firm Uses Cloud-Based Solution to Generate, Execute, and Monitor IT Projects," www.microsoft.com, accessed January 2, 2018; "Leading Arup at the Forefront of Innovation in Today's Built Environment," www.gineersnow.com, accessed January 3, 2018; and www.arup.com, accessed May 2, 2020.

CASE STUDY QUESTIONS

1. What is the relationship between information technology, project management, and Arup's business model and business strategy?
2. How does Microsoft Project Online support Arup's business strategy? How did it change the way the company works?
3. What management, organization, and technology issues did Arup have to address when selecting Project Online as its global project portfolio management tool?



14-5 How will MIS help my career?

Here is how Chapter 14 and this book can help you find an entry-level job as an IT project management assistant.

The Company

Focus Multimedia Entertainment, a large multinational mass media and entertainment company headquartered in Dublin, Ireland, is looking for an entry-level IT project management assistant. Focus Multimedia creates films, TV shows, recordings, streaming Internet content, interactive games, and consumer products for a worldwide audience. It is an intensive user of leading-edge information technology in its products, services, and operations.

Position Description

The IT project management assistant will help IT project managers with planning, budgeting, and overseeing all aspects of information technology projects for the firm. Job responsibilities include:

- Performing tasks designed to enhance the functions and services provided by the firm's centralized Project Management Office. This might include

identifying and documenting best practices, investigating available tools, and making recommendations for improving processes and procedures.

- Collaborating with project managers to ensure that the scope and direction of each technical project is on schedule.
- Working with other project stakeholders for support.

Job Requirements

- Bachelor's degree in Computer Science, Computer Engineering, Management Information Systems, Project Management, or a related field
- Knowledge of project management (PMI) teachings
- Knowledge of process documentation (process flow charting)
- Proficiency with Microsoft Word, Excel, PowerPoint
- Strong interviewing and research skills
- Experience with SharePoint and/or Microsoft Project desirable

Interview Questions

1. Have you ever worked on an IT project? What did you do? Did you work with any project management tools such as Microsoft Project?
2. Did you ever work on a non-IT project? What were your responsibilities? Did you use project management software for your work?
3. Have you taken course work in project management? What do you know about process documentation?
4. What is your proficiency level with Microsoft Office tools and with Microsoft Project and SharePoint?

Author Tips

1. Review this chapter and also Chapter 13 on building information systems to familiarize yourself with project management and systems development techniques and methodologies.
2. Use the web to do more research on project management methodologies and tools. Explore the Project Management Institute (PMI) website or review the Project Management Institute's book, *A Guide to the Project Management Body of Knowledge*.
3. Try to find information on how projects are managed at XYZ Multimedia. Inquire what project management methodologies and tools are used at this company. If possible, show you are familiar with these tools and approaches.
4. Provide examples of any project management work you have done in your courses or on a job. Alternatively, provide examples of your writing and verbal communication skills.

REVIEW SUMMARY**14-1 How should managers build a business case for the acquisition and development of new information systems?**

The business case for an IT investment describes the problem facing the organization that can be solved by investing in a proposed system solution. It provides an analysis of whether an information system project is a good investment by calculating its costs and benefits. Tangible benefits are quantifiable, and intangible benefits cannot be immediately quantified but may provide quantifiable benefits in the future. Benefits that exceed costs should be analyzed using capital budgeting methods to make sure they represent a good return on the firm's invested capital. Organizations should develop an information systems plan that describes how information technology supports the company's overall business plan and strategy. Portfolio analysis and scoring models can be used to evaluate alternative information systems projects.

14-2 What are the objectives of project management, and why is it so essential in developing information systems?

Good project management is essential for ensuring that systems are delivered on time and on budget and provide genuine business benefits. Project management activities include planning the work, assessing the risk, estimating and acquiring resources required to accomplish the work, organizing the work, directing execution, and analyzing the results. Project management must deal with five major variables: scope, time, cost, quality, and risk.

14-3 What are the principal risk factors in information systems projects?

The level of risk in a systems development project is determined by (1) project size, (2) project structure, and (3) experience with technology. IS projects are more likely to fail when there is insufficient or improper user participation in the systems development process, lack of management support, and poor management of the implementation process. There is a very high failure rate among projects involving business process management, enterprise applications, and mergers and acquisitions because they require extensive organizational change.

14-4 How can project risks be managed?

Implementation refers to the entire process of organizational change surrounding the introduction of a new information system. User support and involvement and management support and control of the implementation process are essential, as are mechanisms for dealing with the level of risk in each new systems project. Project risk factors can be brought under some control by a contingency approach to project management. The risk level of each project determines the appropriate mix of external integration tools, internal integration tools, formal planning tools, and formal control tools to be applied. Project management software helps organizations track individual projects and project portfolio management software helps them manage portfolios of projects and dependencies among them.

Key Terms

<i>Business case</i> , 561	<i>Internal integration tools</i> , 574
<i>Capital budgeting</i> , 567	<i>Organizational impact analysis</i> , 577
<i>Change agent</i> , 571	<i>PERT chart</i> , 574
<i>Change management</i> , 571	<i>Portfolio analysis</i> , 564
<i>Counterimplementation</i> , 576	<i>Project</i> , 569
<i>Ergonomics</i> , 577	<i>Project management</i> , 569
<i>External integration tools</i> , 576	<i>Project portfolio management</i> , 579
<i>Formal control tools</i> , 574	<i>Scope</i> , 570
<i>Formal planning tools</i> , 574	<i>Scoring model</i> , 565
<i>Gantt chart</i> , 574	<i>Sociotechnical design</i> , 577
<i>Implementation</i> , 571	<i>Tangible benefits</i> , 566
<i>Information systems plan</i> , 562	<i>User-designer communications gap</i> , 572
<i>Intangible benefits</i> , 566	<i>User interface</i> , 569

MyLab MIS

To complete the problems with MyLab MIS, go to the EOC Discussion Questions in MyLab MIS.

Review Questions

- 14-1** How should managers build a business case for the acquisition and development of new information systems?
- Define and describe the components of a business case for a proposed investment.
 - List and describe the major components of an information systems plan.
 - Explain the difference between tangible and intangible benefits.
 - List six tangible benefits and six intangible benefits of an IT investment.
 - Describe how capital budgeting, portfolio analysis, and scoring models can be used to establish the worth of systems.
- 14-2** What are the objectives of project management, and why is it so essential in developing information systems?
- Describe information system problems resulting from poor project management.
 - Define project management. List and describe the project management activities and variables addressed by project management.

Discussion Questions

- 14-5** MyLab MIS How much does project management impact the success of a new information system?
- 14-6** MyLab MIS It has been said that most systems fail because systems builders ignore

Hands-On MIS Projects

The projects in this section give you hands-on experience evaluating information systems projects, using spreadsheet software to perform capital budgeting analyses for new information systems investments, and using web tools to analyze the financing for a new home. Visit MyLabMIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

- 14-8** Major corporations all over the world are large procurers of all kinds of goods, buying everything from staplers to cars. To keep track of the thousands or even millions of purchases made each year, modern corporations use e-procurement systems. For the Malaysian MajorCorp enterprise, a decision was made that one e-procurement system would replace a functional but older system over a weekend. Though no end users were involved with developing the new system, it was tested thoroughly from a technical viewpoint and approved by the IT department. On Monday morning, as the office personnel started trying to place orders as usual, they found themselves staring at the new, unfamiliar e-procurement system, and within minutes all lines to the IT support staff were busy. However, the new system worked for some people, so the new database records a large amount of data of questionable quality. Eventually, the new system was shut down, leaving the company with no choice but to take orders using paper and pen or whatever else came to mind. Something evidently went terribly wrong during the migration to the new system. What could MajorCorp have done to prevent this outcome?

- 14-3** What are the principal risk factors in information systems projects?

- Explain the role of a systems analyst as a change agent.
- Explain what is meant by the term user-designer communications gap and why it is often a major problem.
- Explain why projects related to mergers and acquisitions tend to have higher-than-average failure rates.

- 14-4** How can project risks be managed?

- Explain why eliciting support of management and end users is so essential for successful implementation of information systems projects.
- Identify and describe the strategies for controlling project risk.
- Explain what is meant by counterimplementation and why it might be adopted.
- Explain how project management techniques can be used to get around bottlenecks.

organizational behavior problems. Why might this be so?

- 14-7** MyLab MIS What is the role of end users in information systems project management?

- 14-9** Caterpillar is the world's leading maker of earth-moving machinery and supplier of agricultural equipment. Caterpillar wants to end its support for its Dealer Business System (DBS), which it licenses to its dealers to help them run their businesses. The software in this system is becoming outdated, and senior management wants to transfer support for the hosted version of the software to Accenture Consultants so it can concentrate on its core business. Caterpillar never required its dealers to use DBS, but the system had become a de facto standard for doing business with the company. The majority of the 50 Cat dealers in North America use some version of DBS, as do about half of the 200 or so Cat dealers in the rest of the world. Before Caterpillar turns the product over to Accenture, what factors and issues should it consider? What questions should it ask? What questions should its dealers ask?

Improving Decision Making: Using Spreadsheet Software for Capital Budgeting for a New CAD System

Software skills: Spreadsheet formulas and functions

Business skills: Capital budgeting

- 14-10** This project provides you with an opportunity to use spreadsheet software to use the capital budgeting models discussed in this chapter and its Learning Tracks to analyze the return on an investment for a new computer-aided design (CAD) system.

Your company would like to invest in a CAD system that requires purchasing hardware, software, and networking technology as well as expenditures for installation, training, and support. MyLab MIS contains tables showing each cost component for the new system as well as annual maintenance costs over a five-year period, along with a Learning Track on capital budgeting models. You believe the new system will reduce the amount of labor required to generate designs and design specifications, increasing your firm's annual cash flow.

- Using the data provided in these tables, create a worksheet that calculates the costs and benefits of the investment over a five-year period and analyzes the investment using the four capital budgeting models presented in this chapter's Learning Track.
- Is this investment worthwhile? Why or why not?

Improving Decision Making: Using Web Tools for Buying and Financing a Home

Software skills: Internet-based software

Business skills: Financial planning

- 14-11** This project will develop your skills using web-based software for searching for a home and calculating mortgage financing for that home.

You would like to purchase a home in Fort Collins, Colorado. Ideally, it should be a single-family house with at least three bedrooms and one bathroom that costs between 350,000 and \$450,000 and can be financed with a 30-year fixed rate mortgage. You can afford a down payment that is 20 percent of the value of the house. Before you purchase a house, you would like to find out what homes are available in your price range, find a mortgage, and determine the amount of your monthly payment. Use Realtor.com to help you with the following tasks:

- Locate homes in Fort Collins, Colorado, that meet your specifications.
- Find a mortgage for 80 percent of the list price of the home. Compare rates from at least three sites.
- After selecting a mortgage, calculate your closing costs and the monthly payment.

When you are finished, evaluate the whole process. For example, assess the ease of use of the site and your ability to find information about houses and mortgages, the accuracy of the information you found, and the breadth of choice of homes and mortgages.

Collaboration and Teamwork Project

Identifying Implementation Problems

- 14-12** Form a group with three or four other students. Write a description of the implementation problems you might expect to encounter in one of the systems described in the Interactive Sessions or chapter-ending cases in this text. Write an analysis of the steps you would take to solve or prevent these problems. If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Pennsylvania's Unemployment Compensation Modernization System: Unfinished Business

CASE STUDY

The Pennsylvania Department of Labor and Industry (DLI) is responsible for the administration and operation of the state's unemployment compensation program, which provides temporary income to replace lost wages for qualified workers. DLI employs over 5,000 people and has approximately 200 offices statewide to serve Pennsylvania's 6.4 million workers and nearly 300,000 employers. Unemployment compensation (UC) claims are usually filed online or by telephone or mailed to a UC service center.

DLI had a legacy mainframe system for processing unemployment benefits that was over 40 years old. However, it became increasingly expensive to maintain and difficult to modify, with limited functionality for case management and integrating newer tools and technologies to enhance productivity.

In June 2006, DLI awarded IBM a fixed price contract totaling \$109.9 million for the Unemployment Compensation Modernization System (UCMS), which would replace the antiquated mainframe system. The initial contract with IBM called for more modern and efficient technology and business processes for (1) maintaining wage records, (2) processing employer taxes, and (3) claims processing, payment, and appeals, to be completed by February 2010. IBM won the UCMS contract after a three-year bidding process, claiming to be the only vendor with the type of proprietary databases capable of supporting a totally integrated computer system.

However, this project experienced significant delays and cost overruns, ultimately costing nearly \$180 million, with much of the system never completed when the contract expired in September 2013. By that time, the project was 45 months behind schedule and \$60 million over budget. Pennsylvania taxpayers had paid IBM nearly \$170 million for what was supposed to be a comprehensive, integrated, and modern system that it never got. IBM's contract was not renewed. In March 2017, Pennsylvania sued IBM for breach of contract, fraudulent and negligent misrepresentation, and charging taxpayers for services it did not provide. IBM said Pennsylvania's claims had no merit and that it would fight the lawsuit. A spokesman for the company laid some of the blame for the project's problems on the state, saying that there was responsibility on both sides for system

performance and service delivery. How did all of this happen?

Phase 1 of UCMS (wage records) was implemented in May 2008. Phase 2, which included the employer tax portion of the system, went live in March 2011 but required additional work, which took years to fix. Phase 3 for benefit claims processing, payment, and appeals continued to lag behind with problems and ultimately never went live.

In 2012, DLI enlisted the Carnegie Mellon Software Engineering Institute to conduct an independent assessment of the UCMS. The study was completed in July 2013, and recommended continuing work on remaining Phase 2 problems, but stopping work on Phase 3. Many of the problems it identified for Phase 3 could not be solved.

The Carnegie Mellon study found many flaws in the systems development process. IBM had extensive systems experience and technology knowledge but its proposal underestimated the project's scope and complexity. DLI lacked sufficient staffing and experience for effective oversight and management of the contract and project. There was no formal delegation of roles and responsibilities for managing the project. No one at DLI was held accountable. DLI essentially relied on the contractor to self-manage.

UCMS was considered a large-scale software project due to its complexity, large number of information requirements and business rules, and its cost. DLI's solicitation for vendor proposals for UCMS exhibited ambiguity in communicating all of these requirements, and also neglected to define and describe quantitative and qualitative performance measures and metrics for the proposed system.

A large-scale software-intensive system such as UCMS requires a rigorous and disciplined testing strategy, but this was not implemented. IBM decided to use DLI users to help develop test scripts. They provided the business expertise, but IBM did not use IT test experts on its end. User acceptance testing was initiated before completing system tests for Phase 2 and Phase 3. Rigorous testing came too late in the project. DLI did not specify a minimum of metrics for UCMS system performance so that there were no identifiable criteria and evidence for determining that Phase 2 and Phase 3 application releases were stable.

DLI staff had approved IBM's representation of business system requirements without fully understanding what they were approving. IBM's software development and testing program for this project lacked rigor. This resulted in a higher number of software defects than industry norms, software code that was excessively complex (which makes testing too difficult), and late discovery of missing business requirements.

The vast majority of the software defects were serious, and 50 percent were not discovered until the User Acceptance test, very late in the system development cycle. Without thorough and complete testing throughout the development process, there is no way to know how many of the total defects residing in software will be discovered as a system is being used. Carnegie Mellon also found that IBM had not performed a stress test to determine the performance limits of the UCMS system.

IBM's software development plan was supposed to use industry and company standards and practices, but there was no ongoing discipline to execute these standards and practices during the project. DLI accepted Phase 2 prematurely for production in March 2011 with known defects impacting system performance, including software defects, unresolved data conversion issues, and problems with batch processing operations.

A project of this complexity and magnitude requires a high degree of continuity in knowledge throughout the system development cycle, but this was never achieved. During requirements determination, DLI didn't have enough user subject matter experts to participate in joint application design (JAD; see Chapter 13) sessions with technical members of the project team. Thirty-six JAD subcontractors were prematurely removed from the project, leaving IBM with incomplete understanding of unemployment claims processing business requirements. System design and testing staff were not included in the JAD process, running counter to sound business practice. Including them was essential to ensure UC business requirements were defined in sufficient detail to be testable. DLI staff often approved JAD requirements documents and Detailed System Design documents under pressure to meet short deadlines for approval.

Ineffective project management and constant changes in the contractor's workforce prevented transfer of essential knowledge for the entire project, a loss of "project memory." Since the UCMS project's start, 638 different contractors and staff members worked on the project. The majority of the project workforce spent less than one year on the project and 75 percent spent less than 2 years. All of these discontinuities and

workforce churn most likely contributed to IBM's schedule delays and inability to provide an accurate picture of the state of the project.

Work on Pennsylvania's UC system continued without IBM. In 2013, the Pennsylvania Legislature passed Act 34, which created a Services Infrastructure Improvement Fund (SIIIF) as a temporary supplemental funding source to improve UC services and systems. A total of \$178.4 million was authorized and spent during calendar years 2013 through 2016. Even then the project stumbled. Pennsylvania Auditor General Eugene A. DePasquale initiated an audit in January 2017 to determine how the \$178 million in SIIIF funds were spent. The auditors found that DLI did not use proper accounting methods to record specific SIIIF expenditures. DLI comingled unemployment compensation administrative funds from all sources, including federal funds for unemployment compensation administration and interest on unemployment compensation tax money as well as outlays from SIIIF.

On a more positive note, there were noticeable improvements and efficiencies from 2013 through 2016 in services provided to UC claimants and in UC system infrastructure. For example, the percentage of first payments paid promptly increased from 81.6 percent to 93.4 percent. However, DLI was unable to show how exactly the SIIIF expenditures contributed to these outcomes.

When SIIIF funding was not reauthorized and supplemental funding ended in December 2016, DLI was forced to cut \$57.5 million from its UC administrative budget for 2017, causing the immediate closure of three of the state's eight UC service centers in December 2016 and the elimination of 521 positions. Customer service declined significantly with claimants not being able to get through on the phone lines and delays in processing claims.

Despite earlier setbacks, DLI is determined to complete the modernization of its unemployment compensation benefits delivery system. In June 2017, DLI signed a \$35 million contract with Florida-based Geographic Solutions to create a system that enhances customer service, improves quality, is more operationally efficient, and is sustainable into the future. Geographic Solutions specializes in designing, developing, and maintaining web-based systems for the workforce development and unemployment insurance industries and has developed over 80 workforce systems for state and

local agencies across the United States. Geographic Solutions was scheduled to begin work on the system on August 1, 2017 with a projected 18 to 24 months for completion.

In 2015, DLI had hired Chicago-based CSG Government Solutions for \$6.1 million to assist with planning for and monitoring this project. CSG specializes in planning, managing, and supporting complex projects that modernize the information technology and business processes of large government programs. CSG analyzed existing systems and workflows, developed the project strategy and technology roadmap, and gathered business and technical requirements to develop an RFP. CSG also established a full-service Project Management Office to monitor project progress, and is providing technical oversight, UC subject matter expertise, requirements management, and testing support throughout the system modernization. Once the new system has been fully implemented, cost savings from benefit modernization are estimated to range from 5 to 10 percent of total UC administrative costs.

DLI's 2017 contract with Geographic Solutions specified that the new benefits delivery system was supposed to go live by April 30, 2018. As of the spring of 2020, the old system was still in place and unable to handle the millions of Pennsylvania workers who applied for benefits during the coronavirus pandemic shutdown. Geographic Solutions President Paul Toomey said the contract with DLI was an initial estimate based on similar systems in other states, but after analyzing the system they found over 1,000

programming changes required. Toomey added there was no additional cost increase and the project remained on budget and schedule for completion in October 2020.

Sources: Aaron Martin, "Aging PA Unemployment System Overwhelmed by COVID-19 Crush of Claims," WPXI.com, May 4, 2020; "UC Management System," uc.pa.gov, accessed May 10, 2020; www.geographicsolutions.com, accessed May 10, 2020; www.csgdelivers.com, accessed May 3, 2020; Jan Murphy, "Take Two: Labor & Industry Tries Again to Modernize Jobless Benefits Computer System," *Penn Live*, June 23, 2017; Commonwealth of Pennsylvania Department of the Auditor General, "Performance Audit Report: Pennsylvania Department of Labor and Industry Service and Infrastructure Improvement Fund (SIIIF)," April 2017; and Constance Bennett, Nanette Brown, Julie Cohen, Dr. Betsy Clark, Jeff Davenport, Eric Ferguson, John Gross, Michael H. McLendon, and Gregory Such, "Independent Assessment of the Commonwealth of Pennsylvania Unemployment Compensation Modernization System Program (UCMS)," Carnegie Mellon University Software Engineering Institute, July 2013.

CASE STUDY QUESTIONS

- 14-13** Assess the importance of the Unemployment Compensation Modernization System project for the state of Pennsylvania.
- 14-14** Why was unemployment compensation modernization a risky project in Pennsylvania? Identify the key risk factors.
- 14-15** Classify and describe the problems encountered by the UCMS projects. What management, organization, and technology factors were responsible for these problems?
- 14-16** What could have been done to mitigate the risks of these projects?

Chapter 14 References

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15

Managing Global Systems

LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

- 15-1** What major factors are driving the internationalization of business?
- 15-2** What are the alternative strategies for developing global businesses?
- 15-3** What are the challenges posed by global information systems and management solutions for these challenges?
- 15-4** What are the issues and technical alternatives to be considered when developing international information systems?
- 15-5** How will MIS help my career?

CHAPTER CASES

- The Bel Group: Laughing All the Way to Success
- Rethinking Global Supply Chains
- Digital Nationalism
- Souq.com: Amazon's Entry into the Middle East

VIDEO CASES

- Daum Runs Oracle Apps on Linux
- Lean Manufacturing and Global ERP: Humanetics and Global Shop

MyLab MIS

Discussion Questions: 15-5, 15-6; Hands-On MIS Projects: 15-7, 15-8, 15-9, 15-10;
eText with Conceptual Animations

The Bel Group: Laughing All the Way to Success

The Bel Group is a global producer and distributor of cheese. Headquartered in Paris, it is best known for its small-portion cheese snacks packaged in branded packets. Born in Leon Bel's French cheese plant in 1921, The Laughing Cow is one of the Bel group's core brands together with Mini Babybel, Kiri, Leerdammer, and Boursin. The Group operates through numerous subsidiaries in Europe, the Americas, Asia, Turkey, and Africa, including a subsidiary in Egypt. As a multinational leader in the production of branded cheeses with a specialization in miniaturization, the group's strategy is to double in size by 2025. Since the focus is primarily on dairy products, the company is exposed to fluctuations in dairy product prices and exchange rates, and achieving this ambitious target might prove challenging if it relies on organic growth alone. The acquisition of the MOM Group in 2016 offered potential expansion into snacks, juices, and sweet desserts. The acquisition of All in Foods in 2020 provides plant-based alternatives to cheese as well as plant-based sauces with the company's new signature of "For All. For Good." being gradually displayed by all Bel brands.

The company markets its core brands in 130 countries as a healthy and fun eating experience, with children an important driver for sales. The challenge is to create a bond with the customer, and key products such as The Laughing Cow are localized in an attempt to build a new dairy generation. The formulas of its various cheeses are changed to meet local taste and regulatory requirements; for example, calcium and vitamin D are added for the Egyptian market, and a sweet strawberry flavor is added for South Korea and China. The core brands are active on a range of social media platforms, and the company has a strategic partnership with Facebook to gain a better understanding of its consumers and more effectively measure marketing campaign performance.

In addition to defending and growing established markets in Europe, untouched market potential exists in Africa, Asia, and South America. The ability to make a proper response as well as manage multinational relationships requires an efficient and effective customer relationship management (CRM) system. CRM is not merely about managing existing customers' expectations, but also about acquiring new customers and building brand loyalty across a range of contact points.



© northshoot - Food/Alamy Stock Photo

The Bel Group identified the need for a single CRM system to coordinate sales and marketing teams across both the new and the more mature marketplaces. Each operating unit and sales office has specific market needs, but coordination is required to ensure market agility while enabling effective management of the diverse multilingual and cultural aspects of the business. A decision was made to use Salesforce's Sales Cloud to provide a sales and marketing tool while enabling the enhancement of overall supply chain management. The system provides the company with scalability as well as with ease of use.

According to CIO Yves Gauguier, the Salesforce system can be customized, allowing for market developments, diverse negotiation, and sales promotion needs, with knowledge and expertise quickly shared across the Group, enabling faster communication. The system provides updates on progress toward its target, helps to measure the effectiveness of different marketing campaigns, and helps convert the data collected via the numerous data streams.

Sources: Bel Foundation website, www.groupe-bel.com, accessed January 13, 2021; Fromageries BEL, "BEL: Bel Unveils a New Corporate Identity That Embodies the Group's Commitments to Championing Healthier and Responsible Food for All," www.globenewswire.com, October 16, 2019; Salesforce IN, "Salesforce Helps Bel Reach Its Growth Targets," www.salesforce.com, accessed January 13, 2019.

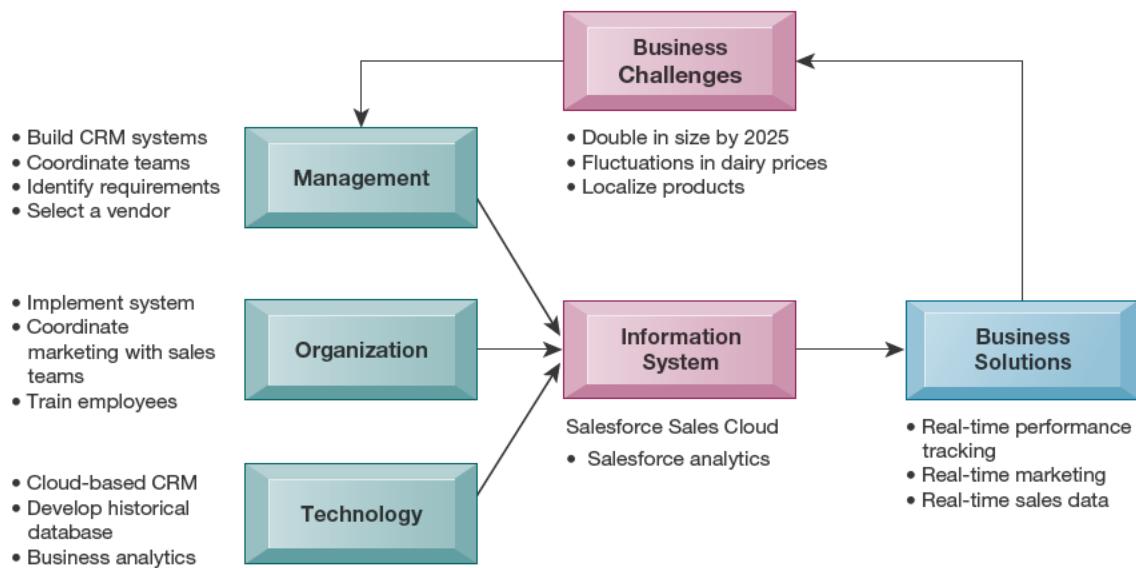
Case contributed by June Clarke, Sheffield Hallam University

The Bel Group's efforts to create global customer relationship management systems highlight some of the issues that organizations need to consider if they want to operate worldwide. Like many large, multinational firms, Bel has subsidiaries and sales offices in a number of different countries. It also has an acquisitions strategy, meaning that potential differences in systems, business processes, and reporting standards have to be managed. Given the Group's product range and target audience, creating a bond with the customer and building customer understanding are vital to success.

In a mobile-enhanced world, speed of communication and customization across diverse contact points become essential. The company identified the need for a scalable, easy-to-use system that would provide an effective measurement tool for different marketing campaigns in order to meet the varying needs of its target audiences.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. To improve global management and customer-facing business processes, the Bel Group implemented a new global system based on Salesforce CRM software. Hosted in the cloud, it provides managers and employees with enterprise-wide information on campaigns, customers, and prospects around the globe. This helps the company manage diverse contact points more efficiently around the world and drives global growth.

Here are some questions to think about: How does information technology improve operations and decision making at the Bel Group? How would the company's new CRM system facilitate its business strategy? Why is it important to incorporate the impact of a social media presence as a measurement tool?



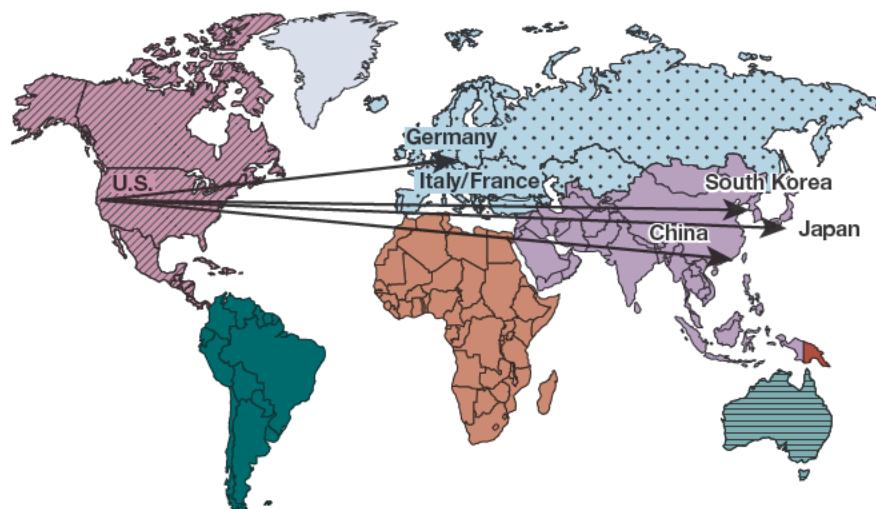
15-1 What major factors are driving the internationalization of business?

In earlier chapters, we describe the emergence of a global economic system and global world order driven by advanced networks and information systems. The new world order is sweeping away many national corporations, national industries, and national economies controlled by domestic politicians. Localized firms are being replaced by fast-moving networked corporations that transcend national boundaries. The growth of international trade has radically altered domestic economies around the globe.

Consider the path to market for an iPhone, which is illustrated in Figure 15.1. The iPhone was designed by Apple engineers in the United States, sourced with

FIGURE 15.1 APPLE IPHONE'S GLOBAL SUPPLY CHAIN

Apple designs the iPhone in the United States and relies on suppliers in the United States, Germany, Italy, France, Japan, and South Korea for other parts. Much of the final assembly occurs in China.



more than 200 high-tech components from around the world, and assembled in China. Companies in Taiwan, South Korea, Japan, France, Italy, Germany, and the United States provided components such as the case, camera, processor, accelerator, gyroscope, electronic compass, power management chip, touch screen controller, and high-definition display screen. Foxconn, a Chinese division of Taiwan's Hon Hai Group, is in charge of manufacturing and assembly.

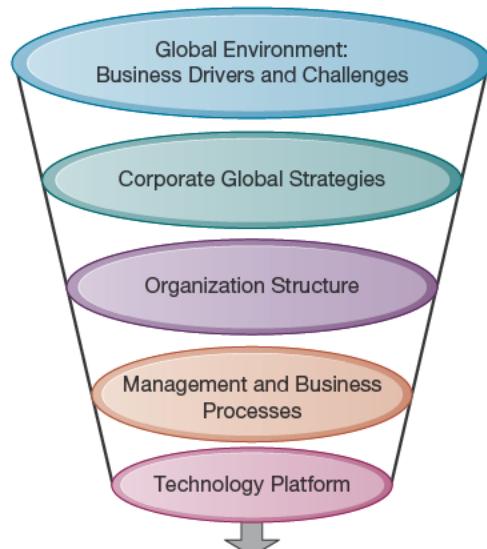
Developing an International Information Systems Architecture

This chapter describes how to go about building an international information systems architecture suitable for your international strategy. An **international information systems architecture** consists of the basic information systems required by organizations to coordinate worldwide trade and other activities. Figure 15.2 illustrates the reasoning we follow throughout the chapter and depicts the major dimensions of an international information systems architecture.

The basic strategy to follow when building an international system is to understand the global environment in which your firm is operating. This means understanding the overall market forces, or business drivers, that are pushing your industry toward global competition. A **business driver** is a force in the environment to which businesses must respond and that influences the direction of the business. Likewise, examine carefully the inhibitors or negative factors that create *management challenges*—factors that could scuttle the development of a global business. Once you have examined the global environment, you will need to consider a corporate strategy for competing in that environment. How will your firm respond? You could ignore the global market and focus on domestic competition only, sell to the globe from a domestic base, or organize production and distribution around the globe. There are many in-between choices.

FIGURE 15.2 INTERNATIONAL INFORMATION SYSTEMS ARCHITECTURE

The major dimensions for developing an international information systems architecture are the global environment, the corporate global strategies, the structure of the organization, the management and business processes, and the technology platform.



After you have developed a strategy, it is time to consider how to structure your organization so it can pursue the strategy. How will you accomplish a division of labor across a global environment? Where will production, administration, accounting, marketing, and human resource functions be located? Who will handle the systems function?

Next, you must consider the management issues in implementing your strategy and making the organization design come alive. Key here will be the design of business processes. How can you discover and manage user requirements? How can you induce change in local units to conform to international requirements? How can you reengineer on a global scale, and how can you coordinate systems development?

The last issue to consider is the technology platform. Although changing technology is a key driving factor leading toward global markets, you need to have a corporate strategy and structure before you can rationally choose the right technology.

After you have completed this process of reasoning, you will be well on your way toward an appropriate international information systems portfolio capable of achieving your corporate goals. Let's begin by looking at the overall global environment.

The Global Environment: Business Drivers and Challenges

Table 15.1 lists the business drivers in the global environment that are leading all industries toward global markets and competition.

The global business drivers can be divided into two groups: general cultural factors and specific business factors. Easily recognized general cultural factors have driven internationalization since World War II. Information, communication, and transportation technologies have created a *global village* in which communication (by telephone, television, radio, or computer network) around the globe is no more difficult than communication down the block. The cost of moving goods and services to and from geographically dispersed locations has fallen dramatically.

The development of global communications has created a global village in a second sense: A **global culture** created by television, the Internet, and other globally shared media such as movies now permits different cultures and peoples to develop common expectations about right and wrong, desirable and undesirable, heroic and cowardly.

A last factor to consider is the growth of a global knowledge base. At the end of World War II, knowledge, education, science, and industrial skills were highly concentrated in North America, Western Europe, and Japan, with the

TABLE 15.1 THE GLOBAL ENVIRONMENT: BUSINESS DRIVERS AND CHALLENGES

GENERAL CULTURAL FACTORS	SPECIFIC BUSINESS FACTORS
Global communication and transportation technologies	Global markets
Development of global culture	Global production and operations
Emergence of global social norms	Global coordination
Political stability	Global workforce
Global knowledge base	Global economies of scale

rest of the world euphemistically called the *Third World*. This is no longer true. Latin America, China, southern Asia, and Eastern Europe have developed powerful educational, industrial, and scientific centers, resulting in a much more democratically and widely dispersed knowledge base.

These general cultural factors leading toward internationalization result in specific business globalization factors that affect most industries. The growth of powerful communications technologies and the emergence of world cultures lay the groundwork for *global markets*—global consumers interested in consuming similar products that are culturally approved. Coca-Cola, American sneakers (made in Korea but designed in Los Angeles), and British Broadcasting Corporation (BBC) programming can now be sold worldwide.

Responding to this demand, global production and operations have emerged with precise online coordination between far-flung production facilities and central headquarters thousands of miles away. At Maersk, a major global shipping company based in Copenhagen, Denmark, shipping managers at Copenhagen and other locations can watch the loading of ships in Rotterdam online, check trim and ballast, and trace packages to specific ship locations as the activity proceeds. This is all possible through an international satellite link.

The new global markets and pressure toward global production and operation have called forth whole new capabilities for global coordination. Production, accounting, marketing and sales, human resources, and systems development (all the major business functions) can be coordinated on a global scale.

Frito-Lay, for instance, can develop a marketing sales force automation system in the United States and, once provided, may try the same techniques and technologies in Spain. Micromarketing—marketing to very small geographic and social units—no longer means marketing to neighborhoods in the United States but to neighborhoods throughout the world! Internet-based marketing means marketing to individuals and social networks across the globe. These new levels of global coordination permit, for the first time in history, the location of business activity according to comparative advantage. Design should be located where it is best accomplished, as should marketing, production, and finance.

Finally, global markets, production, and administration create conditions for powerful, sustained global economies of scale. Production driven by worldwide global demand can be concentrated where it can best be accomplished, fixed resources can be allocated over larger production runs, and production runs in larger plants can be scheduled more efficiently and precisely estimated. Lower-cost factors of production can be exploited wherever they emerge. The result is a powerful strategic advantage to firms that can organize globally. These general and specific business drivers have greatly enlarged world trade and commerce, although the coronavirus pandemic has called into question the dependence on global supply chains where sourcing is concentrated in a single country or supplier. (See the Interactive Session on Management.)

Not all industries are similarly affected by these trends. Clearly, manufacturing has been much more affected than services that still tend to be domestic and highly inefficient. However, the localism of services is breaking down in telecommunications, entertainment, transportation, finance, law, and general business. Clearly, those firms that can understand the internationalization of their own industry and respond appropriately are positioned to reap substantial gains in productivity.

INTERACTIVE SESSION MANAGEMENT

Rethinking Global Supply Chains

In recent years, supply chain management thinking has emphasized optimizing costs by creating global supply chains and relying on one or two key suppliers for a given product or component, even if they are located in a faraway country. Supply chains have become increasingly global. Global supply chains have made it possible for original equipment manufacturers (OEMs) and Tier 1 vendors in the automotive supply chain, for example, to meet aggressive cost targets while keeping the price of new vehicles low. Lower transportation costs, falling trade barriers, the growth of subcontracting, and use of the Internet as a low-cost global communication tool have enabled many companies to shift to a global sourcing model. That prevailing wisdom is now being challenged.

The coronavirus pandemic, an unanticipated "black swan" event of unprecedented magnitude, shut down much of the world economy, disrupting supply chains throughout the globe. China had become a major world supplier to the pharmaceutical, electronics, metals, and auto industries, as well as a wide range of consumer and industrial products, including surgical gowns, masks, and other personal protective equipment. When China shut its factories and halted domestic and international travel to stop the spread of the virus, companies in other countries had to shut down or delay production and deliveries as well. As coronavirus closed borders across the world, China reportedly met its internal demand for masks at the expense of countries who import Chinese masks, like the United States. Supply chains were also disrupted as individual countries shut down production, transportation, and retail sales to block the spread of coronavirus infections.

Subcontracting has become more prevalent, driven by increased sophistication of components, manufacturing processes that require specialists, and the desire on the part of producers to have more flexible capacity that can be turned on and off depending on demand. The result is supply chains with deeper tiering. Suppliers draw upon their suppliers, who in turn draw on their own networks of suppliers in multistage production networks. It is becoming more common to have four or more tiers of suppliers. This level of complexity makes it very difficult

for companies to have visibility into who all their suppliers actually are. Without this knowledge, many companies are caught off guard when major disruptions occur.

Over the past decade, there have been other "black swan" events, including the U.S.–China trade war and the 2011 east Japan earthquake and tsunami. Some companies responded by setting up alternative sources for their supply chains. But many refused to change, believing it would be nearly impossible to replace key Chinese suppliers. No one realized what would happen when the world's second largest economy completely shut down. The coronavirus pandemic should be a wake-up call.

What can companies do now to mitigate global supply chain risk? First, businesses should eliminate their dependence on sourcing from a single supplier, region, or country. They should develop alternate supply sources and increase their safety stocks. These moves will increase costs, but they will make supply chains more resilient. However, supply availability can depend on the unique capabilities of a vendor or the location of specific resources. If a firm can easily locate and work with an alternative supplier, it may be able to get by with less safety stock. Firms with a complex manufacturing process that needs certification will need more. For example, Novo Nordisk, which manufactures half of the world's insulin supply at its facility in Kalundborg, Denmark, maintains a five-year reserve because insulin is such an essential medication for diabetes.

Second, companies should consider more regionalization of production and even localization of suppliers if feasible. When Toyota pioneered lean production in Japan in the 1970s, its suppliers were colocated nearby. Toyota continues to practice localization more than many of its competitors. More than 350 suppliers for Toyota's Georgetown, Kentucky factory are located in the United States, with over 100 within the state of Kentucky. Coca-Cola was well-positioned to weather pandemic supply chain disruptions because its production is localized. Beverages sold in the United States are produced there. Drinks in Germany are made in Germany. Drinks in Kenya are made in Kenya. Unfortunately, many companies have chosen to

adopt lean and just-in-time production methods that span global networks, focusing on price rather than supplier diversity. The coronavirus pandemic exposed the vulnerability of this approach.

Third, companies should consider reducing the number of products they make. Kimberly-Clark, which makes Cottonelle toilet paper, Huggies diapers, and other household goods, saw a surge in sales in the first quarter of 2020 as consumers bought more staples to use while staying at home. Kimberly-Clark decided to limit the number of products it produces. By making a smaller array of products, the company could ease pressure on factories that

had to ramp up production to meet this new level of demand.

All of these measures require a new mindset that recognizes that some amount of profit will have to be sacrificed in exchange for supply security, and that supply chains should be designed with more awareness of risks.

Sources: Micah Maidenberg, "Fewer Products, Localized Production-Companies Seek Supply-Chain Solutions," *Wall Street Journal*, April 26, 2020; Willy Shih, "Is It Time to Rethink Global Supply Chains?" *MIT Sloan Management Review*, March 19, 2020; "Battered and Bruised, Supply Chains Shift to Recover-and-Survive Mode," *Bloomberg*, April 29, 2020; and Rakesh Sharma, "Automotive Procurement: Time to Rethink Supplier Consolidation?" *Supply Chain Brain*, May 15, 2020.

CASE STUDY QUESTIONS

1. What factors have contributed to the growth of global supply chains?
2. What are the advantages and disadvantages of global supply chains?
3. What measures can companies take to mitigate supply chain risk?
4. Should companies continue to maintain global supply chains? Explain your answer.

Business Challenges

Although the possibilities of globalization for business success are significant, fundamental forces are operating to inhibit a global economy and to disrupt international business. Table 15.2 lists the most common and powerful challenges to the development of global systems.

At a cultural level, **particularism**, making judgments and taking action on the basis of narrow or personal characteristics, in all its forms (religious, nationalistic, ethnic, regionalism, geopolitical position), rejects the very concept of a shared global culture and rejects the penetration of domestic markets by foreign goods and services. Differences among cultures produce differences in social expectations, politics, and ultimately legal rules. In certain countries, such as the United States, consumers expect domestic name-brand products to be built domestically and are disappointed to learn that much of what they thought of as domestically produced is in fact foreign made.

Different cultures produce different political regimes. Among the many different countries of the world are different laws governing the movement of information, information privacy of their citizens, origins of software and hardware in systems, and radio and satellite telecommunications. Even the hours of

TABLE 15.2 CHALLENGES AND OBSTACLES TO GLOBAL BUSINESS SYSTEMS

GLOBAL	SPECIFIC
Cultural particularism: Regionalism, nationalism, language differences	Standards: Different Electronic Data Interchange (EDI), email, telecommunications standards
Social expectations: Brand-name expectations, work hours	Reliability: Phone networks not uniformly reliable
Political laws: Transborder data and privacy laws, commercial regulations	Speed: Different data transfer speeds, many slower than United States Personnel: Shortages of skilled consultants

business and the terms of business trade vary greatly across political cultures. These different legal regimes complicate global business and must be considered when building global systems.

For instance, European countries have different laws concerning data flow and privacy from those in the United States. **Transborder data flow** is defined as the movement of information across international boundaries in any form. In 1998, the European Union adopted a Data Protection Directive that broadened and standardized privacy protection in E.U. nations, and allowed for the transfer of personal data to systems located in the United States and other nations where these systems met European privacy standards. The General Data Protection Regulation (GDPR), which went into effect in May 2018, provides additional privacy protection for European citizens and applies to all data produced by EU citizens, whether or not the company collecting the data in question is located within the EU, as well as all people whose data are stored within the EU, whether or not they are actually EU citizens. (Review the discussion of GDPR in Chapter 4.)

Cultural and political differences profoundly affect organizations' business processes and applications of information technology. A host of specific barriers arise from the general cultural differences, everything from different reliability of phone networks to the shortage of skilled consultants.

National laws and traditions have created disparate accounting practices in various countries, which affects the ways profits and losses are analyzed. German companies generally do not recognize the profit from a venture until the project is completely finished and they have been paid. Conversely, British firms begin posting profits before a project is completed, when they are reasonably certain they will get the money.

These accounting practices are tightly intertwined with each country's legal system, business philosophy, and tax code. British, U.S., and Dutch firms share a predominantly Anglo-Saxon outlook that separates tax calculations from reports to shareholders to focus on showing shareholders how fast profits are growing. Continental European accounting practices are less oriented toward impressing investors, focusing rather on demonstrating compliance with strict rules and minimizing tax liabilities. These diverging accounting practices make it difficult for large international companies with units in different countries to evaluate their performance.

Language remains a significant barrier. Although English has become a kind of standard business language, this is truer at higher levels of companies and not throughout the middle and lower ranks. Software may have to be built with local language interfaces before a new information system can be successfully implemented.

Currency fluctuations can play havoc with planning models and projections. A product that appears profitable in Mexico or Japan may actually produce a loss because of changes in foreign exchange rates.

These inhibiting factors must be taken into account when you are designing and building international systems for your business. Companies trying to implement systems spanning national boundaries typically underestimate the time, expense, and logistical difficulties of making goods and information flow freely across different countries.

State of the Art

One might think, given the opportunities for achieving competitive advantages as outlined previously and the interest in future applications, that most international companies have rationally developed marvelous international systems

architectures. Nothing could be further from the truth. Most companies have inherited patchwork international systems from the distant past, often based on outdated concepts of information processing, with reporting from independent foreign divisions to corporate headquarters, manual entry of data from one legacy system to another, and little online control and communication. Corporations in this situation increasingly face powerful competitive challenges in the marketplace from firms that have rationally designed truly international systems. Still other companies have recently built technology platforms for international systems but have nowhere to go because they lack global strategy.

As it turns out, there are significant difficulties in building appropriate international architectures. The difficulties involve planning a system appropriate to the firm's global strategy, structuring the organization of systems and business units, solving implementation issues, and choosing the right technical platform. Let's examine these problems in greater detail.

15-2 What are the alternative strategies for developing global businesses?

Three organizational issues face corporations seeking a global position: choosing a strategy, organizing the business, and organizing the systems management area. The first two are closely connected, so we discuss them together.

Global Strategies and Business Organization

Four main global strategies form the basis for global firms' organizational structure. These are domestic exporter, multinational, franchiser, and transnational. Each of these strategies is pursued with a specific business organizational structure (see Table 15.3). For simplicity's sake, we describe three kinds of organizational structure or governance: centralized (in the home country), decentralized (to local foreign units), and coordinated (all units participate as equals). Other types of governance patterns can be observed in specific companies (e.g., authoritarian dominance by one unit, a confederacy of equals, a federal structure balancing power among strategic units, and so forth).

The **domestic exporter** strategy is characterized by heavy centralization of corporate activities in the home country of origin. Nearly all international companies begin this way, and some move on to other forms. Production, finance/accounting, sales/marketing, human resources, and strategic management are set up to optimize resources in the home country. International sales are sometimes dispersed using agency agreements or subsidiaries, but even here, foreign marketing relies on the domestic home base for marketing strategies.

The **multinational** strategy concentrates financial management and control out of a central home base while decentralizing production, sales, and marketing

TABLE 15.3 GLOBAL BUSINESS STRATEGY AND STRUCTURE

BUSINESS FUNCTION	DOMESTIC EXPORTER	MULTINATIONAL	FRANCHISER	TRANSNATIONAL
Production	Centralized	Dispersed	Coordinated	Coordinated
Finance/accounting	Centralized	Centralized	Centralized	Coordinated
Sales/marketing	Mixed	Dispersed	Coordinated	Coordinated
Human resources	Centralized	Centralized	Coordinated	Coordinated
Strategic management	Centralized	Centralized	Centralized	Coordinated

operations to units in other countries. The products and services on sale in different countries are adapted to suit local market conditions. The organization becomes a far-flung confederation of production and marketing facilities in different countries. Many financial service firms, such as HSBC Holdings, along with a host of manufacturers, such as General Motors and H&M, fit this pattern.

Franchisers are an interesting mix of old and new. On the one hand, the product is created, designed, financed, and initially produced in the home country but for product-specific reasons must rely heavily on foreign personnel for further production, marketing, and human resources. Food franchisers such as McDonald's fit this pattern. McDonald's created a new form of fast-food chain in the United States and continues to rely largely on the United States for inspiration for new products, strategic management, and financing. Nevertheless, because the product must be produced locally—it is perishable—extensive coordination and dispersal of production, local marketing, and local recruitment of personnel are required. Other examples include Quick Restaurants, Telepizza, and Nordsee.

Generally, foreign franchisees are clones of the mother country units, but fully coordinated worldwide production that could optimize factors of production is not possible. For instance, potatoes and beef can generally not be bought where they are cheapest on world markets but must be produced reasonably close to the area of consumption.

Transnational firms are stateless, truly globally managed firms. Transnational firms have no single national headquarters but instead have many regional headquarters and perhaps a world headquarters. In a **transnational** strategy, nearly all the value-adding activities are managed from a global perspective without reference to national borders, optimizing sources of supply and demand wherever they appear, and taking advantage of any local competitive advantages. Transnational firms take the globe, not the home country, as their management frame of reference. The governance of these firms has been likened to a federal structure in which there is a strong central management core of decision making but considerable dispersal of power and financial muscle throughout the global divisions. Few companies have actually attained transnational status.

Information technology and improvements in global telecommunications are giving international firms more flexibility to shape their global strategies. Protectionism and a need to serve local markets better encourage companies to disperse production facilities and at least become multinational. At the same time, the drive to achieve economies of scale and take advantage of short-term local advantage moves transnationals toward a global management perspective and a concentration of power and authority. Hence, there are forces of decentralization and dispersal as well as forces of centralization and global coordination.

Global Systems to Fit the Strategy

Information technology and improvements in global telecommunications are giving international firms more flexibility to shape their global strategies. The configuration, management, and development of systems tend to follow the global strategy chosen. Figure 15.3 depicts the typical arrangements. By *systems* we mean the full range of activities involved in building and operating information systems: conception and alignment with the strategic business plan, systems development, and ongoing operation and maintenance. For the sake of simplicity, we consider four types of systems configuration. *Centralized systems*

FIGURE 15.3 GLOBAL STRATEGY AND SYSTEMS CONFIGURATIONS

The large X's show the dominant patterns, and the small x's show the emerging patterns. For instance, domestic exporters rely predominantly on centralized systems, but there is some development of decentralized systems in local marketing regions.

SYSTEM CONFIGURATION	Strategy			
	Domestic Exporter	Multinational	Franchiser	Transnational
Centralized	X			
Duplicated			X	
Decentralized	x	X	x	
Networked		x		X

are those in which systems development and operation occur totally at the domestic home base. *Duplicated systems* are those in which development occurs at the home base but operations are handed over to autonomous units in foreign locations. *Decentralized systems* are those in which each foreign unit designs its own unique solutions and systems. *Networked systems* are those in which systems development and operations occur in an integrated and coordinated fashion across all units.

As can be seen in Figure 15.3, domestic exporters tend to have highly centralized systems in which a single domestic systems development staff develops worldwide applications. Multinationals offer a direct and striking contrast: Here, foreign units devise their own systems solutions based on local needs with few if any applications in common with headquarters (the exceptions being financial reporting and some telecommunications applications). Franchisers have the simplest systems structure: Like the products they sell, franchisers develop a single system usually at the home base and then replicate it around the world. Each unit, no matter where it is located, has identical applications. Last, the most ambitious form of systems development is found in transnational firms: Networked systems are those in which there is a solid, singular global environment for developing and operating systems. This usually presupposes a powerful telecommunications backbone, a culture of shared applications development, and a shared management culture that crosses cultural barriers. The networked systems structure is the most visible in financial services where the homogeneity of the product—money and money instruments—seems to overcome cultural barriers.

Reorganizing the Business

How should a firm organize itself for doing business on an international scale? To develop a global company and information systems support structure, a firm needs to follow these principles:

1. Organize value-adding activities along lines of comparative advantage. For instance, marketing/sales functions should be located where they can best be performed for least cost, and maximum impact, and reliability; likewise with production (with safeguards for supply chain resiliency), finance, human resources, and information systems.
2. Develop and operate systems units at each level of corporate activity—regional, national, and international. To serve local needs, there should be

host country systems units of some magnitude. *Regional systems units* should handle telecommunications and systems development across national boundaries that take place within major geographic regions (European, Asian, American). *Transnational systems units* should be established to create the linkages across major regional areas and coordinate the development and operation of international telecommunications and systems development (Roche, 1992).

3. Establish at world headquarters a single office responsible for development of international systems—a global chief information officer (CIO) position.

Many successful companies have devised organizational systems structures along these principles. The success of these companies relies not only on the proper organization of activities but also on a key ingredient—a management team that can understand the risks and benefits of international systems and that can devise strategies for overcoming the risks. We turn to these management topics next.

15-3 What are the challenges posed by global information systems and management solutions for these challenges?

Table 15.4 lists the principal management problems posed by developing international systems. It is interesting to note that these problems are the chief difficulties managers experience in developing ordinary domestic systems as well. But these are enormously complicated in the international environment.

A Typical Scenario: Disorganization on a Global Scale

Let's look at a common scenario. A traditional multinational consumer-goods company based in the United States and operating in Europe would like to expand into Asian markets and knows that it must develop a transnational strategy and a supportive information systems structure. Like most multinationals, it has dispersed production and marketing to regional and national centers while maintaining a world headquarters and strategic management in the United States. Historically, it has allowed each of the subsidiary foreign divisions to develop its own systems. The only centrally coordinated system is financial controls and reporting. The central systems group in the United States focuses only on domestic functions and production.

The result is a hodgepodge of hardware, software, and telecommunications. The email systems between Europe and the United States are incompatible. Each production facility uses a different manufacturing resources planning system (or a different version of the same ERP system) and different marketing, sales, and human resource systems. Hardware and database platforms are wildly different. Communications between different sites are poor, given the high cost of European intercountry communications.

What do you recommend to the senior management leaders of this company, who now want to pursue a transnational strategy and develop an information systems architecture to support a highly coordinated global systems environment? Consider the problems you face by reexamining Table 15.4. The foreign divisions will resist efforts to agree on common user requirements; they have never thought about much other than their own units' needs. The systems groups in U.S. local sites, which have been enlarged recently and told to focus

TABLE 15.4 MANAGEMENT CHALLENGES IN DEVELOPING GLOBAL SYSTEMS

- Agreeing on common user requirements
- Introducing changes in business processes
- Coordinating applications development
- Coordinating software releases
- Encouraging local users to support global systems

on local needs, will not easily accept guidance from anyone recommending a transnational strategy. It will be difficult to convince local managers anywhere in the world that they should change their business procedures to align with other units in the world, especially if this might interfere with their local performance. After all, local managers are rewarded in this company for meeting local objectives of their division or plant. Finally, it will be difficult to coordinate development of projects around the world in the absence of a powerful telecommunications network and, therefore, difficult to encourage local users to take on ownership in the systems developed.

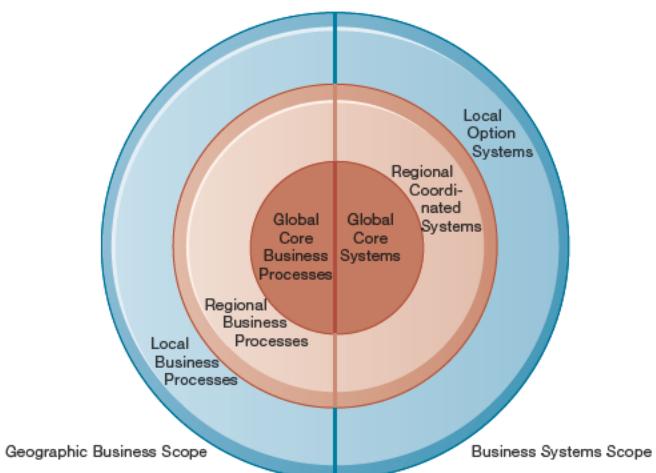
Global Systems Strategy

Figure 15.4 lays out the main dimensions of a solution. First, consider that not all systems should be coordinated on a transnational basis; only some core systems are truly worth sharing from a cost and feasibility point of view. **Core systems** support functions that are absolutely critical to the organization. Other systems should be partially coordinated because they share key elements, but they do not have to be totally common across national boundaries. For such systems, a good deal of local variation is possible and desirable. A final group of systems is peripheral, truly provincial, and needed to suit local requirements only.

FIGURE 15.4 LOCAL, REGIONAL, AND GLOBAL SYSTEMS

Agency and other coordination costs increase as the firm moves from local option systems toward regional and global systems. However, transaction costs of participating in global markets probably decrease as firms develop global systems. A sensible strategy is to reduce agency costs by developing only a few core global systems that are vital for global operations, leaving other systems in the hands of regional and local units.

Source: From *Managing Information Technology in Multinational Corporations* by Edward M. Roche, © 1992. Adapted by permission of Prentice Hall, Inc., Upper Saddle River, NJ.



Define the Core Business Processes

How do you identify core systems? The first step is to define a short list of critical core business processes. Business processes are defined and described in Chapter 2, which you should review. Briefly, business processes are sets of logically related tasks to produce specific business results, such as shipping out correct orders to customers or delivering innovative products to the market. Each business process typically involves many functional areas, communicating and coordinating work, information, and knowledge.

The way to identify these core business processes is to conduct a business process analysis. How are customer orders taken, what happens to them once they are taken, who fills the orders, and how are they shipped to the customers? What about suppliers? Do they have access to manufacturing resource planning systems so that supply is automatic? You should be able to identify and set priorities in a short list of 10 business processes that are absolutely critical for the firm.

Next, can you identify centers of excellence for these processes? Is the customer order fulfillment superior in the United States, manufacturing process control superior in Germany, and human resources superior in Asia? You should be able to identify some areas of the company, for some lines of business, where a division or unit stands out in the performance of one or several business functions.

When you understand the business processes of a firm, you can rank-order them. You then can decide which processes should be core applications, centrally coordinated, designed, and implemented around the globe, and which should be regional and local. At the same time, by identifying the critical business processes, the really important ones, you have gone a long way to defining a vision of the future that you should be working toward.

Identify the Core Systems to Coordinate Centrally

By identifying the critical core business processes, you begin to see opportunities for transnational systems. The second strategic step is to conquer the core systems and define these systems as transnational. The financial and political costs of defining and implementing transnational systems are extremely high. Therefore, keep the list to an absolute minimum, letting experience be the guide and erring on the side of minimalism. By dividing off a small group of systems as absolutely critical, you divide opposition to a transnational strategy. At the same time, you can appease those who oppose the central worldwide coordination implied by transnational systems by permitting peripheral systems development to progress unabated with the exception of some technical platform requirements.

Choose an Approach: Incremental, Grand Design, Evolutionary

A third step is to choose an approach. Avoid piecemeal approaches. These surely will fail for lack of visibility, opposition from all who stand to lose from transnational development, and lack of power to convince senior management that the transnational systems are worth it. Likewise, avoid grand design approaches that try to do everything at once. These also tend to fail because of an inability to focus resources. Nothing gets done properly, and opposition to organizational change is needlessly strengthened because the effort requires extraordinary resources. An alternative approach is to evolve transnational applications incrementally from existing applications with a precise and clear vision of the transnational capabilities the organization should have in five years. This is sometimes referred to as the “salami strategy,” or one slice at a time.

Make the Benefits Clear

What is in it for the company? One of the worst situations to avoid is to build global systems for the sake of building global systems. From the beginning, it is crucial that senior management at headquarters and foreign division managers clearly understand the benefits that will come to the company as well as to individual units. Although each system offers unique benefits to a particular budget, the overall contribution of global systems lies in four areas.

Global systems—truly integrated, distributed, and transnational systems—contribute to superior management and coordination. They should include the ability to switch suppliers on a moment's notice from one region to another in a crisis, the ability to move production in response to natural and man-made disasters, and the ability to use excess capacity in one region to meet raging demand in another.

A second major contribution is vast improvement in production, operation, and supply and distribution. Imagine a global value chain with global suppliers and a global distribution network. For the first time, senior managers can locate value-adding activities in regions where they are most economically and reliably performed (with more emphasis now on supply chain resiliency).

Third, global systems mean global customers and global marketing. Fixed costs around the world can be amortized over a much larger customer base. This will unleash new economies of scale at production facilities.

Last, global systems mean the ability to optimize the use of corporate funds over a much larger capital base. This means, for instance, that capital in a surplus region can be moved efficiently to expand production of capital-starved regions; that cash can be managed more effectively within the company and put to use more effectively.

The Management Solution: Implementation

We now can reconsider how to handle the most vexing problems facing managers developing the global information systems architectures that were described in Table 15.4.

Agreeing on Common User Requirements

Establishing a short list of the core business processes and core support systems will begin a process of rational comparison across the many divisions of the company, develop a common language for discussing the business, and naturally lead to an understanding of common elements (as well as the unique qualities that must remain local).

Introducing Changes in Business Processes

Your success as a change agent will depend on your legitimacy, your authority, and your ability to involve users in the change design process. **Legitimacy** is defined as the extent to which your authority is accepted on grounds of competence, vision, or other qualities. The selection of a viable change strategy, which we have defined as evolutionary but with a vision, should assist you in convincing others that change is feasible and desirable. Involving people in change, assuring them that change is in the best interests of the company and their local units, is a key tactic.

Coordinating Applications Development

Choice of change strategy is critical for this problem. At the global level there is far too much complexity to attempt a grand design strategy of change. It is far easier to coordinate change by making small incremental steps toward a larger vision.

Imagine a five-year plan of action rather than a two-year plan of action, and reduce the set of transnational systems to a bare minimum to reduce coordination costs.

Coordinating Software Releases

Firms can institute procedures to ensure that all operating units convert to new software updates at the same time so that everyone's software is compatible.

Encouraging Local Users to Support Global Systems

The key to this problem is to involve users in the creation of the design without giving up control over the development of the project to parochial interests. The overall tactic for dealing with resistant local units in a transnational company is cooptation. **Cooptation** is defined as bringing the opposition into the process of designing and implementing the solution without giving up control over the direction and nature of the change. As much as possible, raw power should be avoided. Minimally, however, local units must agree on a short list of transnational systems, and raw power may be required to solidify the idea that transnational systems of some sort are truly required.

How should cooptation proceed? Several alternatives are possible. One alternative is to permit each country unit the opportunity to develop one transnational application first in its home territory and then throughout the world. In this manner, each major country systems group is given a piece of the action in developing a transnational system, and local units feel a sense of ownership in the transnational effort. On the downside, this assumes the ability to develop high-quality systems is widely distributed and that a German team, for example, can successfully implement systems in France and Italy. This will not always be the case.

A second tactic is to develop new transnational centers of excellence, or a single center of excellence. There may be several centers around the globe that focus on specific business processes. These centers draw heavily from local national units, are based on multinational teams, and must report to worldwide management. Centers of excellence perform the initial identification and specification of business processes, define the information requirements, perform the business and systems analysis, and accomplish all design and testing. Implementation, however, and pilot testing are rolled out to other parts of the globe. Recruiting a wide range of local groups to transnational centers of excellence helps send the message that all significant groups are involved in the design and will have an influence.

Even with the proper organizational structure and appropriate management choices, it is still possible to stumble over technology issues. Choices of technology platforms, networks, hardware, and software are the final element in building transnational information systems architectures.

15-4 What are the issues and technical alternatives to be considered when developing international information systems?

Once firms have defined a global business model and systems strategy, they must select hardware, software, and networking standards along with key system applications to support global business processes. Hardware, software, and networking pose special technical challenges in an international setting.

One major challenge is finding some way to standardize a global computing platform when there is so much variation from operating unit to operating unit

and from country to country. Another major challenge is finding specific software applications that are user-friendly and that truly enhance the productivity of international work teams. The universal acceptance of the Internet around the globe has greatly reduced networking problems. But the mere presence of the Internet does not guarantee that information will flow seamlessly throughout the global organization because not all business units use the same applications, and the quality of Internet service can be highly variable (just as with the telephone service). For instance, German business units may use an open source collaboration tool to share documents and communicate, which is incompatible with American headquarters teams, which use Microsoft solutions. Overcoming these challenges requires systems integration and connectivity on a global basis.

Computing Platforms and Systems Integration

The development of a transnational information systems architecture based on the concept of core systems raises questions about how the new core systems will fit in with the existing suite of applications developed around the globe by different divisions and different people and for different kinds of computing hardware. The goal is to develop global, distributed, and integrated systems to support digital business processes spanning national boundaries. Briefly, these are the same problems faced by any large domestic systems development effort. However, the problems are magnified in an international environment. Just imagine the challenge of integrating systems based on the Windows, Linux, Unix, or proprietary operating systems running on IBM, Oracle, HP, and other hardware in many different operating units in many different countries!

Moreover, having all sites use the same hardware and operating system does not guarantee integration. Some central authority in the firm must establish data standards as well as other technical standards with which sites are to comply. For instance, technical accounting terms such as the beginning and end of the fiscal year must be standardized (review the earlier discussion of the cultural challenges to building global businesses) as well as the acceptable interfaces between systems, communication speeds and architectures, and network software.

Connectivity

Truly integrated global systems must have connectivity—the ability to link together the systems and people of a global firm into a single integrated network just like the phone system but capable of voice, data, and image transmissions. The Internet has provided an enormously powerful foundation for providing connectivity among the dispersed units of global firms. However, many issues remain. The public Internet does not guarantee any level of service (even in the United States). Few global corporations trust the security of the public Internet and generally use private networks to communicate sensitive data and Internet virtual private networks (VPNs) for communications that require less security. Not all countries support even basic Internet service that requires obtaining reliable circuits, coordinating among different carriers and the regional telecommunications authority, and obtaining standard agreements for the level of telecommunications service provided. Table 15.5 lists the major challenges posed by international networks.

While private networks have guaranteed service levels and better security than the Internet, the Internet is the primary foundation for global corporate networks when lower security and service levels are acceptable. Companies can create global intranets for internal communication or extranets to exchange

TABLE 15.5 CHALLENGES OF INTERNATIONAL NETWORKS

Quality of service
Security
Costs and tariffs
Network management
Installation delays
Poor quality of international service
Regulatory constraints
Network capacity

information more rapidly with business partners in their supply chains. They can use the public Internet to create global networks using VPNs from Internet service providers, which provide many features of a private network using the public Internet (see Chapter 7). However, VPNs may not provide the same level of quick and predictable response as private networks, especially during times of the day when Internet traffic is very congested, and they may not be able to support large numbers of remote users.

Access to Internet service is limited in many developing countries (see Figure 15.5). Where an Internet infrastructure exists in less-developed countries, it often lacks bandwidth capacity and is unreliable in part due to power grid issues. The purchasing power of most people in developing countries makes access to Internet services very expensive in local currencies, although inexpensive mobile devices and low-cost data plans are becoming more widely available.

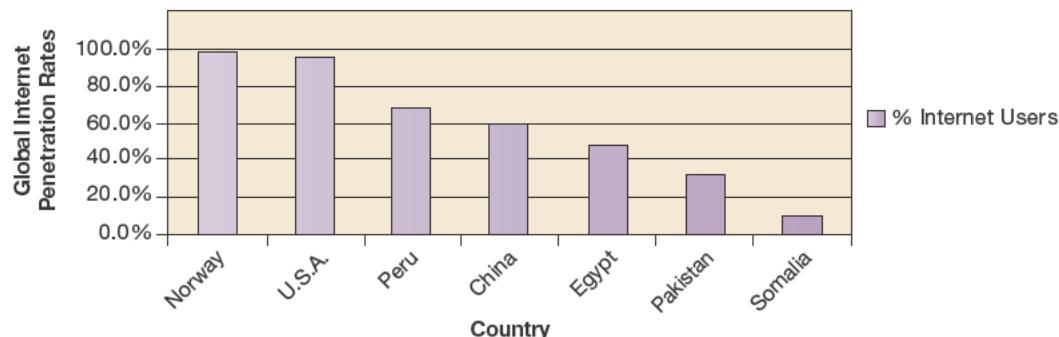
In addition, many countries monitor transmissions. Governments in China, Iran, Turkey, and Saudi Arabia monitor Internet traffic and block access to websites considered morally or politically offensive. Moreover, nation-states all over the world have been asserting their authority over Internet use and claiming various forms of digital sovereignty (see the Interactive Session on Organizations).

On the other hand, the rate of growth in the Internet population has been faster in Asia, Africa, and the Middle East than in North America and Europe. Therefore, in the future, Internet connectivity will be much more widely available and reliable in less-developed regions of the world, and it will play a significant role in integrating these economies with the world economy.

FIGURE 15.5 INTERNET POPULATION IN SELECTED COUNTRIES

The percentage of the total population using the Internet in developing countries is much smaller than in the United States and Europe, but it is growing rapidly.

Source: Based on data from Internetworldstats.com, 2019 and authors.



INTERACTIVE SESSION

ORGANIZATIONS

Digital Nationalism

The Internet began as a network of networks designed to foster the free and open exchange of information anywhere in the world. It has been a major driver of globalization, embodying a public sphere beyond the control of sovereign governments. Today, this is no longer the case. All over the world, nation-states have been asserting their authority over Internet use and claiming various forms of digital sovereignty. The Internet now has become subject to firewalls, shutdowns, and data-localization laws that have fundamentally changed its character as a unified global infrastructure.

Authoritarian governments have long sought to rein in the Internet, China being one of the first. Its Great Firewall, which restricts what people can read and do online (see the chapter-ending case), has served as a model for promoting Chinese “digital sovereignty.” China’s efforts have demonstrated to other authoritarian regimes that the Internet can be effectively controlled.

Several countries are trying to follow the Chinese example. To control contact with the outside world and suppress dissident content, Iran has set up a so-called “halal net,” and North Korea set up its Kwangmyong network. In 2019, Vladimir Putin signed a “sovereign Internet bill” to set up a self-sufficient Runet. The bill also includes a “kill switch” to shut off the global network to Russian users. According to the *New York Times*, at least a quarter of the world’s countries have temporarily shut down the Internet over the past four years.

In recent years, digital nationalism has also taken the form of data localization (or data protectionism) laws in countries such as Vietnam, India, Argentina, Venezuela, and Nigeria. Some countries require that data on their citizens (or certain types of data, such as medical or financial data) be physically stored on servers within their borders. Others allow the data to leave their borders but insist on a copy remaining domestically.

These laws have legitimate uses, including privacy protection and national security. Unfortunately, hate speech expressions and disinformation on the Internet have been co-opted to justify laws enabling repressive governments to monitor online activity and speech. At least 45 countries now have some

version of data localization requirements in place—and they are not limited to authoritarian states. Australia, Canada, New Zealand, South Korea, and Switzerland are among the countries that now restrict cross-border flows of data.

Russia now requires a copy of data on Russian citizens to be stored in the country. The country has banned LinkedIn for defying the rules and fined Facebook and Twitter \$63,000 each for failing to comply with a national data law.

The European Union’s General Data Protection Regulation (GDPR—see Chapter 4) is not specifically about localization, but it imposes stringent restrictions that make it difficult for companies to move data across borders. There is growing sentiment among EU nations to further strengthen data protections and that EU privacy regulation should call for European data to be physically stored in Europe. Data produced in Europe should be processed in Europe.

Many of these laws are ostensibly targeted at Western multinationals, but larger companies are generally better able to meet these requirements than smaller ones, which lack the necessary resources. Developing countries, often at the forefront of digital nationalism, might also suffer. For example, India and the Philippines have large numbers of outsourcing firms that rely on a unified global information network. These countries’ efforts to set up roadblocks on that network could come back to haunt them.

The great risk is that digital nationalism will Balkanize the Internet, breaking it up into a patchwork of incompatible and irreconcilable fiefdoms. This scenario, sometimes referred to as Splinternet, is already affecting Internet-based content and services. China’s population does not have access to Wikipedia, Facebook, and most of Google. When the EU’s GDPR first came into effect, many American media companies were ready to stop offering their content to European consumers, at least temporarily.

Balkanization could also reshape the Internet’s underlying technical infrastructure. Over the last decade, several countries, citing cultural sensitivities, have considered banning or otherwise restricting the .xxx top-level domain name (generally used

for pornography), raising the prospect that the Internet's naming system could eventually fracture. After Edward Snowden's revelations about U.S. spying, Brazil moved to build a separate undersea cable link to the EU to bypass existing Internet infrastructure. At the Engineering Task Force, a key Internet standards committee, representatives who wanted to maintain a backdoor for government agencies clashed with those pushing for more robust encryption.

What can be done to curb digital nationalism?

Experts recommend finding ways to restore a sense of inclusiveness and fair play among Internet users and to remind them of the original principles of universality and inclusiveness that made the network

so effective in the first place. Another recommendation is to develop "zone"-based approaches for running the Internet, where interconnecting blocs of member-nations would commit to uphold liberal principles such as free trade, privacy, and freedom of expression. This approach would not produce a single global network, but a "coalition of the willing" might be the best way to counter growing Internet fragmentation and keep the network relatively open and free.

Sources: Vincent Manancourt, "Europe's Data Grab," *Politico*, February 19, 2020; Akash Kapur, "The Rising Threat of Digital Nationalism," *Wall Street Journal*, November 1, 2019; Fang Kecheng, "Is Cyber-Nationalism on the Rise in China?" *Echo Wall*, September 25, 2019;

CASE STUDY QUESTIONS

1. What is digital nationalism? Give two examples.
2. What problems does digital nationalism pose for conducting business globally?

Software Localization

The development of core systems poses unique challenges for application software: How will the old systems interface with the new? Entirely new interfaces must be built and tested if old systems are kept in local areas (which is common). These interfaces can be costly and messy to build. If new software must be created, another challenge is to build software that can be realistically used by multiple business units from different countries given that business units are accustomed to their unique business processes and definitions of data.

Aside from integrating the new with the old systems, there are problems of human interface design and functionality of systems. For instance, to be truly useful for enhancing productivity of a global workforce, software interfaces must be easily understood and mastered quickly. When international systems involve knowledge workers only, English may be the assumed international standard. But as international systems penetrate deeper into management and clerical groups, a common language may not be assumed and human interfaces must be built to accommodate different languages and even conventions. The entire process of converting software to operate in a second language is called **software localization**.

Most of the world's population accesses the Internet using a mobile device, so apps must be built for mobile platforms, tiny screens, and low bandwidth. Since many mobile Internet users cannot read or write, special interfaces using video and audio need to be built to serve this group.

What are the most important software applications? Many international systems focus on basic transaction and management reporting systems. Increasingly, firms are turning to supply chain management and enterprise resource planning systems to standardize their business processes on a global basis and to create coordinated supply chains and workforces. However, these cross-functional systems are not always compatible with differences in languages, cultural heritages, and business processes in other countries. Company units in

countries that are not technically sophisticated may also encounter problems trying to manage the technical complexities of enterprise applications.

Electronic Data Interchange (EDI) systems and supply chain management systems are widely used by manufacturing and distribution firms to connect to suppliers on a global basis. Collaboration and enterprise social networking systems, email, and videoconferencing are especially important worldwide tools for knowledge- and data-based firms, such as advertising firms, research-based firms in medicine and engineering, and graphics and publishing firms.



15-5 How will MIS help my career?

Here is how Chapter 15 and this book can help you find a job as an entry-level sales and marketing trainee for a global data services company.

The Company

Global Online Stats, a leading global provider of quantitative data, statistics, and market research products, headquartered in London, has an open position for an entry-level sales and marketing trainee. The company has more than 500 employees and offices in London, Paris, and Brussels. The company provides tools and services for accessing an online quantitative database aimed at business firms of all sizes, including consulting firms, media agencies, and marketing departments in large corporations from a variety of industries and countries.

Position Description

This position works closely with the Managing Director and Head of Global Sales to develop and maintain sales leads and new accounts. Job responsibilities include:

- Developing new accounts with leads generated by existing customers and relationships with media and industry associations as well as through cold calling, emailing, and online prospecting.
- Developing account relationships to turn sporadic customers into long-term business accounts.
- Developing sales opportunities for various categories of products and lines of business.
- Finding and scheduling appointments with new prospective clients.
- Updating customer and client profiles.

Job Requirements

- Four-year college degree
- Very strong verbal and written communication skills
- Microsoft Office skills
- Experience at a sales or marketing internship or in cold calling desirable
- Outgoing, competitive, proactive sales personality

Interview Questions

1. Did you work with quantitative data in your college courses or at a prior job? What did you do with the data?
2. Have you ever worked with online databases or database software? Exactly what did you do with these databases? Did you ever take a database course?
3. What is your level of expertise with Microsoft Office tools—Word, Excel, PowerPoint, Access?
4. What sales experience have you had?
5. Do you have any foreign language proficiency?
6. What challenges would you anticipate in trying to sell our products and services to non-U.S. organizations?

Author Tips

1. Review Sections 15-1, 15-3, and 15-4 of this chapter, Chapter 6 on data management, and the Chapter 12 discussion of business intelligence and analytics.
2. Use the web to research the company, its products, services, and customers, and the way it operates. Think about what the company needs to do to expand sales globally.
3. Ask exactly how you would be using Microsoft Office tools in your job.
4. Ask about how much training you would receive in how to use the company's data products.

REVIEW SUMMARY

15-1 What major factors are driving the internationalization of business?

The growth of inexpensive international communication and transportation has created a world culture with stable expectations or norms. Political stability and a growing global knowledge base that is widely shared also contribute to the world culture. These general factors create the conditions for global markets, global production, coordination, distribution, and global economies of scale.

15-2 What are the alternative strategies for developing global businesses?

There are four basic international strategies: domestic exporter, multinational, franchiser, and transnational. In a transnational strategy, all factors of production are coordinated on a global scale. However, the choice of strategy is a function of the type of business and product.

There is a connection between firm strategy and information systems design. Transnational firms must develop networked system configurations and permit considerable decentralization of development and operations. Franchisers almost always duplicate systems across many countries and use centralized financial controls. Multinationals typically rely on decentralized independence among foreign units with some movement toward development of networks. Domestic exporters typically are centralized in domestic headquarters with some decentralized operations permitted.

15-3 What are the challenges posed by global information systems and management solutions for these challenges?

Global information systems pose challenges because cultural, political, and language diversity magnifies differences in organizational culture and business processes and encourages proliferation of disparate local information systems that are difficult to integrate. Typically, international systems have evolved without a conscious plan. The remedy is to define a small subset of core business processes and focus on building systems to support these processes. Tactically, managers will have to co-opt widely dispersed foreign units to participate in the development and operation of these systems, being careful to maintain overall control.

15-4 What are the issues and technical alternatives to be considered when developing international information systems?

Implementing a global system requires an implementation strategy that considers both business design and technology platforms. The main hardware and telecommunications issues are systems integration and connectivity. The choices for integration are to go either with a proprietary architecture or with open systems technology. Global networks are extremely difficult to build and operate. Firms can build their own global networks or they can create global networks based on the Internet (intranets or virtual private networks). The main software issues concern building interfaces to existing systems and selecting applications that can work with multiple cultural, language, and organizational frameworks.

Key Terms

Business driver, 594

Cooptation, 607

Core systems, 604

Domestic exporter, 600

Franchisers, 601

Global culture, 595

International information systems architecture, 594

Legitimacy, 606

Multinational, 600

Particularism, 598

Software localization, 611

Transborder data flow, 599

Transnational, 601

MyLab MIS

To complete the problems with MyLab MIS, go to EOC Discussion Questions in MyLab MIS.

Review Questions

15-1 What major factors are driving the internationalization of business?

- What is a business driver? How does it affect a business?
- Global business drivers can be divided into two groups: general cultural factors and specific business factors. Identify some of the general cultural factors from the 1940s onward.
- Explain what is meant by particularism. What are its implications?
- Explain why there are often complications in relation to trans-border data flow.

15-2 What are the alternative strategies for developing global businesses?

- How does protectionism encourage businesses to become true multinationals?
- Distinguish between centralized, duplicated, decentralized, and networked systems.

15-3 What are the challenges posed by global information systems and management solutions for these challenges?

- Explain how you would define the core systems in an organization.
- Explain how a global system will contribute to superior management and coordination.
- Explain how cooptation can be used to involve users in the creation of a design.
- Explain why legitimacy is an important issue in implementing change driven by management.

15-4 What are the issues and technical alternatives to be considered when developing international information systems?

- Describe the main technical issues facing global systems.
- Identify some technologies that will help firms develop global systems.

Discussion Questions

15-5 MyLab MIS If you were a manager in a company that operates in many countries, what criteria would you use to determine whether an application should be developed as a global application or as a local application?

15-6 MyLab MIS Describe ways the Internet can be used in international information systems.

Hands-On MIS Projects

The projects in this section give you hands-on experience conducting international market research, analyzing international systems issues for an expanding business, and building a job posting database and web page for an international company. Visit MyLab MIS to access this chapter's Hands-On MIS Projects.

Management Decision Problems

15-7 United Parcel Service (UPS) has been expanding its package delivery and logistics services in China, serving both multinational companies and local businesses. UPS drivers in China need to use UPS systems and tools such as its handheld Delivery Information Acquisition Device for capturing package delivery data. UPS wants to make its WorldShip and other shipping-management services accessible to Chinese and multinational customers via the web. What are some of the international systems issues UPS must consider in order to operate successfully in China?

15-8 CrazyKangaroo is an Australian sporting goods online retailer. After five successful years, supported by a \$5 million investment from a private equity fund, they are now ready to expand globally. Having studied from the dotcom era's sporting goods e-commerce startups (notably boo.com), they want to spend the investment capital wisely and target countries or regions one at a time, enabling continuous, profitable growth. Identify and set up a marketing strategy for the first three countries or regions to do business in. Consider cultural variations that may cause controversy in the selected countries or regions.

Achieving Operational Excellence: Building a Job Database and Web Page for an International Consulting Firm

Software skills: Database and web page design

Business skills: Human resources internal job postings

- 15-9** Companies with many overseas locations need a way to inform employees about available job openings in these locations. In this project you'll use database software to design a database for posting internal job openings and a web page for displaying this information.

KTP Consulting operates in various locations around the world. KTP specializes in designing, developing, and implementing enterprise systems for medium- to large-size companies. KTP offers its employees opportunities to travel, live, and work in various locations throughout the United States, Europe, and Asia. The firm's human resources department has a simple database that enables its staff to track job vacancies. When an employee is interested in relocating, she or he contacts the human resources department for a list of KTP job vacancies. KTP also posts its employment opportunities on the company website.

What type of data should be included in the KTP job vacancies database? What information should not be included in this database? Based on your answers to these questions, build a job vacancies database for KTP. Populate the database with at least 20 records. You should also build a simple web page that incorporates job vacancy data from your newly created database. Submit a copy of the KTP database and web page to your professor.

Improving Decision Making: Conducting International Marketing and Pricing Research

Software skills: Internet-based software

Business skills: International pricing and marketing

- 15-10** In this project you'll use the web to research overseas distributors and customs regulations and use Internet-based software to calculate prices in foreign currencies.

You are in charge of marketing for a U.S. manufacturer of furniture that has decided to enter the international market. You want to test the market by contacting a European office furniture retailer to offer it a specific desk that you have to sell at about \$195. Using the web, locate the information needed to locate and contact this firm and to find out how many euros you would get for the chair in the current market. In addition, consider using a universal currency converter website, which determines the value of one currency expressed in other currencies. Obtain both the information needed to contact the firm and the price of your chair in its local currency. Then locate and obtain customs and legal restrictions on the products you will export from the United States and import into the country of the retailer you have selected. Finally, locate a company that will represent you as a customs agent and gather information on shipping costs.

Collaboration and Teamwork Project

Identifying Technologies for Global Business Strategies

- 15-11** With a group of students, identify an area of information technology and explore how this technology might be useful for supporting global business strategies. For instance, you might choose email, smartphones, virtual private networks, enterprise systems, collaboration software, or the web. It will be necessary to identify a business scenario to discuss the technology. You might choose an automobile parts franchise or a clothing franchise, such as Express, as example businesses. Which applications would you make global, which core business processes would you choose, and how would the technology be helpful? If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

Souq.com: Amazon's Entry into the Middle East

CASE STUDY

Since its founding in 1994, Amazon has proved itself to be one of the few e-commerce companies to not only have survived the dot-com bubble of the 2000s but also successfully expanded into several global markets. Based in Seattle, Washington, Amazon's e-commerce business has spread to more than 60 countries. Its globalization drive started in 1998, when it acquired UK-based Bookseller, Ltd. and Germany-based Telebook, Inc. Both of these ventures eventually resulted in Amazon's country-specific websites outside the United States, amazon.co.uk and amazon.de. Currently, besides the United States, Amazon has dedicated websites for a number of countries in local languages, including Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, the Netherlands, Spain, Sweden, Turkey, and the United Kingdom.

Amazon has been relying on various horizontal and vertical integrations to successfully achieve its diversification ambitions. The company has employed an attack growth strategy by leveraging its strengths, such as its global brand image, strong IT infrastructure, robust distribution channels, and long-lasting partnerships. While Amazon has emerged as a global brand, until recently, its presence in the developing and emerging economies was limited to remote operations only, with the exception of China, Brazil, India, Mexico, and Turkey.

The Middle East, especially the Gulf Cooperation Council (GCC) countries—Bahrain, Kuwait, the United Arab Emirates, Saudi Arabia, Qatar, and Oman—have great e-commerce potential due to the high penetration of the Internet and social media. By 2025 it is estimated that there will be 60 million 5G users across the region, accounting for some 8 percent of all Internet connections. Use of smartphones and social media in the United Arab Emirates and Saudi Arabia is among the highest in the world. Most of the online customers in the GCC region prefer smartphones for their Internet searches and fulfillment of orders. Though e-commerce is an emerging phenomenon in the GCC countries, it has great potential; e-commerce revenues rose to \$19.7 billion in 2020 and are projected to reach as much as \$50 billion by 2025. The growth between 2020 and 2022 is estimated at an annual

rate of 20 percent, followed by an annual increase of 14 percent until 2025.

Another important development in the GCC region is the recognition that the region needs to look beyond oil. This is a major shift in government policy, and the United Arab Emirates and Saudi Arabia are investing heavily in innovative technologies and infrastructure to help develop regional capabilities that will lead to knowledge-based products and services. This has provided an opportunity to many global companies to invest in these areas. In 2017, Amazon entered the market by acquiring Souq.com, which has the highest e-commerce market share in the region. Entering the Middle Eastern market was not a straightforward decision; unlike many of the Western countries Amazon had already entered, the Middle East has not only unique social, legal, economic, political, and technological conditions but also different customers, competitors, intermediaries, and suppliers. Applying the same business model it had used before would not return the same results. An understanding of the local environment was crucial.

Headquartered in Dubai, Souq.com was established as an auction site in 2005 by Ronaldo Mouchawar, its CEO and cofounder. It has emerged as a major online retail and marketplace platform in the Middle East and attracts more than 11–20 million unique visitors and 50–100 million page views every month. At the time Souq.com was established, the region was hardly ideal for e-commerce, not only because of a lack of infrastructure and low broadband Internet penetration but also due to low awareness of e-commerce among consumers, who saw high risks in e-transactions and were generally mistrustful of online stores. Nevertheless, with a population of more than 100 million, the majority of whom were young, tech-savvy potential customers, the region had great potential for e-commerce.

After a steady start as an auction website, Souq.com saw rapid growth as an e-commerce marketplace. Realizing the potential of m-commerce, Souq.com launched its app in 2012, which further boosted Souq.com's business. According to Mouchawar, more than 70 percent of Souq.com's transactions were carried out by mobile phone.

Souq.com currently has its operations in seven countries, including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. It has country-specific websites for Kuwait, Egypt, Saudi Arabia, and the United Arab Emirates in Arabic and English.

There were other barriers to penetration into the Middle East market: the region consists of many countries with relatively small populations, and each of these countries has its own laws and regulations. Other problematic areas include modes of payment, on-time and accurate delivery, and language barriers.

In contrast to Western countries, where credit cards and PayPal are popular modes of payment for online shoppers, over 70 percent of e-commerce customers in the GCC prefer to pay cash on delivery. This is even true in the United Arab Emirates, where credit card penetration is higher than other GCC countries and is almost the same as in most Western countries. This problem was especially pronounced at the time in Saudi Arabia and Egypt, yet both of these countries offered a large number of potential customers. Souq.com overcame this barrier by offering multiple payment options to its customers, including cash on delivery, Sadad (a payment system linked with bank accounts), and credit or debit cards. Moreover, to address the limitations of cash on delivery such as delayed payments to the merchants, Souq.com introduced an efficient software solution linking merchants and couriers. This system helped Souq.com to record the payments received by the courier agents and swiftly transfer them to the merchants' accounts.

Another major obstacle was establishing a seamless delivery network to deal with outbound logistics. Making this task even more complicated was the fact that most of the countries in the GCC region do not have postal codes; various landmarks were commonly used instead to reach customers. Efficient management of outbound logistics is especially important when dealing with cash-on-delivery, as any delays in the sell side of the supply chain will result in delayed payments to the merchants, thus placing an additional burden on them. Souq.com established its own delivery network in several major cities in the Middle East by launching Q-Express as its logistics arm, thus avoiding the delays caused by third-party courier services. Q-Express uses Google Maps with GPS-enabled mobile devices to deal with the mailing address

problems and to ensure on-time product delivery. Currently, more than 80 percent of Souq.com's customers are served by Q-Express, and it is now also offering delivery services to third parties.

Souq.com's major pureplay competitors (that is, companies with only an online presence) in the Middle East e-commerce include Noon.com, Wadi.com, and Namshi.com. However, several brick-and-mortar retailers such as Carrefour and Lulu Hypermarket are also adding online platforms to support their traditional stores and to augment their revenues.

Amazon faced a number of options while expanding into the Middle East: it could have entered the market on its own, sought an alliance, or acquired a local company with significant experience of the local environment. Amazon opted for the latter mainly due to Souq.com's large customer awareness, strong customer base, and integrated payment and distribution channels. Since its acquisition by Amazon, the mix of Amazon's global and Souq.com's local experience has provided a significant advantage over their competitors. Mouchawar has stated that working together makes it easier for Amazon and Souq.com to diversify their online business in the Middle East than if they had worked separately. In 2019, Amazon launched its official site in the United Arab Emirates, replacing Souq.com. A year later, in June 2020, the official launch of Amazon Saudi Arabia was announced. All traffic to the Souq website is now redirected to the Amazon site, allowing customers to choose products from an array of local and international businesses, including companies at the American Amazon store.

E-commerce sales in the Middle East account for less than 5 percent of retail sales, in contrast to over 10 percent in Europe. Hence, there is significant room for expansion for e-commerce in the Middle East, and by leveraging their combined strengths, Amazon and Souq.com seem well positioned to lead the way.

Sources: GSM Association, "The Mobile Economy: Middle East and North Africa 2020," www.gsma.com, accessed January 16, 2021; "Souq.com Analytics—Market Share Data & Ranking," similarweb.com, accessed October 21, 2020; "E-commerce \$50 billion Expected in the Gulf by 2025," *alKhaleej Today*, October 7, 2020; "Amazon Saudi Arabia Officially Launched to Replace Souq.com," *Gulf Business*, June 18, 2020; "E-commerce Giant SOUQ.com Takes Its Next Leap with First Customer Experience Center in Dubai," <http://pr.souq.com>, accessed December 14, 2018; Tahani Karrar, "MENA E-commerce Series 2018: 5 Insights Driving Regional E-commerce," www.thinkwithgoogle.com,

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CASE STUDY QUESTIONS

- 15-12** Analyze challenges and opportunities for global companies like Amazon that seek to enter the Middle Eastern market.

15-13 Considering the Middle East's e-commerce environment, did Amazon make a sensible decision by acquiring Souq.com?

15-14 How sustainable is Amazon's strategy of diversification? Can an entry into the Middle East help Amazon enter other emerging markets with a similar environment?

Case contributed by Muhammad Shakaib Akram, King Saud University

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INTEGRATING BUSINESS WITH TECHNOLOGY

By completing the projects in this text, students will be able to demonstrate business knowledge, application software proficiency, and Internet skills. These projects can be used by instructors as learning assessment tools and by students as demonstrations of business, software, and problem-solving skills to future employers. Here are some of the skills and competencies students using this text will be able to demonstrate:

Business Application skills: Use of both business and software skills in real-world business applications. Demonstrates both business knowledge and proficiency in spreadsheet, database, and web page/blog creation tools.

Internet skills: Ability to use Internet tools to access information, conduct research, or perform online calculations and analysis.

Analytical, writing and presentation skills: Ability to research a specific topic, analyze a problem, think creatively, suggest a solution, and prepare a clear written or oral presentation of the solution, working either individually or with others in a group.

Business Application Skills

BUSINESS SKILLS	SOFTWARE SKILLS	CHAPTER
Finance and Accounting		
Financial statement analysis	Spreadsheet charts Spreadsheet formulas Spreadsheet downloading and formatting	Chapter 2* Chapter 10
Pricing hardware and software	Spreadsheet formulas	Chapter 5
Technology rent vs. buy decision	Spreadsheet formulas	Chapter 5*
Total Cost of Ownership (TCO) analysis		
Analyzing telecommunications services and costs	Spreadsheet formulas	Chapter 7
Risk assessment	Spreadsheet charts and formulas	Chapter 8
Retirement planning	Spreadsheet formulas and logical functions	Chapter 11
Capital budgeting	Spreadsheet formulas	Chapter 14 Chapter 14*
Human Resources		
Employee training and skills tracking	Database design Database querying and reporting	Chapter 13*
Job posting database and Web page	Database design Web page design and creation	Chapter 15
Manufacturing and Production		
Analyzing supplier performance and pricing	Spreadsheet date functions Database functions Data filtering	Chapter 2
Inventory management	Importing data into a database Database querying and reporting	Chapter 6
Bill of materials cost sensitivity analysis	Spreadsheet data tables Spreadsheet formulas	Chapter 12*
Sales and Marketing		
Sales trend analysis	Database querying and reporting	Chapter 1
Customer reservation system	Database querying and reporting	Chapter 3

Improving marketing decisions	Spreadsheet pivot tables	Chapter 12
Customer profiling	Database design	Chapter 6*
	Database querying and reporting	
Customer service analysis	Database design Database querying and reporting	Chapter 9
Sales lead and customer analysis	Database design Database querying and reporting	Chapter 13
Blog creation and design	Blog creation tool	Chapter 4

Internet Skills

Using online software tools for job hunting and career development	Chapter 1
Using online interactive mapping software to plan efficient transportation routes	Chapter 2
Researching product information and evaluating websites for auto sales	Chapter 3
Analyzing web browser privacy protection	Chapter 4
Researching travel costs using online travel sites	Chapter 5
Searching online databases for products and services	Chapter 6
Using web search engines for business research	Chapter 7
Researching and evaluating business outsourcing services	Chapter 8
Researching and evaluating supply chain management services	Chapter 9
Evaluating e-commerce hosting services	Chapter 10
Using shopping bots to compare product price, features, and availability	Chapter 11
Using online software tools for retirement planning	Chapter 12
Analyzing website design and information requirements	Chapter 13
Researching real estate prices	Chapter 14
Researching international markets and pricing	Chapter 15

Analytical, Writing and Presentation Skills*

BUSINESS PROBLEM	CHAPTER
Management analysis of a business	Chapter 1
Value chain and competitive forces analysis	Chapter 3
Business strategy formulation	
Formulating a corporate privacy policy	Chapter 4
Employee productivity analysis	Chapter 7
Disaster recovery planning	Chapter 8
Locating and evaluating suppliers	Chapter 9
Developing an e-commerce strategy	Chapter 10
Identifying knowledge management opportunities	Chapter 11
Identifying international markets	Chapter 15

*Dirt Bikes Running Case on MyLab MIS

GLOSSARY

3-D printing Uses machines to make solid objects, layer by layer, from specifications in a digital file. Also known as additive manufacturing.

3G networks Cellular networks based on packet-switched technology with speeds ranging from 144 Kbps for mobile users to more than 2 Mbps for stationary users, enabling users to transmit some video, graphics, and other rich media in addition to voice.

4G networks Recent wireless communication technology capable of up to 100 Mbps speeds.

5G networks Newest wireless technology evolution, supporting transmission of very large amounts of data in the gigabit range, with fewer transmission delays and the ability to connect many more devices (such as sensors and smart devices) at once.

acceptable use policy (AUP) Defines acceptable uses of the firm's information resources and computing equipment, including desktop and laptop computers, wireless devices, telephones, and the Internet, and specifies consequences for noncompliance.

acceptance testing Provides the final certification that the system is ready to be used in a production setting.

accountability The mechanisms for assessing responsibility for decisions made and actions taken.

advertising revenue model Website generating revenue by attracting a large audience.

affiliate revenue model An e-commerce revenue model in which websites are paid as "affiliates" for sending their visitors to other sites in return for a referral fee.

agency theory Economic theory that views the firm as a nexus of contracts among self-interested individuals who must be supervised and managed.

agile development Rapid delivery of working software by breaking a large project into a series of small sub-projects that are completed in short periods of time using iteration and continuous feedback.

analytic platform Preconfigured hardware-software system that is specifically designed for high-speed analysis of large datasets.

analytical CRM Customer relationship management applications dealing with the analysis of customer data to provide information for improving business performance.

Android A mobile operating system developed by Android, Inc. (purchased by Google) and later the Open Handset Alliance as a flexible, upgradeable mobile device platform.

anti-malware software Software designed to detect, and often eliminate, malware from an information system.

application controls Specific controls unique to each computerized application that ensure that only authorized data are completely and accurately processed by that application.

application server Software that handles all application operations between browser-based computers and a company's back-end business applications or databases.

apps Small pieces of software that run on the Internet, on your computer, or on your cell phone and are generally delivered over the Internet.

artificial intelligence (AI) Effort to develop computer-based systems that can think and behave like humans..

attribute A piece of information describing a particular entity.

augmented reality (AR) A technology for enhancing visualization. Provides a live direct or indirect view of a physical real-world environment whose elements are augmented by virtual computer-generated imagery.

authentication The ability of each party in a transaction to ascertain the identity of the other party.

automation Using the computer to speed up the performance of existing tasks.

balanced scorecard method Framework for operationalizing a firm's strategic plan by focusing on measurable financial, business process, customer, and learning and growth outcomes of firm performance.

bandwidth The capacity of a communications channel as measured by the difference between the highest and lowest frequencies that can be transmitted by that channel.

behavioral models Descriptions of management based on behavioral scientists' observations of what managers actually do in their jobs.

behavioral targeting Tracking the click-streams (history of clicking behavior) of individuals across multiple websites for the purpose of understanding their interests and intentions, and exposing them to advertisements that are uniquely suited to their interests.

benchmarking Setting strict standards for products, services, or activities and measuring organizational performance against those standards.

best practices The most successful solutions or problem-solving methods that have been developed by a specific organization or industry.

big data Data sets with volumes so huge that they are beyond the ability of typical relational DBMS to capture, store, and analyze. The data are often unstructured or semistructured.

biometric authentication Technology for authenticating system users that compares a person's unique characteristics such as fingerprints, face, or retinal image against a stored set profile of these characteristics.

bit A binary digit representing the smallest unit of data in a computer system. It can only have one of two states, representing 0 or 1.

blockchain Distributed ledger system that stores permanent and tamper-proof records of transactions and shares them among a distributed network of computers.

blog Popular term for "weblog," designating an informal yet structured website where individuals can publish stories, opinions, and links to other websites of interest.

blogosphere Totality of blog-related websites.

Bluetooth Standard for wireless personal area networks that can transmit up to 722 Kbps within a 10-meter area.

botnet A group of computers that have been infected with bot malware without users' knowledge, enabling a hacker to use the amassed resources of the computers to launch distributed denial-of-service attacks, phishing campaigns, or spam.

broadband High-speed transmission technology. Also designates a single communications medium that can transmit multiple channels of data simultaneously.

bugs Software program code defects.

bullwhip effect Distortion of information about the demand for a product as it passes from one entity to the next across the supply chain.

business case Proposal to management seeking approval for an investment by describing its costs, benefits, and business value.

business continuity planning Planning that focuses on how the company can restore business operations after a disaster strikes.

business driver A force in the environment to which businesses must respond and that influences the direction of business.

business ecosystem Loosely coupled but interdependent networks of suppliers, distributors, outsourcing firms, transportation service firms, and technology manufacturers.

business functions Specialized tasks performed in a business organization, including manufacturing and production, sales and marketing, finance and accounting, and human resources.

business intelligence Applications and technologies to help users make better business decisions.

business model An abstraction of what an enterprise is and how the enterprise delivers a product or service, showing how the enterprise creates wealth.

business performance management (BPM) Attempts to systematically translate a firm's strategies (e.g., differentiation, low-cost producer, market share growth, and scope of operation) into operational targets.

business process management (BPM) An approach to business that aims to continuously improve and manage business processes.

business process redesign Type of organizational change in which business processes are analyzed, simplified, and redesigned.

business processes The unique ways in which organizations coordinate and organize work activities, information, and knowledge to produce a product or service.

business-to-business (B2B) electronic commerce Electronic sales of goods and services among businesses.

business-to-consumer (B2C) electronic commerce Electronic retailing of products and services directly to individual consumers.

BYOD Stands for "bring your own device" and refers to employees using their own computing devices in the workplace.

byte A string of bits, usually eight, used to store one number or character in a computer system.

cable Internet connections Internet connections that use digital cable lines to deliver high-speed Internet access to homes and businesses.

capital budgeting The process of analyzing and selecting various proposals for capital expenditures.

carpal tunnel syndrome (CTS) Type of RSI in which pressure on the median nerve through the wrist's bony carpal tunnel structure produces pain.

change agent In the context of implementation, the individual acting as the catalyst during the change process to ensure successful organizational adaptation to a new system or innovation.

change management Managing the impact of organizational change associated with an innovation, such as a new information system.

chat Live, interactive conversations over a public network.

chatbot Software agent designed to simulate a conversation with one or more human users via textual or auditory methods.

chief data officer (CDO) Responsible for enterprise-wide governance and utilization of information to maximize the value the organization can realize from its data.

chief information officer (CIO) Senior manager in charge of the information systems function in the firm.

chief knowledge officer (CKO) Senior executive in charge of the organization's knowledge management program.

chief privacy officer (CPO) Responsible for ensuring the company complies with existing data privacy laws.

chief security officer (CSO) Heads a formal security function for the organization and is responsible for enforcing the firm's security policy.

choice Simon's third stage of decision making, when the individual selects among the various solution alternatives.

Chrome OS Google's lightweight computer operating system for users who do most of their computing on the Internet; runs on computers ranging from netbooks to desktop computers.

churn rate Measurement of the number of customers who stop using or purchasing products or services from a company. Used as an indicator of the growth or decline of a firm's customer base.

classical model of management Traditional description of management that focused on its formal functions of planning, organizing, coordinating, deciding, and controlling.

click fraud Fraudulently clicking on an online ad in pay-per-click advertising to generate an improper charge per click.

client The user point-of-entry for the required function in client/server computing. Normally a desktop computer, workstation, or laptop computer.

client/server computing A model for computing that splits processing between clients and servers on a network, assigning functions to the machine most able to perform the function.

cloud computing Model of computing in which computer processing, storage, software, and other services are provided as a shared pool of virtualized resources over a network, primarily the Internet.

collaboration Working with others to achieve shared and explicit goals.

communities of practice (COPs) Informal social networks of professionals and employees within and outside the firm who have similar work-related activities and interests and share their knowledge.

community provider A website business model that creates a digital online environment where people with similar interests can transact (buy and sell goods); share interests, photos, videos; communicate with like-minded people; receive interest-related information; and even play out fantasies by adopting online personalities called avatars.

competitive forces model Model used to describe the interaction of external influences, specifically threats and opportunities, that affect an organization's strategy and ability to compete.

complementary assets Additional assets required to derive value from a primary investment.

computer abuse The commission of acts involving a computer that may not be illegal but are considered unethical.

computer crime The commission of illegal acts through the use of a computer or against a computer system.

computer forensics The scientific collection, examination, authentication, preservation, and analysis of data held on or retrieved from computer storage media in such a way that the information can be used as evidence in a court of law.

computer hardware Physical equipment used for input, processing, and output activities in an information system.

computer literacy Knowledge about information technology, focusing on understanding of how computer-based technologies work.

computer software Detailed, preprogrammed instructions that control and coordinate the work of computer hardware components in an information system.

computer virus Rogue software program that attaches itself to other software programs or data files in order to be executed, often causing hardware and software malfunctions.

computer vision syndrome (CVS) Eyestrain condition related to computer display screen use; symptoms include headaches, blurred vision, and dry and irritated eyes.

computer vision systems Systems that try to emulate the human visual system to view and extract information from real-world images.

computer-aided design (CAD) Information system that automates the creation and revision of designs using sophisticated graphics software.

consumer-to-consumer (C2C) Consumers selling goods and services electronically to other consumers.

consumerization of IT New information technology originating in the consumer market that spreads to business organizations.

controls All of the methods, policies, and procedures that ensure protection of the organization's assets, accuracy and reliability of its records, and operational adherence to management standards.

conversion The process of changing from the old system to the new system.

cookies Tiny file deposited on a computer hard drive when an individual visits certain websites. Used to identify the visitor and track visits to the website.

cooptation Bringing the opposition into the process of designing and implementing a solution without giving up control of the direction and nature of the change.

copyright A statutory grant that protects creators of intellectual property against copying by others for any purpose for a minimum of 70 years.

- core competency** Activity at which a firm excels as a world-class leader.
- core systems** Systems that support functions that are absolutely critical to the organization.
- cost transparency** The ability of consumers to discover the actual costs merchants pay for products.
- counterimplementation** A deliberate strategy to thwart the implementation of an information system or an innovation in an organization.
- cross-selling** Marketing complementary products to customers.
- crowdsourcing** Using large Internet audiences for advice, market feedback, new ideas, and solutions to business problems. Related to the “wisdom of crowds” theory.
- culture** The set of fundamental assumptions about what products the organization should produce, how and where it should produce them, and for whom they should be produced.
- customer experience management** Management of all the interactions between a customer and a company throughout their entire business relationship.
- customer lifetime value (CLTV)** Difference between revenues produced by a specific customer and the expenses for acquiring and servicing that customer minus the cost of promotional marketing over the lifetime of the customer relationship, expressed in today's dollars.
- customer relationship management (CRM)** Business and technology discipline that uses information systems to coordinate all of the business processes surrounding the firm's interactions with its customers in sales, marketing, and service.
- customer relationship management systems** Information systems that track all the ways in which a company interacts with its customers and analyze these interactions to optimize revenue, profitability, customer satisfaction, and customer retention.
- customization** The modification of a software package to meet an organization's unique requirements without destroying the package software's integrity.
- customization** In e-commerce, changing a delivered product or service based on a user's preferences or prior behavior.
- cybervandalism** Intentional disruption, defacement, or destruction of a website or corporate information system.
- cyberwarfare** State-sponsored activity designed to cripple and defeat another state or nation by damaging or disrupting its computers or networks.
- dark web** Small portion of the deep web that has been intentionally hidden from search engines in order to preserve anonymity.
- data** Streams of raw facts representing events occurring in organizations or the physical environment before they have been organized and arranged into a form that people can understand and use.
- data cleansing** Activities for detecting and correcting data in a database or file that are incorrect, incomplete, improperly formatted, or redundant. Also known as data scrubbing.
- data definition** DBMS capability that specifies the structure and content of the database.
- data dictionary** An automated or manual tool for storing and organizing information about the data maintained in a database.
- data flow diagram (DFD)** Primary tool for structured analysis that graphically illustrates a system's component process and the flow of data between them.
- data governance** Policies and processes for managing the availability, usability, integrity, and security of the firm's data.
- data inconsistency** The presence of different values for same attribute when the same data are stored in multiple locations.
- data lake** Repository for raw unstructured data or structured data that for the most part have not yet been analyzed.
- data management technology** Software governing the organization of data on physical storage media.
- data manipulation language** A language associated with a database management system that end users and programmers use to manipulate data in the database.
- data mart** A small data warehouse containing only a portion of the organization's data for a specified function or population of users.
- data mining** Analysis of large pools of data to find patterns and rules that can be used to guide decision making and predict future behavior.
- data quality audit** A survey and/or sample of files to determine accuracy and completeness of data in an information system.
- data redundancy** The presence of duplicate data in multiple data files.
- data visualization** Technology for helping users see patterns and relationships in large amounts of data by presenting the data in graphical form.
- data warehouse** A database, with reporting and query tools, that stores current and historical data extracted from various operational systems and consolidated for management reporting and analysis.
- data workers** People such as secretaries or bookkeepers who process the organization's paperwork.
- database** A collection of data organized to service many applications at the same time by storing and managing data so that they appear to be in one location.
- database management system (DBMS)** Special software to create and maintain a database and enable individual business applications to extract the data they need without having to create separate files or data definitions in their computer programs.
- database server** A computer in a client/server environment that is responsible for running a DBMS to process SQL statements and perform database management tasks.
- decisional roles** Mintzberg's classification for managerial roles where managers initiate activities, handle disturbances, allocate resources, and negotiate conflicts.
- decision-support systems (DSS)** Information systems at the organization's management level that combine data and sophisticated analytical models or data analysis tools to support semistructured and unstructured decision making.
- “deep learning”** Using multiple layers of neural networks to reveal the underlying patterns in data, and in some limited cases identify patterns without human training.
- demand planning** Determining how much product a business needs to make to satisfy all its customers' demands.
- denial-of-service (DoS) attack** Flooding a network server or web server with false communications or requests for services in order to crash the network.
- design** Simon's second stage of decision making, when the individual conceives of possible alternative solutions to a problem.
- DevOps** Organizational strategy to create a culture and environment to promote rapid and agile development practices by emphasizing close collaboration between software developers and the IT operational staff.
- digital asset management systems** Classify, store, and distribute digital objects such as photographs, graphic images, video, and audio content.
- digital certificate** An attachment to an electronic message to verify the identity of the sender and to provide the receiver with the means to encode a reply.
- digital dashboard** Displays all of a firm's key performance indicators as graphs and charts on a single screen to provide one-page overview of all the critical measurements necessary to make key executive decisions.
- digital divide** Large disparities in access to computers and the Internet among different social groups and different locations.
- digital firm** Organization where nearly all significant business processes and relationships with customers, suppliers, and employees are digitally enabled, and key corporate assets are managed through digital means.
- digital goods** Goods that can be delivered over a digital network.
- Digital Millennium Copyright Act (DMCA)** Adjusts copyright laws to the Internet Age by making it illegal to make, distribute, or use devices that circumvent technology-based protections of copyrighted materials.

digital resiliency How to maintain and increase the resilience of an organization and its business processes in an all-pervasive digital environment, not just the resiliency of the IT function.

digital subscriber line (DSL) A group of technologies providing high-capacity transmission over existing copper telephone lines.

direct cutover strategy A risky conversion approach where the new system completely replaces the old one on an appointed day.

direct goods Goods used in a production process.

disaster recovery planning Planning for the restoration of computing and communications services after they have been disrupted.

disintermediation The removal of organizations or business process layers responsible for certain intermediary steps in a value chain.

disruptive technologies Technologies with disruptive impact on industries and businesses, rendering existing products, services, and business models obsolete.

distributed database Database stored in multiple physical locations.

distributed denial-of-service (DDoS) attack Numerous computers inundating and overwhelming a network from numerous launch points.

documentation Descriptions of how an information system works from either a technical or end-user standpoint.

domain name English-like name that corresponds to the unique 32-bit numeric Internet Protocol (IP) address for each computer connected to the Internet.

Domain Name System (DNS) A hierarchical system of servers maintaining a database enabling the conversion of domain names to their numeric IP addresses.

domestic exporter Form of business organization characterized by heavy centralization of corporate activities in the home country of origin.

downtime Period of time in which an information system is not operational.

drill down The ability to move from summary data to lower and lower levels of detail.

drive-by download Malware that comes with a downloaded file a user intentionally or unintentionally requests.

due process A process in which laws are well known and understood and there is an ability to appeal to higher authorities to ensure that laws are applied correctly.

dynamic pricing Pricing of items based on real-time interactions between buyers and sellers that determine what a item is worth at any particular moment.

e-government Use of the Internet and related technologies to digitally enable government and public sector agencies' relationships with citizens, businesses, and other arms of government.

edge computing Method of optimizing cloud computing systems by performing some data processing on a set of linked servers at the edge of the network, near the source of the data.

efficient customer response system System that directly links consumer behavior back to distribution, production, and supply chains.

electronic business (e-business) The use of the Internet and digital technology to execute all the business processes in the enterprise. Includes e-commerce as well as processes for the internal management of the firm and for coordination with suppliers and other business partners.

electronic commerce (e-commerce) The process of buying and selling goods and services electronically involving transactions using the Internet, networks, and other digital technologies.

electronic data interchange (EDI) The direct computer-to-computer exchange between two organizations of standard business transactions, such as orders, shipment instructions, or payments.

email The computer-to-computer exchange of messages.

employee relationship management (ERM) Software dealing with employee issues that are closely related to CRM, such as setting objectives, employee performance management, performance-based compensation, and employee training.

encryption The coding and scrambling of messages to prevent their being read or accessed without authorization.

end-user interface The part of an information system through which the end user interacts with the system, such as online screens and commands.

end users Representatives of departments outside the information systems group for whom applications are developed.

enterprise applications Systems that can coordinate activities, decisions, and knowledge across many different functions, levels, and business units in a firm. Include enterprise systems, supply chain management systems, and knowledge management systems.

enterprise content management (ECM) Help organizations manage structured and semistructured knowledge, providing corporate repositories of documents, reports, presentations, and best practices and capabilities for collecting and organizing email and graphic objects.

enterprise software Set of integrated modules for applications such as sales and distribution, financial accounting, investment management, materials management, production planning, plant maintenance, and human resources that allow data to be used by multiple functions and business processes.

enterprise systems Integrated enterprise-wide information systems that coordinate key internal processes of the firm.

enterprise-wide knowledge management systems General-purpose, firmwide systems that collect, store, distribute, and apply digital content and knowledge.

entity A person, place, thing, or event about which information must be kept.

entity-relationship diagram A methodology for documenting databases illustrating the relationship between various entities in the database.

ergonomics The interaction of people and machines in the work environment, including the design of jobs, health issues, and the end-user interface of information systems.

e-tailer Online retail stores from the giant Amazon to tiny local stores that have websites where retail goods are sold.

ethical no-free-lunch rule Assumption that all tangible and intangible objects are owned by someone else, unless there is a specific declaration otherwise, and that the creator wants compensation for this work.

ethics Principles of right and wrong that can be used by individuals acting as free moral agents to make choices to guide their behavior.

evil twins Wireless networks that pretend to be legitimate to entice participants to log on and reveal passwords or credit card numbers.

exchange Third-party Net marketplace that is primarily transaction oriented and that connects many buyers and suppliers for spot purchasing.

executive support systems (ESS) Information systems at the organization's strategic level designed to address unstructured decision making through advanced graphics and communications.

expert system Knowledge-intensive computer program that captures the expertise of a human in limited domains of knowledge.

explicit knowledge Knowledge that has been documented.

Extensible Markup Language (XML) General-purpose language that describes the structure of a document and can perform presentation, communication, and storage of data, allowing data to be manipulated by the computer.

external integration tools Project management technique that links the work of the implementation team to that of users at all organizational levels.

extranet Private intranet that is accessible to authorized outsiders.

Fair Information Practices (FIP) A set of principles originally set forth in 1973 that governs the collection and use of information about individuals and forms the basis of most U.S. and European privacy laws.

fault-tolerant computer systems Systems that contain extra hardware, software, and power supply components that can back a system up and keep it running to prevent system failure.

feasibility study As part of the systems analysis process, the way to determine whether the solution is achievable, given the organization's resources and constraints.

- feedback** Output that is returned to the appropriate members of the organization to help them evaluate or correct input.
- field** A grouping of characters into a word, a group of words, or a complete number, such as a person's name or age.
- file** A group of records of the same type.
- File Transfer Protocol (FTP)** Tool for retrieving and transferring files from a remote computer.
- FinTech** Start-up innovative financial technology firms and services.
- firewall** Hardware and software placed between an organization's internal network and an external network to prevent outsiders from invading private networks.
- foreign key** Field in a database table that enables users find related information in another database table.
- formal control tools** Project management technique that helps monitor the progress toward completion of a task and fulfillment of goals.
- formal planning tools** Project management technique that structures and sequences tasks, budgeting time, money, and technical resources required to complete the tasks.
- franchiser** Form of business organization in which a product is created, designed, financed, and initially produced in the home country, but for product-specific reasons relies heavily on foreign personnel for further production, marketing, and human resources.
- free/premium revenue model** An e-commerce revenue model in which a firm offers basic services or content for free while charging a premium for advanced or high-value features.
- Gantt chart** Visually represents the timing, duration, and resource requirements of project tasks.
- general controls** Overall control environment governing the design, security, and use of computer programs and the security of data files in general throughout the organization's information technology infrastructure.
- General Data Protection Regulation (GDPR)** Legislation effective May 25, 2018 that updates and unifies data privacy laws across the European Union, focusing on making businesses more transparent and expanding the privacy rights of data subjects.
- genetic algorithms** Problem-solving methods that promote the evolution of solutions to specified problems using the model of living organisms adapting to their environment.
- geoadvertising services** Delivering ads to users based on their GPS location.
- geographic information system (GIS)** System with software that can analyze and display data using digitized maps to enhance planning and decision-making.
- geoinformation services** Information on local places and things based on the GPS position of the user.
- geosocial services** Social networking based on the GPS location of users.
- global culture** The development of common expectations, shared artifacts, and social norms among different cultures and peoples.
- Golden Rule** Putting oneself in the place of others as the object of a decision.
- Gramm-Leach-Bliley Act** Requires financial institutions to ensure the security and confidentiality of customer data.
- green computing (green IT)** Refers to practices and technologies for designing, manufacturing, using, and disposing of computers, servers, and associated devices such as monitors, printers, storage devices, and networking and communications systems to minimize impact on the environment.
- hacker** A person who gains unauthorized access to a computer network for profit, criminal mischief, or personal pleasure.
- Hadoop** Open source software framework that enables distributed parallel processing of huge amounts of data across many inexpensive computers.
- hertz** Measure of frequency of electrical impulses per second, with 1 Hertz equivalent to 1 cycle per second.
- HIPAA** Law outlining rules for medical security, privacy, and the management of healthcare records.
- hotspot** A specific geographic location in which an access point provides public Wi-Fi network service.
- HTML5** Next evolution of HTML, which makes it possible to embed images, video, and audio directly into a document without add-on software.
- hubs** Very simple devices that connect network components, sending a packet of data to all other connected devices.
- hybrid cloud** Computing model where firms use both their own IT infrastructure and also public cloud computing services.
- Hypertext Markup Language (HTML)** Page description language for creating web pages.
- Hypertext Transfer Protocol (HTTP)** The communications standard used to transfer pages on the web. Defines how messages are formatted and transmitted.
- identity management** Business processes and software tools for identifying the valid users of a system and controlling their access to system resources.
- identity theft** Theft of key pieces of personal information, such as credit card or Social Security numbers, in order to obtain merchandise and services in the name of the victim or to obtain false credentials.
- Immanuel Kant's categorical imperative** A principle that states that if an action is not right for everyone to take it is not right for anyone.
- implementation** All the organizational activities surrounding the adoption, management, and routinization of an innovation, such as a new information system.
- in-memory computing** Technology for very rapid analysis and processing of large quantities of data by storing the data in the computer's main memory rather than in secondary storage.
- indirect goods** Goods not directly used in the production process, such as office supplies.
- inference engine** The strategy used to search through the rule base in an expert system; can be forward or backward chaining.
- information** Data that have been shaped into a form that is meaningful and useful to human beings.
- information asymmetry** Situation where the relative bargaining power of two parties in a transaction is determined by one party in the transaction possessing more information essential to the transaction than the other party.
- information density** The total amount and quality of information available to all market participants, consumers, and merchants.
- information requirements** A detailed statement of the information needs that a new system must satisfy; identifies who needs what information, and when, where, and how the information is needed.
- information rights** The rights that individuals and organizations have with respect to information that pertains to themselves.
- information system** Interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and visualization in an organization.
- information systems audit** Identifies all the controls that govern individual information systems and assesses their effectiveness.
- information systems department** The formal organizational unit that is responsible for the information systems function in the organization.
- information systems literacy** Broad-based understanding of information systems that includes behavioral knowledge about organizations and individuals using information systems as well as technical knowledge about computers.
- information systems managers** Leaders of the various specialists in the information systems department.
- information systems plan** A road map indicating the direction of systems development: the rationale, the current situation, the management strategy, the implementation plan, and the budget.
- information technology (IT)** All the hardware and software technologies a firm needs to achieve its business objectives.
- information technology (IT) infrastructure** Computer hardware, software, data, storage technology, and networks providing a portfolio of shared IT resources for the organization.
- informational roles** Mintzberg's classification for managerial roles where managers act as the nerve centers of their organizations, receiving and disseminating critical information.

- informed consent** Consent given with knowledge of all the facts needed to make a rational decision.
- infrastructure as a service (IaaS)** Computing infrastructure provisioned and managed as a cloud computing service, usually over the Internet.
- input** The capture or collection of raw data from within the organization or from its external environment for processing in an information system.
- instant messaging** Chat service that allows participants to create their own private chat channels so that a person can be alerted whenever someone on his or her private list is online to initiate a chat session with that particular individual.
- intangible benefits** Benefits that are not easily quantified; they include more efficient customer service or enhanced decision making.
- intellectual property** Intangible property created by individuals or corporations that is subject to protections under trade secret, copyright, and patent law.
- intelligence** The first of Simon's four stages of decision making, when the individual collects information to identify problems occurring in the organization.
- intelligent agent** Software program that uses a built-in or learned knowledge base to carry out specific, repetitive, and predictable tasks for an individual user, business process, or software application.
- intelligent techniques** Technologies that aid human decision makers by capturing individual and collective knowledge, discovering patterns and behaviors in large quantities of data, and generating solutions to problems that are too large and complex for human beings to solve on their own.
- internal integration tools** Project management technique that ensures that the implementation team operates as a cohesive unit.
- international information systems architecture** The basic information systems required by organizations to coordinate worldwide trade and other activities.
- Internet** Global network of networks using universal standards to connect millions of different networks.
- Internet of Things** Pervasive web in which each object or machine has a unique identity and is able to use the Internet to link with other machines or send data. Also known as the Industrial Internet.
- Internet Protocol (IP) address** Four-part numeric address indicating a unique computer location on the Internet.
- Internet service provider (ISP)** A commercial organization with a permanent connection to the Internet that sells temporary connections to subscribers.
- Internet2** Research network with new protocols and transmission speeds that provides an infrastructure for supporting high-bandwidth Internet applications.
- interorganizational systems** Information systems that automate the flow of information across organizational boundaries and link a company to its customers, distributors, or suppliers.
- interpersonal roles** Mintzberg's classification for managerial roles where managers act as figureheads and leaders for the organization.
- intranet** An internal network based on Internet and World Wide Web technology and standards.
- intrusion detection system** Tools to monitor the most vulnerable points in a network to detect and deter unauthorized intruders.
- iOS** Operating system for the Apple iPad, iPhone, and iPod Touch.
- IPv6** New IP addressing system using 128-bit IP addresses. Stands for Internet Protocol version 6.
- IT governance** Strategy and policies for using information technology within an organization, specifying the decision rights and accountabilities to ensure that information technology supports the organization's strategies and objectives.
- iterative** A process of repeating over and over again the steps to build a system.
- Java** Programming language that can deliver only the software functionality needed for a particular task, such as a small applet downloaded from a network; can run on any computer and operating system.
- JavaScript** Core technology for making web pages more interactive.
- joint application design (JAD)** Process to accelerate the generation of information requirements by having end users and information systems specialists work together in intensive interactive design sessions.
- just-in-time strategy** Scheduling system for minimizing inventory by having components arrive exactly at the moment they are needed and finished goods shipped as soon as they leave the assembly line.
- key field** A field in a record that uniquely identifies instances of that record so that it can be retrieved, updated, or sorted.
- key performance indicators** Measures proposed by senior management for understanding how well the firm is performing along specified dimensions.
- keylogger** Spyware that records every keystroke made on a computer to steal personal information or passwords or to launch Internet attacks.
- knowledge** Concepts, experience, and insight that provide a framework for creating, evaluating, and using information.
- knowledge base** Model of human knowledge that is used by expert systems.
- knowledge management** The set of processes developed in an organization to create, gather, store, maintain, and disseminate the firm's knowledge.
- knowledge management systems** Systems that support the creation, capture, storage, and dissemination of firm expertise and knowledge.
- knowledge workers** People such as engineers or architects who design products or services and create knowledge for the organization.
- knowledge work systems** Information systems that aid knowledge workers in the creation and integration of new knowledge into the organization.
- learning management system (LMS)** Tools for the management, delivery, tracking, and assessment of various types of employee learning.
- legacy system** A system that has been in existence for a long time and that continues to be used to avoid the high cost of replacing or redesigning it.
- legitimacy** The extent to which one's authority is accepted on grounds of competence, vision, or other qualities.
- liability** The existence of laws that permit individuals to recover the damages done to them by other actors, systems, or organizations.
- Linux** Reliable and compactly designed operating system that is an offshoot of UNIX and that can run on many different hardware platforms and is available free or at very low cost. Used as alternative to UNIX.
- local area network (LAN)** A telecommunications network that requires its own dedicated channels and that encompasses a limited distance, usually one building or several buildings in close proximity.
- location-based services** GPS map services available on smartphones.
- location analytics** Ability to gain insights from the location (geographic) component of data, including location data from mobile phones, output from sensors or scanning devices, and data from maps.
- long tail marketing** Refers to the ability of firms to profitably market goods to very small online audiences, largely because of the lower costs of reaching very small market segments (people who fall into the long tail ends of a Bell curve).
- low-code development** Software development approach that enables the creation of workable software with minimal hand coding.
- machine learning** Software that can identify patterns and relationships in very large data sets without explicit programming

- although with significant human training.
- mainframe** Largest category of computer, used for major business processing.
- maintenance** Changes in hardware, software, documentation, or procedures to a production system to correct errors, meet new requirements, or improve processing efficiency.
- malware** Malicious software programs such as computer viruses, worms, and Trojan horses.
- managed security service provider (MSSP)** Company that provides security management services for subscribing clients.
- management information systems (MIS)** Specific category of information system providing reports on organizational performance to help middle management monitor and control the business.
- management information systems (MIS)** The study of information systems focusing on their use in business and management.
- managerial roles** Expectations of the activities that managers should perform in an organization.
- market creator** An e-commerce business model in which firms provide a digital online environment where buyers and sellers can meet, search for products, and engage in transactions.
- market entry costs** The cost merchants must pay to bring their goods to market.
- marketspace** A marketplace extended beyond traditional boundaries and removed from a temporal and geographic location.
- mashups** Composite software applications that depend on high-speed networks, universal communication standards, and open source code.
- mass customization** The capacity to offer individually tailored products or services using mass production resources.
- massive open online course (MOOC)** Online course made available via the web to very large numbers of participants.
- menu costs** Merchants' costs of changing prices.
- metropolitan area network (MAN)** Network that spans a metropolitan area, usually a city and its major suburbs. Its geographic scope falls between a WAN and a LAN.
- microblogging** Blogging featuring very short posts, such as using Twitter.
- micropayment systems** Payment for a very small sum of money, often less than \$10.
- middle management** People in the middle of the organizational hierarchy who are responsible for carrying out the plans and goals of senior management.
- minicomputer** Middle-range computer used in systems for universities, factories, or research laboratories.
- mobile commerce (m-commerce)** The use of wireless devices, such as smartphones or tablets to conduct both business-to-consumer and business-to-business e-commerce transactions over the Internet.
- mobile device management (MDM)** Software that monitors, manages, and secures mobile devices that are deployed across multiple mobile service providers and multiple mobile operating systems used in the organization.
- mobile web app** Internet-enabled app with specific functionality for mobile devices that is accessed through a mobile device's web browser.
- mobile website** Version of a regular website that is scaled down in content and navigation for easy access and search on a small mobile screen.
- modem** A device for translating a computer's digital signals into analog form for transmission over analog networks or for translating analog signals back into digital form for reception by a computer.
- Moore's Law** Assertion that the number of components on a chip doubles each year.
- multicore processor** Integrated circuit to which two or more processors have been attached for enhanced performance, reduced power consumption, and more efficient simultaneous processing of multiple tasks.
- multinational** Form of business organization that concentrates financial management, and control out of a central home base while decentralizing production, sales, and marketing.
- multitiered (N-tier) client/server architecture** Client/server network in which the work of the entire network is balanced over several different levels of servers.
- multitouch** Interface that features the use of one or more finger gestures to manipulate lists or objects on a screen without using a mouse or keyboard.
- nanotechnology** Technology that builds structures and processes based on the manipulation of individual atoms and molecules.
- native advertising** Placing ads within social network newsfeeds or traditional editorial content, such as a newspaper article.
- native app** Standalone application designed to run on a specific platform and device and is installed directly on the mobile device
- natural language processing (NLP)** AI technique for enabling a computer to understand and analyze natural language as opposed to language formatted to be understood by computers.
- near field communication (NFC)** Short-range wireless connectivity standard that uses electromagnetic radio fields to enable two compatible devices to exchange data when brought within a few centimeters of each other.
- net marketplace** A single digital marketplace based on Internet technology linking many buyers to many sellers.
- network** The linking of two or more computers to share data or resources, such as a printer.
- network economics** Model of strategic systems at the industry level based on the concept of a network where adding another participant entails zero marginal costs but can create much larger marginal gains.
- network operating system (NOS)** Special software that routes and manages communications on the network and coordinates network resources.
- networking and telecommunications technology** Physical devices and software that link various computer hardware components and transfer data from one physical location to another.
- neural network** Algorithms loosely based on the processing patterns of the biological brain that can be trained to classify objects into known categories based on data inputs.
- no-code development** Platform for creating apps without writing any program code.
- non-relational database management system** Database management system for working with large quantities of structured and unstructured data that would be difficult to analyze with a relational model.
- nonobvious relationship awareness (NORA)** Technology that can find obscure hidden connections between people or other entities by analyzing information from many different sources to correlate relationships.
- normalization** The process of creating small stable data structures from complex groups of data when designing a relational database.
- object** Software building block that combines data and the procedures acting on the data.
- object-oriented development** Approach to systems development that uses the object as the basic unit of systems analysis and design. The system is modeled as a collection of objects and the relationship between them.
- offshore outsourcing** Outsourcing systems development work or maintenance of existing systems to external vendors in another country.
- on-demand computing** Firms off-loading peak demand for computing power to remote, large-scale data processing centers, investing just enough to handle average processing loads and paying for only as much additional computing power as the market demands. Also called utility computing.
- online analytical processing (OLAP)** Capability for manipulating and analyzing large volumes of data from

- multiple perspectives.
- online transaction processing** Transaction processing mode in which transactions entered online are immediately processed by the computer.
- open source software** Software that provides free access to its program code, allowing users to modify the program code to make improvements or fix errors.
- operating system** Software that manages the resources and activities of the computer.
- operational CRM** Customer-facing applications, such as sales force automation, call center and customer service support, and marketing automation.
- operational intelligence** Business analytics that delivers insight into data, streaming events, and business operations.
- operational management** People who monitor the day-to-day activities of the organization.
- opt-in** Model of informed consent permitting prohibiting an organization from collecting any personal information unless the individual specifically takes action to approve information collection and use.
- opt-out** Model of informed consent permitting the collection of personal information until the consumer specifically requests that the data not be collected.
- organization** A stable, formal, social structure that takes resources from the environment and processes them to produce outputs.
- organizational and management capital** Investments in organization and management such as new business processes, management behavior, organizational culture, or training.
- organizational impact analysis** Study of the way a proposed system will affect organizational structure, attitudes, decision making, and operations.
- organizational learning** Creation of new standard operating procedures and business processes that reflect organizations' experience.
- output** The distribution of processed information to the people who will use it or to the activities for which it will be used.
- outsourcing** The practice of contracting computer center operations, telecommunications networks, or applications development to external vendors.
- packet switching** Technology that breaks messages into small, fixed bundles of data and routes them in the most economical way through any available communications channel.
- paradigm shift** Radical reconceptualization of the nature of the business and the nature of the organization.
- parallel strategy** A safe and conservative conversion approach where both the old system and its potential replacement are run together for a time until everyone is assured that the new one functions correctly.
- particularism** Making judgments and taking action on the basis of narrow or personal characteristics, in all its forms (religious, nationalistic, ethnic, regionalism, geopolitical position).
- partner relationship management (PRM)** Automation of the firm's relationships with its selling partners using customer data and analytical tools to improve coordination and customer sales.
- password** Secret word or string of characters for authenticating users so they can access a resource such as a computer system.
- patch** Small pieces of software to repair the software flaws without disturbing the proper operation of the software.
- patent** A legal document that grants the owner an exclusive monopoly on the ideas behind an invention for 20 years; designed to ensure that inventors of new machines or methods are rewarded for their labor while making widespread use of their inventions.
- pattern detection programs** Software that can recognize patterns in data.
- peer-to-peer** Network architecture that gives equal power to all computers on the network; used primarily in small networks.
- personal area network (PAN)** Computer network used for communication among digital devices that are close to one person.
- personalization** Ability of merchants to target marketing messages to specific individuals by adjusting the message for a person's name, interests, and past purchases.
- PERT chart** Network diagram depicting project tasks and their interrelationships.
- pharming** Phishing technique that redirects users to a bogus web page, even when an individual enters the correct web page address.
- phased approach** Introduces the new system in stages either by functions or by organizational units.
- phishing** Form of spoofing involving setting up fake websites or sending email messages that resemble those of legitimate businesses that ask users for confidential personal data.
- pilot study strategy** A strategy to introduce the new system to a limited area of the organization until it is proven to be fully functional; only then can the conversion to the new system across the entire organization take place.
- pivot table** Spreadsheet tool for reorganizing and summarizing two or more dimensions of data in a tabular format.
- platform** Business providing information systems, technologies, and services that thousands of other firms in different industries use to enhance their own capabilities.
- platform as a service (PaaS)** Category of cloud computing services that provides a platform for customers to develop, run, and manage applications without having to build and maintain the infrastructure typically associated with developing an application.
- podcasting** Publishing audio broadcasts via the Internet so that subscribing users can download audio files onto their personal computers or portable music players.
- portal** Web interface for presenting integrated personalized content from a variety of sources. Also refers to a website service that provides an initial point of entry to the web.
- portfolio analysis** An analysis of the portfolio of potential applications within a firm to determine the risks and benefits, and to select among alternatives for information systems.
- post-implementation audit** Formal review process conducted after a system has been placed in production to determine how well the system has met its original objectives.
- predictive analytics** The use of data mining techniques, historical data, and assumptions about future conditions to predict outcomes of events, such as the probability a customer will respond to an offer or purchase a specific product.
- predictive search** Part of a search algorithm that predicts what a user query is looking as it is entered based on popular searches.
- price discrimination** Selling the same goods, or nearly the same goods, to different targeted groups at different prices.
- price transparency** The ease with which consumers can find out the variety of prices in a market.
- primary activities** Activities most directly related to the production and distribution of a firm's products or services.
- primary key** Unique identifier for all the information in any row of a database table.
- privacy** The claim of individuals to be left alone, free from surveillance or interference from other individuals, organizations, or the state.
- private cloud** A proprietary network or a data center that ties together servers, storage, networks, data, and applications as a set of virtualized services that are shared by users inside a company.
- private exchange** Another term for a private industrial network.
- private industrial networks** Web-enabled networks linking systems of multiple firms in an industry for the coordination of trans-organizational business processes.
- process specifications** Describe the logic of the processes occurring within the lowest levels of a data flow diagram.
- processing** The conversion, manipulation, and analysis of raw input into a form that is more meaningful to humans.
- product differentiation** Competitive strategy for creating brand loyalty by developing new and unique products and services that are not easily duplicated by competitors.
- production** The stage after the new system is installed and the conversion is complete; during this time the system is reviewed by users and technical specialists to determine how well it has met

- its original goals.
- production or service workers** People who actually produce the products or services of the organization.
- profiling** The use of computers to combine data from multiple sources and create electronic dossiers of detailed information on individuals.
- program-data dependence** The close relationship between data stored in files and the software programs that update and maintain those files. Any change in data organization or format requires a change in all the programs associated with those files.
- programmers** Highly trained technical specialists who write computer software instructions.
- programming** The process of translating the system specifications prepared during the design stage into program code.
- project** Planned series of related activities for achieving a specific business objective.
- project management** Application of knowledge, tools, and techniques to achieve specific targets within a specified budget and time period.
- project portfolio management** Helps organizations evaluate and manage portfolios of projects and dependencies among them.
- protocol** A set of rules and procedures that govern transmission between the components in a network.
- prototype** The preliminary working version of an information system for demonstration and evaluation purposes.
- prototyping** The process of building an experimental system quickly and inexpensively for demonstration and evaluation so that users can better determine information requirements.
- public cloud** A cloud maintained by an external service provider, accessed through the Internet, and available to the general public.
- public key encryption** Uses two keys: one shared (or public) and one private.
- public key infrastructure (PKI)** System for creating public and private keys using a certificate authority (CA) and digital certificates for authentication.
- pull-based model** Supply chain driven by actual customer orders or purchases so that members of the supply chain produce and deliver only what customers have ordered.
- push-based model** Supply chain driven by production master schedules based on forecasts or best guesses of demand for products, and products are “pushed” to customers.
- quantum computing** Use of principles of quantum physics to represent data and perform operations on the data, with the ability to be in many different states at once and to perform many different computations simultaneously.
- query** Request for data from a database.
- radio frequency identification (RFID)** Technology using tiny tags with embedded microchips containing data about an item and its location to transmit short-distance radio signals to special RFID readers that then pass the data on to a computer for processing.
- ransomware** Malware that extorts money from users by taking control of their computers or displaying annoying pop-up messages.
- Rapid Application Development (RAD)** Process for developing systems in a very short time period by using prototyping, state-of-the-art software tools and close teamwork among users and systems specialists.
- rationalization of procedures** The streamlining of standard operating procedures, eliminating obvious bottlenecks, so that automation makes operating procedures more efficient.
- record** A group of related fields.
- referential integrity** Rules to ensure that relationships between coupled database tables remain consistent.
- relational DBMS** A type of logical database model that treats data as if they were stored in two-dimensional tables. It can relate data stored in one table to data in another as long as the two tables share a common data element.
- repetitive stress injury (RSI)** Occupational disease that occurs when muscle groups are forced through repetitive actions with high-impact loads or thousands of repetitions with low-impact loads.
- request for proposal (RFP)** A detailed list of questions submitted to vendors of software or other services to determine how well the vendor's product can meet the organization's specific requirements.
- responsibility** Accepting the potential costs, duties, and obligations for the decisions one makes.
- responsive web design** Ability of a website to automatically change screen resolution and image size as a user switches to devices of different sizes, such as a laptop, tablet computer, or smartphone. Eliminates the need for separate design and development work for each new device.
- revenue model** A description of how a firm will earn revenue, generate profits, and produce a return on investment.
- richness** Measurement of the depth and detail of information that a business can supply to the customer as well as information the business collects about the customer.
- risk assessment** Determining the potential frequency of the occurrence of a problem and the potential damage if the problem were to occur. Used to determine the cost/benefit of a control.
- risk aversion principle** Principle that one should take the action that produces the least harm or incurs the least cost.
- robotics** Use of machines that can substitute for human movements as well as computer systems for their control, sensory feedback, and information processing.
- router** Specialized communications processor that forwards packets of data from one network to another network.
- routes** Precise rules, procedures, and practices that have been developed to cope with expected situations.
- RSS** Technology using aggregator software to pull content from websites and feed it automatically to subscribers' computers.
- safe harbor** Private self-regulating policy and enforcement mechanism that meets the objectives of government regulations but does not involve government regulation or enforcement.
- sales force automation (SFA)** Software to automate the business tasks of sales, including lead management, information sharing, order management, sales forecast analysis, and employee performance evaluation.
- sales revenue model** Selling goods, information, or services to customers as the main source of revenue for a company.
- Sarbanes-Oxley Act** Law passed in 2002 that imposes responsibility on companies and their management to protect investors by safeguarding the accuracy and integrity of financial information that is used internally and released externally.
- scalability** The ability of a computer, product, or system to expand to serve a larger number of users without breaking down.
- scope** Defines what work is and is not included in a project.
- scoring model** A quick method for deciding among alternative systems based on a system of ratings for selected objectives.
- search costs** The time and money spent locating a suitable product and determining the best price for that product.
- search engine** A tool for locating specific sites or information on the Internet.
- search engine marketing** Use of search engines to deliver in their results sponsored links, for which advertisers have paid.
- search engine optimization (SEO)** The process of changing a website's content, layout, and format in order to increase the ranking of the site on popular search engines and to generate more site visitors.
- Secure Hypertext Transfer Protocol (S-HTTP)** Protocol used for encrypting data flowing over the Internet; limited to individual messages.
- Secure Sockets Layer (SSL)** Enables client and server computers to manage encryption and decryption activities as they communicate with each other during a secure web session.
- security** Policies, procedures, and technical measures used to prevent unauthorized access, alteration, theft, or physical damage to information systems.
- security policy** Statements ranking information risks, identifying acceptable security goals, and identifying the mechanisms for

- achieving these goals.
- semantic search** Search technology capable of understanding human language and behavior.
- semistructured decisions** Decisions in which only part of the problem has a clear-cut answer provided by an accepted procedure.
- senior management** People occupying the topmost hierarchy in an organization who are responsible for making long-range decisions.
- sensitivity analysis** Models that ask “what-if” questions repeatedly to determine the impact of changes in one or more factors on the outcomes.
- sentiment analysis** Mining text comments in an email message, blog, social media conversation, or survey form to detect favorable and unfavorable opinions about specific subjects.
- server** Computer specifically optimized to provide software and other resources to other computers over a network.
- service level agreement (SLA)** Formal contract between customers and their service providers that defines the specific responsibilities of the service provider and the level of service expected by the customer.
- service-oriented architecture (SOA)** Software architecture of a firm built on a collection of software programs that communicate with each other to perform assigned tasks to create a working software application.
- shopping bot** Software with varying levels of built-in intelligence to help electronic commerce shoppers locate and evaluate products or service they might wish to purchase.
- Six Sigma** A specific measure of quality, representing 3.4 defects per million opportunities; used to designate a set of methodologies and techniques for improving quality and reducing costs.
- slippery slope rule** Ethical principle that if an action cannot be taken repeatedly, it is not right to take at all.
- smart card** A credit-card-size plastic card that stores digital information and that can be used for electronic payments in place of cash.
- smartphone** Wireless phone with voice, text, and Internet capabilities.
- sniffer** Type of eavesdropping program that monitors information traveling over a network.
- social business** Use of social networking platforms, including Facebook, Twitter, and internal corporate social tools, to engage employees, customers, and suppliers.
- social CRM** Tools enabling a business to link customer conversations, data, and relationships from social networking sites to CRM processes.
- social engineering** Tricking people into revealing their passwords by pretending to be legitimate users or members of a company in need of information.
- social graph** Map of all significant online social relationships, comparable to a social network describing offline relationships.
- social networking sites** Online community for expanding users' business or social contacts by making connections through their mutual business or personal connections.
- social shopping** Use of websites featuring user-created web pages to share knowledge about items of interest to other shoppers.
- sociotechnical design** Design to produce information systems that blend technical efficiency with sensitivity to organizational and human needs.
- sociotechnical view** Seeing systems as composed of both technical and social elements.
- software as a service (SaaS)** Services for delivering and providing access to software remotely as a web-based service.
- software-defined networking (SDN)** Using a central control program separate from network devices to manage the flow of data on a network.
- software-defined storage (SDS)** Software to manage provisioning and management of data storage independent of the underlying hardware.
- software localization** Process of converting software to operate in a second language.
- software package** A prewritten, precoded, commercially available set of programs that eliminates the need to write software pro-
- grams for certain functions.
- spam** Unsolicited commercial email.
- spoofing** Tricking or deceiving computer systems or other computer users by hiding one's identity or faking the identity of another user on the Internet.
- spyware** Technology that aids in gathering information about a person or organization without their knowledge.
- SQL injection attack** Attacks against a website that take advantage of vulnerabilities in poorly coded SQL (a standard and common database software application) applications in order to introduce malicious program code into a company's systems and networks.
- streaming** A publishing method for music and video files that flows a continuous stream of content to a user's device without storing it locally on the device.
- structure chart** System documentation showing each level of design, the relationship among the levels, and the overall place in the design structure; can document one program, one system, or part of one program.
- structured** Refers to the fact that techniques are carefully drawn up, step by step, with each step building on a previous one.
- structured decisions** Decisions that are repetitive and routine and have a definite procedure for handling them.
- structured knowledge** Knowledge in the form of structured documents and reports.
- Structured Query Language (SQL)** The standard data manipulation language for relational database management systems.
- subscription revenue model** Website charging a subscription fee for access to some or all of its content or services on an ongoing basis.
- supervised learning** Machine learning algorithm trained by providing specific examples of desired inputs and outputs classified by humans in advance.
- supply chain** Network of organizations and business processes for procuring materials, transforming raw materials into intermediate and finished products, and distributing the finished products to customers.
- supply chain execution systems** Systems to manage the flow of products through distribution centers and warehouses to ensure that products are delivered to the right locations in the most efficient manner.
- supply chain management systems** Information systems that automate the flow of information between a firm and its suppliers in order to optimize the planning, sourcing, manufacturing, and delivery of products and services.
- supply chain planning systems** Systems that enable a firm to generate demand forecasts for a product and to develop sourcing and manufacturing plans for that product.
- support activities** Activities that make the delivery of a firm's primary activities possible. Consist of the organization's infrastructure, human resources, technology, and procurement.
- switch** Device to connect network components that has more intelligence than a hub and can filter and forward data to a specified destination.
- switching costs** The expense a customer or company incurs in lost time and expenditure of resources when changing from one supplier or system to a competing supplier or system.
- system testing** Tests the functioning of the information system as a whole in order to determine if discrete modules will function together as planned.
- systems analysis** The analysis of a problem that the organization will try to solve with an information system.
- systems analysts** Specialists who translate business problems and requirements into information requirements and systems, acting as liaison between the information systems department and the rest of the organization.
- systems design** Details how a system will meet the information requirements as determined by the systems analysis.
- systems development** The activities that go into producing an information systems solution to an organizational problem or

opportunity.

systems life cycle A traditional methodology for developing an information system that partitions the systems development process into formal stages that must be completed sequentially with a very formal division of labor between end users and information systems specialists.

T lines High-speed guaranteed service level data lines leased from communications providers, such as T-1 lines (with a transmission capacity of 1.544 Mbps).

tablet computer Mobile handheld computer that is larger than a mobile phone and operated primarily by touching a flat screen.

tacit knowledge Expertise and experience of organizational members that has not been formally documented.

tangible benefits Benefits that can be quantified and assigned a monetary value; they include lower operational costs and increased cash flows.

taxonomy Method of classifying things according to a predetermined system.

teams Formal groups whose members collaborate to achieve specific goals.

technology standards Specifications that establish the compatibility of products and the ability to communicate in a network.

telepresence Telepresence is a technology that allows a person to give the appearance of being present at a location other than his or her true physical location.

Telnet Network tool that allows someone to log on to one computer system while doing work on another.

test plan Prepared by the development team in conjunction with the users; it includes all of the preparations for the series of tests to be performed on the system.

testing The exhaustive and thorough process that determines whether the system produces the desired results under known conditions.

text mining Discovery of patterns and relationships from large sets of unstructured data.

token Physical device similar to an identification card that is designed to prove the identity of a single user.

total cost of ownership (TCO) Designates the total cost of owning technology resources, including initial purchase costs, the cost of hardware and software upgrades, maintenance, technical support, and training.

total quality management (TQM) A concept that makes quality control a responsibility to be shared by all people in an organization.

touch point Method of firm interaction with a customer, such as telephone, email, customer service desk, conventional mail, or point-of-purchase.

trade secret Any intellectual work or product used for a business purpose that can be classified as belonging to that business, provided it is not based on information in the public domain.

trademarks Marks, symbols, or images used to distinguish products in the marketplace.

transaction costs Costs incurred when a firm buys on the marketplace what it cannot make itself.

transaction cost theory Economic theory stating that firms grow larger because they can conduct marketplace transactions internally more cheaply than they can with external firms in the marketplace.

transaction fee revenue model An online e-commerce revenue model where the firm receives a fee for enabling or executing transactions.

transaction processing systems (TPS) Computerized systems that perform and record the daily routine transactions necessary to conduct the business; they serve the organization's operational level.

transborder data flow The movement of information across international boundaries in any form.

Transmission Control Protocol/Internet Protocol (TCP/IP)

Dominant model for achieving connectivity among different networks. Provides a universally agreed-on method for breaking

up digital messages into packets, routing them to the proper addresses, and then reassembling them into coherent messages.

transnational Truly global form of business organization with no national headquarters; value-added activities are managed from a global perspective without reference to national borders, optimizing sources of supply and demand and local competitive advantage.

Trojan horse A software program that appears legitimate but contains a second hidden function that may cause damage.

tuple A row or record in a relational database.

two-factor authentication Validating user identity with two means of identification, one of which is typically a physical token, and the other of which is typically data.

unified communications Integrates disparate channels for voice communications, data communications, instant messaging, email, and electronic conferencing into a single experience where users can seamlessly switch back and forth between different communication modes.

unified threat management (UTM) Comprehensive security management tool that combines multiple security tools, including firewalls, virtual private networks, intrusion detection systems, and web content filtering and anti-spam software.

uniform resource locator (URL) The address of a specific resource on the Internet.

unit testing The process of testing each program separately in the system. Sometimes called program testing.

Unix Operating system for all types of computers, which is machine independent and supports multiuser processing, multitasking, and networking. Used in high-end workstations and servers.

unstructured decisions Nonroutine decisions in which the decision maker must provide judgment, evaluation, and insights into the problem definition; there is no agreed-upon procedure for making such decisions.

unsupervised learning Machine learning algorithm trained to use information that is neither classified nor labeled in advance and to find patterns in that information without explicit human guidance.

user interface The part of the information system through which the end user interacts with the system; type of hardware and the series of on-screen commands and responses required for a user to work with the system.

user-designer communications gap The difference in backgrounds, interests, and priorities that impede communication and problem solving among end users and information systems specialists.

utilitarian principle Principle that assumes one can put values in rank order of utility and understand the consequences of various courses of action.

value chain model Model that highlights the primary or support activities that add a margin of value to a firm's products or services where information systems can best be applied to achieve a competitive advantage.

value web Customer-driven network of independent firms who use information technology to coordinate their value chains to collectively produce a product or service for a market.

virtual company Organization using networks to link people, assets, and ideas to create and distribute products and services without being limited to traditional organizational boundaries or physical location.

virtual private network (VPN) A secure connection between two points across the Internet to transmit corporate data. Provides a low-cost alternative to a private network.

virtual reality systems Interactive graphics software and hardware that create computer-generated simulations that provide sensations that emulate real-world activities.

virtualization Presenting a set of computing resources so that they can all be accessed in ways that are not restricted by physical configuration or geographic location.

visual web Refers to web linking visual sites such as Pinterest where

pictures replace text documents and where users search on pictures and visual characteristics.

Voice over IP (VoIP) Facilities for managing the delivery of voice information using the Internet Protocol (IP).

war driving Technique in which eavesdroppers drive by buildings or park outside and try to intercept wireless network traffic.

web beacons Tiny objects invisibly embedded in email messages and web pages that are designed to monitor the behavior of the user visiting a website or sending email.

web browser An easy-to-use software tool for accessing the World Wide Web and the Internet.

web hosting service Company with large web server computers to maintain the websites of fee-paying subscribers.

web mining Discovery and analysis of useful patterns and information from the World Wide Web.

web server Software that manages requests for web pages on the computer where they are stored and that delivers the page to the user's computer.

web services Set of universal standards using Internet technology for integrating different applications from different sources without time-consuming custom coding. Used for linking systems of different organizations or for linking disparate systems within the same organization.

website All of the World Wide Web pages maintained by an organization or an individual.

Wi-Fi Stands for "wireless fidelity" and refers to the 802.11 family of wireless networking standards.

wide area network (WAN) Telecommunications network that spans a large geographical distance. May consist of a variety of cable, satellite, and microwave technologies.

wiki Collaborative website where visitors can add, delete, or modify

content, including the work of previous authors.

WiMax Popular term for IEEE Standard 802.16 for wireless networking over a range of up to 31 miles with a data transfer rate of up to 75 Mbps. Stands for Worldwide Interoperability for Microwave Access.

Windows Microsoft family of operating systems for both network servers and client computers.

Windows 10 Most recent Microsoft Windows client operating system.

Wintel PC Any computer that uses Intel microprocessors (or compatible processors) and a Windows operating system.

wireless sensor networks (WSNs) Networks of interconnected wireless devices with built-in processing, storage, and radio frequency sensors and antennas that are embedded into the physical environment to provide measurements of many points over large spaces.

wisdom The collective and individual experience of applying knowledge to the solution of problems.

wisdom of crowds The belief that large numbers of people can make better decisions about a wide range of topics or products than a single person or even a small committee of experts.

World Wide Web A system with universally accepted standards for storing, retrieving, formatting, and displaying information in a networked environment.

worms Independent software programs that propagate themselves to disrupt the operation of computer networks or destroy data and other programs.

zero-day vulnerabilities Security vulnerabilities in software, unknown to the creator, that hackers can exploit before the vendor becomes aware of the problem.

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