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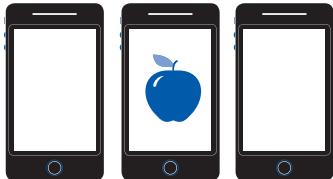
Essentials of MIS

FOURTEENTH EDITION

Kenneth C. Laudon and Jane P. Laudon



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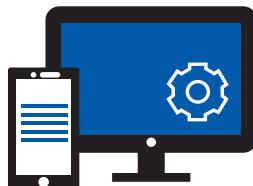
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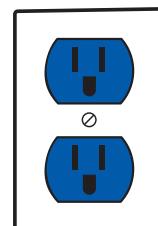
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Integrating Business with Technology

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.

* Dirt Bikes Running Case in MyLabMIS

Business Application Skills

Business Skills	Software Skills	Chapter
Finance and Accounting		
Financial statement analysis	Spreadsheet charts	Chapter 2*
	Spreadsheet formulas	Chapter 10
	Spreadsheet downloading and formatting	
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
Human Resources		
Employee training and skills tracking	Database design	Chapter 12*
	Database querying and reporting	
Manufacturing and Production		
Analyzing supplier performance and pricing	Spreadsheet date functions	Chapter 2
	Data filtering	
	Database functions	
Inventory management	Importing data into a database	Chapter 6
	Database querying and reporting	
Bill of materials cost sensitivity analysis	Spreadsheet data tables	Chapter 11*
	Spreadsheet formulas	
Sales and Marketing		
Sales trend analysis	Database querying and reporting	Chapter 1
Customer reservation system	Database querying and reporting	Chapter 3
Customer sales analysis	Database design	
Marketing decisions	Spreadsheet pivot tables	Chapter 11
Customer profiling	Database design	Chapter 6*
	Database querying and reporting	

Customer service analysis	Database design	Chapter 9
Sales lead and customer analysis	Database querying and reporting	Chapter 12
Blog creation and design	Database design	Chapter 4
	Database querying and reporting	
	Blog creation tool	

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	Chapter 3
Evaluating Web sites for auto sales	
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
Analyzing Web site design	Chapter 12

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

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Essentials of Management Information Systems

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New York University

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Azimuth Information Systems



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The Laudons have two daughters, Erica and Elisabeth.

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Here are some of the business firms you will find described in the cases and Interactive Sessions of this book:

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- PCL Construction: The New Digital Firm
- UPS Competes Globally with Information Technology
- Will AI Kill Jobs?
- New Technology at UPS Clashes with Outdated Ways of Working

Chapter 2: Global E-business and Collaboration

- Enterprise Social Networking Transforms Sharp Corporation into a More Innovative Connected Organization
- Japan Embraces E-governance Tools for Tokyo 2020
- Videoconferencing: Something for Everyone
- Should Companies Embrace Social Business?

Chapter 3: Achieving Competitive Advantage with Information Systems

- N26: A Bank Without Branches
- Singapore as a Smart Nation
- Strategic Information Systems at Hong Kong Disneyland
- Offline, Online, and Back: The Evolution of the UK Grocery Market

Chapter 4: Ethical and Social Issues in Information Systems

- Are Cars Becoming Big Brother on Wheels?
- The Boeing 737 MAX Crashes: What Happened and Why?
- How Harmful Are Smartphones?
- Facebook Privacy: Your Life for Sale

Chapter 5: IT Infrastructure: Hardware and Software

- American Airlines Heads for the Cloud
- Open Source Innovation: The New Competitive Advantage
- Look to the Cloud
- What Should Firms Do About BYOD?

Chapter 6: Foundations of Business Intelligence: Databases and Information Management

- Astro: Leveraging Data for Customer-driven Service
- The Paradise Papers and Big Data Journalism
- DEWA: Evolving Utilities for a Smart City
- Does Big Data Provide the Answer?

Chapter 7: Telecommunications, the Internet, and Wireless Technology

- Tour de France Wins with Wireless Technology
- Singapore Shuts Down 2G Network
- Talking Cars Make for Better Road Safety
- Google, Apple, and Facebook Battle for Your Internet Experience

Chapter 8: Securing Information Systems

- The Electric Power Grid Becomes a Cyberwarfare Battleground
- Meltdown and Spectre Haunt the World's Computers
- Phishing for Money: Dangerous Emails
- Bulgaria: A Whole Nation Hacked

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CRM Helps Adidas Know Its Customers One Shoe Buyer at a Time

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

E-commerce Comes to the Dashboard: The Battle for the “Fourth Screen”

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Chapter 11: Improving Decision Making and Managing Artificial Intelligence

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Predictive Maintenance in the Oil and Gas Industry

Can Cars Drive Themselves—And Should They?

Chapter 12: Making the Business Case for Information Systems and Managing Projects

Angostura Builds a Mobile Sales System

Systems Development Is Different for Mobile Apps

Arup Moves Project Management to the Cloud

Maersk’s TradeLens: Digitizing the Global Supply Chain

Preface

The Global Edition is written for business school students in Europe, the Middle East, South Africa, Australia, and the Pacific Asian region. Case studies and examples focus on how firms in these regions use information systems. We wrote this book for business school students who wanted an in-depth look at how today's business firms use information technologies and systems to achieve corporate objectives. Information systems are one of the major tools available to business managers for achieving operational excellence, developing new products and services, improving decision making, and achieving competitive advantage. Students will find here 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.

When interviewing potential employees, business firms often look for new hires who know how to use information systems and technologies for achieving bottom-line business results. Regardless of whether you are an accounting, finance, management, operations management, marketing, or information systems major, the knowledge and information you find in this book will be valuable throughout your business career.

New To This Edition

Essentials of Management Information Systems, 14th Global edition has been thoroughly updated to cover the latest industry and technology changes that impact the course.

MyLab MIS™

The MyLab MIS platform provides an interactive digital environment that supports the unique strengths of the content. The goal of *Essentials of Management Information Systems* is to provide students and instructors with an authoritative, up-to-date, interactive, and engaging introduction to the MIS field. The MyLab MIS edition extends these features to a digital platform that emphasizes videos, animations, interactive quizzes, and 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 take notes, highlight, and bookmark important content,
- **New Video Cases** collection – 28 video cases (two or more per chapter) and 10 additional instructional videos covering key concepts and experiences in the MIS world. The video cases are written by Ken Laudon and illustrate how real-world corporations and managers are using information technology and systems and are paired with a brief quiz. Video Cases are listed at the beginning of each chapter. (See page 23 for a list of Video Cases available).
- **MIS Decision Simulations** – interactive exercises allowing students to play the role of a manager and make business decisions.
- **Chapter Warm Ups, Chapter Quizzes** – objective-based quizzing to test knowledge.
- **Discussion Questions** – threaded discussion topics taken from the end of chapter.

- **Excel & Access Graded 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 Catalytics™** 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** – 53 Learning Tracks in MyLab MIS for additional coverage of selected topics. This edition includes new Learning Tracks for Structured Methodologies and Object-Oriented Development. (See page 22 for list of Learning Tracks available.)

ENHANCED EBOOK

Essentials of Management Information Systems is also available as a stand-alone eBook which extends the learning experience, anytime and anywhere: The Enhanced eBook includes integrated resources designed to aid learning and engagement, allowing students to read and interact with their textbook content, with regular opportunities for self-assessment. Students can also take notes, highlight, and bookmark important content.

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

NEW AND UPDATED TOPICS

The 14th edition features all new opening, closing, and Interactive Session cases. The text, figures, tables, and cases have been updated through September 2019 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 12 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.
- **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 11. Includes, 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 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 12 (cloud-based systems development).

- **Social, Mobile, Local:** New content in Chapter 10 describing how social tools, mobile technology, and location-based services are transforming e-commerce.
- **Social Business:** Expanded coverage of social business, introduced in Chapter 2 and discussed throughout the text. Detailed discussions of enterprise (internal corporate) social networking as well as social networking in e-commerce.
- Supervised learning
- Unsupervised learning
- Edge computing
- 5G networks
- General Data Protection Regulation (GDPR)
- Mobile device management (MDM)
- Data governance
- Dark web

The Laudon text, MyLab MIS, and Enhanced eBook 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

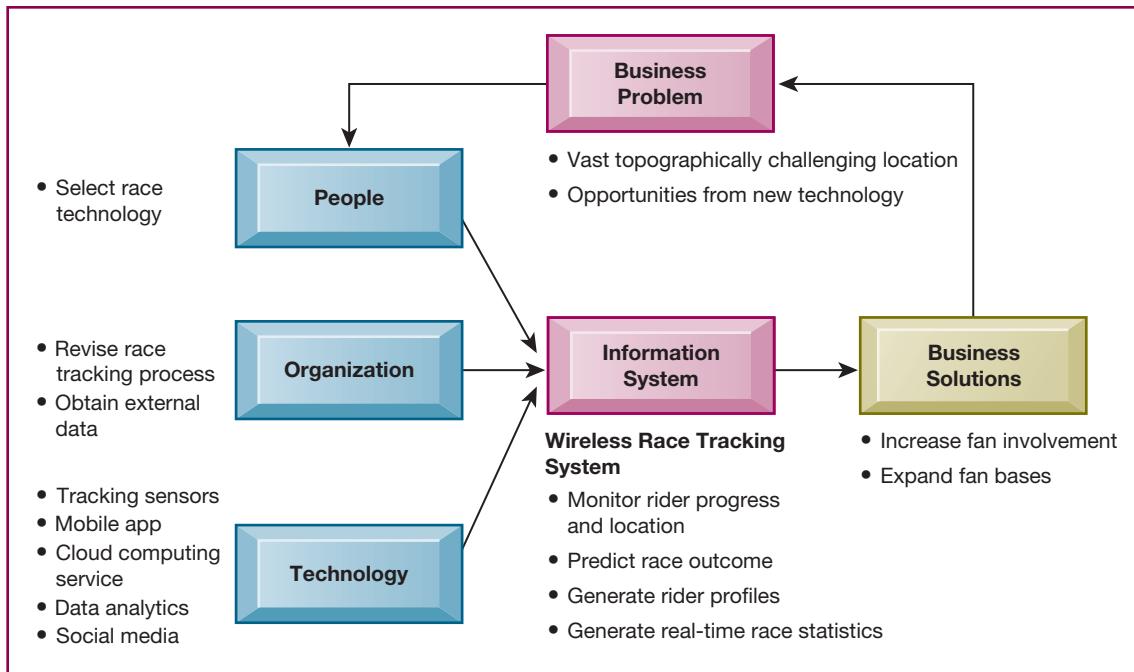
MyLab MIS is the teaching and learning platform that empowers you to reach every student. By combining trusted authors' content with digital tools and a flexible platform, MyLab MIS personalizes the learning experience and improves results for each student. And with MIS Decision-Making Sims and auto-graded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

The MyLab MIS and Enhanced eBook editions offer unique digital interactive features that hold student attention spans longer and make learning more effective, including 36 conceptual animations that walk students through key concepts in each chapter, 28 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 *Essentials* 14e, MyLab MIS, and Enhanced eBook 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.



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

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 people, organization, and technology elements and is reinforced in student projects and case studies. The Core text consists of 12 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: 28 video case studies (two to three per chapter) plus 10 instructional videos that illustrate business uses of information systems, explain new technologies, and explore concepts. Videos are keyed to the topics of each chapter.

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 people, 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 (2019) 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.

Hands-On Text Activities

Real-world business scenarios and data help students 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.
- **Hands-On MIS Projects:** Every chapter concludes with a Hands-On MIS Projects section containing three types of projects: two Management Decision Problems;

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, such as poor function in extreme weather and blind spots, by getting cars to talk to one another. The system allows a vehicle's on-board computer to perform vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) wireless communication—collectively known as vehicle-to-everything (V2X) wireless communication—continuously with other vehicles and with roadside infrastructure (lamp poles and traffic light poles). It collects this information, analyzes it, and then responds automatically or gives instant audio or visual safety information to the driver accordingly.

Using an international vehicular communication standard called dedicated short-range communications (DSRC), ITS Connect allows effective communication within a radius of up to 300 meters at a frequency of 760 MHz. A V2V message in the ITS Connect is quite small in size (36 bytes to 100 bytes) with free fields reserved for service expansion.

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 through the cellular network.

One of the advocates of C-V2X, German-based Continental AG, is a pioneer in applying the technology in automotive parts and has been carrying out field trials in several countries. In late 2018, Continental AG carried out a joint trial of C-V2X in Japan using 5.8 GHz as the experimental radio frequency. The test involved several avoid-collision scenarios; the results showed that the average latency was 20 milliseconds, and throughout the tests the error rate was nearly 0 percent over a distance as long as 1.2 kilometers.

It is believed that V2X will reduce the incidence of 80 percent of traffic accidents, particularly of collisions. In addition, V2X can increase efficiency in coordination of traffic flow through platooning and green wave. 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

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

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

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

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

	Store	Sales Regic	Item I	Item Descrip	Unit Pri	Units So	Week Ending	Click to Add
1	South	2005	17" Monitor	\$229.00	28	10/27/2018		
2	South	2005	17" Monitor	\$229.00	30	11/24/2018		
3	South	2005	17" Monitor	\$229.00	9	12/29/2018		
4	South	3006	101 Keyboard	\$19.95	30	10/27/2018		
5	South	3006	101 Keyboard	\$19.95	35	11/24/2018		
6	South	3006	101 Keyboard	\$19.95	39	12/29/2018		
7	South	6050	PC Mouse	\$8.95	28	10/27/2018		
8	South	6050	PC Mouse	\$8.95	3	11/24/2018		
9	South	6050	PC Mouse	\$8.95	38	12/29/2018		
10	South	8500	Desktop CPU	\$849.95	25	10/27/2018		
11	South	8500	Desktop CPU	\$849.95	27	11/24/2018		
12	South	8500	Desktop CPU	\$849.95	33	12/29/2018		
13	South	2005	17" Monitor	\$229.00	8	10/27/2018		
14	South	2005	17" Monitor	\$229.00	8	11/24/2018		
15	South	2005	17" Monitor	\$229.00	10	12/29/2018		
16	South	3006	101 Keyboard	\$19.95	8	10/27/2018		
17	South	3006	101 Keyboard	\$19.95	8	11/24/2018		
18	South	3006	101 Keyboard	\$19.95	8	12/29/2018		
19	South	6050	PC Mouse	\$8.95	9	10/27/2018		
20	South	6050	PC Mouse	\$8.95	9	11/24/2018		
21	South	6050	PC Mouse	\$8.95	8	12/29/2018		
22	South	8500	Desktop CPU	\$849.95	18	10/27/2018		

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-II** In this exercise, you will use software at car-selling 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 and begin your investigation.

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.

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 *Essentials of Management Information Systems*, 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? Our new Career Opportunities feature shows how to use this text, MyLab MIS, and Enhanced eBook 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. Business Information Systems in Your Career	Financial Client Support and Sales Assistant
2. Global E-business and Collaboration	Entry Level Sales Support Specialist
3. Achieving Competitive Advantage with Information Systems	Entry Level Business Development Representative
4. Ethical and Social Issues in Information Systems	Junior Privacy Analyst
5. IT Infrastructure: Hardware and Software	Entry Level IT Consultant
6. Foundations of Business Intelligence: Databases and Information Management	Global Data Services Sales and Marketing Assistant
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. Improving Decision Making and Managing Artificial Intelligence	AI Technology Sales Assistant
12. Making the Business Case for Information Systems and Managing Projects	IT Project Management Assistant

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	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.
authored by Professor Kenneth Laudon, New York University	AACSB Assessment Guidelines
	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.
	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 e-mail the authors or contact your local Pearson representative for contact information.
Computerized TestGen	TestGen allows instructors to:
	<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	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.
authored by Professor Kenneth Laudon, New York University	PowerPoints meet accessibility standards for students with disabilities. Features include but are not limited to:
	<ul style="list-style-type: none">• Keyboard and Screen Reader access• Alternative text for images• High color contrast between background and foreground colors

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.

Learning Tracks

There are 53 Learning Tracks in MyLab MIS available to instructors and students.

Chapter	Learning Tracks
Chapter 1: Business Information Systems in Your Career	How Much Does IT Matter? The Changing Business Environment for IT The Business Information Value Chain The Mobile Digital Platform Occupational and Career Outlook for Information Systems Majors 2014–2020
Chapter 2: Global E-business and Collaboration	Systems from a Functional Perspective IT Enables Collaboration and Teamwork Challenges of Using Business Information Systems Challenges of Knowledge Management Systems Organizing the Information Systems Function
Chapter 3: Achieving Competitive Advantage with Information Systems	Challenges of Using Information Systems for Competitive Advantage Primer on Business Process Design and Documentation Primer on Business Process Management
Chapter 4: Ethical and Social Issues in Information Systems	Developing a Corporate Code of Ethics for IT
Chapter 5: IT Infrastructure: Hardware and Software	How Computer Hardware and Software Work Service Level Agreements Cloud Computing The Open Source Software Initiative The Evolution of IT Infrastructure Technology Drivers of IT Infrastructure Fourth Generation Languages
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	Broadband Network Services and Technologies Cellular System Generations Wireless Applications for Customer Relationship Management, Supply Chain Management, and Healthcare Introduction to Web 2.0 LAN Topologies
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	SAP Business Process Map Business Processes in Supply Chain Management and Supply Chain Metrics 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 Building an E-commerce Website
Chapter 11: Improving Decision Making and Managing Artificial Intelligence	Building and Using Pivot Tables The Expert Systems Inference Engine Case-Based Reasoning Fuzzy Logic
Chapter 12: 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 Unified Modeling Language Structured Methodologies and Object-Oriented Development

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: Business Information Systems in Your Career	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	Vision X Grows with SAP Business One CEMEX: Becoming a Social Business Instructional Video: US Foodservice Grows Market with Oracle CRM on Demand
Chapter 3: Achieving Competitive Advantage with Information Systems	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? The 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: Hardware and Software	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	Dubuque Uses Cloud Computing and Sensors to Build a Smarter City 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 Instructional Video: GSMS Protects Products and Patients by Serializing Every Bottle of Drugs
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 Instructional Video: Walmart's eCommerce Fulfillment Center Network Instructional Video: Behind the Scenes of an Amazon Warehouse
Chapter 11: Improving Decision Making and Managing Artificial Intelligence	How IBM's Watson Became a Jeopardy Champion Business Intelligence Helps the Cincinnati Zoo Work Smarter
Chapter 12: Making the Business Case for Information Systems and Managing Projects	IBM: Business Process Management in a SaaS Environment IBM Helps the City of Madrid with Real-Time BPM Software Instructional Video: What is PaaS? What is Predix? Instructional Video: BPM: Business Process Management Customer Story

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Essentials of Management Information Systems

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Chapter 1

Business Information Systems in Your Career

Chapter 2

Global E-business and Collaboration

Chapter 3

Achieving Competitive Advantage with Information Systems

Chapter 4

Ethical and Social Issues in Information Systems

Information Systems in the Digital Age

Part I introduces the major themes and the problem-solving approaches that are used throughout this book. While surveying the role of information systems in today's businesses, this part raises a series of major questions: What is an information system? Why are information systems so essential in businesses today? How can information systems help businesses become more competitive? What do I need to know about information systems to succeed in my business career? What ethical and social issues do widespread use of information systems raise?

Business Information Systems in Your Career

LEARNING OBJECTIVES

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

- I-1 Why are information systems so essential for running and managing a business today?
- I-2 What exactly is an information system? How does it work? What are its people, organizational, and technology components?
- I-3 How will a four-step method for business problem solving help you solve information system-related problems?
- I-4 What information systems skills and knowledge are essential for business careers?
- I-5 How will MIS help my career?

CHAPTER CASES

- PCL Construction: The New Digital Firm
- UPS Competes Globally with Information Technology
- Will AI Kill Jobs?
- New Technology at UPS Clashes with Outdated Ways of Working

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: 1-5, 1-6, 1-7
- Hands-on MIS Projects: 1-8, 1-9, 1-10, 1-11

PCL CONSTRUCTION: THE NEW DIGITAL FIRM

Many people think the most widely used tool in a construction project is a hammer, but it is more likely a filing cabinet or fax machine. The construction industry has traditionally been paper-intensive and manual. A complex project such as a large building requires hundreds of architectural drawings and design documents, which can change daily. Costly delays because of difficulty locating and accessing documents and other project information could make or break a project. Now that's changing, and PCL Construction is at the forefront. Information technology has transformed the way this business works, and it is a prime example of the new digital firm.

PCL is a group of independent general contracting construction companies, with over 4,400 employees in the United States, Canada, and Australia. The organization is active in the commercial, institutional, multifamily residential, renewable energy, heavy industrial, historical restoration, and civil-construction sectors. PCL has corporate headquarters in Edmonton, Alberta, Canada and a United States head office in Denver, Colorado.

At a PCL job site, you'll now see employees using mobile devices, including smartphones, tablets, and laptops, to access important information from PCL systems or input data. Digital touch-screen kiosks throughout the job site and electronic plan rooms provide access to digitized, updated blueprints so team members don't have to waste time tracking down paper versions.

In the past, on-site trailers used to house large paper blueprints for a project. Each time a project team member wanted to view plans, that person had to visit a trailer. With up to 800 active construction projects running simultaneously, PCL had trouble keeping project documentation up to date. Information on paper forms to track small changes to project specifications or work requirements might not reach project decision makers until 30–40 days from the time it was recorded. By then, it was too late—decisions were made “from the gut” rather than based on facts.

PCL Construction plans are now in digital form, or the paper versions are scanned for digital storage. Digitized plans can be revised much more rapidly. By performing much of the design and planning work on the computer, PCL is able to identify and resolve conflicts and constructability issues early in the construction process to help keep projects ahead of schedule and within budget.

PCL implemented Project Document Controls (PDC) to facilitate collaboration among project team members. A secure project-based website provides real-time storage and management of information in a single shared accessible



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location. Construction contractors, subcontractors, consultants, suppliers, and clients can work from the same documents wherever they are. PCL uses its own proprietary project management system for budgeting, costing, forecasting, subcontractor tracking, production, and reporting. The project management system is linked to other PCL systems, including the People and Projects database, client management and accounting systems, and the BEST Estimating system. BEST Estimating is PCL's in-house estimating program for creating lump sum and unit price estimates and providing accurate resource and cost information.

PCL started moving its computing work to Microsoft Azure Cloud, which hosts the hardware and software for running some of PCL's applications in remote computing centers managed by Microsoft. Staff working on PCL projects can access information from cloud-based systems at any time and location using mobile devices as well as conventional desktop machines and an Internet connection. PCL saves 80 percent of the cost of backing up its corporate data by using the Azure platform. Azure Cloud also hosts a real-time analytics dashboard to monitor project performance in terms of quality, safety, schedule, and cost. The data are displayed visually as bar graphs or pie charts to construction field staff, project managers, and executives, and colors ranging from red to orange to green display performance ratings.

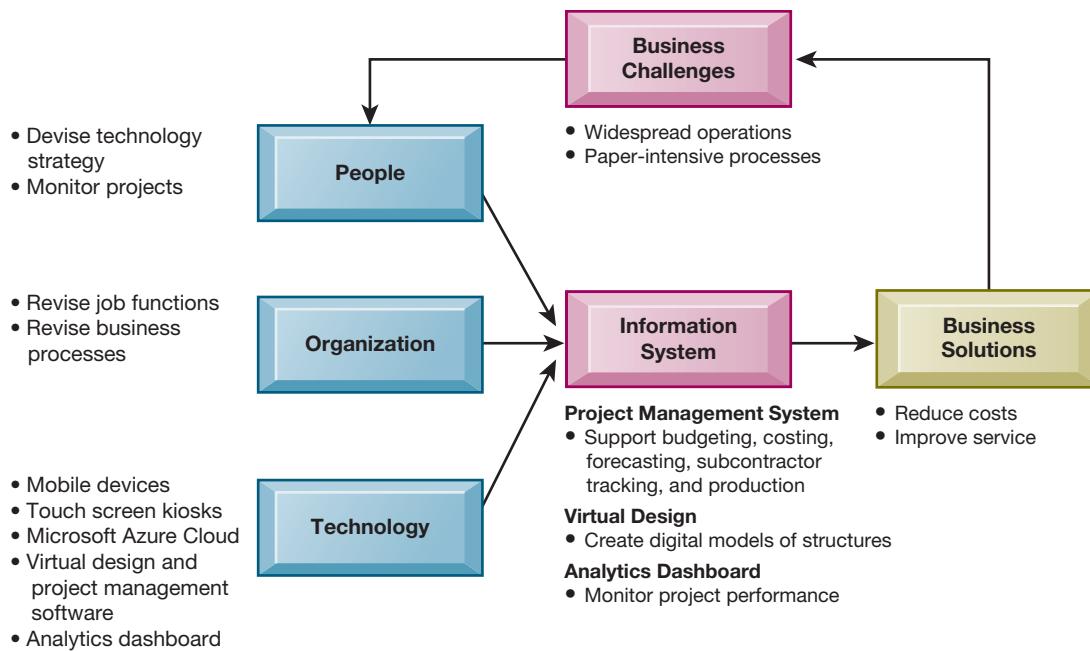
Sources: "Technology and Innovation," pcl.com, accessed February 9, 2019; "PCL: Capitalizing on the Cloud," itworldcanada.com, accessed February 9, 2019; Brian Jackson, "PCL Constructors Reach New Heights with Real-time Analytics Solution in the Cloud," *IT World Canada*, November 9, 2017.

PCL Construction's experience shows how essential information systems are today. PCL operates construction projects in numerous distributed locations in an industry that traditionally has been paper-intensive. Processing and accessing the large number of documents and other information required by construction projects was excessively costly and time-consuming, driving up costs. PCL used leading-edge information technology to digitize documents and streamline business processes for documenting, tracking, and analyzing projects. The information flows that drive PCL's business have become largely digital, making use of mobile tools and a cloud computing infrastructure. PCL Construction has become a leading example of a digital firm.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. To reduce time and costs and improve customer service in a heavily paper-based industry, PCL management chose to use information technology to increase the precision and efficiency of key business activities for designing, costing, budgeting, and monitoring a construction project. These technologies include mobile devices (phones, tablets, laptops), touch screen kiosks, cloud computing services, the Internet, and software for creating models, managing documents, monitoring project progress, budgeting, estimating costs, and displaying key project performance indicators on a digital dashboard. 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 PCL Construction runs its business. To effectively use all of its new digital tools, PCL had to redesign jobs and procedures for gathering, inputting, and accessing information, for designing, budgeting, and calculating costs, and for monitoring project progress. These changes had to be carefully planned to make sure they enhanced efficiency, service, and profitability.

Here are some questions to think about: How did information technology change operations at PCL Construction? What was the role of mobile technology and cloud computing?



I-1 Why are information systems so essential for running and managing a business today?

It's not business as usual in America, or the rest of the global economy, anymore. In 2018, American businesses invested nearly \$1 trillion in information systems hardware, software, and telecommunications equipment—about 33 percent of all capital investment in the United States. In addition, they spent another \$143 billion on business and management consulting and information technology services, much of which involves redesigning firms' business operations to take advantage of these new technologies. Together, investments in technology and management consulting grew at around 3.5 percent in 2018, far faster than the economy as a whole (Bureau of Economic Analysis, 2018). Worldwide, non-US expenditures for information technology exceeded \$3.8 trillion in 2019 (Gartner, Inc., 2019).

HOW INFORMATION SYSTEMS ARE TRANSFORMING BUSINESS

You can see the results of this spending around you every day. Cell phones, smartphones, tablet computers, email, and online conferencing over the Internet have all become essential tools of business. Worldwide, 4.3 billion people are online, more than half of the world's population (Internet World Stats, 2019). What this means is that if you and your business aren't connected to the Internet and mobile apps, chances are you are not being as effective as you could be (eMarketer, 2019; Pew Internet and American Life, 2019).

In 2018 FedEx moved more than 1 billion packages worldwide, mostly overnight, and United Parcel Service (UPS) moved more than 5 billion packages as businesses sought to sense and respond to rapidly changing customer demand, reduce inventories to the lowest possible levels, and achieve higher levels of operational efficiency. Amazon delivered more packages than both FedEx and UPS combined. The growth of e-commerce has had a significant impact on UPS's shipping volume; UPS delivers about 45 percent of all e-commerce shipments, representing about 25 percent of its revenue. Supply chains have become faster paced, with companies of all sizes depending on the delivery of just-in-time inventory to

help them compete. Companies today manage their inventories in near real time to reduce their overhead costs and get to market faster. If you are not part of this new supply chain management economy, chances are your business is not as efficient as it could be.

Print newspaper readership continues to decline, but more than 200 million people read at least some news online, and 180 million read actual newspapers online, with digital newspaper subscriptions growing at 10 percent annually. Two hundred-twenty million used a social networking site such as Facebook, Tumblr, or Pinterest. More than 160 million banked online, and about 85 million read blogs, creating an explosion of new writers, readers, and new forms of customer feedback that did not exist before. At 39 of the top 50 news sites, 60 percent of the visitors came from mobile devices. Adding to this mix of new social media, about 325 million people worldwide used Twitter (about 126 million in the United States), including 80 percent of *Fortune* 500 firms communicating with their customers. This means your customers are empowered and able to talk to each other about your business products and services. Do you have a solid online customer relationship program in place? Do you know what your customers are saying about your firm? Is your marketing department listening?

E-commerce and Internet advertising spending reached \$105 billion in 2018, growing at about 15 percent at a time when traditional advertising and commerce have been flat. Facebook's ad revenue hit \$55 billion in 2018, and Google's online ad revenues surpassed \$116 billion. Is your advertising department reaching this new web and mobile customer?

Federal security and accounting laws require many businesses to keep email messages for five years. Coupled with existing occupational and health laws requiring firms to store employee chemical exposure data for up to 60 years, these laws are spurring the growth of digital information now estimated to be 4.7 zettabytes (4.7 trillion gigabytes), equivalent to more than 60,000 Libraries of Congress. This trove of information is doubling every year thanks in part to more than 200 billion Internet-linked sensors and data generators. Does your compliance department meet the minimal requirements for storing financial, health, and occupational information? If it doesn't, your entire business may be at risk.

Briefly, it's a new world of doing business, one that will greatly affect your future business career. Along with the changes in business come changes in jobs and careers. No matter whether you are a finance, accounting, management, marketing, operations management, or information systems major, how you work, where you work, and how well you are compensated will all be affected by business information systems. The purpose of this book is to help you understand and benefit from these new business realities and opportunities.

KEY CHALLENGES IN MANAGEMENT INFORMATION SYSTEMS

What makes management information systems the most exciting topic in business today is the continual change in technology, management use of the technology, and the impact on business success. New start-up firms arrive in traditional industries using the latest technologies and business models. These changes present challenges to all business managers who need to decide how to adapt their firm to new developments. What are the benefits and costs of these new developments in hardware, software, and business practice?

Table 1.1 summarizes the major challenges in business uses of information systems. These challenges confront all managers, not just information systems professionals. These challenges will appear throughout the book in many chapters, so it might be a good idea to take some time now to discuss them with your professor and classmates.

TABLE I.I

Keys Challenges in MIS

Change	Management Challenge
Technology	
Cloud computing platform emerges as a major business area of innovation.	A flexible collection of computers on the Internet begins to perform tasks traditionally performed at corporate data centers. Major business applications can be delivered online as an Internet service (software as a service [SaaS]). What are the costs and benefits of cloud computing and how much of the firm's IT infrastructure should be moved to cloud providers?
Big Data and the Internet of Things (IoT)	Businesses look for insights in huge volumes of data from web traffic, email messages, social media content, and Internet-connected machines (sensors). More powerful data analytics and interactive dashboards can provide real-time performance information to managers to enhance decision making. Does our firm have the ability to analyze and use Big Data and analytics? How can we use IoT to provide better products and services?
Artificial Intelligence (AI)	Computer programs can find patterns in large databases that can help managers understand their business, and provide better products. Where could we use AI and where can we find the expertise? What benefits can we expect? How much will it cost?
The mobile platform	Business and personal computing is increasingly moving to smartphones, high-definition tablet computers, car infotainment systems, and wearable devices. These mobile devices can use thousands of applications to support collaboration, coordination of work, communication with colleagues and customers, and online purchases. Over 90 percent of Internet users access the web with mobile devices. Are we making the best use of mobile capabilities for our employees and customers? Where could we improve? What are the costs and benefits?
Management and People	
Return on investment (ROI)	Although firms spend millions on information systems and services, they typically have little understanding of how much benefit they receive. How can we measure and understand the benefit we are receiving from IS/IT expenditures? Are there alternative sources of these services that would cost less?
Online collaboration and social networking	Millions of business professionals use Google Apps, Google Drive, Microsoft Office 365, Yammer, Zoom, and IBM Connections to support blogs, project management, online meetings, personal profiles, and online communities. Is our firm making a coordinated effort to use new technologies to improve coordination, collaboration, and knowledge sharing? Which of the many alternatives should we be using?
Organizations	
Security and privacy	Security lapses and protecting customer privacy are major public issues that affect all businesses. How do we know our data are secure? How much do we spend on security now? What privacy policies do we have in place, and how should we expand our privacy protections as new laws emerge?
Social business	Businesses use social networking platforms, including Facebook, Twitter, Instagram, and internal corporate social tools, to deepen interactions with employees, customers, and suppliers. What use are we making of social business tools? Where should we go from here? Are we getting real value from these platforms?
Telework gains momentum in the workplace.	The Internet, cloud computing, smartphones, and tablet computers make it possible for growing numbers of people to work away from the traditional office. Forty-three percent of employed Americans reported spending some time working remotely and doing so for longer times. Are we taking advantage of telework, and what are the risks of telework for productivity?

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 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 2018, an estimated 30 percent of the US economy resulted from foreign trade of goods and services, both imports and exports. In Europe and Asia, the number exceeds 50 percent. 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 2018 came from overseas sales of its microprocessors. Eighty percent of the toys sold in the United States are manufactured in China; about 90 percent of the PCs manufactured in China use American-made Intel or Advanced Micro Design (AMD) chips.

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. In the past 15 years, the United States has lost an estimated 2.5 million manufacturing jobs to offshore, low-wage producers, so manufacturing is now a small part of US employment (less than 12 percent) even though it accounts for \$2.1 trillion of GDP. 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. You can learn how to profit from the lower costs available in world markets and the chance to serve a marketplace with billions of customers. You have the opportunity to develop higher-level and more profitable products and services. 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? The answer is 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 Amsterdam, is now instant and virtually free. Customers now can 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, can replicate their business models and services in multiple countries without having to redesign their expensive, fixed-cost information systems infrastructure.

BUSINESS DRIVERS OF INFORMATION SYSTEMS

What makes information systems so essential today? Why are businesses investing so much in information systems and technologies? They do so to achieve six important 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 to achieve higher profitability. Information systems and technologies are some of the most important tools available to managers for achieving higher 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 sophisticated business practices and supportive management to achieve world-class operational efficiency. In 2019, Walmart achieved more than \$514 billion in sales worldwide—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 11,666 stores worldwide. 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 its industry, achieving sales of more than \$600 per square foot compared to its closest competitor, Target, at \$300 a square foot.

Amazon, the largest online retailer on earth, generating more than \$232 billion in global sales in 2018, invested \$2.1 billion in information systems so that when one of its estimated 300 million users searches for a product, Amazon can respond in milliseconds with the correct product displayed (and recommendations for other products).

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 download distribution model based on its own operating system and iTunes store. Apple has prospered from a continuing stream of innovations, including the original iPod, iTunes music service, iPhone, and iPad.

Customer and Supplier Intimacy

When a business really knows its customers and serves them well, the way they want to be served, 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 really to know your customers, or suppliers, is a central problem for businesses with millions of offline and online customers.

The Mandarin Oriental and other high-end hotels exemplify the use of information systems and technologies to achieve customer intimacy. These hotels use information systems 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 giant data repository. Individual rooms in the hotels

are networked to a central network server so that they can be remotely monitored or 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 develop individualized marketing campaigns based on customers' preferences.

JCPenney exemplifies the benefits of information systems-enabled supplier intimacy. Every time a dress shirt is bought at a JCPenney store in the United States, the record of the sale appears immediately on computers in Hong Kong at TAL Apparel Ltd., a giant contract manufacturer that produces one in eight dress shirts sold in the United States. TAL runs the numbers through a computer model it developed and decides how many replacement shirts to make and in what styles, colors, and sizes. TAL then sends the shirts to each JCPenney store, completely bypassing the retailer's warehouses. In other words, JCPenney's surplus shirt inventory is near zero, as is the cost of storing it.

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. Information systems and technologies have now made it possible for managers to use real-time data from the marketplace when making decisions.

For instance, Verizon Communications, one of the largest telecommunications operating companies in the United States, uses a web-based digital dashboard to provide managers with precise real-time information on customer complaints, network performance for each locality served, and line outages or storm-damaged lines. Using this information, managers can immediately allocate repair resources to affected areas, inform consumers of repair efforts, and restore service fast.

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 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 Citibank introduced the first automated teller machines (ATMs) in the New York region to attract customers through higher service levels, its competitors rushed to provide ATMs to their customers to keep up with Citibank. Today, virtually all large global banks have regional ATMs and link to national and international ATM networks, such as CIRRUS. Providing ATM services to retail banking customers is simply a requirement of being in and surviving in the retail banking business.

Many nations have statutes and regulations that create a legal duty for companies and their employees to retain records, including digital records. For instance, the Toxic Substances Control Act (1976), which regulates the exposure of US workers to more than 75,000 toxic chemicals, requires firms to retain records on employee exposure

for 30 years. The Sarbanes–Oxley Act (2002), which was intended to improve the accountability of public firms and their auditors, requires public companies to retain audit working papers and records, including all email messages, for five years. Firms turn to information systems and technologies to provide the capability to respond to these information retention and reporting requirements. The Dodd–Frank Act (2010) requires financial service firms to expand their public reporting greatly on derivatives and other financial instruments. Financial regulatory authorities in Europe, Japan, India, and China have similar information management requirements.

I-2 What exactly is an information system? How does it work? What are its people, organizational, and technology components?

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 to achieve its business objectives. This includes not only computers, storage technology, and mobile handheld 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 understood best by looking at them from both a technology and a business perspective.

WHAT IS AN INFORMATION SYSTEM?

An **information system (IS)** can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making, coordinating, and control in an organization. In addition, 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.

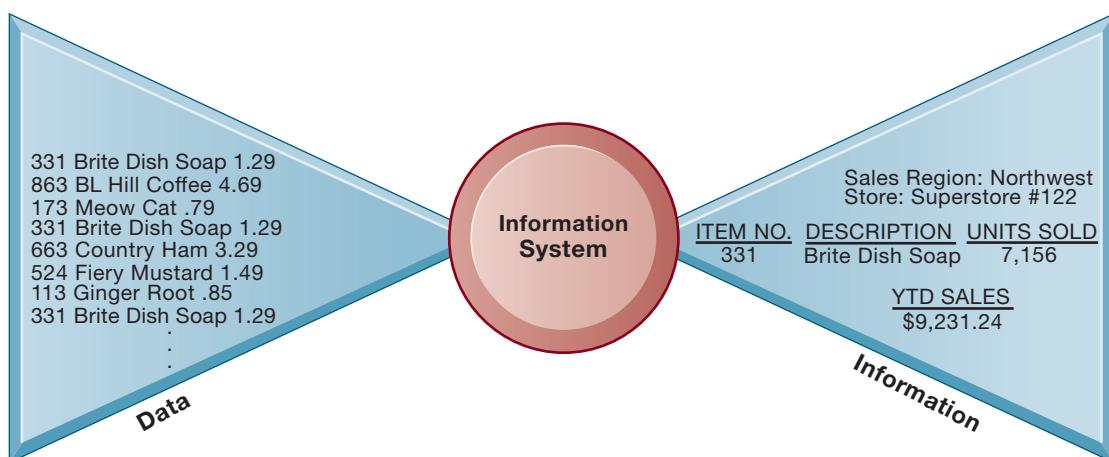


Figure I.1
Data and Information

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, such as bar codes, that describe the 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 1.1).

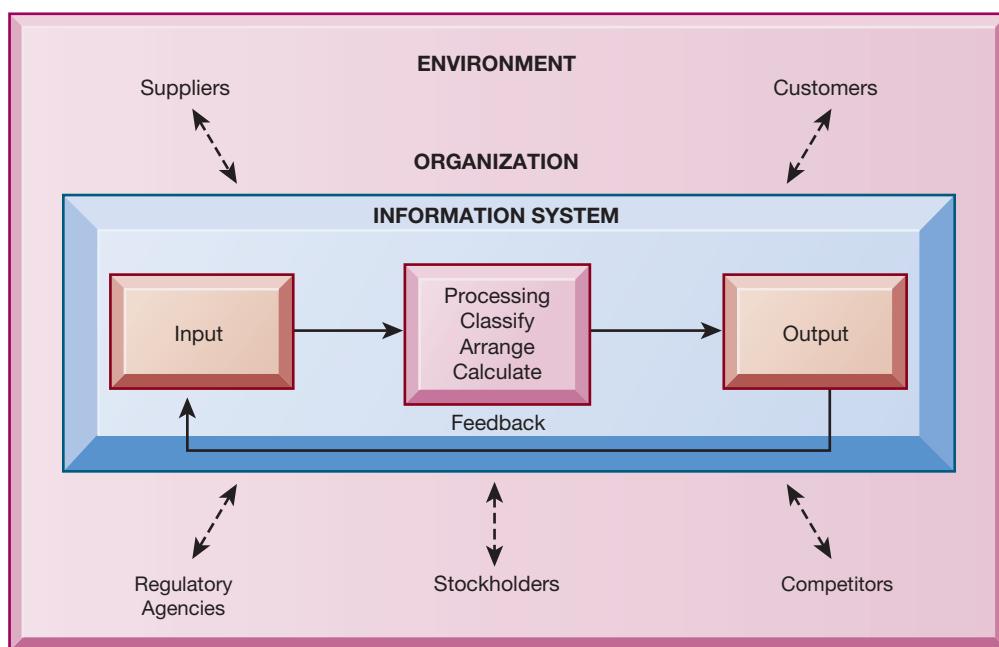
Three activities in an information system produce the information that organizations need to make decisions, control operations, analyze problems, and create new products or services. These activities are input, processing, and output (see Figure 1.2). **Input** captures or collects raw data from within 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 PCL's project management system, input includes the names and addresses of contractors and subcontractors, project names and identification numbers, project activities, labor costs, materials costs, and start and completion dates for project activities. Computers store these data and process them to calculate how much each project activity and the entire project will cost and estimated completion time. The system provides meaningful information such as the size, cost, and duration of all projects under PCL management, projects over and under budget, and projects and project activities that are late or on time.

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

Figure 1.2
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.



A house is an appropriate analogy. Houses are built with hammers, nails, and wood, but these alone 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 hammer, 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 these solutions.

IT ISN'T SIMPLY TECHNOLOGY: THE ROLE OF PEOPLE AND ORGANIZATIONS

To understand information systems fully, you will need to be aware of the broader organization, people, and information technology dimensions of systems (see Figure 1.3) 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 people and organizational dimensions of systems as well as the technical dimensions of systems, as **information systems literacy**. Information systems literacy includes a behavioral as well as a technical approach to studying information systems. **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 that managers and employees in the firm use.

DIMENSIONS OF INFORMATION SYSTEMS

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

Organizations

Information systems are an integral part of organizations and, although we tend to think about information technology changing organizations and business firms, it is, in fact, a two-way street. The history and culture of business firms also affects how the technology is used and how it should be used. To understand how a specific business firm uses information systems, you need to know something about the structure, history, and culture of the company.

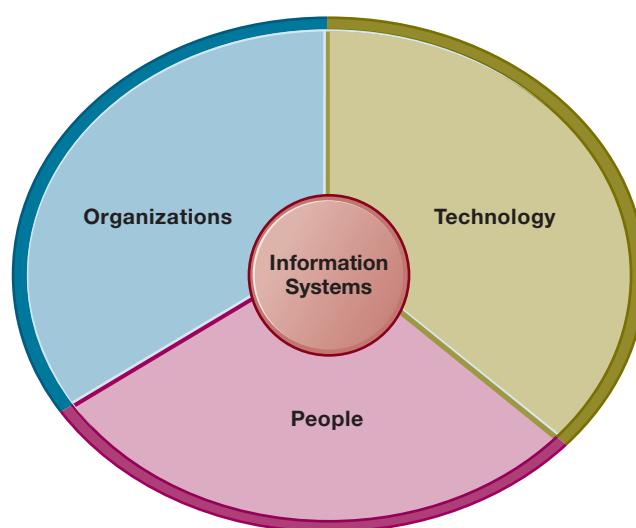


Figure I.3
Information Systems Are More Than Computers
Using information systems effectively requires an understanding of the organization, people, and information technology shaping the systems. An information system provides a solution to important business problems or challenges facing the firm.

Organizations have a structure that is composed of different levels and specialties. Their structures reveal a clear-cut division of labor. A business firm is organized as a hierarchy, or a pyramid structure, of rising authority and responsibility. The upper levels of the hierarchy consist of managerial, professional, and technical employees, whereas the lower levels consist of operational personnel. Experts are employed and trained for different business functions, such as sales and marketing, manufacturing and production, finance and accounting, and human resources. The firm builds information systems to serve these different specialties and levels of the firm. Chapter 2 provides more detail on these business functions and organizational levels and the ways in which information systems support them.

An organization accomplishes and coordinates work through this structured hierarchy and through its **business processes**, which are logically related tasks and behaviors for accomplishing work. Developing a new product, fulfilling an order, and hiring a new employee are examples of business processes.

Most organizations' business processes include formal rules that 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. Parts of an organization's culture can always be found embedded in its information systems. For instance, the United Parcel Service's concern with placing service to the customer first is an aspect of its organizational culture that can be found in the company's package tracking systems.

Different levels and specialties in an organization create different interests and points of view. These views often conflict. 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.

People

A business is only as good as the people who work there and run it. Likewise with information systems, they are useless without skilled people to build and maintain them or people who can understand how to use the information in a system to achieve business objectives.

For instance, a call center that provides help to customers by using an advanced customer relationship management system (described in later chapters) is useless if employees are not adequately trained to deal with customers, find solutions to their problems, and leave the customer feeling that the company cares for them. Likewise, employee attitudes about their jobs, employers, or technology can have a powerful effect on their abilities to use information systems productively.

Business firms require many kinds of skills and people, including managers as well as rank-and-file employees. The job of managers is to make sense out of the many situations organizations face, 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.

However, 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 develop novel solutions to a broad range of problems.

As you will learn throughout this text, technology is relatively inexpensive today, but people are very expensive. Because people are the only ones capable of business problem solving and converting information technology into useful business solutions, we spend considerable effort in this text looking at the people dimension of information systems.

Technology

Information technology is one of many tools managers use to cope with change and complexity. **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; various input, output, and storage devices; and networking devices that link computers.

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 firms use 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**, 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 performing other interorganizational work. For most business firms today, using Internet technology is a business necessity and a competitive advantage.

The **World Wide Web** is a service the Internet provides 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 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.

All 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 information technology infrastructure so that it has the set of technology services it needs for the work it wants to accomplish with information systems. Chapters 5, 6, 7, and 8 of this text examine each major technology component of information technology infrastructure and show how they all work together to create the technology platform for the organization.

United Parcel Service (UPS) started out in 1907 in a closet-sized basement office. Jim Casey and Claude Ryan—two teenagers from Seattle with two bicycles and one phone—promised the “best service and lowest rates.” UPS has used this formula successfully for more than a century to become the world’s largest ground and air package-delivery company. It’s a global enterprise with more than 454,000 employees and over 119,000 delivery vehicles.

Today UPS delivers 5.1 billion packages and documents in more than 220 countries and territories. The firm has been able to maintain leadership in small-package delivery services despite stiff competition from FedEx and the US Postal Service by investing heavily in advanced information technology. UPS spends more than \$1 billion each year to maintain a high level of customer service while keeping costs low and streamlining its overall operations.

It all starts with the scannable bar-coded label attached to a package, which contains detailed information about the sender, the destination, and when the package should arrive. Customers can download and print their own labels using special software provided by UPS or by accessing the UPS website. Before the package is even picked up, information from the “smart” label is transmitted to one of UPS’s computer centers in Mahwah, New Jersey, or Alpharetta, Georgia, and sent to the distribution center nearest its final destination.

Dispatchers at this center download the label data and use special routing software called ORION to create the most efficient delivery route for each driver that considers traffic, weather conditions, and the location of each stop. Each UPS driver makes an average of 100 stops per day. In a network with 55,000 routes in the United States alone, shaving even one mile off each driver’s daily route translates into big savings in time, fuel consumption, miles driven, and carbon emissions—as much as \$400 million per year.

These savings are critical as UPS tries to boost earnings growth as more of its business shifts to less-profitable e-commerce deliveries. UPS drivers who used to drop off several heavy packages a day at one retailer now often make multiple stops scattered across residential neighborhoods, delivering one package per household. The shift requires more fuel and more time, increasing the cost to deliver each package.

The first thing a UPS driver picks up each day is a handheld computer called a Delivery Information Acquisition Device (DIAD), which can access a wireless cell phone network. As soon as the driver logs on, his or her day’s route is downloaded onto the handheld. The DIAD also automatically captures customers’ signatures along with pickup and delivery information. Package tracking information is then transmitted to UPS’s computer network for storage and processing. From there, the information can be accessed worldwide to provide proof of delivery to customers or to respond to customer queries. It usually takes less than 60 seconds from the time a driver presses “complete” on the DIAD for the new information to be available on the web.

Through its automated package tracking system, UPS can monitor and even reroute packages throughout the delivery process. At various points along the route from sender to receiver, bar code devices scan shipping information on the package label and feed data about the progress of the package into the central computer. Customer service representatives are able to check the status of any package from desktop computers linked to the central computers and respond immediately to inquiries from customers. UPS customers can also access this information from the company’s website using their own computers or mobile phones. UPS now has mobile apps and a mobile website for iPhone, BlackBerry, and Android smartphone users.

Anyone with a package to ship can access the UPS website to track packages, check delivery routes, calculate shipping rates, determine time in transit, print labels, and schedule a pickup. The data collected at the UPS website are transmitted to the UPS central computer and then back to the customer after processing. UPS also provides tools that enable customers, such as Cisco Systems, to embed UPS functions, such as tracking and cost calculations, into their own websites so that they can track shipments without visiting the UPS site.

UPS is now leveraging its decades of expertise managing its own global delivery network to manage logistics and supply chain activities for other companies. It created a UPS Supply Chain Solutions division that provides a complete bundle of standardized services to subscribing companies at a fraction of what it would cost to build their own systems and infrastructure. These services include supply chain design and management,

freight forwarding, customs brokerage, mail services, multimodal transportation, and financial services in addition to logistics services.

UPS technology and business services are helpful to businesses of all sizes, including small startups. Fondarific is a Savannah-based company that manufactures and sells fondant icings for decorating wedding cakes and children's cakes. UPS made it possible for Fondarific to grow rapidly when international sales took off. UPS set up a class in exporting to teach Fondarific how to manage international sales and logistics and how to use its WorldShip global shipping software for UPS package and freight services. UPS also showed the company how to integrate shipping systems with Quickbooks accounting software and inventory software.

UPS provides both financial and shipping advice and services to 4Moms, a Pittsburgh-headquartered company with 80 employees that makes innovative baby products using consumer technology. 4Moms uses UPS Trade Direct, which enables companies to reduce freight and inventory costs by bypassing distribution centers and shipping their goods directly to retailers. The UPS Cargo Finance service helps 4Moms manage the cost of inventory as it is shipped around the world.

Sources: Bloomberg, "UPS Sees Payoff From \$20Bn Tech Bet, SupplyChainBrain," April 24, 2019; www.ups.com, accessed February 7, 2019; Shefali Kapadia, "Company of the Year: UPS," *Supply Chain Dive*, December 3, 2018; and Haylie Sok, "UPS Technology to Save \$75 Million per Year in 2020," *Global Trade*, December 25, 2018.

CASE STUDY QUESTIONS

- 1.** What are the inputs, processing, and outputs of UPS's package tracking system?
- 2.** What technologies are used by UPS? How are these technologies related to UPS's business strategy?
- 3.** What strategic business objectives do UPS's information systems address?
- 4.** What would happen if UPS's information systems were not available?

The Interactive Session on Technology describes some of the typical technologies used in computer-based information systems today. 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 pieces of software for tracking packages, calculating fees, maintaining customer accounts, and managing logistics. As you read this case, try to identify the problem this company was facing, what alternative solutions were available to management, and how well the chosen solution worked.

Let's identify the organization, people, and technology elements in the UPS package tracking system we have just described. 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 automation to increase the ease of sending a package via 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, wired and wireless communications networks, desktop computers, UPS's central computer, 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.

I-3 How will a four-step method for business problem solving help you solve information system-related problems?

Our approach to understanding information systems is to consider information systems and technologies as solutions to a variety of business challenges and problems. We refer to this as a problem-solving approach. Businesses face many challenges and problems, and information systems are one major way of solving these problems. All the cases in this book illustrate how a company used information systems to solve a specific problem.

The problem-solving approach has direct relevance to your future career. Your future employers will hire you because you can solve business problems and achieve business objectives. Your knowledge of how information systems contribute to problem solving will be very helpful to both you and your employers.

THE PROBLEM-SOLVING APPROACH

At first glance, problem solving in daily life seems to be perfectly straightforward; a machine breaks down, parts and oil spill all over the floor, and, obviously, somebody has to do something about it. So, of course, you find a tool around the shop and start repairing the machine. After a cleanup and proper inspection of other parts, you start the machine, and production resumes.

No doubt, some problems in business are this straightforward, but few problems are this simple in the real world of business. In real-world business firms, a number of major factors are simultaneously involved in problems. These major factors can usefully be grouped into three categories: *organization*, *technology*, and *people*. In other words, a whole set of problems is usually involved.

A MODEL OF THE PROBLEM-SOLVING PROCESS

There is a simple model of problem solving that you can use to help you understand and solve business problems by using information systems. You can think of business problem-solving as a four-step process (see Figure 1.4). Most problem solvers work through this model on their way to finding a solution. Let's take a brief look at each step.

Problem Identification

The first step in the problem-solving process is to understand what kind of problem exists. Contrary to popular beliefs, problems are not like basketballs on a court simply waiting to be picked up by some objective problem solver. Before problems can be solved, there must be agreement in a business that a problem exists, about what the problem is, about its causes, and about what can be done about it, given the limited resources of the organization. Problems have to be properly defined by people in an organization before they can be solved.

For instance, what at first glance what might seem like a problem with employees not adequately responding to customers in a timely and accurate manner might in reality be a result of an older, out-of-date information system for keeping track of customers; or it might be a combination of both poor employee incentives for treating

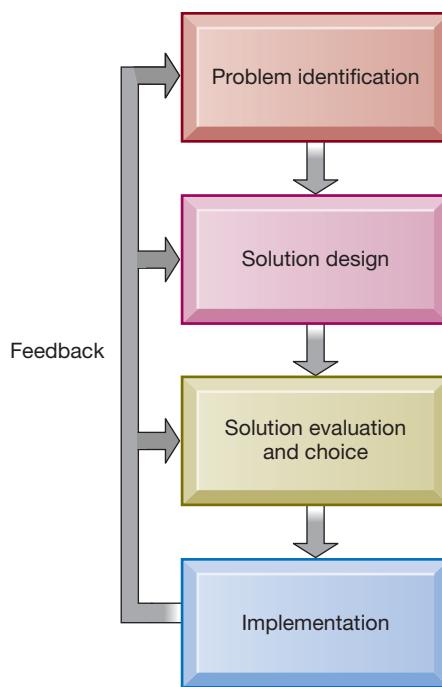


Figure I.4
Problem Solving Is a Continuous Four-Step Process

During implementation and thereafter, the outcome must be continually measured, and the information about how well the solution is working is fed back to the problem solvers. In this way, the identification of the problem can change over time, solutions can be changed, and new choices can be made, all based on experience.

customers well and an outdated system. Once you understand this critical fact, you can start to solve problems creatively. Finding answers to these questions will require fact gathering, interviews with people involved in the problem, and analysis of documents and data.

In this text, we emphasize three different and typical dimensions of business problems: organizations, technology, and people (see Table 1.2). Typical organizational problems include poor business processes (usually inherited from the past), unsupportive culture, political infighting, and changes in the organization's surrounding environment. Typical technology problems include insufficient or aging hardware, outdated software, inadequate database capacity, insufficient network capacity, and the incompatibility of old systems with new technology. Typical people problems include employee training, difficulties of evaluating performance, legal and regulatory compliance, ergonomics, poor or indecisive management, and employee support and participation. When you begin to analyze a business problem, you will find these dimensions are helpful guides to understanding the kind of problem with which you are working.

Solution Design

The second step is to design solutions to the problem(s) you have identified. As it turns out, there are usually a great many solutions to any given problem, and the choice of solution often reflects the differing perspectives of people in an organization. You should try to consider as many solutions as possible so that you can understand the range of possible solutions. Some solutions emphasize technology; others focus on change in the organization and people aspects of the problem. As you will find throughout the text, most successful solutions result from an integrated approach in which changes in organization and people accompany new technologies.

Solution Evaluation and Choice

Choosing the best solution for your business firm is the next step in the process. Some of the factors to consider when trying to find the best single solution are the cost of the solution, the feasibility of the solution for your business given existing resources and skills, and the length of time required to build and implement the solution. Also very important at this point are the attitudes and support of your employees and

TABLE 1.2

Dimensions of Business Problems

Dimension	Description
Organizational dimensions	Outdated business processes Unsupportive culture and attitudes Political conflict Turbulent business environment, change Complexity of task Inadequate resources
Technology dimensions	Insufficient or aging hardware Outdated software Inadequate database capacity Insufficient network capacity Incompatibility of old systems with new technology Rapid technological change and failure to adopt new technology
People dimensions	Lack of employee training Difficulties of evaluating performance Legal and regulatory compliance Work environment Lack of employee support and participation Indecisive management Poor management Wrong incentives

managers. A solution that does not have the support of all the major interests in the business can quickly turn into a disaster.

Implementation

The best solution is one that can be implemented. Implementation of an information system solution involves building the solution and introducing it into the organization. This includes purchasing or building the software and hardware—the technology part of the equation. The software must be tested in a realistic business setting; then employees need to be trained, and documentation about how to use the new system needs to be written.

You will definitely need to think about change management. **Change management** refers to the many techniques used to bring about successful change in a business. Nearly all information systems require changes in the firm's business processes and, therefore, changes in what hundreds or even thousands of employees do every day. You will have to design new, more efficient business processes and then figure out how to encourage employees to adapt to these new ways of doing business. This may require meeting sessions to introduce the change to groups of employees, new training modules to bring employees quickly up to speed on the new information systems and processes, and, finally, some kind of rewards or incentives to encourage people to support the changes enthusiastically.

Implementation also includes the measurement of outcomes. After a solution has been implemented, it must be evaluated to determine how well it is working and whether any additional changes are required to meet the original objectives. This information is fed back to the problem solvers. In this way, the identification of the problem can change over time, solutions can be changed, and new choices made, all based on experience.

Problem Solving: A Process, Not an Event

It is easy to fall into the trap of thinking about problem solving as an event that is over at some point, like a relay race or a baseball game. Often in the real world, this

does not happen. Sometimes the chosen solution does not work, and new solutions are required.

For instance, the US National Aeronautics and Space Administration (NASA) spent more than \$1 billion to fix a problem with shedding foam on the space shuttle. Experience proved the initial solution did not work. More often, the chosen solution partially works but needs a lot of continuous changes to fit the situation well. Sometimes, the nature of the problem changes in a way that makes the initial solution ineffective. For instance, hackers create new variations on computer viruses that require continually evolving antivirus programs to hold them in check. For all these reasons, problem solving is a continuous process rather than a single event.

THE ROLE OF CRITICAL THINKING IN PROBLEM SOLVING

It is amazingly easy to accept someone else's definition of a problem or to adopt the opinions of some authoritative group that has objectively analyzed the problem and offers quick solutions. You should try to resist this tendency to accept existing definitions of any problem. It is essential for you to try to maintain some distance from any specific solution until you are sure you have properly identified the problem, developed understanding, and analyzed alternatives. Otherwise, you may leap off in the wrong direction, solve the wrong problem, and waste resources. You will have to engage in some critical-thinking exercises.

Critical thinking can be briefly defined as the sustained suspension of judgment with an awareness of multiple perspectives and alternatives. It involves at least four elements as described below:

- Maintaining doubt and suspending judgment
- Being aware of different perspectives
- Testing alternatives and letting experience guide
- Being aware of organizational and personal limitations

Simply following a rote pattern of decision making, or a model, does not guarantee a correct solution. The best protection against incorrect results is to engage in critical thinking throughout the problem-solving process.

First, maintain doubt and suspend judgment. Perhaps the most frequent error in problem solving is to arrive prematurely at a judgment about the nature of the problem. By doubting all solutions at first and refusing to rush to a judgment, you create the necessary mental conditions to take a fresh, creative look at problems, and you keep open the chance to make a creative contribution.

Second, recognize that all interesting business problems have many dimensions and that the same problem can be viewed from different perspectives. In this text, we have emphasized the usefulness of three perspectives on business problems: technology, organizations, and people. Within each of these broad perspectives are many subperspectives, or views. The *technology perspective*, for instance, includes a consideration of all the components in the firm's IT infrastructure and the way they work together. The *organization perspective* includes a consideration of a firm's business processes, structure, culture, and politics. The *people perspective* includes consideration of the firm's management as well as employees as individuals and their interrelationships in workgroups.

You will have to decide for yourself which major perspectives are useful for viewing a given problem. The ultimate criterion here is usefulness: Does adopting a certain perspective tell you something more about the problem that is useful for solving the problem? If not, reject that perspective as not meaningful in this situation and look for other perspectives.

The third element of critical thinking involves testing alternatives, or modeling solutions to problems, letting experience be the guide. Not all contingencies can be known in advance, and much can be learned through experience. Therefore, experiment, gather data, and reassess the problem periodically.

THE CONNECTIONS AMONG BUSINESS OBJECTIVES, PROBLEMS, AND SOLUTIONS

Now let's make the connection between business information systems and the problem-solving approach. At the beginning of this chapter, we identified six business objectives of information systems: operational excellence; new products, services, and business models; customer/supplier intimacy; improved decision making; strategic advantage; and survival. When firms cannot achieve these objectives, they become challenges or problems that receive attention. Managers and employees who are aware of these challenges often turn to information systems as one of the solutions or the entire solution.

Review the diagram at the beginning of this chapter. The diagram shows how PCL's systems solved the business problem of inefficiencies created by a far-flung, highly paper-intensive business. These systems provided a solution that takes advantage of opportunities provided by new wireless digital technology and the Internet. PCL digitally enabled its key business processes for planning, designing, and monitoring its construction projects. These systems have been essential in improving PCL's overall business performance. The diagram also illustrates how people, technology, and organizational elements work together to create the systems.

Each chapter of this text begins with a diagram similar to this one to help you analyze the chapter-opening case. You can use this diagram as a starting point for analyzing any information system or information system problem you encounter.

I-4 What information systems skills and knowledge are essential for business careers?

Looking out to 2026, the US economy will create 11.5 million new jobs, and 34 million existing jobs will open up as their occupants retire. More than 95 percent of the new jobs will be created in the service sector, and the fastest growing jobs will be in health-care services. About 35 percent of the new jobs will require at least a bachelor's degree, another 30 percent some postsecondary education (US Bureau of Labor Statistics, 2019; US Census, 2019). Similar changes are occurring in developed countries around the world.

What this means is that business firms and government agencies are looking for candidates who have a broad range of problem-solving skills—the ability to read, write, and present ideas—as well as the technical skills required for specific tasks. Regardless of your business school major, or your future occupation, information systems and technologies will play a major and expanding role in your career. Your career opportunities, and your compensation, will in part depend on your ability to help business firms and other organizations use information systems.

HOW INFORMATION SYSTEMS WILL AFFECT BUSINESS CAREERS

In the following sections, we describe how specific occupations will be affected by information systems and what skills you should be building in order to benefit from this emerging labor market based on the research of the Bureau of Labor Statistics (Bureau of Labor Statistics, 2019; US Census, 2019).

Accounting

There are about 1.4 million accountants in the US labor force today, and the field is expected to expand by 11 percent by the year 2026, adding 140,000 new jobs and twice as many to replace retirees. This above-average growth in accounting is driven in part by new accounting laws for public companies, greater scrutiny of public and private firms by government tax auditors, and a growing demand for management and operational advice.

Accountants rely heavily on information systems to summarize transactions, create financial records, organize data, and perform financial analysis. Because of new public laws, accountants require an intimate knowledge of databases, reporting systems, and networks to trace financial transactions. Because so many transactions are occurring over the Internet, accountants need to understand online transaction and reporting systems and how systems are used to achieve management accounting functions in an online and mobile business environment.

Finance

If you include financial analysts, stock analysts, brokers, loan officers, budget analysts, financial advisors, and related financial service occupations, there are currently about 2 million managers and employees in finance. These financial occupations are expected to grow on average by about 12 percent by the year 2026 and add more than 130,000 new jobs. Financial advisors will grow by 15 percent in this period.

Financial managers play important roles in planning, organizing, and implementing information system strategies for their firms. Financial managers work directly with a firm's board of directors and senior management to ensure that investments in information systems help achieve corporate goals and high returns. The relationship between information systems and the practice of modern financial management and services is so strong that many advise finance majors to comajor in information systems (and vice versa).

Marketing

No field has undergone more technology-driven change in the past five years than marketing and advertising. The explosion in e-commerce activity described earlier means that eyeballs are moving rapidly to the Internet. Internet advertising is the fastest-growing form of advertising, reaching \$105 billion in 2018. Product branding and customer communication are moving online at a fast pace.

There are about 1.5 million public relations, marketing analysts, and marketing and sales managers in the US labor force. This field is growing faster than average, at about 10 percent, and is expected to add more than 300,000 jobs by 2026. There is a much larger group of 1.2 million nonmanagerial employees in marketing-related occupations (art, design, entertainment, sports, and media) and more than 15.9 million employees in sales. These occupations together are expected to create an additional 2 million jobs by 2026. Marketing and advertising managers and specialists deal with large databases of customer behavior both online and offline in the process of creating brands and selling products and services. They develop reports on product performance, retrieve feedback from customers, and manage product development. These managers need an understanding of how enterprise-wide systems for product management, sales force management, and customer relationship management are used to develop products that consumers want, to manage the customer relationship, and to manage an increasingly mobile sales force.

Operations Management in Services and Manufacturing

The growing size and complexity of modern industrial production and the emergence of huge global service companies have created a growing demand for employees who can coordinate and optimize the resources required to produce goods and services. Operations management as a discipline is directly relevant to three occupational categories: industrial production managers, administrative service managers, and operations analysts.

Production managers, administrative service managers, and operations analysts will be employing information systems and technologies every day to accomplish their jobs, with extensive use of database and analytical software.

The job of management requires extensive use of information systems to support decision making and monitor the performance of the firm.



Management

Management is the largest single group in the US business labor force with more than 13 million members, not including an additional 612,000 management analysts and consultants. Overall, the management corps in the United States is expected to expand at an average pace of 7 percent, adding about 1 million new jobs by 2026. The Bureau of Labor Statistics tracks more than 20 types of managers, all the way from chief executive officer to human resource managers, production managers, project managers, lodging managers, medical managers, and community service managers.

Arguably, it would be impossible to manage business firms today, even very small firms, without the extensive use of information systems. Nearly all US managers use information systems and technologies every day to accomplish their jobs, from desktop productivity tools to mobile applications coordinating the entire enterprise. Managers today manage through a variety of information technologies without which it would be impossible to control and lead the firm.

Information Systems

The information systems field is one of the fastest-changing and dynamic of all the business professions because information technologies are among the most important tools for achieving business firms' key objectives. The explosive growth of business information systems has generated a growing demand for information systems employees and managers who work with other business professionals to design and develop new hardware and software systems to serve the needs of business.

There are about 3.7 million information system managers and employees in the United States, with an estimated growth rate of 13 percent through 2026, expanding the number of new jobs by more than 500,000. As businesses and government agencies increasingly rely on the Internet for communication and computing resources, system and network security management positions are growing very rapidly. The fastest-growing occupations in this category are software developers (up 24 percent) and web developers (up 15 percent).

Outsourcing and Offshoring

The Internet has created new opportunities for outsourcing many information systems jobs, along with many other service sector and manufacturing jobs. There are two kinds of outsourcing: outsourcing to domestic US firms and offshore outsourcing to low-wage countries such as India, China, and eastern European countries. Even this distinction blurs as domestic service providers develop global outsourcing centers offshore.

Artificial Intelligence (AI) is causing another paradigm shift, just as the World Wide Web did before it. AI has been widely employed by many industries, from banking, to education, to marketing, to health-care, to perform a wide range of repetitive tasks, including customer service, technical support, facial recognition, online search, online ad targeting, and limited medical diagnoses. Despite its limitations, AI in the form of machine learning can be used to increase the efficiency of business operations and management decision making. Supplemented with other technologies, such as robots, big data, and cloud computing, AI is expected to be the next big thing that helps enterprises create value and reduce costs.

While AI is beneficial to businesses, some worry that the technology threatens job stability. In a survey of 2,092 people in Switzerland by the Swiss Broadcasting Corporation, two-thirds of the respondents believed that the emergence of AI would render many jobs obsolete. Among the respondents, only 9 percent of the farmers and a quarter of the senior management were confident that their jobs would not be affected by AI. As noted by the European Commission in a comprehensive study on the changing nature of work and skills in the digital age, it is difficult to estimate the number of jobs that may be impacted by AI in the future, with estimates varying widely. In one study conducted in 32 countries, the Organization for Economic Co-operation 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 loss. McKinsey & Company estimated that 60 percent of current jobs have technically automatable activities of over 30 percent. Moreover, many AI applications are designed to facilitate individuals in doing their jobs rather than replacing them completely. Human-machine collaboration is expected to generate optimal results.

McKinsey & Company's study of historical data also found that new waves of technology have both eliminated and created jobs. There are always shortages of the sort of labor that can master the skills related to new technologies. Advancements in tech-

nology 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. Dun & Bradstreet conducted a survey among 100 attendees of the AI World Conference and Expo held in late 2018 and found that only 8 percent of respondents said that their organizations were axing jobs because of AI deployment. As much as 40 percent of respondents' organizations are adding more jobs because of AI implementation within their business. The respondents also said that a lack of internal human expertise was one of the obstacles to further implementation of AI in 2019. Thus, AI will definitely take away many jobs but will likely create many others, perhaps at an unprecedented rate. McKinsey & Company posits that AI will generate 50 million jobs by 2030, creating vacancies we cannot yet foresee.

The European Commission, OECD, and McKinsey & Company studies all note that the number of jobs affected by AI will vary by country and by industry. For example, the European Commission study notes that the percentage of jobs at risk is much higher in eastern and southern Europe than in the Nordic countries and the UK. 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; generally, 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 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. Surprisingly, the peak is at the young age group rather than the older generation, with the valley at the age group of 30–35. This means that the chance of losing a job to an AI is higher among the younger workforce—with less work experience—than the age group that's close to retirement age. 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: I. Gonzalez Vazquez et al., “The Changing Nature of Work and Skills in the Digital Age,” EUR 29823 EN, Publications Office of the European Union, September 24, 2019; Dun & Bradstreet, “Artificial Intelligence Is Creating Jobs, Dun & Bradstreet Survey Finds,” MarketScreener, January 8, 2019; “Two-Thirds of Swiss See Artificial Intelligence as Job Threat,” SWI swissinfo.ch, November 21, 2018; H. James Wilson and Paul R. Daugherty, “Collaborative Intelligence: Humans and AI Are Joining Forces,” *Harvard Business*

Review, July–August 2018, pp. 114–123; and Michael Xie, “AI Doesn’t Eliminate Jobs, It Creates Them,” *Forbes CommunityVoice*, May 1, 2018; Mark Knickrehm, “How Will AI Change Work? Here Are 5 Schools of Thought,” *Harvard Business Review*, January 24, 2018; Infosys, “Leadership in the Age of AI Adapting, Investing and Reskilling to Work Alongside AI,” 2018, www.infosys.com; 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,” www.mckinsey.com, 2017; “David H. Autor, Why Are There Still So Many Jobs? The History and Future of Workplace Automation,” *Journal of Economic Perspectives* 29, No. 3 (Summer 2015).

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

The most common and successful offshore outsourcing projects involve production programming and system maintenance programming work, along with call center work related to customer relationship management systems. However, inflation in Indian and Chinese wages for technology work, coupled with the additional management costs incurred in outsourcing projects, is leading to a counter movement of some IT jobs back to the United States. Moreover, although routine technical information systems (IS) jobs such as software maintenance can be outsourced easily, all those management and organizational tasks required in systems development—including business process design, user interface design, and supply chain management—often remain in the United States.

Innovative new products, services, and systems are rarely outsourced either domestically or globally. The advantage of low-wage countries is their low wages and ready availability of technical talent, not their keen sense of new products, services, and technologies for other countries’ markets. Software outsourcing of routine IS work to low-wage countries lowers the cost of building and maintaining systems in the United States and other high-wage countries. As systems become less expensive, more are built. The net result is that offshore outsourcing likely increases demand domestically for employment in a wide variety of IS positions.

Given all these factors in the IT labor market, on what kinds of skills should information system majors focus? Following is a list of general skills we believe will optimize employment opportunities:

- An in-depth knowledge of how business firms can use new and emerging hardware and software to make them more efficient and effective, enhance customer and supplier intimacy, improve decision making, achieve competitive advantage, and ensure firm survival. This includes an understanding of artificial intelligence, cloud computing, business analytics, databases, system implementation, and mobile application development.
- An ability to take a leadership role in the design and implementation of new information systems, work with other business professionals to ensure systems meet business objectives, and work with cloud computing services and software firms providing new system solutions.

Information Technology and the Future of Jobs

Few topics have recently captured the attention of journalists, academics, and the general public than the impact of artificial intelligence, and automation in general, on employment in the United States and worldwide. This general concern is not new, but recurs with every advance in information technology since the 1950s. The Interactive Session on People illustrates some of the differing views on how new information technologies like artificial intelligence may impact employment in coming years.

INFORMATION SYSTEMS AND BUSINESS CAREERS: WRAP-UP

Looking back at the information system skills and knowledge required for specific majors, there are some common themes that affect all business majors. Following is a list of these common requirements.

- All business students, regardless of major, should understand how information systems and technologies can help firms achieve business objectives such as attaining operational efficiency, developing new products and services, and maintaining customer intimacy.
- All business students need to develop skills in analysis of information and helping firms understand and make sense of their data. Business analytics and business intelligence are important skill sets to analyze the mountains of big data the on-line business environment and Internet of Things (IoT) produce.
- All business majors need to be able to work with specialists and system designers who build and implement information systems. This is necessary to ensure that the systems that are built actually service business purposes and provide the information and understanding managers and employees require.
- Each of the business majors will be affected by changes in the ethical, social, and legal environment of business. Business school students need to understand how information systems can be used to meet business requirements for reporting to government regulators and the public and how information systems affect the ethical issues in their fields.

Regardless of your major, liberal arts skills (often called “soft” skills) are highly prized, including the ability to communicate verbally and in writing, and to collaborate with others on a team. If you are a liberal arts major and combine these skills with business experience, your prospects for a high-paying career are bright. English and history majors may not initially earn as much as their classmates focusing on business or science, but their earning potential develops over the course of their careers to nearly equal STEM majors as they become skilled problem-solvers.

HOW THIS BOOK PREPARES YOU FOR THE FUTURE

This book is explicitly designed to prepare you for your future business career. It provides you with the necessary knowledge and foundational concepts for understanding the role of information systems in business organizations. You will be able to use this knowledge to identify opportunities for increasing the effectiveness of your business. You will learn how to use information systems to improve operations, create new products and services, improve decision making, increase customer intimacy, and promote competitive advantage.

Equally important, this book develops your ability to use information systems to solve problems that you will encounter on the job. You will learn how to analyze and define a business problem and how to design an appropriate information system solution. You will deepen your critical-thinking and problem-solving skills. The following features of the text and the accompanying learning package reinforce this problem-solving and career orientation.

A Framework for Describing and Analyzing Information Systems

The text provides you with a framework for analyzing and solving problems by examining the people, organizational, and technology components of information systems. This framework is used repeatedly throughout the text to help you understand information systems in business and analyze information systems problems.

A Four-Step Model for Problem Solving

The text provides you with a four-step method for solving business problems, which we introduced in this chapter. You will learn how to identify a business problem, design alternative solutions, choose the correct solution, and implement the solution. You will be asked to use this problem-solving method to solve the case studies in each chapter. Chapter 12 will show you how to use this approach to design and build new information systems and determine their business value.

Hands-On MIS Projects for Stimulating Critical Thinking and Problem Solving

Each chapter concludes with a series of hands-on MIS projects to sharpen your critical-thinking and problem-solving skills. These projects include two Management Decision Problems, hands-on application software problems, and projects for building Internet skills. For each of these projects, we identify both the business skills and the software skills required for the solution.

Career Resources

To make sure you know how the text is directly useful in your future business career, we've added a full set of career resources to help you with career development and job hunting.



Career Opportunities Feature To show you how this book can help you find a job and build your career, we have added a new “Career Opportunities” feature, identified by this icon, to each chapter. The last major section of each chapter, titled “How will MIS help my career?,” presents a description of an entry-level job for a recent college graduate based on a real-world job description. The job requirements are related to the topics covered in that chapter. The job description shows the required educational background and skills, lists business-related questions that might arise during the job interview, and provides author tips for answering the questions and preparing for the interview. Students and instructors can find more detail about how to use this feature in the Preface and in MyLab MIS.

Digital Portfolio MyLab MIS includes a template for preparing a structured digital portfolio to demonstrate the business knowledge, application software skills, Internet skills, and analytical skills you have acquired in this course. You can include this portfolio in your résumé or job applications. Your professors can also use the portfolio to assess the skills you have learned.

Additional Career Resources A Career Resources section in MyLab MIS shows you how to integrate what you have learned in this course in your résumé, cover letter, and job interview to improve your chances for success in the job market.



I-5 How will MIS help my career?

Here is how Chapter 1 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 Frankfurt, Istanbul, Dhubai, Sydney, and Cape Town, 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 Why are information systems so essential for running and managing a business today? Information systems are a foundation for conducting business today. In many industries, survival and even existence is difficult without extensive use of information technology. Businesses 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 exactly is an information system? How does it work? What are its people, organizational, and technology components? 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 people, organization, and technology elements.

The people dimension of information systems involves issues such as training, job attitudes, 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.

1-3 How will a four-step method for business problem solving help you solve information system-related problems? Problem identification involves understanding what kind of problem is being presented and identifying people, organizational, and technology factors. Solution design involves designing several alternative solutions to the problem that has been identified. Evaluation and choice entail selecting the best solution, taking into account its cost and the available resources and skills in the business. Implementation of an information system solution entails purchasing or building hardware and software, testing the software, providing employees with training and documentation, managing change as the system is introduced into the organization, and measuring the outcome. Problem solving requires critical thinking in which one suspends judgment to consider multiple perspectives and alternatives.

1-4 What information system skills and knowledge are essential for business careers? Business careers in accounting, finance, marketing, operations management, management and human resources, and information systems all will need an understanding of how information systems help firms achieve major business objectives; skills in data analysis and business intelligence; sensitivity to the ethical, social, and legal issues systems raise; and the ability to work with technology specialists and other business professionals in designing and building systems. The ability to communicate verbally and in writing and to collaborate with others on a team have also become increasingly important skills in all areas of today's workplace.

Key Terms

Business model, 35	Culture, 40	Information system (IS), 37
Business processes, 40	Data, 37	Information systems literacy, 39
Change management, 46	Data management	Information
Computer hardware, 41	technology, 41	technology (IT), 37
Computer literacy, 39	Extranets, 41	Information technology (IT)
Computer software, 41	Feedback, 38	infrastructure, 41
Critical thinking, 47	Information, 37	Input, 38

Internet, 41	Network, 41	Output, 38
Intranets, 41	Networking and telecommunications technology, 41	Processing, 38
Management information systems (MIS), 39		World Wide Web, 41

Review Questions

- I-1** Why are information systems so essential for running and managing a business today?
- List and describe the six reasons information systems are so important for business today.
 - Describe the challenges and opportunities of globalization.
- I-2** What exactly is an information system? How does it work? What are its people, organization, and technology components?
- Describe the three activities in an information system that produce the information that organizations need.
 - Explain the differences between information and data. Why is the former essential to the latter?
 - 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.
- I-3** How will a four-step method for business problem solving help you solve information system-related problems?
- Explain why it is essential to treat problem solving as a process and not an event.
 - Identify and describe the people-based techniques that could be used to implement solutions to problems.
 - How would you distinguish between technological, organizational, and people perspectives in the context of problems?
 - Explain how you might distinguish between technological, organizational, and people perspectives in relation to information systems.
- I-4** What information system skills and knowledge are essential for business careers?
- Describe the role of information systems in careers in accounting, finance, marketing, management, and operations management and explain how careers in information systems have been affected by new technologies and outsourcing.
 - List and describe the information system skills and knowledge that are essential for all business careers.

MyLab MIS™

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

Discussion Questions

- I-5** Information systems are too important to be left to computer scientists. Do you agree? Why or why not?
MyLab MIS
- I-6** If you were setting up the website for a business firm, what people, organizational, and technology issues might you encounter?
MyLab MIS
- I-7** How have global and national statutes and regulations impacted the use of information systems?
MyLab MIS

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

- I-8** 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?
- I-9** Bargain Land is a small chain of discount stores operating throughout the United Kingdom. It sells a broad range of high-demand household products and works on very low margins but with a high turnover of stock. The popularity of the stores is based on the low-cost business model and a wide customer base. There is no tracking technology used to manage inventory either in terms of receiving stock on delivery or of stock management and conversion to sales. There has also been a significant increase in losses associated with missing and damaged stock. Management is unsure whether this is related to internal employee theft or mishandling, or theft from the shops by external parties. Bargain Land wants to keep costs as low as possible and has therefore not yet implemented an automated method for keeping track of inventory at each store. How is the lack of an automated system causing the company problems? Given that investing in an information system solution is becoming increasingly necessary, what decisions should now be made?

IMPROVING DECISION MAKING: USING DATABASES TO ANALYZE SALES TRENDS

Software skills: Database querying and reporting
Business skills: Sales trend analysis

- I-10** 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?
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

- I-11** Visit a job-posting website such as Monster.com. 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

- I-12** 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, 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 by using the Google tool you have selected.

BUSINESS PROBLEM-SOLVING CASE

NEW TECHNOLOGY AT UPS CLASHES WITH OUTDATED WAYS OF WORKING

This chapter's Interactive Session on Technology described how UPS investments in information technology are helping it remain competitive in the package delivery market. Unfortunately, UPS has not been as competitive as it could be because critical aspects of its operations have been saddled with outdated technology and manual procedures.

Although much of UPS's IT infrastructure is leading-edge, not all of it is. UPS moves millions of packages each day using 80,000 drivers. Until recently, about half were processed through automated facilities, the rest being handled using 30-year-old equipment and manual processes.

For example, in UPS's Mesquite, Texas, package-sorting facility, a 30-year-old analog control panel the size of a chest freezer with rows of red and green lights informs workers when something on the facility's web of conveyor belts goes awry. The sorting process begins with boxes being unloaded from trucks onto conveyor belts. A worker is required to align each box so that a scanner can read the delivery label on the front, top, or one side. The packages move inside to a line of about 50 workers. There are nine conveyor belts, three along the ground, three waist-high, and three directly overhead. A human sorter picks a package, quickly deciphers the label, and then places the package onto the correct belt. A worker around the corner sorts packages down chutes, where loaders fill truck trailers. In an automated facility scanners would read a package's destination and use equipment called shoe pucks to push packages down the proper chute.

At an older less-automated facility such as Mesquite, a medium-sized package receives four "touches," with each "touch" representing an act of handling. Each "touch" increases the chance of a sorting error or damage to the package. Mesquite processes about 40,000 pieces per hour, so even rare human mistakes add up. Missorted packages can add an extra day to a UPS delivery, degrading customer service and adding to operating costs.

All FedEx ground hubs, such as the facility in Edison, New Jersey, are automated. There, FedEx workers "touch" most packages only twice, for unloading and loading only. Amazon operations likewise are heavily automated, especially its warehouses, which feature driverless forklifts and robots that bring shelves to workers.

About 30 miles from Mesquite, UPS's Fort Worth facility illustrates UPS's efforts to catch up. There boxes are scanned, sorted by destination, and sent to outbound vehicles via machines. With six-sided scanners, employees do not need to worry about which side is up. UPS employees in an air-conditioned control room view a wall of flat-screen monitors displaying live video feeds. The computer detects jams and other malfunctions, and workers can reroute where the conveyors send packages. There is no human element in rerouting a package in the Fort Worth building. A few workers walk alongside the belts to replace any package that falls off, which rarely happens any more. Directing the sorting network is software that helps manage package flows, including those between automated facilities and older ones. The technology can divert additional packages destined for areas overwhelmed by volume. This automated 750-worker facility can process the same number of packages daily as can Mesquite with 1,170 workers. Automation has increased the accuracy of the sorting, and also generates data to help the company optimize delivery routes using fewer miles, less fuel, and less equipment and also provide better forecasts of shipping volume.

In contrast, 96 percent of competitor FedEx's ground packages move through automated sites. FedEx discarded outdated equipment and manual processes years ago, and new rival Amazon.com never had to deal with outdated systems at all.

UPS initially applied a "band-aid" approach to dealing with surging e-commerce shipments. It would add extra shifts, extend working hours, or retrofit parts of older buildings with new equipment. But UPS management knows it has to rectify this situation to remain competitive in the twenty-first century, and be able to handle the new distribution requirements posed by e-commerce.

The company plans to invest \$20 billion between 2019 and 2022 to adequately meet twenty-first-century shopping and shipping trends. Much of this investment will be directed toward new automated shipping and warehousing facilities, including seven "super hubs," which can sort packages 30 percent more efficiently than standard facilities.

In the past, most of the shipments handled by UPS went to retailers and business corporations. Today, more and more of these shipments are destined for

individual households who have purchased an item or two online using the Internet. UPS now delivers more than 50 percent of the packages it handles to homes. Numerous deliveries to far-flung suburban homes are more costly to UPS than delivering and picking up multiple packages at large businesses or offices.

Although some of UPS's management worried about so much company business going toward lower-margin deliveries, the company knew it had to embrace e-commerce. According to UPS spokesperson Steve Gant, there is "tremendous opportunity" in delivering e-commerce orders even amidst formidable competitors who at the moment appear to be more technologically and organizationally advanced. UPS plans to process all packages, with the exception of some large ones that travel short distances, through automated hubs by 2022.

Trying to use outdated shipping technology and procedures in the new e-commerce environment had caused UPS to lose business. Bottlenecks from being overwhelmed at times by online orders created delays that drove some health care, industrial, and other corporate customers to switch to FedEx. Amazon is creating its own delivery network of trucks, vans, and planes to handle most of its online orders, especially in cities and suburbs. Since Amazon accounts for as much as 10 percent of UPS's revenue and an even higher share of shipping volume, UPS will definitely be affected.

UPS is unionized, FedEx ground-operation workers are not. Has that made a difference? The International Brotherhood of Teamsters represents 260,000 UPS drivers, sorters, and other workers, and it wants UPS to hire more full-time workers to help handle the surging UPS package shipments. The union has opposed technology such as drones and self-driving vehicles and is concerned about changes that can perform the same work with fewer employees. As Sean O'Brien, a Boston Teamsters leader pointed out, technology streamlines and eliminates jobs. Once jobs are replaced, "it's pretty tough to get them back."

FedEx has no unionized workers in its ground network, so it doesn't have to deal quite as much with opposition from organized labor. Additionally, FedEx's ground delivery network is newer than that of UPS, employing more modern technology and operating procedures. It doesn't have to grapple with retrofitting automation into facilities with older ways of working.

According to UPS, unionization has not heavily impeded company efforts to spend more on automation. The cost of new machines to automate an older facility have become low enough for UPS to both retrofit older facilities and build new ones.

In some instances, new automated package sorting facilities have helped UPS create new jobs. For example, a new automated UPS package delivery center in northwest Houston has created 575 full- and part-time jobs. The 238,000-square-foot center added 300 trucks to the company's delivery fleet in the Houston area.

FedEx, which has spent \$10 billion on its network of 37 ground hubs since 2005, is now trying to slim down. Some places, such as the \$259 million FedEx Indianapolis ground hub, are being closed. FedEx has ground hubs such as the one in Edison, New Jersey, that are designed for flexibility. This facility uses only one-third of a building's space and has room to expand with additional equipment on short notice. This arrangement enables FedEx to adjust its network to accommodate more volatile flows of online orders.

UPS is also implementing other technologies to complement automated package sorting. In 2017 it started placing wireless Bluetooth receivers inside delivery trucks to reduce the likelihood of misloaded packages. Wireless signals are passed between Bluetooth beacons and the scanning devices worn on workers' hands and hips to read UPS package labels. The beacons beep loudly if a worker places a package into a delivery truck that is not headed to the package's destination. A different beep confirms when packages enter the correct truck. Before deploying this technology, UPS did not perform a final scan to confirm that all parcels were on the right truck. Drivers had to drive out of their way to deliver these packages or find a supervisor to transfer them to the correct truck.

Besides reducing delays, the Bluetooth-driven system can furnish customers with more details about upcoming deliveries. When packages are scanned in the morning, the data update UPS's service for sending customers emails showing the status of their shipments. Customers signed up for this service receive a message about the package's arrival date and estimated delivery time.

Another Bluetooth enhancement informs seasonal workers about where to direct outbound packages that UPS vehicles pick up during the day and bring to the company's sorting facilities. UPS hires nearly 100,000 seasonal workers from November through January. In the past, these workers would have to memorize hundreds of zip codes to know where to place parcels. UPS started outfitting some of these seasonal workers with scanning devices and inexpensive Bluetooth headphones that issue one-word commands for "Red," "Green," or "Blue," designating specific conveyor belts for transporting packages to locations for further processing.

New technology makes it possible for UPS processing facility managers to know exactly how many undeliverable packages they must process each night and when they will arrive, which helps them plan work shifts for rerouting the packages. The information is displayed in real time on managers' Samsung smartphones in the form of graphs showing the number of incoming packages, how quickly they are being processed, and which worker groups are busiest, so staff can be allocated where demand is highest. In the past, UPS managers had to rely on historical data and radio conversations with drivers to estimate how many undeliverable packages they would have to handle each night.

All of these technology investments are starting to pay off. UPS was able to handle the upsurge in deliveries during the 2018 holiday season much more easily than in the past. By the end of 2019, about 80 percent of UPS-eligible ground shipment volume will be processed in automated facilities, resulting in annual savings and cost avoidance of as much as \$1 billion.

Sources: Bloomberg, "UPS Sees Payoff from \$20BN Tech Bet," *SupplyChainBrain*, April 24, 2019; Paul Ziobro, "UPS's \$20 Billion Problem: Operations Stuck in the Twentieth Century," *Wall Street Journal*, June 15, 2018; Katherine Feser, "UPS Package Delivery Facility in NW Houston Creates 575 Jobs," *Chron*, January 17, 2019; Elizabeth Woyke, "How UPS Delivers Faster Using \$8 Headphones and Code That Decides When Dirty Trucks Get Cleaned," *MIT Technology Review*, February 16, 2018; and Shefali Kepadia, "Company of the Year: UPS," *Supply Chain Dive*, December 3, 2018.

CASE STUDY QUESTIONS:

- I-13** Identify the problem faced by UPS. Was it a people problem, an organizational problem, or a management problem? Explain your answer.
- I-14** Describe the solution to this problem pursued by UPS? Is this a successful solution? Why or why not?
- I-15** Diagram the packing sorting process at UPS before and after automation.
- I-16** How did automated package sorting change operations and decision making at UPS?

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Global E-business and Collaboration

LEARNING OBJECTIVES

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

- 2-1 What major features of a business are important for understanding the role of information systems?
- 2-2 How do systems serve different management groups in a business, and how do systems that link the enterprise improve organizational performance?
- 2-3 Why are systems for collaboration, social business, and knowledge management 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
- Japan Embraces E-governance Tools for Tokyo 2020
- Videoconferencing: Something for Everyone
- Should Companies Embrace Social Business?

VIDEO CASES

- Vision X Grows with SAP Business One
 - CEMEX—Becoming a Social Business
- Instructional Video:*
- US Foodservice Grows Market with Oracle CRM on Demand

MyLab MIS

- Discussion questions:
2-5, 2-6, 2-7
- Hands-On MIS Projects:
2-8, 2-9, 2-10, 2-11

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 50,000 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 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 company. A People Directory provides a searchable



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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 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.

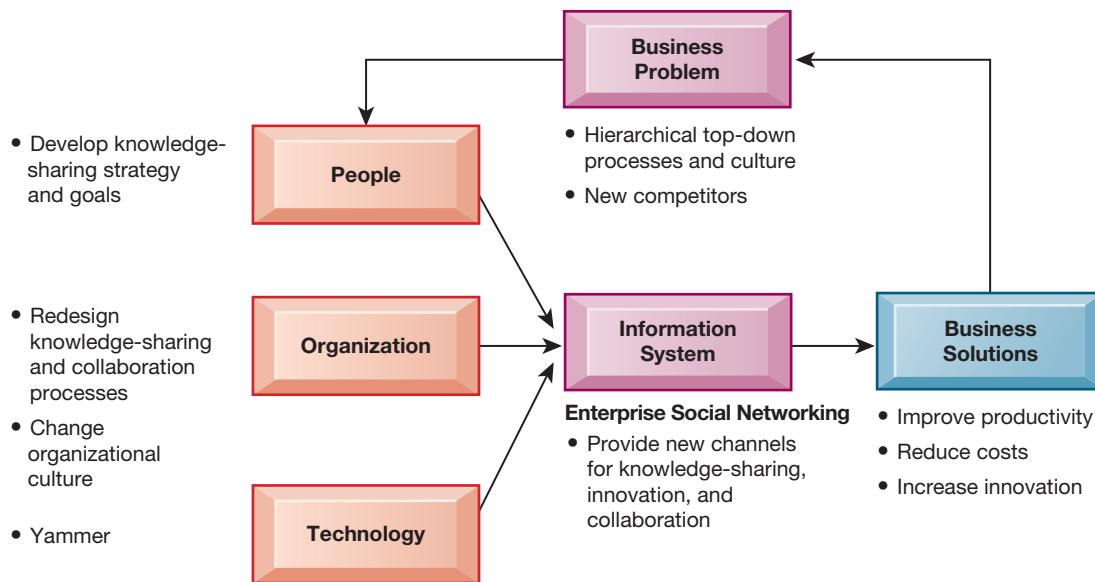
Sources: “Sharp: A Culture Reborn through Enterprise Social,” www.microsoft.com, accessed January 12, 2019; www.sharp-world.com, accessed January 21, 2019; and Sharp Corporation, “Sharp Is Back with Big Screens,” Hexus, February 5, 2019.

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 Asian 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 productive.

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 major features of a business are important for understanding the role of information systems?

A **business** is a formal organization whose aim is to produce products or provide services for a profit—that is, to sell products or services at a price greater than the costs of production. Customers are willing to pay this price because they believe they receive a value greater than or equal to the sale price. Business firms purchase inputs and resources from the larger environment (suppliers who are often other firms). Employees of the business firm transform these inputs by adding value to them in the production process.

There are, of course, nonprofit firms and government agencies that are complex formal organizations that produce services and products but do not operate to generate a profit. Nevertheless, even these organizations consume resources from their environments, add value to these inputs, and deliver their outputs to constituents and customers. In general, the information systems found in government and nonprofit organizations are remarkably similar to those found in private industry.

ORGANIZING A BUSINESS: BASIC BUSINESS FUNCTIONS

Imagine you want to set up your own business. Simply deciding to go into business is the most important decision, but next is the question of what product or service to produce (and hopefully sell). The decision of what to produce is called a *strategic choice* because it determines your likely customers, the kinds of employees you will need, the production methods and facilities needed, the marketing themes, and many other choices.

Once you decide what to produce, what kind of organization do you need? First, you need to develop a production division—an arrangement of people, machines, and business processes (procedures) that will produce the product. Second, you need a sales and marketing group who will attract customers, sell the product, and keep track of after-sales issues, such as warranties and maintenance. Third, once you generate sales, you will need a finance and accounting group to keep track of financial transactions, such as orders, invoices, disbursements, and payroll. In addition, this

Figure 2.1
The Four Major Functions of a Business.

Every business, regardless of its size, must perform four functions to succeed. It must produce the product or service; market and sell the product or service; keep track of accounting and financial transactions; and perform basic human resources tasks such as hiring and retaining employees.



group will seek out sources of credit and finance. Finally, you will need a group of people to focus on recruiting, hiring, training, and retaining employees. Figure 2.1 summarizes the four basic functions found in every business.

If you were an entrepreneur or your business was small with only a few employees, you would not need, and probably could not afford, all these separate groups of people. Instead, in small firms, you would be performing all these functions yourself or with a few others. In any event, even in small firms, the four basic functions of a firm are required. Larger firms often will have separate departments for each function: production and manufacturing, sales and marketing, finance and accounting, and human resources.

Figure 2.1 is also useful for thinking about the basic entities that make up a business. The five basic entities in a business with which it must deal are: suppliers, customers, employees, invoices/payments, and, of course, products and services. A business must manage and monitor many other components, but these are the basic ones at the foundation of any business.

BUSINESS PROCESSES

Once you identify the basic business functions and entities for your business, your next job is to describe exactly how you want your employees to perform these functions. What specific tasks do you want your sales personnel to perform, in what order, and on what schedule? What steps do you want production employees to follow as they transform raw resources into finished products? How will customer orders be fulfilled? How will vendor bills be paid?

The actual steps and tasks that describe how work is organized in a business are called **business processes**. A business process is a logically related set of activities that defines how specific business tasks are performed. Business processes also refer to the unique ways in which work, information, and knowledge are coordinated in a specific organization.

Every business can be seen as a collection of business processes. Some of these processes are part of larger, encompassing processes. Many business processes are tied to a specific functional area. For example, the sales and marketing function would be responsible for identifying customers, and the human resources function would be responsible for hiring employees. Table 2.1 describes some typical business processes for each of the functional areas of business.

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

TABLE 2.1

Examples of Functional Business Processes

Other business processes cross many functional areas and require coordination across departments. Consider the seemingly simple business process of fulfilling a customer order (see Figure 2.2). Initially, the sales department receives a sales order. The order goes to accounting to ensure that 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 has to pull the product from inventory or produce the product. Next, the product needs to be shipped (which may require working with a logistics firm such as UPS or FedEx). The accounting department then generates a bill or invoice and sends a notice to the customer, indicating that the product has shipped. Sales has to be notified of the shipment and prepare 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 coordination of major functional groups in a firm. Moreover, to perform all these steps efficiently in the order fulfillment process requires the rapid flow of a great deal of information within the firm, with business partners such as delivery firms, and with the customer. The particular order fulfillment process we have just described is not only *cross-functional*, it is also *interorganizational* because it includes interactions with delivery firms and customers who are outside the boundaries of the organization. Ordering raw materials or components from suppliers would be another interorganizational business process.

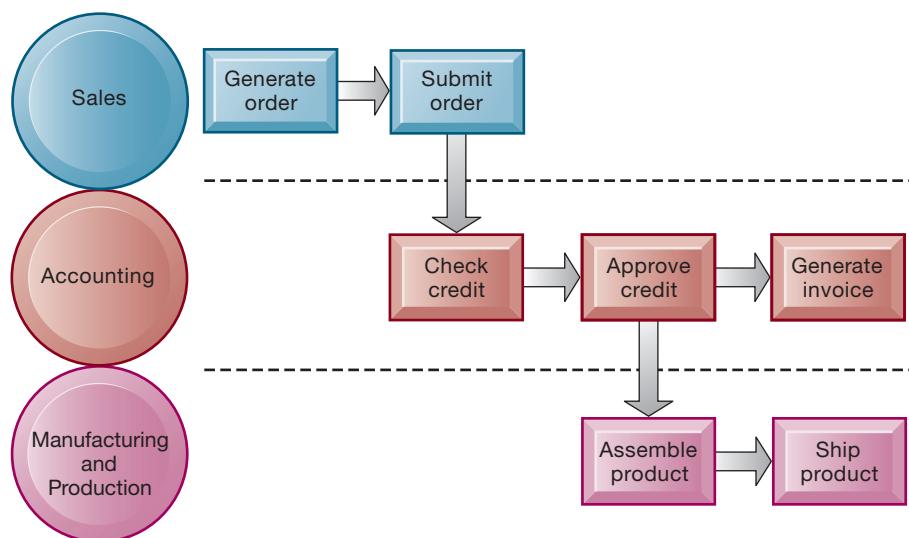


Figure 2.2
The Order Fulfillment Process.
Fulfilling a customer order involves a complex set of steps that requires the close coordination of the sales, accounting, and manufacturing functions.

To a large extent, the efficiency of a business firm depends on how well its internal and interorganizational 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 outdated ways of working that impede organizational responsiveness and efficiency.

How Information Technology Enhances Business Processes

Exactly how do information systems enhance 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. Today, however, 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. It can even transform the way the business works and drive new business models. Ordering a book online from Amazon.com and streaming a song from Apple Music are new business processes based on new business models that are inconceivable without 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 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 to make it more efficient or effective. Throughout this book, we examine business processes with a view to understanding how they might be changed, or replaced, by using information technology to achieve greater efficiency, innovation, and customer service. Chapter 3 discusses the business impact of using information technology to redesign business processes, and MyLab MIS™ has a Learning Track with more detailed coverage of this topic.

MANAGING A BUSINESS AND FIRM HIERARCHIES

Each business function has its own goals and processes, and they obviously need to cooperate for the whole business to succeed. Business firms, like all organizations, achieve coordination by hiring managers whose responsibility is to ensure that all the various parts of an organization work together. Firms coordinate the work of employees in various divisions by developing a hierarchy in which authority (responsibility and accountability) is concentrated at the top.

The hierarchy of management is composed of **senior management**, which makes long-range strategic decisions about products and services and ensures financial performance of the firm; **middle management**, which carries out the programs and plans of senior management; and **operational management**, which 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 administrative work at all levels of the firm. **Production or service workers** actually produce the product and deliver the service (Figure 2.3).

Each of these groups has different needs for information given their different responsibilities. Senior managers need summary information that can quickly inform them about the overall performance of the firm, such as gross sales revenues, sales by product group and region, and overall profitability. Middle managers need more specific information about the results of specific functional areas and departments of the firm such as sales contacts by the sales force, production statistics for specific factories or product lines, employment levels and costs, and sales revenues for each month or even each day. Operational managers need transaction-level information such as the number of parts in inventory each day or the number of hours logged on

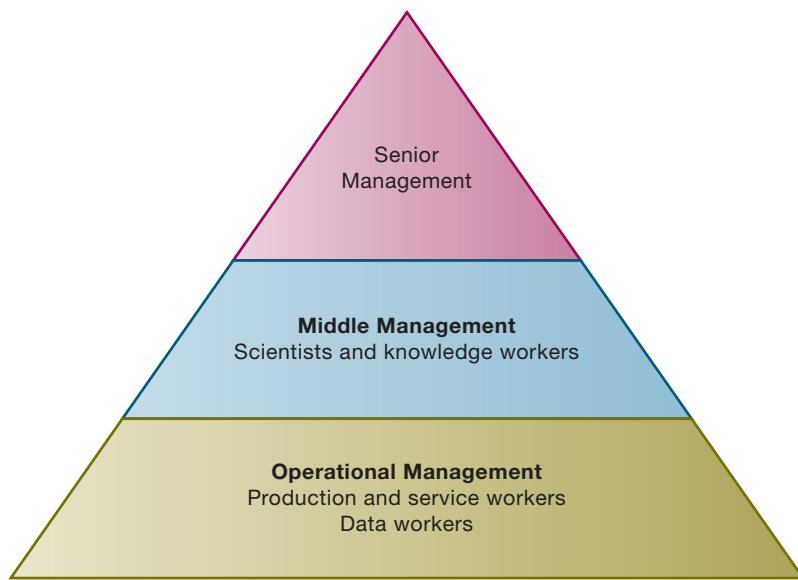


Figure 2.3
Levels in a Firm.
Business organizations are hierarchies consisting of three principal levels: senior management, middle management, and operational management. Information systems serve each of these levels. Scientists and knowledge workers often work with middle management.

Tuesday by each employee. Knowledge workers may need access to external scientific databases or internal databases with organizational knowledge. Finally, production workers need access to information from production machines, and service workers need access to customer records to take orders and answer questions from customers.

THE BUSINESS ENVIRONMENT

So far, we have talked about business as if it operated in a vacuum, but nothing could be further from the truth. In fact, business firms depend heavily on their environments to supply capital, labor, customers, new technology, services and products, stable markets and legal systems, and general educational resources. Even a pizza parlor cannot survive long without a supportive environment that delivers the cheese, tomato sauce, and flour!

Figure 2.4 summarizes the key actors in the environment of every business. To stay in business, a firm must monitor changes in its environment and share information

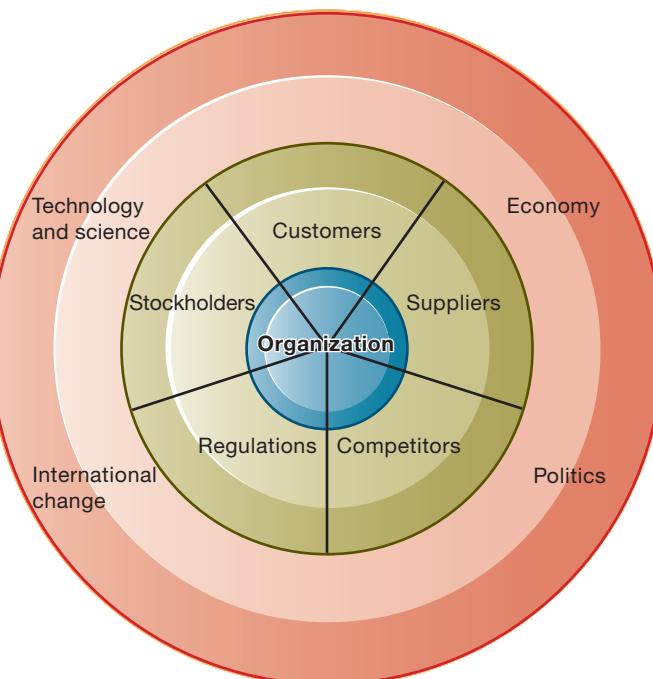


Figure 2.4
The Business Environment.
To be successful, an organization must constantly monitor and respond to—or even anticipate—developments in its environment. A firm's environment includes specific groups with which the business must deal directly, such as customers, suppliers, and competitors, as well as the broader general environment, including socioeconomic trends, political conditions, technological innovations, and global events.

with the key entities in that environment. For instance, a firm must respond to political shifts, respond to changes in the overall economy (such as changes in labor rates and price inflation), keep track of new technologies, and respond to changes in the global business environment (such as foreign exchange rates). In their immediate environment, firms need to track and share information with suppliers, customers, stockholders, regulators, and logistic partners (such as shipping firms).

Business environments are constantly changing; new developments in technology, politics, customer preferences, and regulations happen all the time. In general, when businesses fail, it is often because they failed to respond adequately to changes in their environments.

Changes in technology, such as the Internet, are forcing entire industries and leading firms to change their business models or suffer failure. Apple's iTunes and other online music services have made the music industry's traditional business model based on distributing music on CDs obsolete. Traditional cameras with film have been largely supplanted by digital photography, and digital cameras themselves are losing ground to iPhones and other mobile devices with cameras.

THE ROLE OF INFORMATION SYSTEMS IN A BUSINESS

Until now, we have not mentioned information systems, but from the brief review of business functions, entities, and environments, you can see the critical role that information plays in the life of a business. Up until the mid-1950s, firms managed all this information and information flow with paper records. Since then, more and more business information, and the flow of information among key business actors in the environment, has been moved from manual to digital systems.

Businesses invest in information systems as a way to cope with and manage their internal production functions and cope with the demands of key actors in their environments. Specifically, as we noted in Chapter 1, firms invest in information systems for the following business objectives:

- To achieve operational excellence (productivity, efficiency, agility)
- To develop new products and services
- To attain customer intimacy and service (continuous marketing, sales, and service; customization and personalization)
- To improve decision making (accuracy and speed)
- To achieve competitive advantage
- To ensure survival

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

Now it is time to look more closely at how businesses use information systems to achieve these goals. 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 will have 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 outdated because they cannot easily share information to support cross-functional business processes. They are being 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 will also have different systems supporting the decision-making needs of each of the main management groups described earlier. Operational management, middle management, and senior management each use a specific type of system 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 decision making and work activities at different levels of the organization. They 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. Williams'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 2.5 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, identification number, and number of hours worked per week represents a single transaction for this system. Once this transaction is input in the system, it updates the system's

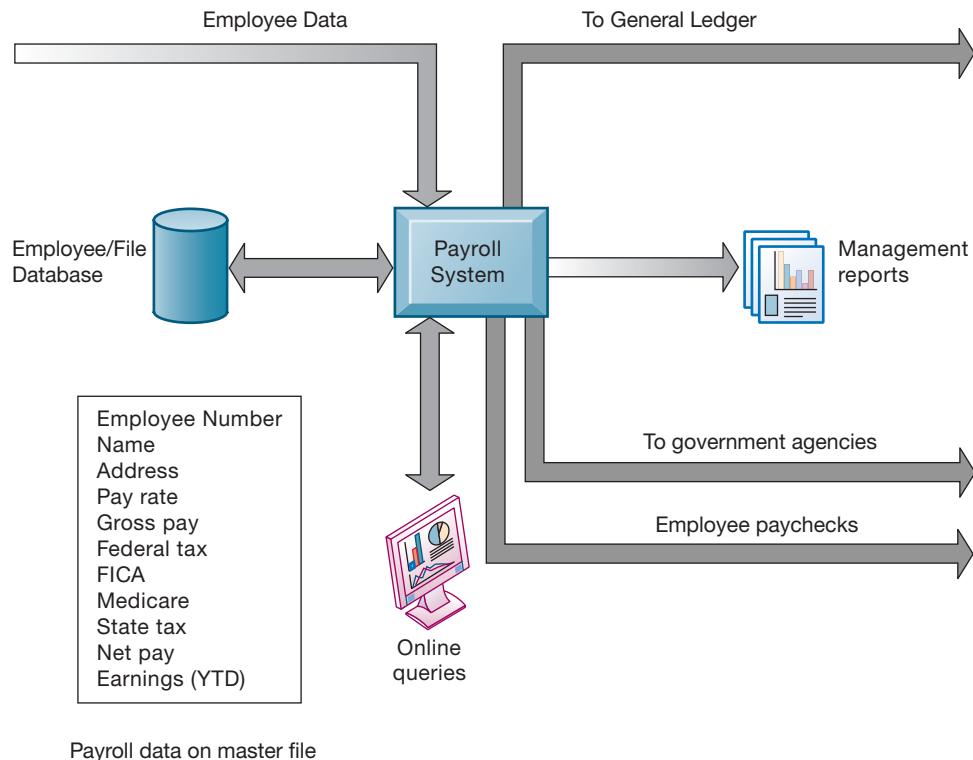


Figure 2.5

A Payroll TPS.

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

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 2.5, 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 such as the U.S. Internal Revenue Service and Social Security Administration.

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 were not working! What would the airlines do without their computerized reservation systems?

Systems for Business Intelligence

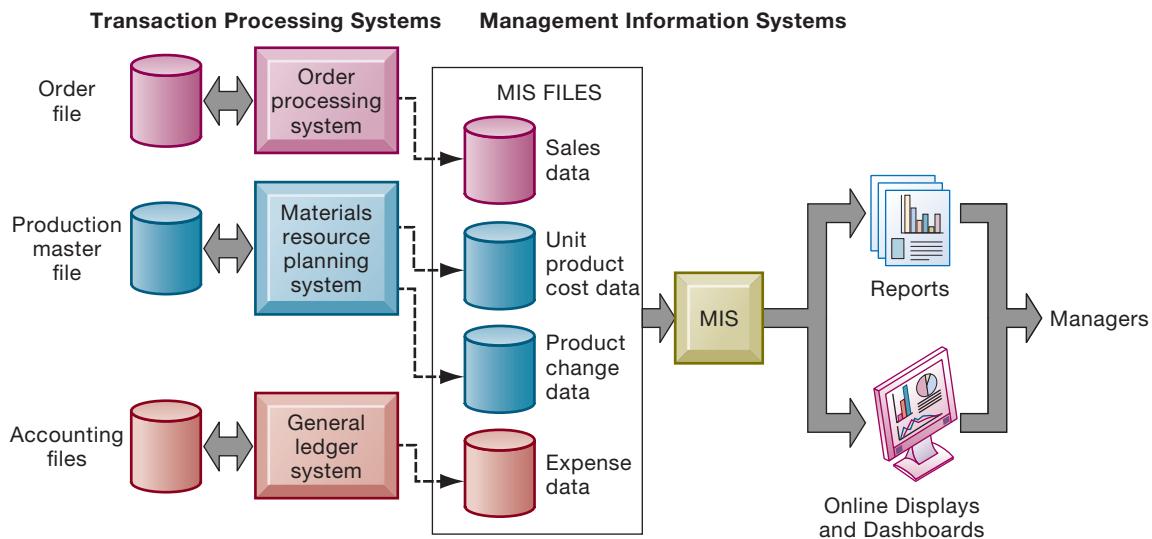
Firms also have business intelligence systems that focus on delivering information to support management decision making. **Business intelligence** is a contemporary term for data and software tools for organizing, analyzing, and providing access to data to help managers and other enterprise users make 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 11.

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 about the organization's current performance. Managers use this information 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 2.6 shows how a typical MIS transforms transaction-level data from inventory, production, and accounting into MIS files that provide managers with reports. Figure 2.7 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 2.7, 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 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?

**Figure 2.6**

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.

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. Super-user managers and business analysts who want to use sophisticated analytics and models to analyze data employ these systems.

An interesting, small, but powerful DSS is the voyage-estimating system of a large global shipping company that exists primarily to carry bulk cargoes of coal, oil, ores, and finished products for its parent company. 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).

Consolidated Consumer Products Corporation Sales by Product and Sales Region: 2019

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

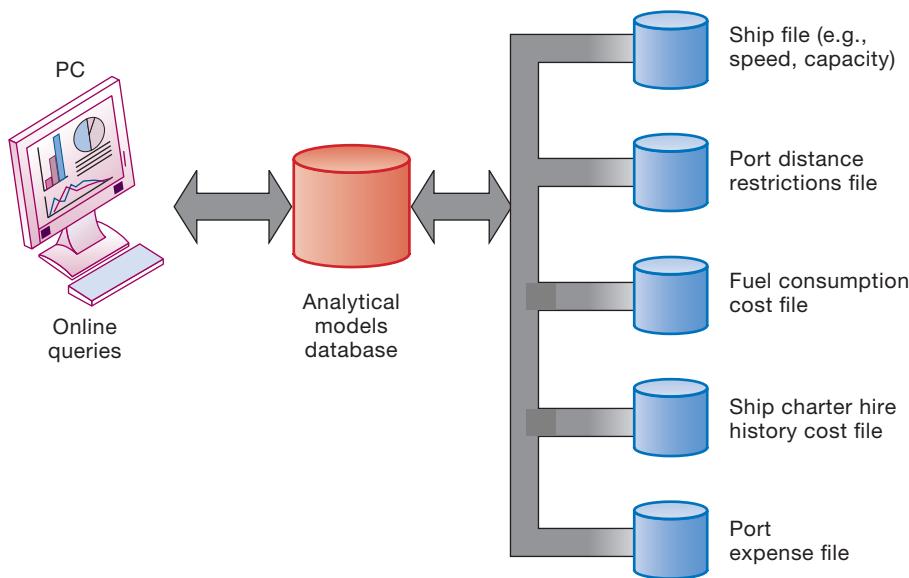
Figure 2.7

Sample MIS Report.

This report, showing summarized annual sales data, was produced by the MIS in Figure 2.6.

Figure 2.8
Voyage-Estimating
Decision-Support
System.

This DSS operates on a powerful PC. Managers who must develop bids on shipping contracts use it daily.



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 2.8 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.

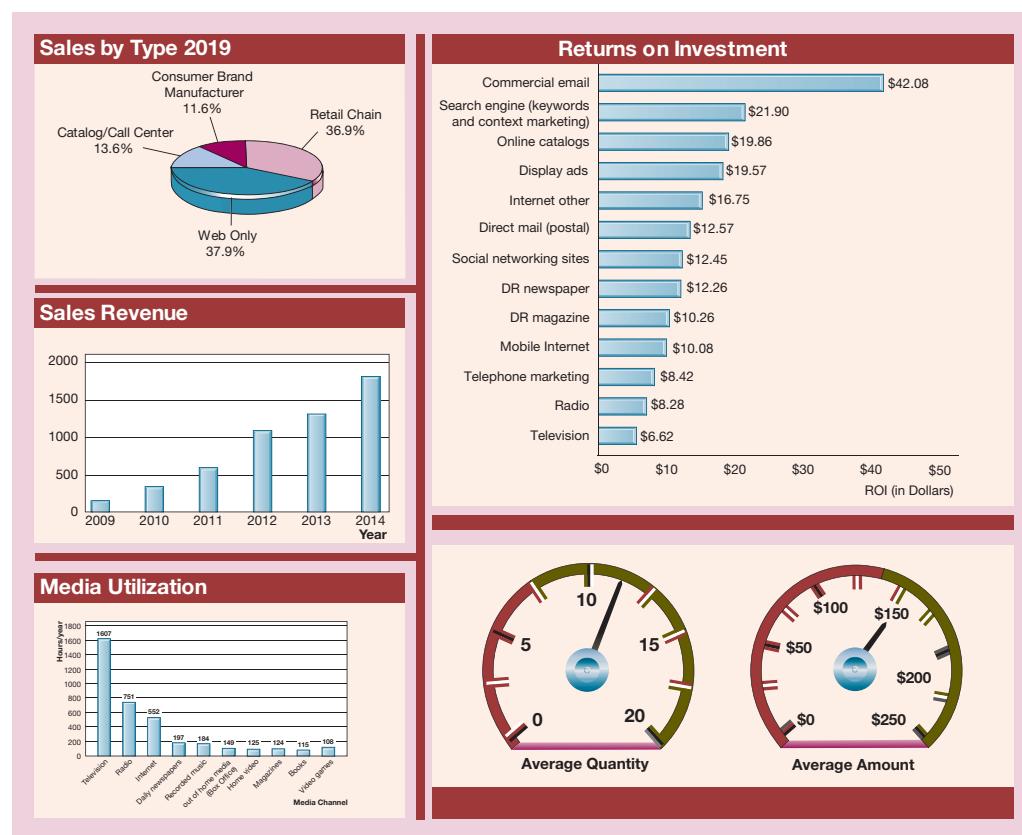
The voyage-estimating DSS we have just described draws heavily on models. Other business intelligence systems are more data-driven, focusing instead on extracting useful information from massive quantities of data. For example, major ski resort companies such as Intrawest and Vail Resorts collect and store large amounts of customer data from call centers, lift tickets, 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.

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 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,



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.

safety, and energy consumption. With the displayed information, management 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 to 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.

SYSTEMS FOR LINKING THE ENTERPRISE

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

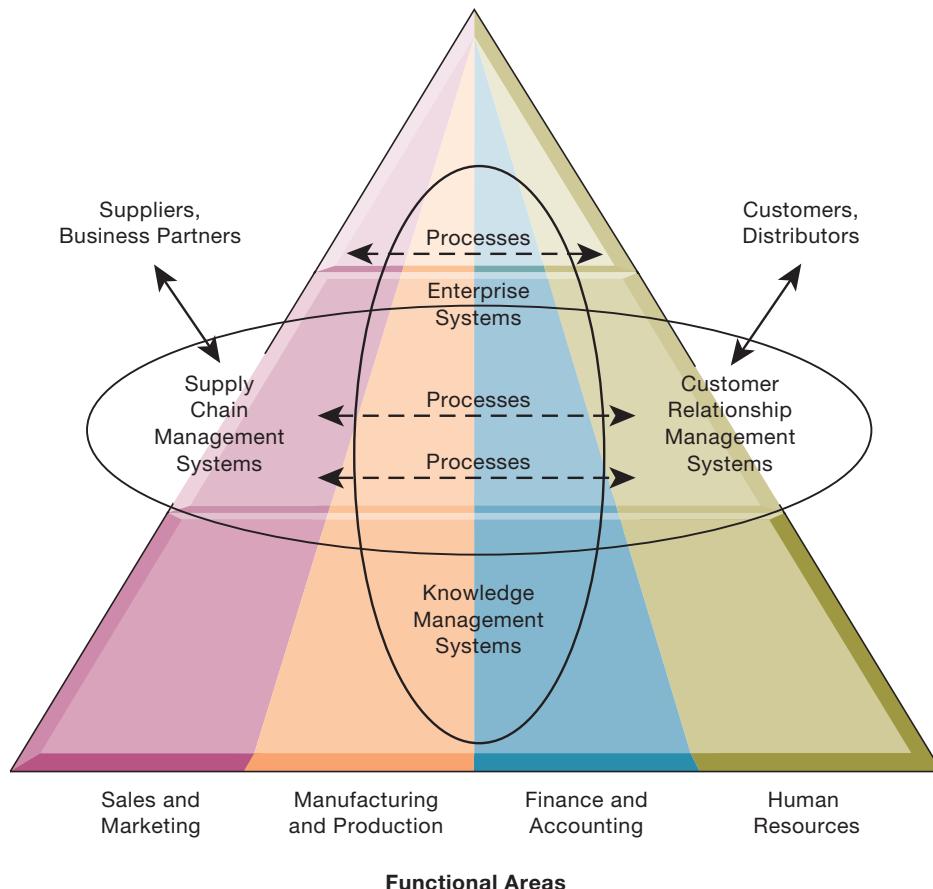
Enterprise Applications

Getting 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 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 business firm, and include all levels of management. Enterprise applications help businesses become more flexible and productive by coordinating their business processes more closely

Figure 2.9
Enterprise Application Architecture.

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



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 2.9 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 systems is stored in a single comprehensive data repository where it can be used by many parts of the business.

For example, when a customer places an order, the order data flow automatically to other parts of the company that they affect. 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 can use firmwide information to make more precise and timely decisions about daily operations and longer-term planning.

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 that they can source, produce, and deliver goods and services efficiently. The ultimate objective is to get the right number of their products from their source to their point of consumption in the shortest 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 firms 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 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 do because they have better knowledge about how to create, produce, and deliver products and services. **Knowledge management systems (KMS)** 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 knowledge management along with systems for collaboration in Section 2-3.

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. Extranets are company websites that are accessible to authorized vendors and suppliers and often used to coordinate the movement of supplies to the firm's production apparatus.

For example, Bank of America North America maintains a Human Resources intranet that helps employees take advantage of all the benefits available to them. Employees can review benefit plans, track time worked and time off, and learn about the bank's employee career development and training resources. 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 by using networks and the Internet. So much business is now enabled by or based on digital networks that we use the terms *e-business* and *e-commerce* frequently throughout this text.

At the beginning of the millennium, the central government of Japan set a mandate for its agencies to make the transition toward e-governance. For the Japanese government, going digital meant establishing effective organizational and governance frameworks; its agencies had to digitize administrative procedures, disseminate data electronically, provide services online, and update information security measures. At the same time, it needed to actively engage citizens and businesses in the process and collect their inputs across a range of channels. These initiatives paid off, and by 2018, Japan was ranked 10 among the 193 countries in the United Nations' e-government survey.

The 2020 Olympic and Paralympic Games, commonly known as Tokyo 2020, offered the Japanese government a chance to advance the city's telecommunication infrastructure and improve public services through public-private cooperation. By collaborating with the private sector, the government could not only gain access to the latest information and communication technologies but also reduce its financial risk in the large investments necessary for IT infrastructure and new technology.

Tokyo 2020 has accelerated the introduction of the fifth-generation (5G) telecommunication networks in the country, with the Japanese government approving plans by mobile carriers such as NTT DoCoMo to build 5G wireless networks and develop applications for widespread adoption. These networks offer massive device connectivity, low latency, and ultra-high speed data transmission of two gigabits per second. One of the immediate beneficiaries is national television network NHK, which will be able to broadcast real-time 8K—up to 7,680 by 4,320 pixels—high-definition 360-degree video streams recorded by drones floating around the competition arenas at Tokyo 2020.

The number of foreign visitors to Japan is expected to increase from 28.7 million in 2017 to 40 million by 2020, boosted by the 2020 Olympic and Paralympic Games. To handle the huge number of visa applications from tourists, the Japanese government is introducing an online service. Instead of having to submit the necessary application forms and multiple supplementary documents (such as income tax returns or bank certificates) in person to a Japanese embassy or consulate, foreign visitors will be able to submit their application

online through the new Electronic Visa System. The fees can be paid electronically too. The system is capable of automatically evaluating the information provided by the applicant, thus simplifying and streamlining the visa application and issuance processes.

NEC Corporation has designed an identity verification system specifically for the sports event to quickly process the over 300,000 authorized athletes, workers, volunteers, and journalists entering the various venues of Tokyo 2020, which are widely scattered across the Tokyo metropolitan area. The system works by collecting the facial image of each authenticated participant beforehand and storing it in a database. Each participant is given an identity lanyard equipped with an integrated circuit chip that stores their facial image. To enter a venue, the participant must scan the identity lanyard at a kiosk at the security checkpoint. The system determines whether the user is an accredited attendee within 0.3 seconds by comparing the photo on the identity lanyard with their facial image captured by a high-quality camera at the kiosk. The system is expected to significantly shorten the time spent in identity checks and greatly increase security levels by eliminating identity forgery as well as the use of lost or stolen identification passes. In the future, this technology can be rolled out in other venues, such as government premises, or for processes such as immigration clearance.

The Tokyo Metropolitan Police will use the Crowd Forecasting System, developed by Panasonic, to ease congestion caused by the tens of thousands of overseas spectators attending Tokyo 2020. The system monitors the flow of pedestrians and vehicles around competition arenas at the end of an event by analyzing images uploaded to the cloud from cameras installed on police vehicles parked and patrolling—if the traffic allows—throughout the city. The Crowd Forecasting System informs spectators about forecast outcomes and guides them to less crowded exits through instructions on electronic signs as well as messages sent to their phone. The system also helps to identify abnormal situations or suspicious activities for the police to investigate immediately.

The summer heat in Tokyo can be fatal not only to athletes but also to workers and spectators at the outdoor endurance events in Tokyo 2020. The Japan Meteorological Agency has developed the Heatstroke Warning System to reduce the risk of

this illness among attendees as well as the general public by sending alerts to their mobile phones. Through big data analysis of heat index information from the Ministry of the Environment, crowd forecast data, and real-time weather data from Yahoo! Japan, the system can forecast the heatstroke risks in specific geo-units of about 125 square meters each. The system will issue warnings if the temperature is over 28 degrees Celsius and danger alerts if it is above 31 degrees Celsius so that the public and the workers of Tokyo 2020 can take heat countermeasures.

Sources: Futurism, Y. Rirou, "One Year Countdown: Readyng AI Security for the Tokyo 2020 Olympics," July 20, 2019, syncedreview.com; J. Ryall, "Games Changer: Technology That Will Innovate the Olympics in 2020," September 2018, journal.accj.or.jp; Futurism, "Tokyo 2020: The Olympics of the Future," 2016, futurism.com; Japan Gov, "The Government of Japan," JapanGov, www.japan.go.jp, accessed October 9, 2019; OECD, "Japan," *The Governance of Inclusive Growth: An Overview of Country Initiatives* (Paris: OECD Publishing, 2016); Tokyo 2020, tokyo2020.org, accessed October 9, 2019; Visa Japan, www.visasjapan.com, accessed October 9, 2019.

CASE STUDY QUESTIONS

1. Describe the identity verification system and describe the inputs, business processes, and outputs of the system.
2. Discuss how these IT applications strengthen the relationship between citizens and their government.
3. What are the implementation challenges of these systems? How can they be addressed?
4. What people, organization, and technology factors contributed to development of these IT applications?

Case contributed by Joyce Chan, City University of Hong Kong

E-business, or **electronic 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 **e-commerce**, or **electronic commerce**. E-commerce is the part of e-business that deals with buying and selling 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 enable government and public sector agencies' relationships with citizens, businesses, and other arms of government digitally. In addition to improving delivery of government services, e-government can make empower citizens by giving them easier access to information and the ability to network with other citizens. The Interactive Session on Organizations describes how organizing the Olympic Games has contributed to e-government development in Japan.

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

With all these systems and information, how do people make sense of them, 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 knowledge management.

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 within a business or other organization and between businesses. You collaborate with a colleague in Tokyo who has expertise in 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 pre-computer office work, when each stage in the production process occurred independently of one another and was coordinated by supervisors. Work was organized into silos, and passed from one machine tool station to another, from one desktop to another, until the finished product was completed. Today, the kinds of jobs we have require much closer coordination and interaction among the parties involved in producing the service or product. The consulting firm McKinsey and Company has argued that 41 percent of the U.S. labor force is now composed of jobs in which interaction (talking, emailing, presenting, and persuading) is the primary value-adding activity (McKinsey, 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 sharing information and opinions to get work done. Each actor on the job brings specialized expertise to the problem, and all the actors need to consider one another 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, which 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 spread from a single location to occupying 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 2019, 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 teams to work 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, respectively), 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?

Today, many firms are enhancing 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*. Organizations are networks of conversations (Zaffron and Unruh, 2018). 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 into these conversations, they will 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. Chapter 10 will describe social business applications relating to customers and suppliers outside the company.

BUSINESS BENEFITS OF COLLABORATION AND SOCIAL BUSINESS

Although many articles and books have been written about collaboration, nearly all the research on this topic is anecdotal. Nevertheless, among both business and academic communities, there is a general belief that the more collaborative a business firm is, the more successful it will be and that collaboration within and among firms is more essential than in the past. 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

TABLE 2.2

Applications of Social Business

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, co-create content
Blogs and wikis	Publish and rapidly access knowledge; discuss opinions and experiences
Social commerce	Share opinions about purchasing or purchase 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

investment, with the greatest benefits for sales, marketing, and research and development functions (Frost and Sullivan, 2009). McKinsey & Company consultants predicted that social technologies used within and across enterprises could raise the productivity of interaction workers by 20 to 25 percent (McKinsey, 2015).

Table 2.3 summarizes some of the benefits of collaboration and social business that have been identified. Figure 2.10 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 if there is no supportive culture or business processes for knowledge-sharing and innovating in diverse and geographically distributed teams (Magni and Maruping, 2019). Large business firms in the past were largely command-and-control organizations in which 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. Lower-level employees carried out orders without asking too many questions, with

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 correct 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. 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 these factors, collaborative firms have superior sales, sales growth, and financial performance.

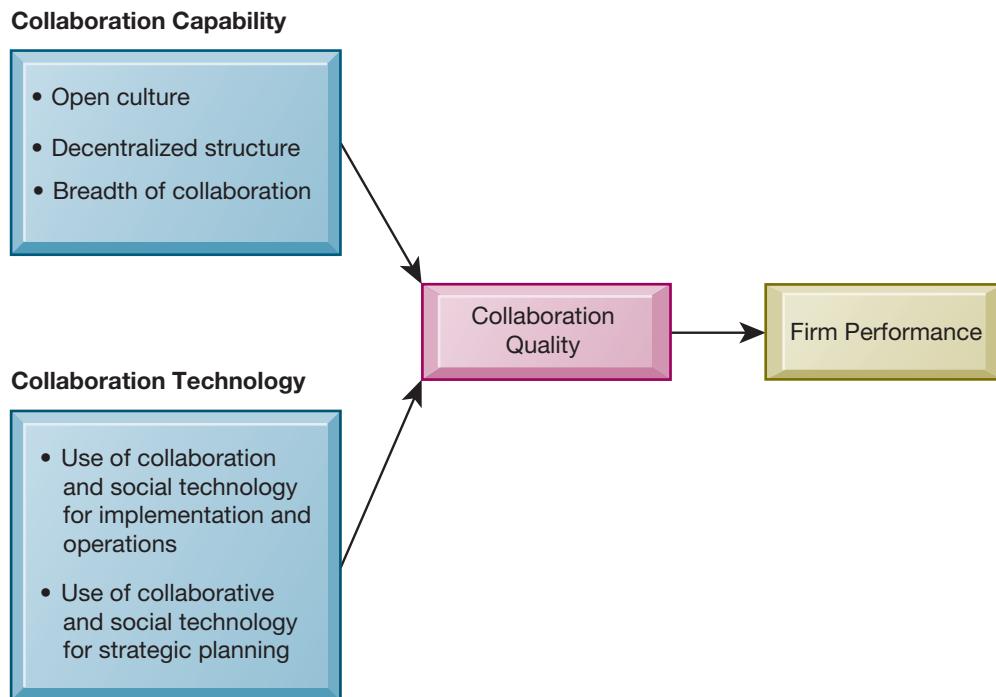


Figure 2.10
Requirements for Collaboration.

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

no rewards for teamwork or team performance. If your workgroup 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. Many business firms still operate this way.

With collaborative business culture and business processes, 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 and social business. Currently, hundreds of tools are designed for this purpose. Some of these tools are expensive, but others are available online for free (or with premium versions for a modest fee) and are suitable for small businesses. 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 and wireless mobile 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, and messaging and social media have become 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 repeatedly.

Virtual Worlds

Virtual worlds, such as Second Life, are online 3-D environments populated by residents who have built graphical representations of themselves known as avatars. Companies such as IBM, Cisco, and Intel Corporation have used this virtual world for online 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 box conversations, and voice communication.

Collaboration and Social Business Platforms

There are now suites of software products providing multifunction platforms for collaboration and social business among teams of employees who work together from many locations. The most widely used are Internet-based audioconferencing and videoconferencing systems, cloud collaboration services such as Google's online services and tools, corporate collaboration systems such as IBM Notes and Microsoft SharePoint, and enterprise social networking tools such as Salesforce Chatter, Microsoft Yammer, Jive, Facebook Workplace, and IBM Connections.

Virtual Meeting Systems In an effort to reduce travel expenses, many companies, both large and small, are adopting videoconferencing and web conferencing technologies. Companies such as Heinz, General Electric, and PepsiCo are using virtual meeting systems for product briefings, training courses, and strategy sessions.

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 (see the Interactive Session on Technology). Free or low-cost Internet-based systems such as Skype for Business, Google Hangouts Meet, and Amazon Chime are lower quality but still useful for smaller companies. Apple's FaceTime is useful for one-to-one or small group videoconferencing. Some of these tools are available on mobile devices.

Companies of all sizes are finding web-based online meeting tools such as Cisco WebEx, Skype for Business, GoToMeeting, and Adobe Connect especially helpful for training and sales presentations. These products enable participants to share documents and presentations in conjunction with audioconferencing and live video.

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 web-based 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

INTERACTIVE SESSION: TECHNOLOGY

Videoconferencing: Something for Everyone

When it comes to collaboration, videoconferencing is becoming a tool of choice for organizations of all sizes. In the past, videoconferencing was limited to the very largest companies that could afford dedicated videoconference rooms and expensive networking and software for this purpose. Today, videoconferencing has been democratized. There's something for everyone.

The cost of the technology has radically fallen; global Internet and desktop transmission of video and audio data is affordable. There are inexpensive mobile and desktop tools as well as high-end videoconferencing and telepresence systems to manage business processes and to connect and collaborate with others—even customers—around the globe.

The current generation of telepresence platforms provide much more than video collaboration, with the ability to coordinate multiple rich data streams that integrate digital information from mobile, desktop, and video; create a collaborative environment; and move the information to where managers and professionals are making decisions. Cisco's IX5000 immersive telepresence system is an example. It offers leading-edge telepresence, but it's more affordable and easier to use than in the past. High-definition video and theater-quality sound create a high-quality lifelike collaboration experience for 8 to 18 people. The camera and graphic processors are able to capture the whole room in fine detail, so you can stand up and move around or go to the whiteboard. Images can be cropped to show participants seated behind their tables, but when someone stands up, the crop is removed to show both standing and sitting participants. Installing the IX500 system requires no special changes to a room, and it needs only half the power, installation time, and data transmission capacity (bandwidth) as previous telepresence systems. A six-seat IX5000 studio lists for \$299,000, while the 18-seat studio costs \$339,000.

Zoom has emerged as a powerful videoconferencing tool with many features of high-end systems but is much less expensive and easier to use. Zoom is a cloud platform for online video and audio conferencing, collaboration, chat, screen-sharing, and webinars across mobile devices, desktops, telephones, and room systems. Zoom allows you to conduct a video meeting or webinar directly from your computer, mobile device, or Zoom Configured conference room. Zoom software is

available in a number of different price and packaging models. There is a free Basic version for short personal meetings with a maximum of 100 participants, and more full-featured business versions ranging from \$14.99 to \$19.99 per month per online meeting host. Zoom can accommodate up to 1,000 video participants and 10,000 viewers.

The two core pieces of Zoom technology are Zoom Meetings and Zoom Rooms. Zoom Meetings supports online, video-hosted meetings that are free to join for users with Zoom video conferencing software installed on their computer or mobile device. Participants can join Zoom Meetings from different locations, regardless of whether they're joining the meeting from home, in a conference room in the office, or on their mobile phone. Zoom Rooms consist of hardware and software technology to power physical conference rooms. Zoom Meetings can be activated with just a tap of the button on a tablet. All of the video and audio is integrated into the conference room equipment and calendar systems.

Austin, Texas-based Nepris is a web-based service that connects teachers and industry experts to make curriculum topics more relevant for students. Nepris uses Zoom for this purpose. Employees in major corporations typically lack the time to visit many different classrooms personally. The Zoom videoconferencing software is easy for teachers to use and to install, and can work on almost any device, including tablets, smartphones, or desktop computers. Industry experts can use Zoom to share what's on their screens, such as presentations or demonstrations of certain processes.

Zoom can provide high-quality video streaming but it can also scale down to lower video resolutions if classrooms lack the transmission capacity for high-end video. Nepris also finds Zoom useful for connecting teachers, students, and experts in a way that compensates for their busy schedules. Zoom allows up to 25 video streams to join a meeting, so that multiple classrooms can interact with an industry expert at the same time. Users can also record a Zoom meeting for later use. Industry experts do not need to stay all day or travel to different schools for their presentations.

FCTI is a leading US ATM (automatic teller machine) network and service provider, with headquarters in Los Angeles and an office in Las Vegas. It also collaborates with contractors in Guadalajara, Mexico. FCTI was recently acquired

by Seven Bank in Japan, further increasing the need for long-distance communication and collaboration. FCTI believed videoconferencing would help employees collaborate more effectively than email, text messaging, or phone calls. It had tried to host video conferences with an Internet video call service, but this required too many configurations to use the product. There were constant dropped connections and the quality of the video was quite low.

FCTI adopted Zoom to make video conferencing more streamlined, easier, and affordable. Management especially appreciates the high-quality video Zoom delivers. FCTI now hosts board meetings on Zoom every month from conference

rooms built at a fraction of the cost of high-end, enterprise-class telepresence rooms. Zoom's tablet and smartphone compatibility enables participants to join conferences from remote locations. For instance, some FCTI employees at busy airports have joined Zoom conferences using their tablets and were able to collaborate in smooth, high-definition video. Board meetings can take place even if some participants' airline flights are delayed or cancelled.

Sources: "Leading ATM Provider Builds Employee Relationships Through Video" and "Nepris Inspires Students Through Zoom," www.zoom.us.com, accessed April 24, 2019; "'Less Is More' as Cisco Completely Reimagines Flagship Three-Screen Video Conferencing Technology" and "Cisco Telepresence IX5000 Series," www.cisco.com, accessed March 20, 2019; www.ivci.com, accessed March 20, 2019.

CASE STUDY QUESTIONS

1. Compare the capabilities of the videoconferencing tools described in this case. How do they promote collaboration and innovation?
2. How is videoconferencing related to the business models and business strategies of the organizations described in this case?
3. Describe the specific ways in which videoconferencing technology helped each of the organizations in this case improve their operations and decision making.

of storage space and administration required. Users can 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 by 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 through 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 quickly and efficiently while working together closely on tasks, projects, and documents. Enterprise search tools help locate people, expertise, and content. SharePoint now features social tools.

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.

TABLE 2.4

Enterprise Social Networking Software Capabilities

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, Jive, 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 many companies have benefited from enterprise social networking, internal social networking has not caught on as quickly as consumer uses of Facebook, Twitter, and other public social networking products. The chapter-ending case addresses this topic.

Checklist for Managers: Evaluating and Selecting Collaboration Software Tools

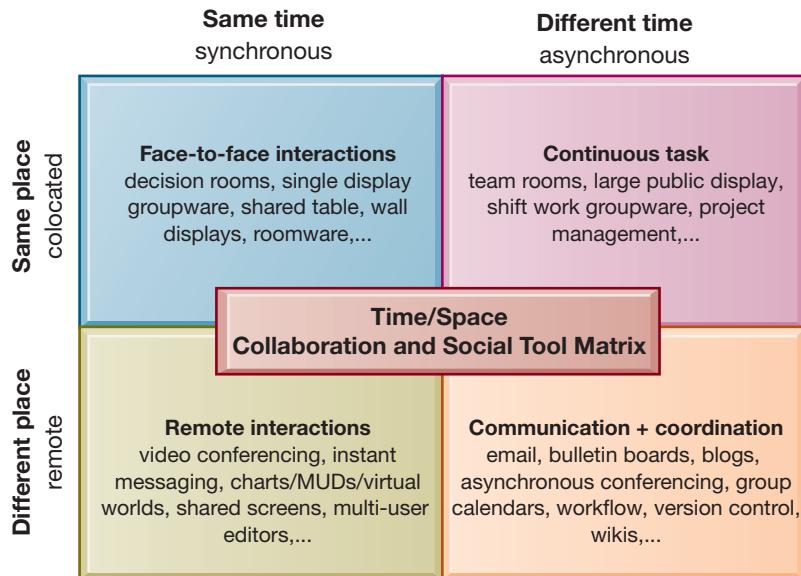
With so many collaboration tools and services available, how do you choose the right collaboration technology for your firm? You need a framework for understanding just what problems these tools are designed to solve. One framework that has been helpful for us in talking about collaboration tools is the time/space collaboration and social tool matrix developed by a number of collaborative-work scholars (Figure 2.11).

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

Figure 2.11

The Time/Space Collaboration and Social Tool Matrix.

Collaboration technologies can be classified in terms of whether they support interactions at the same or different time or place and whether these interactions are remote or colocated.



Bombay, so this makes it difficult to have a video conference. 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 technologies described previously are ways of overcoming the limitations of time and space. Using this time/space framework will help you 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 their cost and benefits to your firm. Be sure to include the costs of training and the costs of involving the information systems department in your cost estimates 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 risk its important operations in systems that other firms control? 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 are.
6. Make your selection of candidate tools, and invite the vendors to make presentations.

In addition to selecting the right digital tools for communication and collaboration, organizations need to make sure the tools actually support productive ways of

working. Access to technology alone often can't fix poorly designed business processes and entrenched organizational behaviors (Dodge et al., 2018).

SYSTEMS FOR KNOWLEDGE MANAGEMENT

Collaboration and knowledge-sharing will be less effective and efficient if the requisite knowledge for collaboration, decision-making, and ongoing operations is not available. Knowledge management systems, which we introduced earlier in this chapter, are a specific capability for addressing this need.

Some knowledge exists within the firm in the form of **structured knowledge**, consisting of formal text documents (reports and presentations). According to experts, however, at least 80 percent of an organization's business content is semistructured or unstructured—information in folders, messages, memos, proposals, emails, graphics, chat room exchanges, electronic slide presentations, and even videos created in different formats and stored in many locations. 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** and is rarely written down. Enterprise-wide knowledge management systems feature capabilities for storing and searching for all of these different types of knowledge and for locating employee expertise within the firm.

Enterprise Content Management Systems

Enterprise Content Management (ECM) systems help organizations manage structured, semistructured, and unstructured types of information. They have capabilities for knowledge capture, storage, retrieval, distribution, and preservation. 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 2.12). Major ECM systems also enable users to access external sources of information, such as news feeds and research, and to communicate by email, chat/instant messaging, discussion groups, and videoconferencing. They are starting to incorporate blogs, wikis, and other enterprise social networking tools.

A key problem in managing knowledge is the creation of an appropriate classification scheme to organize information into meaningful categories. 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. ECM systems have capabilities for tagging, interfacing with corporate data repositories where the documents are stored, and creating an enterprise portal environment for employees to use when searching for corporate knowledge. Open Text, EMC, IBM, and Oracle are leading vendors of enterprise content management software.

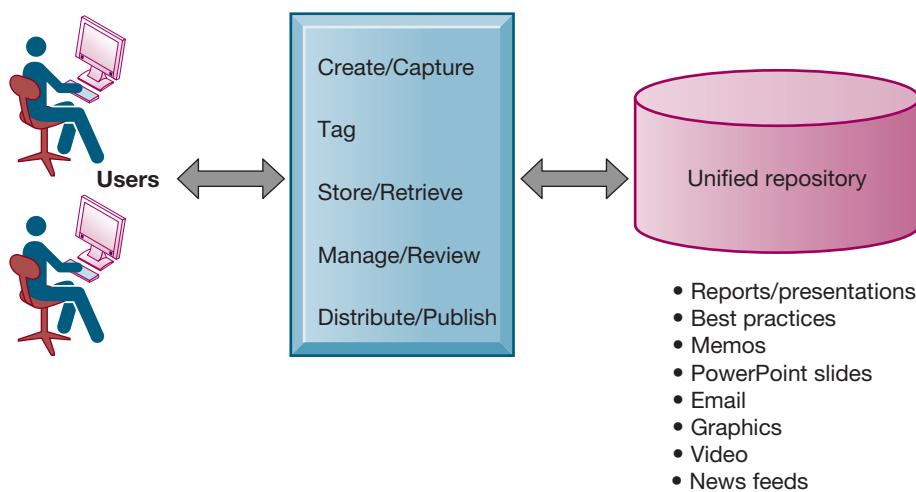


Figure 2.12
An Enterprise Content Management System.
An enterprise content management system has capabilities for classifying, organizing, and managing structured and semistructured knowledge and making it available throughout the enterprise.

Locating and Sharing Expertise

Some of the knowledge that 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, 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.

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 kinds of systems, but who is responsible for running these systems? End users manage their systems from a business standpoint, but managing the technology requires a special information systems function. 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

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. External specialists, such as hardware vendors and manufacturers, software firms, and consultants, also 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 integrating technology with 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). (Where information systems security is separated from physical security, this position is sometimes called the chief information security officer [CISO].) 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 usage of information to maximize the value of the organization's data. The CDO ensures that the firm is collecting 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 massive amounts of data that 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 SYSTEMS SERVICES

Services the information systems department provides include the following:

- Computing services connect employees, customers, and suppliers into a coherent digital environment, including large mainframes, desktop and laptop computers, and mobile handheld devices.
- Telecommunications services provide data, voice, and video connectivity to employees, customers, and suppliers.
- Data management services store and manage corporate data and provide capabilities for analyzing the data.
- Application software services provide development and support services for the firm's business systems.
- IT management services 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 provide the firm and its business units with policies that determine not only which information technology will be used but when and how it is used.
- IT educational services provide training in system use to employees and IT specialists.
- IT research and development services provide the firm with research on potential future information systems projects and investments that could help the firm differentiate itself in the marketplace.

In the past, firms generally built their own software and managed their own computing facilities. As our discussion of collaboration systems has shown, many firms are turning to external vendors and Internet-based services to provide these services (see also Chapters 5 and 12) and are using their information systems departments to manage these service providers.

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, a leading global provider of individual supplemental accident, disability, health, and life insurance products headquartered in Amsterdam, 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 more than 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
- Bachelor's degree or two years' equivalent experience

INTERVIEW QUESTIONS

1. What do you know about our company? Our commitment to technology? Have you been following us on press releases, LinkedIn, and our company Twitter account?
2. What do you know about customer relationship management? Have you ever worked with Salesforce.com? If so, what have you used the system for?
3. What do you know about data management? Have you ever worked with data management software? If so, what exactly have you done with it?
4. Tell us what you can do with Excel. What kinds of problems have you used Excel to solve? Did you take courses in Excel?
5. Have you ever worked in customer service? What exactly did you do? What do you think it takes to successfully take on a client-oriented role for this company's agents and customers?
6. 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 to research 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 at this firm. 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 that you would like to learn more about Salesforce and work with this tool to support the sales function for the company.
4. Ask exactly how you would be using Excel, for example, calculating agent commissions. If you've never done that before, describe some of the Excel work you have done (and perhaps bring examples with you to the interview).

Review Summary

2-1 **What major features of a business are important for understanding the role of information systems?** A business is a formal, complex organization producing products or services for a profit. Businesses have specialized functions such as finance and accounting, human resources, manufacturing and production, and sales and marketing. Business organizations are arranged hierarchically into levels of management. A business process is a logically related set of activities that define how specific business tasks are performed. Business firms must monitor and respond to their surrounding environments.

2-2 **How do systems serve 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. Business intelligence systems serve multiple levels of management and help employees make more informed decisions. Management information systems (MIS) and decision-support systems (DSS) support middle management. Most MIS reports condense information from TPS and are not highly analytical. DSS support management decisions that are unique and rapidly changing, using advanced analytical models and data analysis capabilities. Executive support systems (ESS) support senior management by providing data that are often in the form of graphs and charts delivered in portals and dashboards 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 (SCM) 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. Extranets make portions of private corporate intranets available to outsiders.

2-3 **Why are systems for collaboration, social business, and knowledge management so important, and what technologies do they use?** Collaboration means 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 platforms such as Microsoft SharePoint and IBM Notes, and enterprise social networking tools such as Chatter, Yammer, Jive, and IBM Connections. Knowledge management systems such as enterprise content management systems help organizations collect, store, and distribute the requisite knowledge for collaboration, decision-making, and ongoing operations.

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 chief information officer (CIO).

Key Terms

Business, 67	E-government, 81	Knowledge workers, 70
Business intelligence, 74	Electronic business (e-business), 81	Management information systems (MIS), 74
Business processes, 68	Electronic commerce (e-commerce), 81	Middle management, 70
Chief data officer (CDO), 93	End users, 93	Operational management, 70
Chief information officer (CIO), 92	Enterprise applications, 77	Portal, 76
Chief knowledge officer (CKO), 93	Enterprise content management (ECM) systems, 91	Production or service workers, 70
Chief privacy officer (CPO), 92	Enterprise systems, 78	Programmers, 92
Chief security officer (CSO), 92	Executive support systems (ESS), 76	Senior management, 70
Collaboration, 82	Information systems department, 92	Social business, 83
Customer relationship management (CRM) systems, 79	Information systems managers, 92	Structured knowledge, 91
Data workers, 70	Interorganizational system, 79	Supply chain management (SCM) systems, 78
Decision-support systems (DSS), 74	Knowledge management systems (KMS), 79	Systems analysts, 92
Digital dashboard, 77		Tacit knowledge, 91
		Teams, 82
		Telepresence, 86
		Transaction processing systems (TPS), 73

Review Questions

- 2-1** What major features of a business are important for understanding the role of information systems?
- Define a business and describe the major business functions.
 - Describe with examples how business processes are tied to the specific functional area of an organization.
 - Identify and describe the different levels in a business firm and their information needs.
 - Explain why environments are important for understanding a business.
- 2-2** How do systems serve different management groups in a business, and how do systems that link the enterprise improve organizational performance?
- Describe the characteristics of business intelligence and explain why it is important in terms of decision making.
 - Describe the characteristics of transaction processing systems (TPS) and the role they play in a business.
 - Describe the characteristics of management information systems (MIS), decision support systems (DSS), and executive support systems (ESS) and explain how each type of system helps managers make decisions.

- 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, social business, and knowledge management so important, and what technologies do they use?

- List the ways businesses have changed working conditions, procedures, and systems to encourage social business.
- Explain the purpose and the mission of a team within a business organization.
- Distinguish between horizontal and vertical communication in an organization.
- List and describe the various types of collaboration and social business tools.
- Describe how knowledge management systems help organizations make better use of their structured, semistructured, and unstructured knowledge and also their tacit knowledge assets.

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 programmers, systems analysts, information systems managers, the chief information officer (CIO), chief security officer (CSO), chief data officer (CDO), chief privacy officer (CPO), and chief knowledge officer (CKO) play.

MyLab MIS™

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

Discussion Questions

2-5 How could information systems be used to support the order fulfillment process illustrated in Figure 2.2? What are the most important pieces of information these systems should capture? Explain your answer.

2-6 Identify the steps that are performed in the process of selecting and checking out a book from your college library and the

information that flows among these activities. Diagram the process. Are there any ways this process could be adjusted to improve the performance of your library or your school? Diagram the improved process.

2-7 Use the Time/Space Collaboration and Social Tool Matrix to classify the collaboration and social technologies Sharp Corporation uses.

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 about suppliers based on several 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 the items 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

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

You have just started working as a dispatcher for Cross-Country Transport, a new trucking and delivery service based in Germany. Your first assignment is to plan a delivery of office equipment and furniture from Berlin to Leipzig. To guide your trucker, you need to know the most efficient route between the two cities. Use MapQuest to find the route that is the shortest distance between

the two cities. Use MapQuest 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-I2** With a team of three or four other students, find a description of a manager in a corporation in *Forbes*, *Fortune*, *Wall Street Journal*, 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 that 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.

BUSINESS PROBLEM-SOLVING CASE

SHOULD COMPANIES EMBRACE SOCIAL BUSINESS?

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.

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 e-mail 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 ModCloth, a popular online apparel, accessories, and home décor retailer noted for its fun and engaging customer shopping experience. The company's business is based on strong social media ties with customers, with 134,000 Twitter followers and 1,600,000 Facebook "likes." Because social networks played such a large role in ModCloth's growth and development, the company was eager to adopt social networking tools for internal communication. ModCloth adopted Microsoft's Yammer as its social business tool.

ModCloth started piloting Yammer with a small test group and used a People Team to promote the tool. Yammer caught on quickly with employees and was soon being used by over 250 employees across four offices in the United States. Every new ModCloth employee is introduced to Yammer on that person's first day of work. Yammer helps new hires learn their co-workers' names and feel they are part of the company.

Yammer has proved very useful for connecting people and ideas, saving ModCloth considerable time and money. For example, Scott Hernandez, ModCloth Head of Talent Acquisition, has used Yammer to

identify promising hires for engineering through referrals from ModCloth employees. Yammer has helped save teams from duplicating work that has already been done. ModCloth's User Experience group began designing a research campaign to find out what users wanted in mobile applications for the company, posting news of the project to Yammer. Within hours a member of ModCloth's Social Team posted the results of an already completed large user survey on mobile expectations, including a detailed spreadsheet with customer feedback data. The User Experience team was able to save two weeks of work.

The Esquel Group, based in Hong Kong, is a supplier of cotton textiles and apparel, doing everything from cotton farming and fabric production to garment manufacturing and finishing. Its core business is making cotton tops for fashion brands such as Lacoste, Ralph Lauren, and Nike. This company was attracted to internal social networking as a way to unite its different lines of business in various locations. Esquel chose Microsoft Yammer as its enterprise social networking tool. Esquel's employees communicate in a variety of languages, so it especially appreciated Yammer's translation capabilities.

Management sees many benefits in being able to "listen" to its workforce. When people post complaints on the network, it is able to find innovative solutions and new ideas. For example, workers in Esquel's garment operation posted a complaint on Yammer about having to wait in a long line to recharge their cards for purchasing meals in the company cafeteria. Four months later, the company had a solution—a kiosk that instantly transferred funds from payroll to the meal card.

Ideas posted on Yammer were used to improve Esquel's quality control process. Instead of using measuring tape to ensure that sleeves and collars matched specifications, an employee in the quality control department used Yammer to float the idea of an electric ruler. The concept was refined through more Yammer discussion. Instead of taking measurements and writing numbers down, staff can capture measurements faster and more accurately electronically.

Yammer also helps Esquel replicate innovation- and efficiency-promoting solutions throughout the company. An innovation at one site often is not rolled out to other locations. Yammer provides a channel for news of innovations and better practices to spread more easily throughout the organization.

Esquel's industry is one where companies often move to lower-wage countries as labor costs rise. Rather than relocating operations, Esquel prefers to achieve savings through improvements in productivity. By helping employees work more efficiently and effectively, business social networking has helped Esquel save approximately \$2 million each year.

Sources: "Duha Group Innovates by Inviting Their Customers into the Manufacturing Process Using Salesforce," www.salesforce.com, accessed March 26, 2019; "ModCloth: Keeping Employees Engaged While Scaling Up," <https://media.featuredcustomers.com>, accessed April 11, 2019; "Esquel Group: Social Technology Weaves an Enterprise Together," blogs.office.com, accessed February 7, 2018; Sheila Dodge, Don Kieffer, and Nelson P. Repenning. "Breaking Logjams in Knowledge Work," *MIT Sloan Management Review*, Fall 2018. Margaret Jones Cordelia Kroob, "The Growth of an Enterprise Social Network at BASF," www.simply-communicate.com, accessed March 12, 2018; Paul Leonardi and Tsedal Neeley, "What Managers Need to Know About Social Tools," *Harvard Business Review*, November–December 2017; Arunima Majumdar, "3 Reasons Why Collaboration Tools Fail to Make the Indented Impact," *eLearning Industry*, January 20, 2017; Harvard Business Review Analytic Services, "Collaboration Technology Boosts Organizations," Insight Enterprises Inc. (February 13, 2017); and Dimension Data, "2016 Connected Enterprise Report," 2016.

CASE STUDY QUESTIONS

- 2-13** Identify the people, 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 were some 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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Achieving Competitive Advantage with Information Systems

LEARNING OBJECTIVES

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

- 3-1** How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network-based strategies help companies use information systems for competitive advantage?
- 3-2** How do information systems help businesses compete globally?
- 3-3** How do information systems help businesses compete using quality and design?
- 3-4** What is the role of business process management (BPM) in enhancing competitiveness?
- 3-5** How will MIS help my career?

CHAPTER CASES

- N26: A Bank Without Branches
- Singapore as a Smart Nation
- Strategic Information Systems at Hong Kong Disneyland
- 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

N26: A BANK WITHOUT BRANCHES

N26, a mobile bank, was founded in 2013 by Valentin Stalf and Maximilian Tayenthal. Since its launch in January 2015, N26 has built a network of 3.5 million customers in 24 European countries. In total, N26 has raised over \$500 million from investors and, with a market value of over \$3 billion, it is the most valuable FinTech startup in Europe. N26 is one of the few FinTech banks that is hosted entirely in the cloud on a single system.

Banks have always been an attractive target for criminals, and their IT systems get more than their fair share of cyber-attacks. To limit the damage in the event of an attack, a bank's systems are designed as a distributed IT landscape. Banks 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. In the modern mobile economy, this can be an important competitive advantage.

Stalf and Tayenthal conceived N26 as offering simplicity and customer-centric processes that could be used anywhere in the world. Based on this philosophy, 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.

As a mobile bank, N26 has encountered peculiar challenges that it did not anticipate. In 2016, there was a spate of account closures after a number of customers made one withdrawal too many—N26 offered no reason for the closure, causing even more confusion. The company was widely criticized for their handling of the situation, prompting them to introduce guidelines and limit the number of free withdrawals.

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

A common problem in online banking is phishing, and N26 has been a target as well: many of its customers have found themselves locked out of their accounts as a result of this. Individual phishing attacks led to widespread coverage in



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the media as customers demanded compensation from N26. In response, the company is investing heavily in the further development of security systems. Customers had also complained about a lack of support, so the number of customer service personnel was increased to over 600 people. Meanwhile, N26 is also looking into the ways AI can be integrated into its security.

Sources: N26 Corporation, "The N26 History," n26.com, accessed 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; 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 Finanzierungsgrunde in Höhe von 300 Millionen US-Dollar bekannt," APA-OTS, January 10, 2019; 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 by Handelsblatt, <https://orange.handelsblatt.com>, March 20, 2018; Emilie Rauschütz, "Ein Meilenstein bei N26—500 Angestellte," N26 Magazine, October 16, 2018; Jan Schulze-Siebert, "N26 Erfahrungen," [Youtube.com](https://www.youtube.com/watch?v=JyfXWVQHgjU), August 8, 2017.

Case contributed by Bernd Schenk, University of Liechtenstein

N26 is a good example of disruption across an entire industry. The banking sector is changing slowly compared to others, with many traditional services and processes that have yet to be virtualized. However, as cash balances and cash flows are increasingly mapped as data across the world, information systems are becoming vital to the banking sector and beginning to represent a core area of the organization. Banks in particular are relied upon to allow no mistakes and to ensure that their clients' money is protected in the best possible way. This contradicts the idea of the average start-up company, which usually has the scope to take risks, try out many things, offer new services, transform rapidly, and secure a good competitive position through speed and agility.

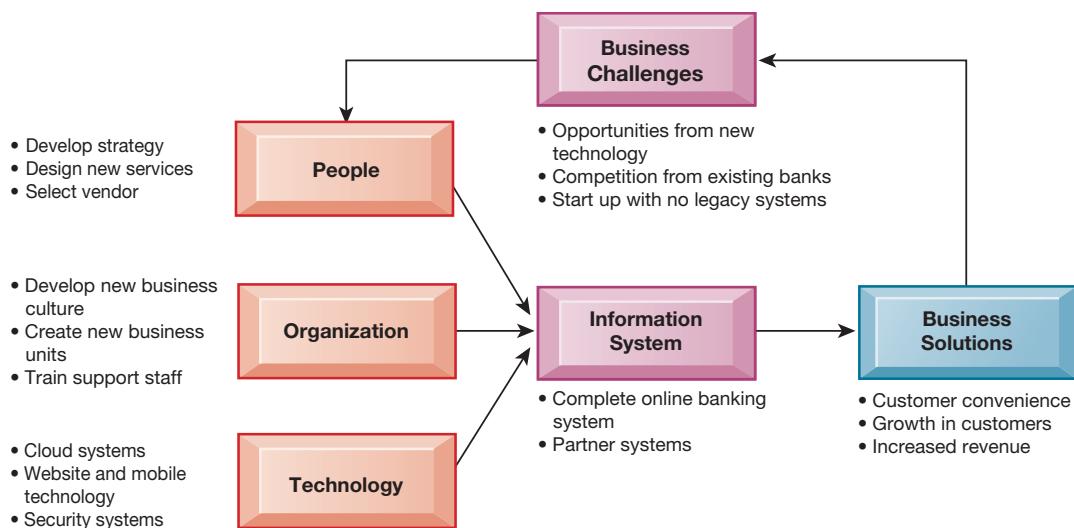
The chapter-opening diagram calls attention to important points raised by this case and this chapter. N26 is a pure-virtual player that decided at the outset that it would not open physical branches. The virtualization of the service is therefore a strategic decision. At the same time, the application is under constant development. N26's behavior is characterized by rapid learning and quick implementation of measures while continuously improving its services. AI is being used to further improve the security of N26's systems, while the mobile app uses the latest security technology, such as face recognition, to keep the app as user-friendly as possible.

Here are some questions to think about: What is N26's business strategy? What types of technology does N26 use to impress customers and differentiate itself from its competitors?

3-1 How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network-based strategies help companies use information systems for competitive advantage?

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

Firms that do better than others are said to have a competitive advantage. They either have access to special resources that others do not, or they 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 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? How do information systems contribute to strategic advantages? One answer to these questions 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 3.1). This model provides a general view of the firm, its competitors, and the firm's environment. Recall that in Chapter 2 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.

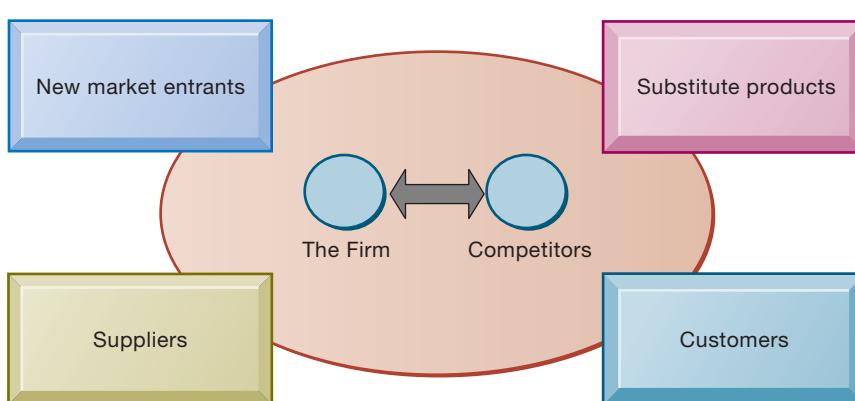


Figure 3.1

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 forces in the industry's environment: new market entrants, substitute products, customers, and suppliers.

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 is hard to obtain. New companies have several possible 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 hydropower for coal, oil, and gas electricity generation. Likewise, Internet telephone service has substituted for traditional telephone service, and streaming Internet music services for CDs, music stores, and digital download sites like iTunes. 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 suppliers can. The more suppliers a firm has, the greater control it can exercise over those suppliers in terms of price, quality, and delivery schedules. For instance, manufacturers of laptop PCs usually 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 faced with all these competitive forces? How can the firm use information systems to counteract some of these forces? How do you prevent substitutes and inhibit new market entrants? How do you become the most successful firm in an industry in terms of profit and share price (two measures of success)?

Basic Strategy 101: Align the IT with the Business Objectives

The basic principle of IT strategy for a business is to ensure that the technology serves the business and not the other way around. The research on IT and business performance has found that (a) the more successfully a firm can align its IT with its business goals, the more profitable it will be, and (b) only about one-quarter of firms

achieve alignment of IT with business. About half of a business firm's profits can be explained by alignment of IT with business (Luftman, 2003; Weill and Aral, 2005). Instead of taking an active role in shaping IT to the enterprise, most businesses 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.

So how do you as a manager achieve this alignment of IT with business? In the following sections, we discuss some basic ways to do this, but here's a summary:

- Identify your business strategy and goals.
- Break these strategic goals down into concrete activities and processes.
- Identify how you will measure progress toward the business goals (e.g., by using metrics).
- Ask yourself, "How can information technology help me achieve progress toward our business goals, and how will it improve our business processes and activities?"
- Measure actual performance. Let the numbers speak.

Let's see how this works out in practice. 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. 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 by 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 the items stocked in its stores to meet customer demands. By using systems to keep operating costs low, Walmart can charge less for its products than competitors yet reap higher profits.



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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 availability to meet customer demands.

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.

Product Differentiation

Use information systems to provide new products and services or greatly change the customer convenience in using your existing products and services. For instance, Google continuously introduces new and unique digital services, such as Google Pay peer payments, and improvements in Google Photos and Google Assistant in 2018. Apple has continued to differentiate its handheld computing products with nearly annual introductions of new iPhone and iPad models. Crayola is creating new digital products and services such as Lights, Camera, Color!, which allows children to turn their favorite photos into digital coloring book pages.

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 can select the type of shoe, colors, material, outsoles, and laces. Nike transmits the orders by computers to specially equipped plants in China and Korea. The sneakers take only 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**.

Table 3.1 lists a number of companies that have developed IS-based products and services that other firms have found difficult to copy.

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 that can be used to guide decision making. Analysis of such data drives one-to-one marketing by which personal messages can be created 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).

TABLE 3.1

IS-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 Music	Apple sells music from an online library of 50 million songs.
Golf club customization: Ping	Customers can select from more than 1 million golf club options; a build-to-order system ships their customized clubs within 48 hours.
Online person-to-person payment: PayPal.com	PayPal enables transfer of money between individual bank accounts and between bank accounts and credit card accounts.

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 provide new services and products.	Uber, Nike, Apple, Starbucks
Focus on market niche	Use information systems to enable a focused strategy on a single market niche; specialize.	Hilton Hotels, Harrah's
Customer and supplier intimacy	Use information systems to develop strong ties and loyalty with customers and suppliers.	Toyota Corporation, Amazon

TABLE 3.2

Four Basic Competitive Strategies

Strengthen Customer and Supplier Intimacy

Use information systems to tighten linkages with suppliers and develop intimacy with customers. Toyota, Ford, and other automobile manufacturers have information systems that give their suppliers direct access to their production schedules, enabling suppliers to decide how and when to ship supplies to the plants where cars are assembled. This allows suppliers more lead time in producing goods. On the customer side, Amazon.com keeps track of user preferences for all the products it sells, including book and music 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 or service to a competitor) and loyalty to your firm. Table 3.2 summarizes the competitive strategies we have just described.

As shown by the cases throughout this book, successfully using information systems to achieve a competitive advantage requires a precise coordination of technology, organizations, and people. Indeed, as many have noted with regard to Walmart, Apple, and Amazon, the ability to implement information systems successfully is not equally distributed, and some firms are much better at it than others are.

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 easier 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 often been dampened as a result of increased competition. Table 3.3 summarizes some of the potentially negative impacts of the Internet on business firms Porter has identified.

The Internet has nearly destroyed some industries and has severely threatened others. 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, and telecommunications 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, iTunes, YouTube, Facebook, Uber, 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 Internet-linked 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.

TABLE 3.3

Impact of the Internet on Competitive Forces and Industry Structure

Competitive Force	Impact of the Internet
Substitute products or services	Enables new substitutes to emerge with new approaches to meeting needs and performing functions
Customers' bargaining power	Shifts bargaining power to customers due to the availability of global price and product information
Suppliers' bargaining power	Tends to raise bargaining power over suppliers in procuring products and services; however, suppliers can 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

Nike, 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 computing centers where the data can be analyzed. Farm tractors are loaded with field radar, GPS transceivers, and hundreds of sensors keeping track of the equipment. GE created a new business out of 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's referred to as smart products—products that are a part of a larger set of information services sold by firms (Iansiti and Lakhani, 2014; Porter and Heppelmann, 2014; Gandhi and Gervet, 2016).

The impact of smart, Internet-connected products is just now being understood. Smart products offer new functionality, greater reliability, and more intense use of products. They expand opportunities for product and service differentiation, while providing opportunities for improving both the product and the customer experience. When you buy a wearable digital health product, you not only get the product itself, you also get a host of services available from the manufacturer's cloud servers. Smart products generally inhibit new entrants to a market simply because existing customers are enmeshed in the dominant firm's software environment. Finally, smart products may decrease the power of suppliers of industrial components if, as many believe, the physical product becomes less important than the software and hardware that make it run.

THE BUSINESS VALUE CHAIN MODEL

Although the Porter model is helpful for identifying competitive forces and suggesting generic strategies, it is not 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 advantage points at which 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 3.2).

Singapore is a small island at the southern tip of the Malay Peninsula with a population of 5.7 million. Over the second half of the last century, this tiny dot on the map has been well-known to the world for its astonishing economic development—it is now one of the countries with the highest GDP per capita in the world.

Singapore aims to transform itself into a smart nation by using information technology to reinvent itself. 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. In November 2014, Singapore's Prime Minister Lee Hsien Loong announced the Smart Nation initiative to make Singapore a sustainable, modern city, countering the pressures of increasing urban density and an aging population. Recently, Singapore has launched a national AI 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 travellers hit the road, they can now consult the Realtime Singapore Traffic Watch website or third-party mobile apps for traffic conditions and trends such as bus arrival timings.

Virtual Singapore is a dynamic 3D city model and data hub available to the general public, government bureaus, businesses, and research institutes to conduct long-term planning and virtual experiments. One of its applications is housing planning. Located one degree north of the Equator, the small and integrated city-state is consistently sunny, hot, and humid all year round. Virtual Singapore allows simulation of residential area planning that takes into consideration microclimate conditions for designing a comfortable living environment balancing the needs of a large population in a limited space: ventilation, energy conservation, and sufficient public open spaces. Pilot schemes have been rolled out in some public housing projects. Smart Towns will be equipped with

solar energy panels and smart lights, which light up or dim depending on whether they detect passers-by, thus saving energy. 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 adjust the service cycle of trash collection trucks through sensors.

Patients in Singapore may seek medical advice from healthcare professionals without leaving home through the Smart Health Video Consultation system. This is possible thanks to the wide coverage of stable, high-speed household Internet connections and the high smartphone penetration of the city. Patients in Singapore may also perform their rehabilitation exercises anytime and anywhere under the remote, asynchronous monitoring of a therapist using the TeleRehab kit. To keep its senior citizens healthy and active, Singapore introduced RoboCoach, a robot fitness trainer that replicates human movements, gives instructions in one of four languages or dialects, and uses motion-sensor technology.

There are other infrastructural projects in progress, such as CODEX (a data exchange architecture that enables internal data-sharing among government agencies, coupled with a suite of shared software components and infrastructure that enables more efficient development of digital applications), NDI (a digital identification program of citizens and businesses that allows pre-filled form information to be shared with authorized public or private parties, intended to become fully operational in 2020), Moments of Life (a mobile app providing a one-stop portal for parents to register the birth of their child, as well as a new Active Ageing module catering to seniors), and the Smart Nation Sensor Platform (a platform that collects different types of data, such as air quality, on a territory-wide scale). The private sector, research institutions, and individuals are encouraged to contribute ideas and launch their projects. These have included e-payment tools and Smart Urban Mobility (a testing of on-demand driverless vehicles).

Smart cities and smart nations are not without their issues and critics. Critics point out that in the last ten years smart city and 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 security issues as well.

Sources: 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,”

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CASE STUDY QUESTIONS

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

Case contributed by Joyce Chan, City University of Hong Kong

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

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 examine critically how you perform value-adding activities at each stage and how the business processes might be improved. For example, value chain analysis points to opportunities for further development for N26, as described in the chapter-opening case. 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. In Technology, they could take advantage of complementary existing technologies (such as wearables) that customers already own and are familiar with.

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 in Chapter 9.

Using the business value chain model will also encourage 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, when you have a list of candidate applications, you can decide which to develop first. By making improvements in your own business value chain 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 3.2 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 industry-wide standards for exchanging information or business

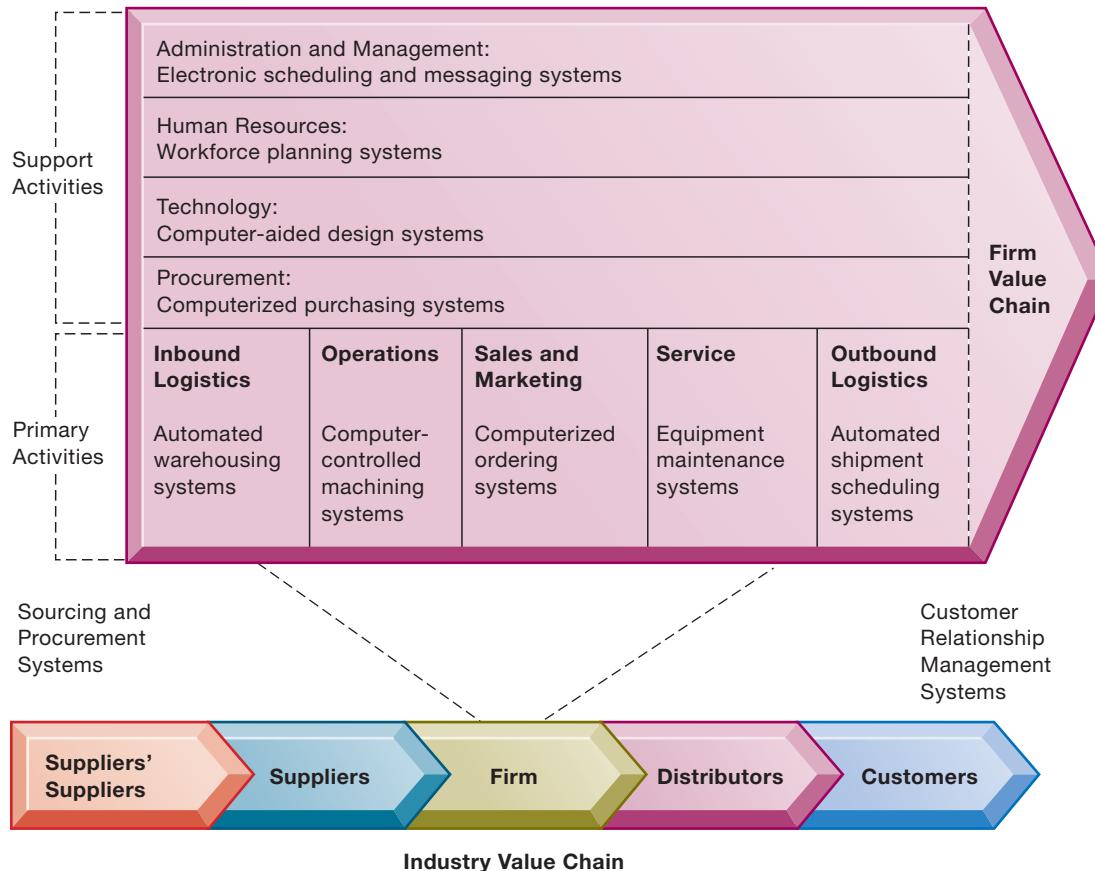


Figure 3.2

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 would add a margin of value to a firm's products or services.

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. Moreover, industry members can build industrywide, IT-supported consortia, symposia, and communications networks to coordinate activities concerning government agencies, foreign competition, and competing industries.

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 were Amazon.com, you would 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 search for goods.
- make it easy for customers to order and pay for goods.
- track and coordinate the shipment of goods to customers.

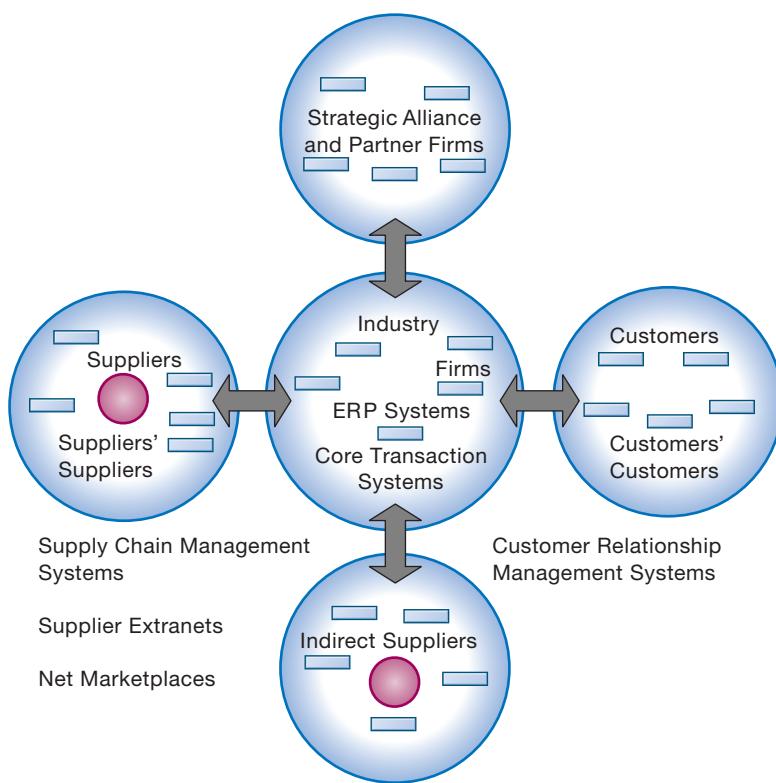
In fact, this is exactly what Amazon has done to make it one of the web's most satisfying online retail shopping sites.

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 3.3 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.

Figure 3.3
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.



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 units. For instance, General Electric—one of the largest industrial firms in the world—is a collection of aerospace, heavy manufacturing, energy management, medical imaging, electronics, and software services firms called *business units*. Information systems can improve the overall performance of these business units by promoting communication, synergies, and core competencies among the units.

Synergies

Synergies develop when the output of some units can be used as inputs to other units, or two organizations can pool markets and expertise, and these relationships lower costs and generate profits. Information technology in these synergy situations can help tie together the operations of disparate business units so that they can act as a whole. For example, when large national banks acquire mortgage originating firms, they are able to tap into a large pool of new customers who might be interested in their credit card, consumer banking, and other financial products. Information systems help the merged companies consolidate operations, lower retailing costs, and increase cross-marketing of financial products.

Enhancing Core Competencies

Another use of 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 can 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 an industry leader, best in class leader. Core competencies may involve being the 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 experience and a first-class research organization or, simply, key people who follow the literature and stay abreast of new external knowledge.

Any information system that encourages the sharing of knowledge across business units enhances competency (see Chapter 2). Such systems might encourage or enhance existing competencies and help employees become aware of new external knowledge; such systems might also help a business take advantage of existing competencies to related markets. For example, Procter & Gamble (P&G), a world leader in brand management and consumer product innovation, uses a series of systems to help 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 have online access to documents, reports, charts, videos, and other data from various sources. These systems also enable users to locate subject matter experts within the company as well as external research scientists and entrepreneurs who are searching for new, innovative products worldwide.

Network-Based Strategies

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

A **virtual company** 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. 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.

Global fashion companies, such as GUESS, Levi Strauss, and Reebok, enlist Hong Kong-based Li & Fung to manage product design, raw material sourcing, manufacturing, quality assurance, and shipping for their garments. 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 to 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 its clients' products quickly to keep pace with rapidly changing fashion trends.

Business models based on a network may help firms strategically by taking advantage of **network economics**. 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 when the additional inputs produce no additional outputs. This is the law of diminishing returns, and it is one foundation 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 no more expensive to operate a television station with 1,000 subscribers than with 10 million subscribers. The value of a community of people grows as the number of participants increases, whereas the cost of adding new members is inconsequential. This is referred to as a “network effect.”

From this network economics perspective, information technology can be strategically useful. Firms can use Internet sites to build communities of like-minded customers who want to share their experiences. EBay, the giant online auction and retail 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 provide strategic benefits to commercial software vendors such as Microsoft. 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.

Business Ecosystems and Platforms 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. **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). Information technology plays an important role in enabling a dense network of interactions among the participating firms.

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

DISRUPTIVE TECHNOLOGIES: RIDING THE WAVE

Sometimes a technology and resulting business innovation comes along to change the business landscape and environment radically. These innovations are loosely called *disruptive* (Christensen, 2003). In some cases, **disruptive technologies** are substitute products that perform as well or better than anything currently produced. The automobile substituted for the horse-drawn carriage, the Apple iPod for portable CD players, digital photography for process film photography, and on-demand services like Uber for dispatched taxis. In these cases, entire industries are put out of business or significantly challenged.

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 computer disk drives by offering cheap digital storage for small files on small computers.

Some firms can create these technologies and ride the wave to profits, whereas others learn quickly and adapt their business; still others are obliterated because their products, services, and business models become obsolete. There are also cases when no firms benefit, and all gains go to consumers (firms fail to capture any profits). Table 3.4 provides examples of some disruptive technologies.

Disruptive technologies are tricky. Firms that invent disruptive technologies as first movers do not always benefit. 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. Citibank's ATMs revolutionized retail banking, but other banks copied them. Now all banks use ATMs, and the benefits go mostly to the consumers.

Technology	Description	Winners and Losers
Microprocessor chips (1971)	Thousands and eventually millions of transistors on a silicon chip	Microprocessor firms win (Intel, Texas Instruments); transistor firms (GE) decline
Personal computers (1975)	Small, inexpensive, but fully functional desktop computers	PC manufacturers (HP, Apple, IBM) and chip manufacturers prosper (Intel); mainframe (IBM) and minicomputer (DEC) firms lose
Digital photography 1975	Using charge-coupled device (CCD) image sensor chips to record images	CCD manufacturers and smartphone companies win, manufacturers of film products lose
World Wide Web (1989)	A global database of digital files and pages instantly available	E-commerce online stores benefit; small retailers and shopping malls lose
Internet music, video, TV services	Repositories of downloadable music, video, TV broadcasts on the web	Owners of Internet platforms, telecommunications providers owning Internet backbone (AT&T, Verizon), Internet service providers win; content owners and physical retailers lose (Tower Records, Blockbuster)
PageRank algorithm	A method for ranking web pages in terms of their popularity to supplement web search by key terms	Google is the winner (it owns the patent); traditional keyword search engines (Alta Vista) lose
Software as web service	Using the Internet to provide remote access to online software	Online software services companies (Salesforce.com) win; traditional boxed software companies (Microsoft, SAP, Oracle) lose

TABLE 3.4

Disruptive Technologies:
Winners and Losers

3-2 How do information systems help businesses compete globally?

Look closely at your jeans or sneakers. Even if they have a US label, they were probably designed in California and stitched together in Hong Kong or Guatemala, using materials from China or India. Call Microsoft Support, or Vodafone Support, and chances might speak to a customer service representative located in India.

Consider the path to market for an iPhone, which is illustrated in Figure 3.4. The iPhone was designed by Apple engineers in the United States, sourced with more than 200 high-tech components from around the world, and primarily 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.

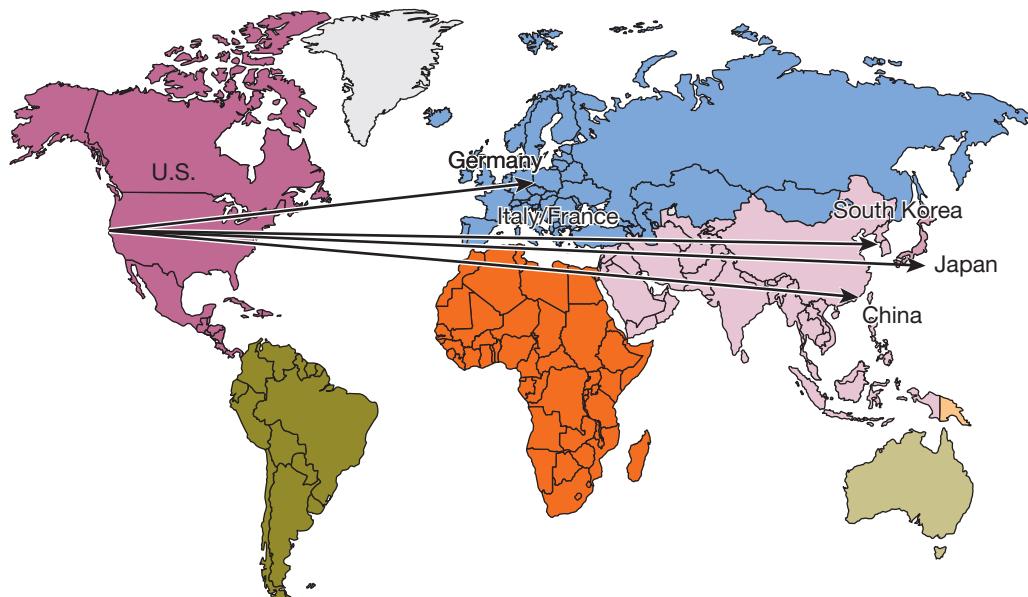
Firms pursuing a global strategy benefit from economies of scale and resource cost reduction (usually wage cost reduction). For example, Apple spread design, sourcing, and production for its iPhone over multiple countries overseas to reduce tariffs and labor costs.

THE INTERNET AND GLOBALIZATION

Until the mid-1990s, huge multinational firms, such as General Electric, Siemens, Toyota, and IBM, dominated competition on a global scale. These large firms could afford huge investments in factories, warehouses, and distribution centers in foreign countries and proprietary networks and systems that could operate on a global scale. The emergence of the Internet into a full-blown international communications system has drastically reduced the costs of operating on a global scale, enlarging the possibilities for large companies and simultaneously creating many opportunities for small and medium-sized firms.

The global Internet, along with internal information systems, puts manufacturing firms in nearly instant contact with their suppliers. Internet telephony (see Chapter 7) permits millions of service calls to US companies to be answered in India and Jamaica just as easily and cheaply as if the help desk were in New Jersey or California.

Figure 3.4
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 parts. Much of the final assembly occurs in China.



Likewise, the Internet makes it possible to move very large computer files with hundreds of graphics, or complex industrial designs, across the globe in seconds.

GLOBAL BUSINESS AND SYSTEM STRATEGIES

There are four main ways of organizing businesses internationally: domestic exporter, multinational, franchiser, and transnational, each with different patterns of organizational structure or governance. In each type of global business organization, business functions may be centralized (in the home country), decentralized (to local foreign units), and coordinated (all units participate as equals).

The **domestic exporter** strategy is characterized by heavy centralization of corporate activities in the home country of origin. 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 foreign marketing still relies completely on the domestic home base for marketing themes and strategies. Caterpillar Corporation and other heavy capital equipment manufacturers fall into this category of firm.

A **multinational** strategy concentrates financial management and control out of a central home base while decentralizing production, sales, and marketing 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 operating in different countries. Many financial service firms, along with a host of manufacturers, such as Ford Motor Co. and Intel Corporation, fit this pattern.

Franchisers have the product created, designed, financed, and initially produced in the home country but rely heavily on foreign personnel for further production, marketing, and human resources. Food franchisers, such as McDonald's and Starbucks, 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 of new products, strategic management, and financing. Nevertheless, local production of some items, local marketing, and local recruitment of personnel are required.

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. There is a strong central management core of decision making but considerable dispersal of power and financial muscle throughout the global divisions. Many *Fortune* 500 companies are transnational.

Nestlé S.A., the largest food and beverage company in the world, is one of the world's most globalized companies, with 308,000 employees at 413 facilities in 85 countries. Nestlé launched a \$2.4 billion initiative to adopt a single set of business processes and systems for procurement, distribution, and sales management using SAP enterprise software. All of Nestlé's worldwide business units use the same processes and systems for making sales commitments, establishing factory production schedules, billing customers, compiling management reports, and reporting financial results. Nestlé has learned how to operate as a single unit on a global scale.

GLOBAL SYSTEM CONFIGURATION

Figure 3.5 depicts four types of systems configurations for global business organizations. *Centralized systems* 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

Figure 3.5

Global Business Organization and Systems Configurations.

The large Xs show the dominant patterns, and the small Xs show the emerging patterns. For instance, domestic exporters rely predominantly on centralized systems, but there is continual pressure and 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

systems development and operations occur in an integrated and coordinated fashion across all units.

As can be seen in Figure 3.5, domestic exporters tend to have highly centralized systems in which a single domestic systems development staff develops worldwide applications. Multinationals allow foreign units to 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 typically 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. Firms such as Nestlé, organized along transnational lines, use networked systems that span multiple countries, using powerful telecommunications networks and a shared management culture that crosses cultural barriers.

3-3 How do information systems help businesses compete using quality and design?

Quality has developed from a business buzzword into a serious goal for many companies. Quality is a form of differentiation. Companies with reputations for high quality, such as Lexus or Intel, can charge premium prices for their products and services. Information systems have a major contribution to make in this drive for quality. In the services industries in particular, superior information systems and services generally enable quality strategies.

WHAT IS QUALITY?

Quality can be defined from both producer and customer perspectives. From the perspective of the producer, quality signifies conformance to specifications or the absence of variation from those specifications. The specifications for a smartphone might include one that states the strength of the phone should not be weakened if the phone is dropped from a four-foot height onto a concrete floor.

A customer definition of quality is much broader. First, customers are concerned with the quality of the physical product—its durability, safety, ease of use, and installation. Second, customers are concerned with the quality of service, by which they mean the accuracy and truthfulness of advertising, responsiveness to warranties, and ongoing product support. Finally, customer concepts of quality include psychological aspects: the company's knowledge of its products, the courtesy and sensitivity of sales and support staff, and the reputation of the product. Today, as the quality movement in business progresses, the definition of quality is increasingly from the perspective of the customer.

Many companies have embraced the concept of **total quality management (TQM)**. TQM makes quality the responsibility of all people and functions within an organization. TQM holds that the achievement of quality control is an end in itself. Everyone is expected to contribute to the overall improvement of quality—the engineer who avoids design errors, the production worker who spots defects, the sales representative

who presents the product properly to potential customers, and even the secretary who avoids typing mistakes. TQM derives from quality management concepts that American quality experts such as W. Edwards Deming and Joseph Juran developed, but the Japanese popularized it.

Another quality concept that is widely implemented today is Six Sigma, which Amazon.com used to reduce errors in order fulfillment. **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 to implement a set of methodologies and techniques for improving quality and reducing costs. Studies have repeatedly shown that the earlier in the business cycle a problem is eliminated, the less it costs the company. Thus, quality improvements not only raise the level of product and service quality but can also lower costs.

HOW INFORMATION SYSTEMS IMPROVE QUALITY

Let's examine some of the ways companies face the challenge of improving quality to see how information systems can be part of the process.

Reduce Cycle Time and Simplify the Production Process

Studies have shown that one of the best ways to reduce quality problems is to reduce **cycle time**, which refers to the total elapsed time from the beginning of a process to its end. Shorter cycle times mean that problems are caught earlier in the process, often before the production of a defective product is completed, saving some of the hidden production costs. Finally, finding ways to reduce cycle time often means finding ways to simplify production steps. The fewer steps in a process, the less time and opportunity for an error to occur. Information systems help eliminate steps in a process and critical time delays.

1-800-Flowers, a multimillion-dollar company selling flowers over the web, used to be a much smaller company that had difficulty retaining its customers. It had poor service, inconsistent quality, and a cumbersome manual order-taking process. Telephone representatives had to write each order, obtain credit card approval, determine which participating florist was closest to the delivery location, select a floral arrangement, and forward the order to the florist. Each step in the manual process increased the chance of human error, and the whole process took at least half an hour. A new information system now downloads orders taken over the web to a central computer and electronically transmits them to local florists. Orders are more accurate and arrive at the florist within two minutes.

Benchmark

Companies achieve quality by using benchmarking to set standards for products, services, and other activities and then measuring performance against those standards. Companies may use external industry standards, standards other companies set, internally developed standards, or some combination of the three. L.L. Bean, the Freeport, Maine, clothing company, used benchmarking to achieve an order-shipping accuracy of 99.9 percent. Its old batch order fulfillment system could not handle the surging volume and variety of items to be shipped. After studying German and Scandinavian companies with leading-edge order fulfillment operations, L.L. Bean carefully redesigned its order fulfillment process and information systems so that orders could be processed as soon as they were received, and shipped within 24 hours.

Use Customer Demands to Improve Products and Services

Improving customer service, and making customer service the number-one priority, will improve the quality of the product itself. Delta Airlines decided to focus on its customers, installing a customer care system at its airport gates. For each flight, the airplane seating chart, reservations, check-in information, and boarding data are linked in a central database. Airline personnel can track which passengers are on

board regardless of where they checked in and use this information to help passengers reach their destination quickly, even if delays cause them to miss connecting flights.

Improve Design Quality and Precision

Computer-aided design software has made a major contribution to quality improvements in many companies, from producers of automobiles to producers of razor blades. A **computer-aided design (CAD) system** automates the creation and revision of designs, using computers and sophisticated graphics software. The software enables users to create a digital model of a part, a product, or a structure and make changes to the design on the computer without having to build physical prototypes.

For example, Ford Motor Company used a computer simulation that came up with the most efficient design possible for an engine cylinder. Engineers altered that design to account for manufacturing constraints and tested the revised design on the computer, using models with decades of data on material properties and engine performance. Ford then created the physical 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 some 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 being 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 for specialized applications, including batteries, transistors, prosthetic devices, and LEDs. 3-D printing services are now available on the web.

Improve Production Precision and Tighten Production Tolerances

For many products, quality can be enhanced by making the production process more precise, thereby decreasing the amount of variation from one part to another. CAD software often produces design specifications for tooling and manufacturing processes, saving additional time and money while producing a manufacturing process with far fewer problems. The user of this software can design a more precise production system, a system with tighter tolerances, than could ever be done manually.

Computer-aided design (CAD) systems improve the quality and precision of product design by performing much of the design and testing work on the computer. This is a 3-D CAD model of a car wheel.



© Alexlmx / iStock

3-4 What is the role of business process management (BPM) in enhancing competitiveness?

Technology alone is often not enough to make organizations more competitive, efficient, or quality-oriented. The organization itself needs to be changed to take advantage of the power of information technology. These changes may require minor adjustments in work activities, but, often, entire business processes will need to be redesigned. Business process management (BPM) addresses these needs.

WHAT IS BUSINESS PROCESS MANAGEMENT?

Business process management (BPM) is an approach to business that aims to improve business processes continuously. BPM uses a variety of tools and methodologies to understand existing processes, design new processes, and optimize those processes. BPM is never concluded because continuous improvement requires continual change. Companies practicing business process management need to 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, rather, understanding which 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 which 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.

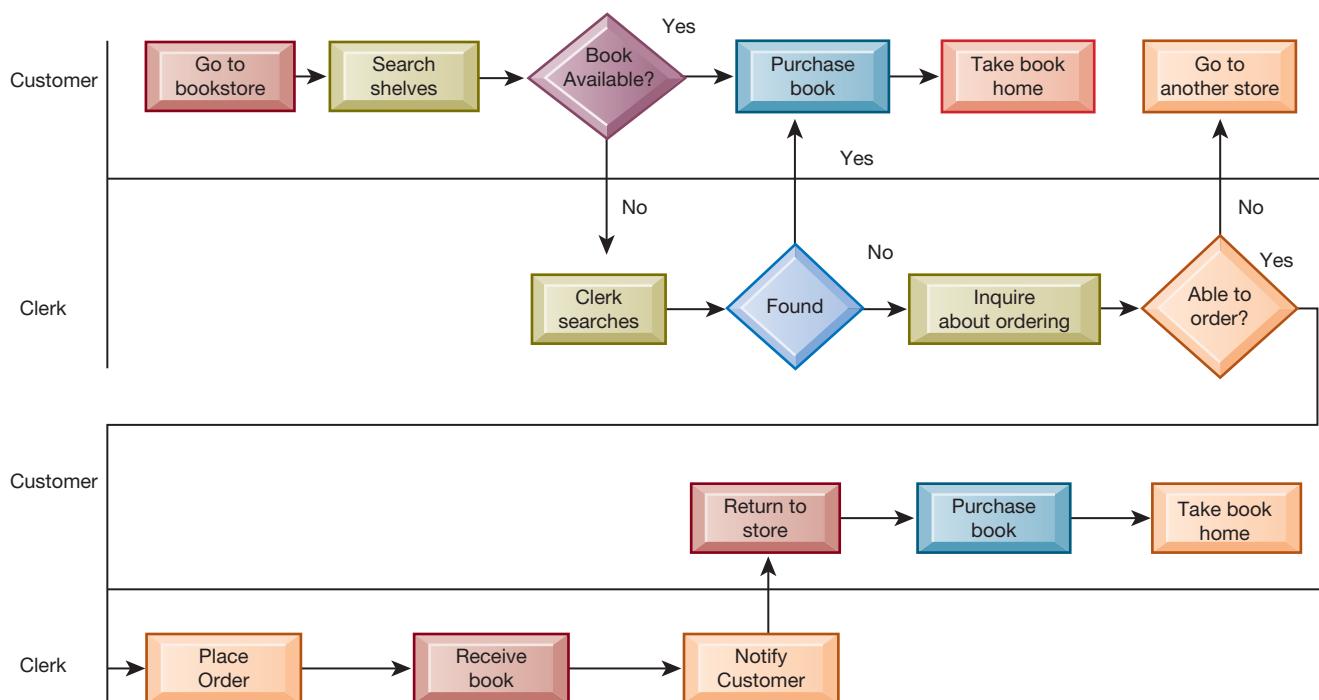


Figure 3.6

As-Is Business Process for Purchasing a Book from a Physical Bookstore.

Purchasing a book from a physical bookstore requires both the seller and the customer to perform many steps.

Figure 3.6 illustrates the as-is process for purchasing a book from a physical bookstore. A customer would visit a physical bookstore and search its shelves for a book. If he or she finds the book, that person takes it to the checkout counter and pays for it by credit card, cash, or check. If the customer cannot locate the book, he or she must ask a bookstore clerk to search the shelves or check the bookstore's inventory records to see whether 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, either 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 cannot 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.

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.

Figure 3.7 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 that for purchasing the book in a physical bookstore, requires much less effort from the customer, and requires fewer sales staff for customer service. The new process is therefore much more efficient and timesaving.

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, 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 sales staff has to locate it. If the book has to be ordered from another source, the process might take one or two weeks and another trip to

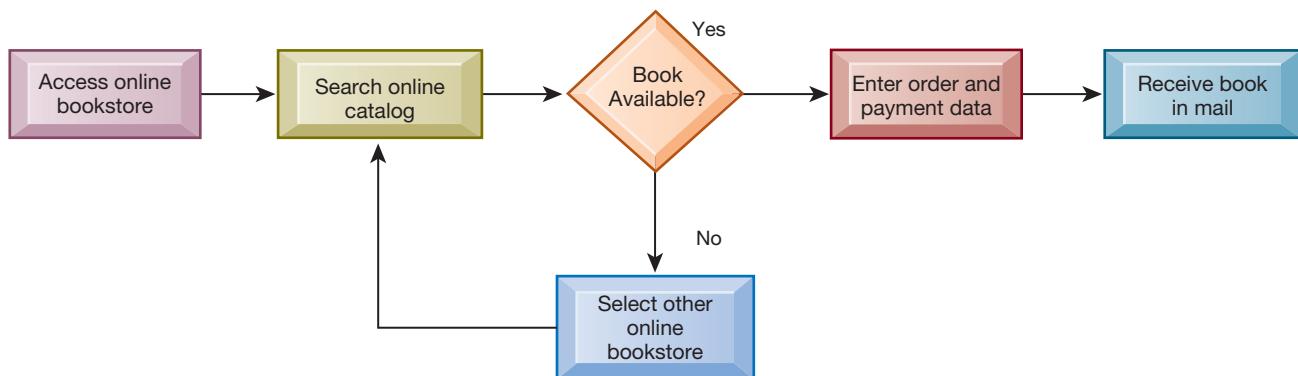


Figure 3.7

Redesigned Process for Purchasing a Book Online

Using Internet technology makes it possible to redesign the process for purchasing a book so that it only has a few steps and consumes fewer resources.

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 weeks to receive the book in the mail and will have to pay a small shipping charge. Nevertheless, 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.

4. **Implement the new process:** After 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:** After a process has been implemented and optimized, it needs to be measured continually. 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.

Many software tools are available to facilitate various aspects of BPM. 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.

The Interactive Session on Organizations illustrates how a company can benefit from business process management. As you read this case, try to find out how strategic application of information systems improved Hong Kong Disneyland's business performance

Business Process Reengineering

Many business process improvements are incremental and ongoing, but occasionally, more radical change is required. 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. This radical rethinking and redesign of business processes is called **business process reengineering (BPR)**.

When properly implemented, BPR can lead to dramatic gains in productivity and efficiency, even changing 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. By radically rethinking the way a book can be 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 most significant barrier to successful business process change is organizational culture. Employees do not like unfamiliar routines and often resist change. This is especially true of business process reengineering projects because the organizational changes are so far-reaching. Managing change is neither simple nor intuitive, and companies committed to extensive process improvement need a good change management strategy (see Chapter 12).

Spread across 68 acres on Lantau Island, Hong Kong Disneyland is the largest theme park in Hong Kong. Though the park now attracts more than 7 million visitors a year, its current success is a remarkable example of a turnaround achieved through the strategic application of information systems. When it opened in 2005, it failed to meet its target of 5.6 million visitors the first year, and that figure dropped by 20 percent the second year against fierce competition from other tourist spots and theme parks. Hong Kong Disneyland decided to re-engineer its core operations by realigning its information systems.

Every operation was studied exhaustively to re-position information systems as a strategic asset. Online ticketing systems and point-of-sales (POS) terminals recorded visitors' email addresses so that notifications could be sent to them whenever a new ride or a new character was introduced. This also enabled the park's management to identify regular visitors and send them special offers, such as a 2-for-1 pass. In addition, text messages were sent to regular visitors to inform them about special events. These measures worked, and visitors began to show up in great numbers again. The long queues, however, were their own problem. The management turned again to the information it had gathered from visitors' emails, sending text messages to direct visitors toward other, less crowded sections of the park.

One of Disneyland's innovations in information collection is the MagicBand, a wristband provided to all the visitors of Disneyland. Based on RFID technology and powered by a battery that can last two years, a MagicBand can store all the visitors' vital information, including hotel keys, credit cards, and tickets. Data from the credit card tells Disneyland which products are being purchased, enabling it to manage inventories in real time. Visitors must swipe their MagicBands to get on a ride, and this tells Disneyland the exact location of its visitors, how many rides each one has taken, and what the waiting times of the rides are, which again allows it to direct visitors to those with low waiting times. The MagicBand is more than just about directing visitor traffic, however. Disneyland wants to give its visitors a unique experience, so it mines information that will help it decide which characters and themes to promote in the park. Much of this information is sourced at the Disney Studio, where cameras capture the facial

movements of audiences as they watch Disney movies. Disneyland then predicts which character or theme is most appealing and promotes the most liked theme or character in the park to match the collective tastes of its customers.

Another strategic application of information systems is the management of Hong Kong Disneyland's suppliers, who play a crucial role in running the eateries and souvenir shops. To ensure close coordination with them, a uniform interface was developed to share real-time data—as soon as a product is sold or an eatable is ordered, the suppliers know about it. This strategy has not only played a vital role in managing inventory but has also reduced waste of perishable items.

Employees are a strategic asset for any organization, and Disneyland understands this well. A specially designed staff engagement app called CastApp connects every employee, anywhere at the park. The app is based on Web Content Accessibility Guidelines (WCAG) 2.0, so the content can be easily read by employees with vision problems. CastApp allows Disneyland's management to share the daily rooster with employees, and the latter can keep tabs on any activity taking place at the park. Moreover, there is a constant need to train the employees as new characters and themes are introduced, and CastApp helps employees enroll in the different training modules that are offered regularly at Disneyland..

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CASE STUDY QUESTIONS

1. Discuss the various strategies adopted by Hong Kong Disneyland to attract visitors.
2. What problem did Disneyland face as it began to draw more visitors to the theme park? How was it overcome?
3. How does Hong Kong Disneyland manage its suppliers?
4. How does Hong Kong Disneyland determine which theme or character should be introduced in the park?

Case contributed by Sahil Raj, Punjabi University

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

A+ Superior Data Quality, a fast-growing London-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? Do you have 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 this chapter's discussion of IT and business strategy and also Chapter 6 on data management, including the section on data quality.
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 the company seems to be focused on? Be prepared to show that you understand the kinds of business challenges and opportunities 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 most likely encounter on the job.

Review Summary

3-1 How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network-based strategies help companies use information systems for competitive advantage? In Porter's competitive forces model, the strategic position of the firm, and its strategies, are determined by competition with its traditional direct competitors. 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. Information systems are most successful when the technology is aligned with business objectives.

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 industry-wide consortia and by enabling businesses to work more efficiently with their value partners.

Information systems achieve additional efficiencies or enhanced services by tying together the operations of disparate business units. Information systems help businesses use 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. Firms can also redefine their businesses to become niche players or keystone firms in platform-based business ecosystems where multiple industries work together to deliver value to the customer. Disruptive technologies provide strategic opportunities, although first movers do not necessarily obtain long-term benefit.

3-2 How do information systems help businesses compete globally? Information systems and the Internet help companies operate internationally by facilitating coordination of geographically dispersed units of the company and communication with faraway customers and suppliers. There are four main strategies for organizing businesses internationally: domestic exporter, multinational, franchiser, and transnational.

3-3 How do information systems help businesses compete using quality and design? Information systems can enhance quality by simplifying a product or service, facilitating benchmarking, reducing product development cycle time, and increasing quality and precision in design and production.

3-4 What is the role of business process management (BPM) in enhancing competitiveness? Organizations often have to change their business processes to execute their business strategies successfully. If these business processes use technology, they can be redesigned to make the technology more effective. BPM combines and streamlines the steps in a business process to eliminate repetitive and redundant work and to achieve dramatic improvements in quality, service, and speed. BPM is most effective when it is used to strengthen a good business model and when it strengthens processes that have a major impact on firm performance.

Key Terms

3-D printing, 124	Core competency, 117	Primary activities, 114
Benchmarking, 114	Cycle time, 123	Quality, 122
Best practices, 115	Disruptive technologies, 119	Six Sigma, 123
Business ecosystem, 118	Domestic exporter, 121	Support activities, 114
Business process management (BPM), 125	Efficient customer response system, 110	Switching costs, 111
Business process reengineering (BPR), 127	Franchiser, 121	Total quality management (TQM), 122
Competitive forces model, 107	Mass customization, 110	Transnational, 121
Computer-aided design (CAD) system, 124	Multinational, 121	Value chain model, 112
	Network economics, 118	Value web, 116
	Platforms, 118	Virtual company, 117

Review Questions

- 3-1** How do Porter's competitive forces model, the value chain model, synergies, core competencies, and network-based strategies help companies use information systems for competitive advantage?
- Define Porter's competitive forces model and explain how it works.
 - 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.
- Describe how the Internet has changed competitive forces and competitive advantage.
- Explain how information systems promote synergies and core competencies that enhance competitive advantage.
- Explain how businesses benefit by using network economics.
- Define and describe a virtual company and the benefits of pursuing a virtual company strategy.
- Define and describe a business ecosystem and how it can provide competitive advantage.
- Explain how disruptive technologies create strategic opportunities.

3-2 How do information systems help businesses compete globally?

- Describe how globalization has increased opportunities for businesses.
- List and describe the four main ways of organizing a business internationally and the types of systems configuration for global business organizations.

3-3 How do information systems help businesses compete using quality and design?

- Define TQM and explain who has the associated responsibilities within an organization.
- Describe the purpose and the value of benchmarking.

3-4 What is the role of business process management (BPM) in enhancing competitiveness?

- Define BPM and explain how it helps firms become more competitive.
- Explain how a business can go about identifying processes for change.
- Explain the value and purpose of tools provided by software companies in relation to BPM.

MyLab MIS™

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

Discussion Questions

3-5 It has been said that there is no **MyLab MIS** such thing as a sustainable competitive advantage. Do you agree? Why or why not?

3-6 What are some of the issues to **MyLab MIS** consider in determining whether the Internet would provide your business with a competitive advantage?

3-7 It has been said that the advantage that leading-edge retailers such as Walmart have over competitors isn't technology—it's their management. Do you agree? Why or why not?

Hands-On MIS Projects

The projects in this section give you hands-on experience identifying information systems to support a business strategy and 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** Tracfone Wireless is a leading prepaid wireless service in the United States, Puerto Rico, and the US Virgin Islands. Despite its rock-bottom rates for mobile voice and data services, Tracfone's growth has been slowing. Management wants to know why this is happening and what can be done to attract more customers. Are customers rejecting Tracfone because of poor customer service, uneven network coverage, or low-cost wireless service charges offered by competitors such as Sprint and T-Mobile? How can the company use information systems to help find the answer? What management decisions could be made using information from these 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'll 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'll find a database for hotel reservation transactions developed in Microsoft Access with information about The President's Inn hotel in Cape May, New Jersey. At the Inn, 10 rooms overlook side streets, 10 rooms have bay windows with 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 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 cannot provide management with immediate data about the hotel's daily operations and revenue. Use the database to develop reports on average length of stay per room type, average visitors per room type, base revenue per room (i.e., length of visit multiplied by the daily rate) during a specified period of time, 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-selling 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 and begin your investigation. Locate the Ford Escape. Research the various Escape models; 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. 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 the CarsDirect and Ford websites.

COLLABORATION AND TEAMWORK PROJECT

Identifying Opportunities for Strategic Information Systems

3-I2 With your team of three or four students, select a company described in the *Wall Street Journal*, *Fortune*, *Forbes*, or another business publication. 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.

BUSINESS PROBLEM-SOLVING CASE

OFFLINE, ONLINE, AND BACK: THE EVOLUTION OF THE UK GROCERY MARKET

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 September 2019, had a market share of 26.9 percent; Sainsbury, 15.3 percent; ASDA, 15.1 percent; and Morrisons, 9.9 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 groceries 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 September 2019, Aldi was the fifth largest grocery chain in the United Kingdom with a market share of 8.1 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 between £25 and £30 million. According to Charles Wilson, who recently took over as 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 £11.3bn 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 during 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.

In addition to gaining a larger market share every year, Aldi and Lidl are contributing to the UK economy in different ways. According to some analysis, Aldi has contributed over £8.5 billion to the GDP of the United Kingdom through job creation, taxes, and capital investment. Predictions also show that Aldi is expected to provide a £2.2 billion boost for British businesses. 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. 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.

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. However, it has since scaled back those plans and even closed some of those stores. History has shown that attempts by big supermarkets to launch discount brands have largely failed.

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

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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

- Are Cars Becoming Big Brother on Wheels?
- The Boeing 737 MAX Crashes: What Happened and Why?
- How Harmful Are Smartphones?
- 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

ARE CARS BECOMING BIG BROTHER ON WHEELS?

Cars today have become sophisticated listening posts on wheels. They can track phone calls and texts, record what radio stations you listen to, monitor the speed at which you drive and your braking actions, and even tell when you are breaking the speed limit, often without your knowledge.

Tens of millions of drivers in the United States are currently being monitored, with that number rising every time a new vehicle is sold or leased. There are at least 78 million cars on the road with an embedded cyberconnection that can be used for monitoring drivers. According to research firm Gartner Inc., 98 percent of new cars sold in the United States and Europe will be connected by 2021.

Since 2014, every new car in the United States comes with an event data recorder (EDR), which records and stores over a dozen data points, including vehicle speed, seat belt use, and braking activation. EDR data are available to any auto maker as well as to insurance companies, which use these stored EDR data to help establish responsibility for an accident or to detect fraud.

EDRs are mandated and regulated by the US government, but other data-gathering software in today's cars is not. Such software underlies numerous sensors, diagnostic systems, in-dash navigation systems, and built-in cellular connections, as well as driver-assistance systems to help drivers park, stay in their lane, avoid rear-ending another car, and steer for short time periods. All of this software keeps track of what drivers are doing. Newer cars may record driver eye movements, the weight of people in the front seats, and whether the driver's hands are on the wheel. Smartphones, whether connected to the car or not, can also track your activities, including any texting while driving. Auto makers are able to mine all this information, as are app developers and companies such as Google or Spotify.

With the exception of medical information, the United States has few regulations governing what data companies can gather and how they can use the data. Companies generally are not required to conceal names or other personal details. In most cases the driver must consent to allowing his or her personal information to be tracked or monitored. Many people unwittingly provide this consent when they check off a box on one of the lengthy service agreement forms required to register a car's in-dash system or navigation app.

Collecting such large amounts of personal data generated by drivers has raised concerns about whether automakers and others are doing enough to protect people's privacy. Drivers may welcome the use of information to relay helpful diagnostic information or updates on nearby traffic jams. But they do not necessarily endorse other uses, and automakers have refrained from commenting on future data collection plans and policies.



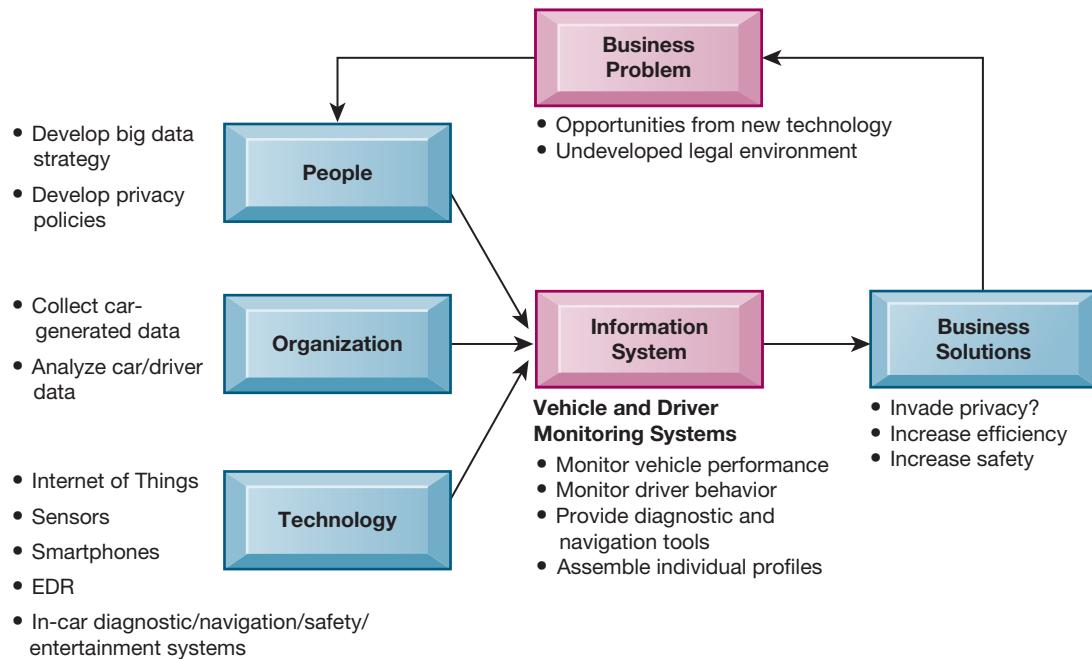
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Automakers argue that the data are valuable for improving vehicle performance and vehicle safety and soon will be able to reduce traffic accidents and fatalities. Amassing detailed data about human driving behavior is also essential for the development of self-driving cars. But privacy experts believe the practice is dangerous. With enough data about driver behavior, individual profiles as unique as fingerprints could be developed. Trips to businesses reveal buying habits and relationships that could be valuable to corporations, government agencies, or law enforcement. For example, frequent visits to a liquor store or mental health clinic could reveal information about someone's drinking habits or health problems. People obviously would not want such confidential data shared with others.

Sources: Jaclyn Trop, "The Spy Inside Your Car," *Fortune*, January 24, 2019; Peter Holley, "Big Brother on Wheels: Why Your Car Company May Know More About You Than Your Spouse," *Washington Post*, January 15, 2018; Christina Rogers, "What Your Car Knows about You," *Wall Street Journal*, August 18, 2018; John R. Quain, "Cars Suck Up Data About You. Where Does It All Go?" *New York Times*, July 27, 2017; and Russ Heaps, "Data Collection for Self-Driving Cars Could Be Risking Your Privacy," *Autotrader*, September 2016.

The challenges that connected vehicles and big data pose 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 capability to make driving safer and more efficient. 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. Developments in data management technology, the Internet of Things (IoT), and analytics have created opportunities for organizations to use big data to improve operations and decision making. Big data analytics are now being applied to all the data generated by motor vehicles, especially those with Internet connections. The auto makers and other organizations described here are benefiting from using big data to monitor vehicle performance and driver behavior and to provide drivers with helpful tools for driving safely and caring for their cars. The use of big data from motor vehicles, however, is also taking benefits away from individuals. Individuals might be subject to job discrimination or higher insurance rates because organizations have new tools to assemble and analyze huge quantities of data about



their driving behavior. There are very few privacy protections for all the personal data gathered from car driving. New privacy protection laws and policies need to be developed to keep up with the technologies for assembling and analyzing big data.

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 the data generated by connected vehicles and those who fervently believe that businesses and public organizations should not use big data analysis 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 big data from motor vehicles create an ethical dilemma? Why or why not? Should there be new privacy laws to protect personal data collected from cars? 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 US 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. US federal sentencing guidelines adopted in 1987 mandate that federal judges impose stiff sentences on business executives based on the monetary value of the crime, the presence of a conspiracy to prevent discovery of the crime, the use of structured financial transactions to hide the crime, and failure to cooperate with prosecutors (US Sentencing Commission, 2004). 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

Volkswagen AG (2015)	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 US 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 \$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.
General Motors, Inc. (2015)	General Motors CEO admitted the firm covered up faulty ignition switches for more than a decade, resulting in the deaths of at least 114 customers. More than 100 million vehicles worldwide were affected.
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.

TABLE 4.1

Recent Examples of Failed Ethical Judgment by Senior Managers

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 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, 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.

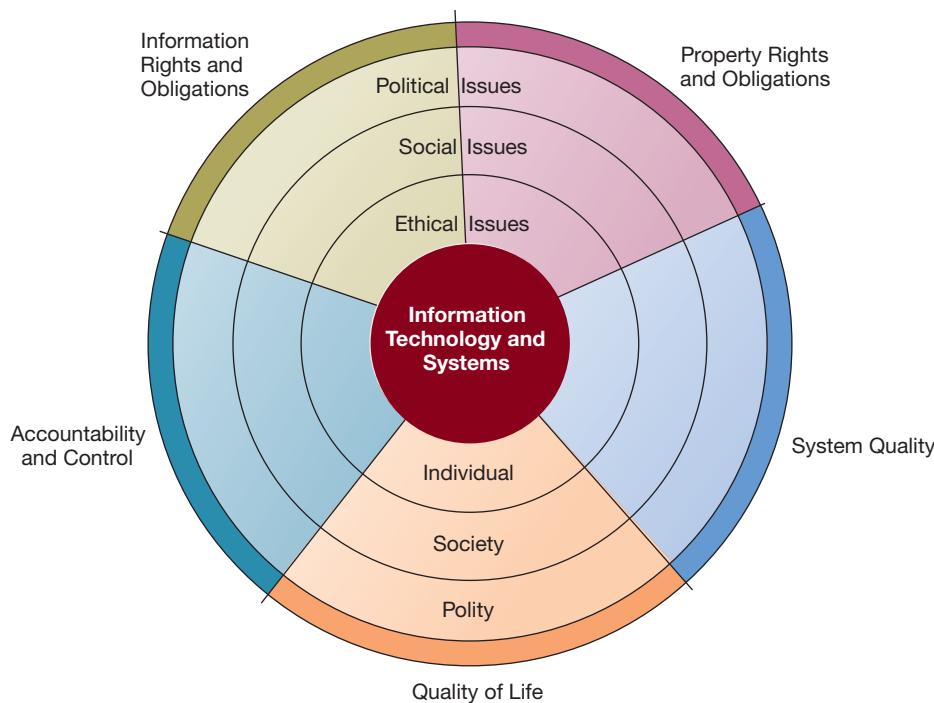


Figure 4.1
The Relationship among Ethical, Social, and Political Issues in an Information Society.

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.

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 Section 4-3.

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,

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	Individual cell phones may be tracked without user consent or knowledge. The always-on device becomes a tether, and a tracker.

and potential customers—maintained by private and public organizations. These advances in data storage have made the routine 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 11 describe how companies can analyze large pools of data from multiple sources to identify buying patterns of customers rapidly and make individualized recommendations.

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.



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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 the Google Platform gathers. The firm uses this information to create a profile of each online visitor, adding more detail to the profile as the visitor accesses an associated Google Platform site. Over time, the 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).

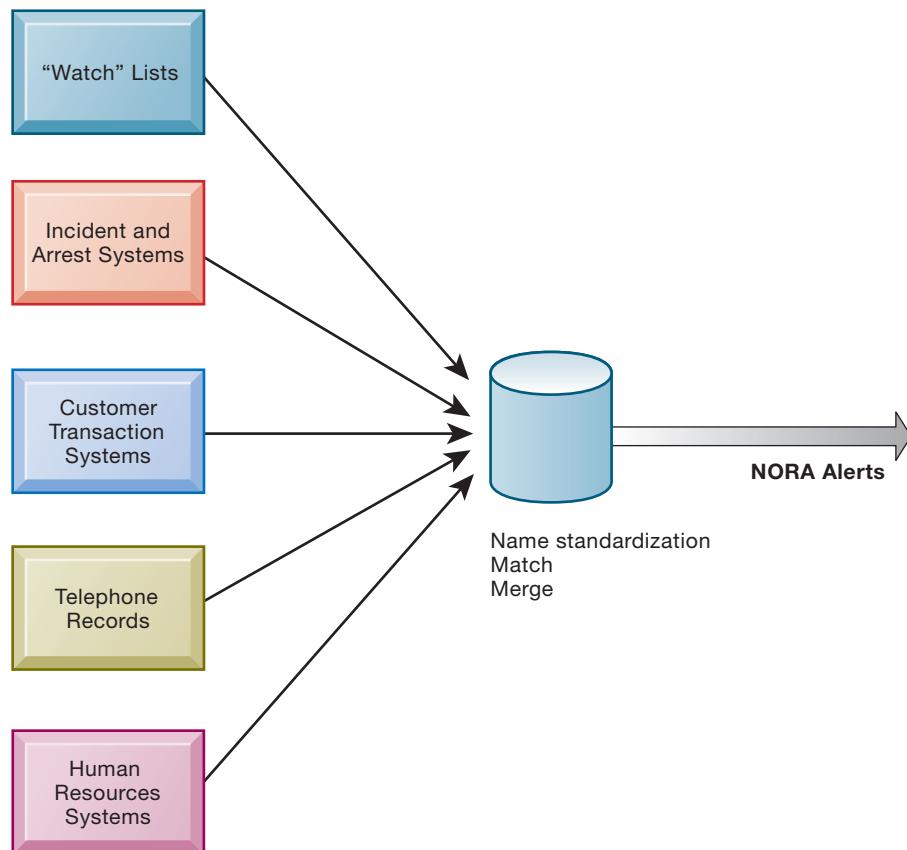


Figure 4.2
Nonobvious Relationship Awareness (NORA).
NORA technology can take information about people from disparate sources and find obscure, nonobvious relationships. It might discover, for example, that an applicant for a job at a casino shares a telephone number with a known criminal and issue an alert to the hiring manager.

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.

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 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 American Medical Association (AMA), the American Bar Association (ABA), 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.

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.

General Federal Privacy Laws	Privacy Laws Affecting Private Institutions
Freedom of Information Act of 1966 as Amended (5 USC 552)	Fair Credit Reporting Act of 1970
Privacy Act of 1974 as Amended (5 USC 552a)	Family Educational Rights and Privacy Act of 1974
Electronic Communications Privacy Act of 1986	Right to Financial Privacy Act of 1978
Computer Matching and Privacy Protection Act of 1988	Privacy Protection Act of 1980
Computer Security Act of 1987	Cable Communications Policy Act of 1984
Federal Managers Financial Integrity Act of 1982	Electronic Communications Privacy Act of 1986
Driver's Privacy Protection Act of 1994	Video Privacy Protection Act of 1988
E-Government Act of 2002	The Health Insurance Portability and Accountability Act (HIPAA) of 1996 Children's Online Privacy Protection Act (COPPA) of 1998 Financial Modernization Act (Gramm-Leach-Bliley Act) of 1999

TABLE 4.3

Federal Privacy Laws in the United States

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.

Table 4.3 describes the major US federal statutes that set forth the conditions for handling information about individuals in such areas as credit reporting, education, financial records, newspaper records, and electronic and digital communications. The Privacy Act of 1974 has been the most important of these laws, regulating the federal government's collection, use, and disclosure of information. At present, most US 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 (US 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 4.4 describes the FTC's FIP principles.

The FTC's FIP principles are being used as guidelines to drive changes in privacy legislation. In July 1998, the US Congress passed the Children's Online Privacy Protection Act (COPPA), requiring websites to obtain parental permission before collecting information on children under the age of 13. The FTC has recommended additional legislation to protect online consumer privacy in advertising networks that collect records of consumer web activity to develop detailed profiles, which other

TABLE 4.4

Federal Trade Commission Fair Information Practice Principles

<i>Notice/awareness (core principle).</i> 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.
<i>Choice/consent (core principle).</i> 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.
<i>Access/participation.</i> Consumers should be able to review and contest the accuracy and completeness of data collected about them in a timely, inexpensive process.
<i>Security.</i> Data collectors must take responsible steps to ensure that consumer information is accurate and secure from unauthorized use.
<i>Enforcement.</i> 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.

companies then use to target online ads. The FTC has also 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 clear options to opt out of data-collection schemes. Other proposed Internet privacy legislation focuses on protecting the online use of personal identification numbers, such as social security numbers; protecting personal information collected on the Internet from individuals not covered by COPPA; and limiting the use of data mining for homeland security. 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 recent laws deregulating financial services and safeguarding the maintenance and transmission of health information about individuals. The Gramm-Leach-Bliley Act of 1999, which repeals earlier restrictions on affiliations among banks, securities firms, and insurance companies, 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 Health Insurance Portability and Accountability Act (HIPAA) of 1996, which took effect on April 14, 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. Doctors, hospitals, and other healthcare providers must limit the disclosure of personal information about patients to the minimum amount necessary to achieve a given purpose.

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 twenty 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, for example, 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 block 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); limit 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% 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 are widely criticized for invading privacy and not protecting PII.

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 across the web because doing so allows more relevant ads to be targeted to users, and this pays for the cost of publishing websites. In this sense, it's like broadcast television: advertiser-supported content that is free to the user. 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. DoubleClick, 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.

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

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.
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.

on 50 of the most popular US 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.

Nearly 80% 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 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 its 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 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. For the most part, 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

A **patent** grants the owner an exclusive monopoly on the ideas behind an invention for 20 years. The congressional intent behind 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.

In what some call the patent trial of the century, in 2011, Apple sued Samsung for violating its patents for iPhones, iPads, and iPods. On August 24, 2012, a California jury in federal district court awarded Apple \$1 billion in damages and prohibited Samsung from selling its new Galaxy 10 tablet computer in the United States. The decision established criteria for determining just how close a competitor can come to an industry-leading and standard-setting product like Apple's iPhone before it violates the design and utility patents of the leading firm. Samsung subsequently won a patent infringement case against Apple that banned a handful of older iPhone and iPad devices. In 2014, Apple sued Samsung again, claiming infringement of five patents covering hardware and software techniques for handling photos, videos, and lists used on the Samsung Galaxy 5. In 2015, the US Court of Appeals reaffirmed that Samsung had copied specific design patents, but reduced the damages asked by Apple from \$2 billion to \$930 million. After seven years of battling in court, the two firms finally settled in 2018 with Apple receiving an estimated \$500 million from Samsung.

To make matters more complicated, Apple has been one of Samsung's largest customers for flash memory processors, graphic chips, solid-state drives, and display parts that are used in Apple's iPhones, iPads, iPod Touch devices, and MacBooks. The Samsung and Apple patent cases are indicative of the complex relationships among the leading computer firms.

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 search engine 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.

Trade Secrets

Any intellectual work product—a formula, device, pattern, 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.

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 US authorities to shut down illegal sharing sites, with mixed results.

As legitimate online music stores such as iTunes and streaming services such as Pandora 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. By 2019 the music industry generated \$10 billion in revenue, equaling its peak revenue in 2010, entirely on the basis of streaming music revenue (RIAA, 2019).

The **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. Microsoft and other major software and information content firms are represented by the Software and Information Industry Association (SIIA), which lobbies for new laws and enforcement of existing laws to protect intellectual property around the world. The SIIA runs an antipiracy hotline for individuals to report piracy activities, offers educational programs to help organizations combat software piracy, and has published guidelines for employee use of software.

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% following the announcement and likely caused 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 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.

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 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 effected 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, however, the 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 (see the Interactive Session on Technology). The gray area is that some system errors are foreseeable and correctable only at great expense, expense so great that pursuing this level of perfection is not feasible economically—no one could afford the product.

Shortly after takeoff from Jakarta, Indonesia, on October 29, 2018, Lion Air Flight 610 crashed 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% of its own work.

The FAA does allow every US 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 nosedives. 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 F.A.A. 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.)

A day after the Ethiopian crash, China grounded all of its 737 MAX planes. Other nations followed, including Ethiopia, Indonesia, Singapore, the United Kingdom, the European Union, Australia, Malaysia, and Canada. The FAA initially defended the 737 MAX, but finally succumbed to intense pressure to ground the plane. 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 2019, Boeing had lost around \$28 billion in its stock market value. While regulators await a fix 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 looks very clouded.

Sources: Oliver Taylor, "10 Facts about the Boeing 737 MAX Air Crashes," *ListVerse*, April 8, 2019; 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; Robert Wall and Andrew Tangel, "Safety Fears Put Boeing on the Defensive," *Wall Street Journal*, March 11, 2019; Andrew J. Hawkins, "Everything You Need to Know about the Boeing 737 MAX Airplane Crashes," *The Verge*, March 22, 2019; and Zach Wichter, "The Boeing Crashes: A Brief Guide to What Happened," *New York Times*, 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 people, organization, and technology factors in the Boeing 737 MAX safety problems. To what extent was management responsible?

- 3.** Is the solution provided by Boeing adequate? Explain your answer.
- 4.** What steps could Boeing and the FAA have taken to prevent this problem from occurring?

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 human errors or natural events, 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%.

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 over 90 percent of the world's 2 billion 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, likewise for Android apps running 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 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, or even anticompetitive behavior. Instead price and consumer welfare became paramount. As long as consumers were not forced to pay higher prices, then 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 law suits 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. Heretofore the poster children of American capitalism at its best, 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 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 face-to-face relationships with their families 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 systems now as ubiquitous as the telephone system, it is startling to remember that there are no

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.



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regulatory or standard-setting forces in place that are similar to telephone, electrical, radio, television, or other public utility technologies. The absence of standards and the criticality of some system applications will probably 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. Some countries have passed laws to outlaw spamming or restrict its use. In the United States, it is still legal if it does not involve fraud and the sender and subject of the email are properly identified.

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 2018 (Symantec, 2019). 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. Digital marketing can be targeted only to people who have given prior consent. Australia, South Africa, the European Union, Sweden, and Malaysia are among the countries that have anti-spam laws.

The US 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. The law has had a negligible impact on spamming, in large part because of 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. The Chapter 1 Interactive Session on People explores this issue.

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 the United States 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.

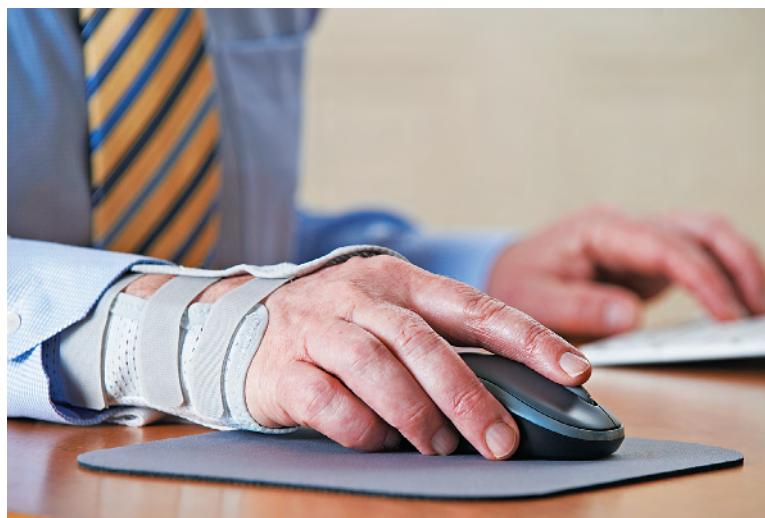
The single largest source of RSI is computer keyboards. The most common kind of computer-related RSI is **carpal tunnel syndrome (CTS)**, in which pressure on the median nerve through the wrist's bony structure, called a carpal tunnel, produces pain. The pressure is caused by constant repetition of keystrokes: 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).

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 People) 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.



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Repetitive stress injury (RSI) is a leading occupational disease today. The single largest cause of RSI is computer keyboard work.

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. A number of studies have pointed out 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 US 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).

Nicholas Carr, who has studied the impact of technology on business and culture, shares these concerns. He has been highly critical of the Internet’s effect on cognition, and these cognitive effects extend to smartphone use. Carr worries that excessive use of mobile devices diminishes the capacity for concentration and contemplation.

Carr recognizes that smartphones provide many useful functions in a handy form. This extraordinary usefulness, however, gives them too much influence on our attention, thinking, and behavior. Smartphones shape our thoughts in deep and complicated ways, and their effects persist even when we aren’t using the devices. Research suggests that the intellect weakens as the brain grows dependent on the technology.

Carr points to the work of Adrian Ward, a cognitive psychologist and marketing professor at the University of Texas at Austin, who for a decade has been studying how smartphones and the Internet affect people’s thoughts and judgment. Ward has observed that using a smartphone, or even hearing one ring or vibrate, produces distractions that make it harder to concentrate on a difficult problem or job. Divided attention impedes reasoning and performance.

A study published in *Applied Cognitive Psychology* in April 2017 examined how smartphones affected learning in a lecture class with 160 students at the University of Arkansas at Monticello. It found that students who didn’t bring their phones to the classroom scored a full letter-grade higher on a test of the material presented than those who brought their phones. It didn’t matter whether students who brought their phones used them or not. A study of 91 UK secondary schools, published in 2016 in the journal *Labour Economics*, found that when schools ban smartphones, students’ examination scores go up substantially, and the weakest students benefit the most.

Carr also observes that using smartphones extensively can be detrimental to social skills and relationships. Connecting with “friends” electronically via smartphones is not a substitute for genuine person-to-person relationships and face-to-face conversations.

In early 2018 two of the largest investors in Apple called for the iPhone maker to take more action against smartphone addiction among children. The investors urged Apple to offer more tools to prevent smartphone addiction and to provide more parental options for monitoring children’s smartphone usage. The iOS operating system for Apple smartphones and tablets already has limited parental controls for restricting apps, features such as location sharing, and access to certain types of content. The investors felt Apple needed to do

more—for example, enable parents to specify the age of the user of the phone during setup, establish limits on screen time, select hours of the day the phone can be used, and block social media services.

Apple created its own screen-time tracker to help parents limit the time they and their children spent on iPhones. But Apple also has removed or restricted at least 11 of the 17 most downloaded screen-time and parental-control apps, according to an analysis by the *New York Times* and Sensor Tower, an app-data firm. Apple has also removed some lesser-known apps. In some cases, Apple

forced companies to remove features that allowed parents to control their children's devices or that blocked children's access to certain apps and adult content. In other cases, it simply pulled the apps from its App Store.

Sources: 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 about Screens and Kids Begins to Emerge in Silicon Valley," *New York Times*, October 26, 2018; Samuel Gibbs, "Apple Investors Call for Action over iPhone 'Addiction' among Children," *The Guardian*, January 8, 2018; David Benoit, "iPhones and Children Are a Toxic Pair, Say Two Big Apple Investors," *Wall Street Journal*, January 7, 2018; and Nicholas Carr, "How Smartphones Hijack Our Minds," *Wall Street Journal*, October 7, 2017.

CASE STUDY QUESTIONS

1. Identify the problem described in this case study. In what sense is it an ethical dilemma?
2. Should restrictions be placed on children's and teenagers' smartphone use? Why or why not?
3. Can the problem of smartphones reducing cognitive skills be solved? Why or why not? Explain your answer.

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

Pinnacle Air Force Base in Sweden 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 federal and state privacy regulations. Job responsibilities include:

- Analyzing and developing policy and procedures related to privacy office functions.
- Logging and tracking Privacy Act 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 Privacy Act?
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 Privacy Act and privacy protection procedures and policies for personnel records.
3. Try to find out more about employee recordkeeping and privacy protection at US military bases or 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 socioeconomic 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

Accountability, 148	Fair Information Practices (FIP), 151	Patent, 157
Carpal tunnel syndrome (CTS), 167	General Data Protection Regulation (GDPR), 152	Privacy, 150
Computer abuse, 165	Golden Rule, 149	Profiling, 147
Computer crime, 165	Immanuel Kant's categorical imperative, 149	Repetitive stress injury (RSI), 166
Computer vision syndrome (CVS), 167	Information rights, 145	Responsibility, 148
Cookies, 154	Informed consent, 155	Risk aversion principle, 149
Copyright, 156	Intellectual property, 156	Safe harbor, 153
Digital divide, 166	Liability, 148	Slippery slope rule, 149
Digital Millennium Copyright Act (DMCA), 159	Nonobvious relationship awareness (NORA), 147	Spam, 165
Due process, 148	Opt-in, 155	Spyware, 155
Ethical no-free-lunch rule, 149	Opt-out, 155	Trade secret, 158
Ethics, 144		Trademarks, 158
		Utilitarian principle, 149
		Web beacons, 154

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?
- Explain the purpose and the significance of GDPR in its current form.
 - Distinguish between opt-in and opt-out with respect to data collection online.
 - Explain the value of a patent and how it protects the intellectual property of an individual or organization.
 - 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.

MyLab MIS™

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

Discussion Questions

- 4-5** Should producers of software-based services, such as ATMs, be held liable for economic injuries suffered when their systems fail? **4-7** Discuss the pros and cons of allowing companies to amass personal data for behavioral targeting.
- 4-6** Should companies be responsible for unemployment their information systems cause? Why or why not?

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. They keep 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.

BUSINESS PROBLEM SOLVING CASE

FACEBOOK PRIVACY: YOUR LIFE FOR SALE

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 US 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 US 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 UK 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 networks. 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, the Russian messages were sent to an estimated 146 million people on Facebook. The messages targeted people based on their personal

information collected by Facebook in the normal course of business, including users' 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.

There are some signs, however, 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 US 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.

While 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 openly that if you use Facebook you agree to their terms of service, which enable it to share your information with third parties of their choosing. As Apple CEO Tim Cook noted, at Facebook, the product they sell is you.

Sources: 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; David Mayer, “Facebook Is Giving You New Privacy Options, But It’s Clear What It Wants You to Choose,” *Fortune*, March 19, 2018; Matthew Rosenberg, Nicholas Confessore, and Carole Cadwalladr, “How Trump Consultants Exploited the Facebook Data of Millions,” *New York Times*, March 17, 2018; Georgia Wells and Deepa Seetharaman, “New Facebook Data Shows Russians Targeted Users by Education, Religion, Politics,” *Wall Street Journal*, November 1, 2017; Hunt Allcott and Matthew Gentzkow, “Social Media and Fake News in the 2016 Election,” *Journal of Economic Perspectives*, March 2017.

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 people, 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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Chapter 5

IT Infrastructure: Hardware and Software

Chapter 6

Foundations of Business Intelligence: Databases and Information Management

Chapter 7

Telecommunications, the Internet, and Wireless Technology

Chapter 8

Securing Information Systems

Information Technology Infrastructure

Part II provides the technical knowledge foundation for understanding information systems by examining hardware, software, databases, networking technologies, and tools and techniques for security and control. This part answers questions such as these: What technologies and tools 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 my 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?

IT Infrastructure: Hardware and Software

LEARNING OBJECTIVES

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

- 5-1** What are the components of IT infrastructure?
- 5-2** What are the major computer hardware, data storage, input, and output technologies used in business and the major hardware trends?
- 5-3** What are the major types of computer software used in business and the major software trends?
- 5-4** What are the principal issues in managing hardware and software technology?
- 5-5** How will MIS help my career?

CHAPTER CASES

- Hermes UK: Success Delivered Through the Cloud
- Open Source Innovation: The New Competitive Advantage
- Look to the Cloud
- What Should Firms Do About BYOD?

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: 5-5, 5-6, 5-7
- Hands-On MIS Projects: 5-8, 5-9, 5-10, 5-11

HERMES UK: SUCCESS DELIVERED THROUGH THE CLOUD

Hermes UK, the second largest delivery company in the United Kingdom, is a subsidiary of Hermes Europe GmbH, which is headquartered in Germany. With 10,000 couriers, 27 depots, and 3 distribution hubs, Hermes UK operates all along the retail value chain. The company has been investing in its infrastructure to keep up with the United Kingdom's growing delivery service market, which was worth £10 billion in 2018; that same year, it handled more than 300 million parcels.

Despite the massive potential market, the firm faces various challenges, especially higher and higher expectations from customers, who demand faster delivery, more delivery options, and a lower service charge. Customers rarely show loyalty to any particular parcel delivery company and are likely to switch to another if the quality of service fails to meet their expectations. Switches are particularly frequent during peak hours and peak seasons (such as Christmas), when the demand for parcel delivery services skyrockets. Additionally, cutthroat competition between delivery companies has resulted in extremely low profit margins.

For Hermes UK, a further threat came from Amazon, a pioneer in the industry with various package delivery innovations behind it—and promising free one-day delivery. Worse still, the vast numbers of parcels Hermes UK handled every day resulted in a much larger volumes of data—which increased exponentially during peak times—than its information systems could handle. The delivery company had no choice but to process data in batches instead of in real-time, and some of the tasks suffered considerable delays. Its data center at Hamburg could no longer accommodate the daily operational needs of the delivery specialist. It was time to change.

Hermes UK decided to retire its DB2 and Oracle systems and build a real-time database supplemented with streamlined processes deployed on Amazon Web Services (AWS) infrastructure. AWS was selected because Amazon had been the most suitable service provider for the delivery company, and AWS-hosted solutions were already widely installed among its business partners. The transformation project automated most of the batch-oriented information processes. The time interval for updating delivery information online for customer enquiry plummeted from two hours to one minute, which significantly improved its customer service. The consumption-based, scalable cloud architecture also enables Hermes UK to process the incoming delivery instructions of each of its 1.5 million deliveries every day within 15 minutes. It can now cope with any demand spikes in information processing that accompanies the growth of its market share.



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This migration project also gave Hermes UK a chance to transform its data structure from a package-based data model to a customer-centric one. The new data model gives the delivery company 360-degree knowledge of every client that sends a parcel and every customer that receives one. Hermes UK has also revised its business processes to accumulate customer information at a rate of up to 1,000 records per second at peak times. With the aid of cloud computing and a GPS-enabled mobile app used by its delivery workers, Hermes UK now collects customer preferences even from doorstep delivery, such as the name of a trusted neighbor who can collect the packages on behalf of the recipient or a safe place where parcels can be left when the recipient cannot collect them personally. Such preferences are stored in the transaction history, allowing Hermes UK to provide bespoke services to its customers.

Sources: Hermes World, www.hermesworld.com, accessed November 22, 2019; MyHermes, www.myhermes.co.uk, accessed November 22, 2019; P. Sayer, "Hermes Transforms Data Infrastructure to Speed Parcel Deliveries," CIO (July 8, 2019), www.cio.com; Datalytx, "Hermes Parcel Delivery: High Volume Master Data Management" (2019), www.datalytx.com; M. Perry, "Parcel Delivery: Should the Customer Be in Charge?", *Supply Chain Innovation 2019 Report* (Raconteur Media Ltd., 2019); A. Mari, "CIO Interview: Chris Ashworth, CIO, Hermes," *Computer Weekly*, May 29, 2018.

Case contributed by Joyce Chan, City University of Hong Kong

The Hermes UK case shows that using the right information technology can facilitate the smooth daily operation of a business. Hermes UK's information systems lacked the necessary capacity to deal with the enormous amount of data that accompanied the over 300 million parcels it handled annually. Data was queuing up to be processed in batches by the legacy systems, and the situation only got worse during peak seasons. The information system had become a bottleneck that was hindering the delivery company's business growth.

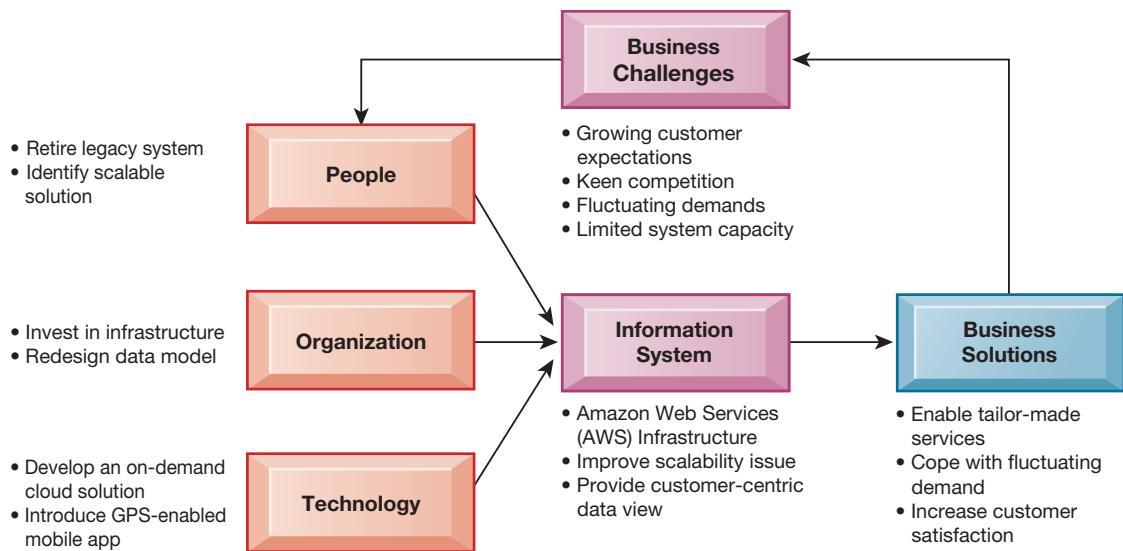
The chapter-opening case diagram calls attention to important points raised by this case and this chapter. Hermes UK no longer relies on the ageing legacy systems; it migrated its data instead to an on-demand cloud solution provided by AWS, with some redundant processes eliminated. The delivery company took the opportunity to adopt a customer-centric data model and invested in hardware to collect customer preferences from the doorstep delivery process. With a rounded view of its customers, Hermes UK can provide personalized services to each one based on their transaction history.

Here are some questions to think about: How did using an on-demand cloud solution help Hermes UK gain its competitive edge? How did Hermes UK generate customer value through this solution?

5-1 What are the components of IT infrastructure?

If you want to know why businesses worldwide spend about \$3.8 trillion annually on computing and information systems, just consider what it would take for you personally to set up a business or manage a business today. Businesses require a wide variety of computing equipment, software, and communications capabilities simply to operate and solve basic business problems.

Do your employees travel or do some work from home? You will want to equip them with laptop computers, tablets, or smartphones. If you are employed by a medium or large business, you will also need larger server computers, perhaps an entire data center or server farm with hundreds or even thousands of servers. A **data center** is a facility housing computer systems and associated components such as telecommunications, storage, security systems, and backup power supplies.



You will also need plenty of software. Each computer will require an operating system and a wide range of application software capable of dealing with spreadsheets, documents, and data files. Unless you are a single-person business, you will most likely want to have a network to link all the people in your business and perhaps your customers and suppliers. In fact, you will probably want several networks: a local area network connecting employees in your office and remote access capabilities so that employees can share email and computer files while they are out of the office. You will also want all your employees to have access to landline phone systems, mobile phone networks, and the Internet. Finally, to make all this equipment and software work harmoniously, you will also need the services of trained people to help you run and manage this technology.

All the elements we have just described combine to make up the firm's *information technology (IT) infrastructure*, which we first defined in Chapter 1. A firm's IT infrastructure provides the foundation, or platform, for supporting all the information systems in the business.

IT INFRASTRUCTURE COMPONENTS

Today's IT infrastructure is composed of five major components: computer hardware, computer software, data management technology, networking and telecommunications technology, and technology services (see Figure 5.1). These components must be coordinated with each other.

Computer Hardware

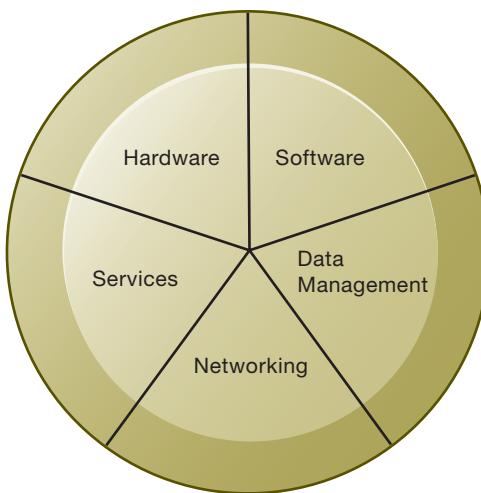
Computer hardware consists of technology for computer processing, data storage, input, and output. This component includes large mainframes, servers, desktop and laptop computers, and mobile devices for accessing corporate data and the Internet. It also includes equipment for gathering and inputting data, physical media for storing the data, and devices for delivering the processed information as output.

Computer Software

Computer software includes both system software and application software. **System software** manages the resources and activities of the computer. **Application software** applies the computer to a specific task for an end user, such as processing an order

Figure 5.1
IT Infrastructure Components.

A firm's IT infrastructure is composed of hardware, software, data management technology, networking technology, and technology services.



or generating a mailing list. Today, most system and application software is no longer custom programmed but rather is purchased from outside vendors. We describe these types of software in detail in Section 5-2.

Data Management Technology

In addition to physical media for storing the firm's data, businesses need specialized software to organize the data and make them available to business users. **Data management software** organizes, manages, and processes business data concerned with inventory, customers, and vendors. Chapter 6 describes data management software in detail.

Networking and Telecommunications Technology

Networking and telecommunications technology provides data, voice, and video connectivity to employees, customers, and suppliers. It includes technology for running a company's internal networks, telecommunications/telephone services, and technology for running websites and linking to other computer systems through the Internet. Chapter 7 provides an in-depth description of these technologies.

Technology Services

Businesses need people to run and manage the infrastructure components we have just described and to train employees in how to use these technologies for their work. Chapter 2 described the role of the information systems department, which is the firm's internal business unit set up for this purpose. Today, many businesses supplement their in-house information systems staff with external technology consultants to provide expertise that is not available internally. When businesses need to make major system changes or implement an entirely new IT infrastructure, they typically turn to external consultants to help them with systems integration.

Systems integration means ensuring that the new infrastructure works with the firm's legacy systems and that the new elements of the infrastructure work with one another. **Legacy systems** are generally older transaction-processing systems created for older computers that continue in use to avoid the high cost of replacing or redesigning them.

Thousands of technology vendors supply IT infrastructure components and services, and an equally large number of ways of putting them together exists. This chapter is about the hardware and software components of infrastructure you will need to run a business. Chapter 6 describes the data management component, and Chapter 7 is devoted to the networking and telecommunications technology component. Chapter 8 deals with hardware and software for ensuring that information systems are reliable and secure.

5-2 What are the major computer hardware, data storage, input, and output technologies used in business and the major hardware trends?

Business firms face many challenges and problems that computers and information systems can solve. To be efficient, firms need to match the right computer hardware to the nature of the business challenge, neither overspending nor underspending for the technology.

TYPES OF COMPUTERS

Computers come in an array of sizes with differing capabilities for processing information, from the smallest handheld devices to the largest mainframes and supercomputers. If you're working alone or with a few other people in a small business, you'll probably be using a desktop or laptop **personal computer (PC)**. You will likely have a mobile device with substantial computing capability, such as an iPhone, iPad, or Android mobile device. If you're doing advanced design or engineering work requiring powerful graphics or computational capabilities, you might use a **workstation**, which fits on a desktop but has more powerful mathematical and graphics-processing capabilities than a PC.

If your business has a number of networked computers or maintains a website, it will need a **server**. Server computers are specifically optimized to support a computer network, enabling users to share files, software, peripheral devices (such as printers), or other network resources.

Servers provide the hardware platform for electronic commerce. By adding special software, they can be customized to deliver web pages, process purchase and sale transactions, or exchange data with systems inside the company. You will sometimes find many servers linked to provide all the processing needs for large companies. If your company has to process millions of financial transactions or customer records, you will need multiple servers or a single large mainframe to do this work.

Mainframe computers first appeared in the mid-1960s, and large banks, insurance companies, stock brokerages, airline reservation systems, and government agencies still use them to keep track of hundreds of thousands or even millions of records and transactions. A **mainframe** is a large-capacity, high-performance computer that can process large amounts of data very rapidly. For example, the IBM Z14 mainframe can process 12 billion encrypted transactions per day. IBM has repurposed its mainframe systems so they can be used as giant servers for large-scale enterprise networks and corporate websites. A single IBM mainframe can run enough instances of Linux or Windows server software to replace thousands of smaller Windows-based servers. A **supercomputer** is a specially designed and more sophisticated computer that is used for tasks requiring extremely rapid and complex calculations with thousands of variables, millions of measurements, and thousands of equations. Supercomputers traditionally have been used in engineering analysis of structures, scientific exploration and simulations, and military work such as classified weapons research. Volvo and most other automobile manufacturers use supercomputers to simulate vehicle crash tests.

If you are a long-term weather forecaster, such as the National Oceanic and Atmospheric Administration (NOAA) or the National Hurricane Center, and your challenge is to predict the movement of weather systems based on hundreds of thousands of measurements and thousands of equations, you would want access to a supercomputer or a distributed network of computers called a grid.

Grid computing involves connecting geographically remote computers into a single network and combining the computational power of all computers on the grid. Grid computing takes advantage of the fact that most computers in the United States use their central processing units on average only 25 percent of the time, leaving

75 percent of their capacity available for other tasks. By using the combined power of thousands of PCs and other computers networked together, the grid can solve complicated problems at supercomputer speeds at far lower cost.

For example, Royal Dutch/Shell Group is using a scalable grid computing platform that improves the accuracy and speed of its scientific modeling applications to find the best oil reservoirs. This platform, which links 1,024 IBM servers running the Linux operating system, in effect creates one of the largest commercial Linux supercomputers in the world. The grid adjusts to accommodate the fluctuating data volumes that are typical in this seasonal business.

Computer Networks and Client/Server Computing

Unless you are in a small business with a stand-alone computer, you'll be using networked computers for most processing tasks. The use of multiple computers linked by a communications network for processing is called **distributed processing**. **Centralized processing**, in which all processing is accomplished by one large central computer, is much less common.

One widely used form of distributed processing is **client/server computing**. Client/server computing splits processing between clients and servers. Both are on the network, but each machine is assigned functions it is best suited to perform. The **client** is the user point of entry for the required function and is normally a desktop or laptop computer. The user generally interacts directly only with the client portion of the application. The server provides the client with services. Servers store and process shared data and perform such functions as printer management and backup storage and network activities such as security, remote access, and user authentication. Figure 5.2 illustrates the client/server computing concept. Computing on the Internet uses the client/server model (see Chapter 7).

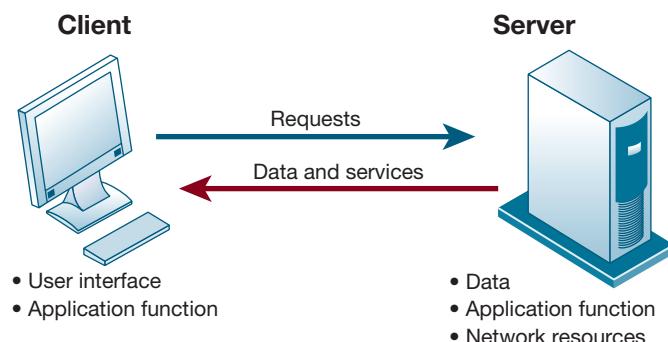
Figure 5.2 illustrates the simplest client/server network, consisting of a client computer networked to a server computer, with processing split between the two types of machines. This is called a *two-tiered client/server architecture*. Whereas simple client/server networks can be found in small businesses, most corporations have more complex, multilayered (often called **N-tier client/server architectures**), in which the work of the entire network is balanced over several 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 about other pieces of software that are used in multilayered client/server architectures for e-commerce and e-business.

Figure 5.2

Client/Server Computing.

In client/server computing, computer processing is split between client machines and server machines linked by a network. Users interface with the client machines.



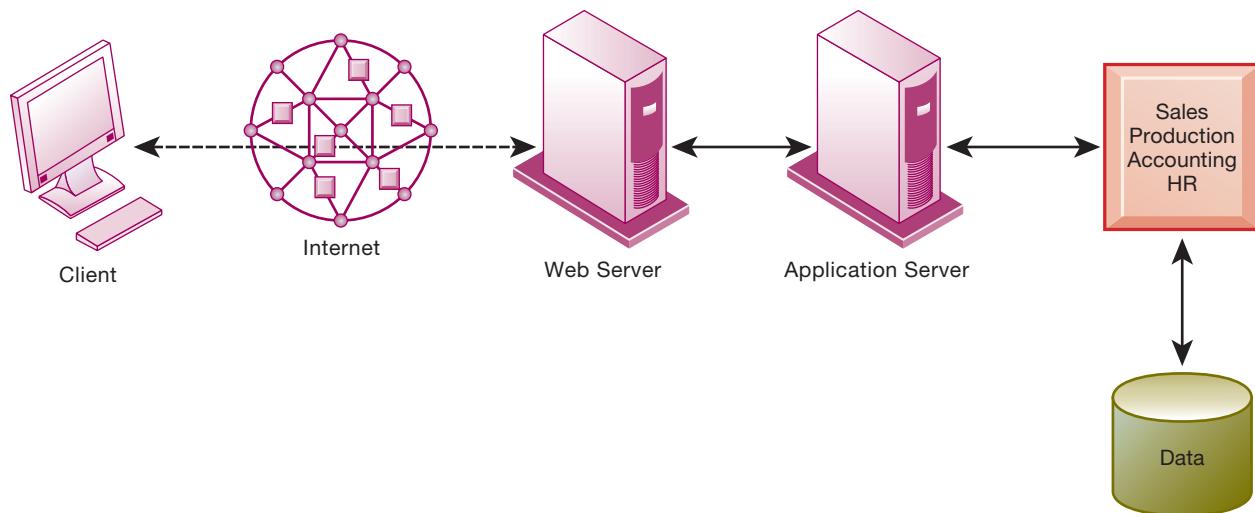


Figure 5.3

A Multitiered Client/Server Network (N-Tier).

In a multitiered client/server network, client requests for service are handled by different levels of servers.

STORAGE, INPUT, AND OUTPUT TECHNOLOGY

In addition to hardware for processing data, you will need technologies for data storage and input and output. Storage and input and output devices are called *peripheral devices* because they are outside the main computer system unit.

Secondary Storage Technology

Electronic commerce and electronic business, and regulations such as the Sarbanes-Oxley Act of 2002 and the Dodd-Frank Act of 2010 have made storage a strategic technology. The amount of data that companies now need to store is doubling every 12 to 18 months. Traditional storage technologies include magnetic disks, optical drives, magnetic tape, and storage networks, which connect multiple storage devices on a separate high-speed network dedicated to storage.

Magnetic disk drives are still used for secondary storage in large and midrange computers and in some PCs. However, data storage in many PCs, as well as smartphones and tablets is based on **solid state drives (SSDs)**, which use an array of semiconductors organized as a very fast internal disk drive. Portable USB flash drives use similar technology for external storage. Optical drives (CD, DVD, and Blu-ray) use laser beaming technology to store very large quantities of data, including sound and images, in compact form. Firms also use cloud computing services for large scale data storage. We discuss cloud computing later in this chapter.

Input and Output Devices

Human beings interact with computer systems largely through input and output devices. **Input devices** gather data and convert them into electronic form for use by the computer, whereas **output devices** display data after they have been processed. Table 5.1 describes the principal input and output devices.

CONTEMPORARY HARDWARE TRENDS

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. Let's look at eight hardware trends: the mobile digital platform, consumerization of IT and BYOD, nanotechnology and quantum computing, virtualization, cloud computing, edge computing, green computing, and high-performance/power-saving processors.

TABLE 5.1

Input and Output Devices

Input Device	Description
Keyboard	Principal method of data entry for text and numerical data.
Computer mouse	Handheld device with point-and-click capabilities for controlling a cursor's position on a computer display screen and selecting commands. Trackballs and touch pads often are used in place of the mouse as pointing devices on laptop PCs.
Touch screen	Device that allows users to interact with a computer by touching the surface of a sensitized display screen. Used in kiosks in airports, retail stores, and restaurants and in multitouch devices such as the iPhone, iPad, and multitouch PCs.
Optical character recognition	Device that can translate specially designed marks, characters, and codes into digital form. The most widely used optical code is the bar code.
Magnetic ink character recognition (MICR)	Technology used primarily in check processing for the banking industry. Characters on the bottom of a check identify the bank, checking account, and check number and are preprinted using special magnetic ink for translation into digital form for the computer.
Pen-based input	Handwriting-recognition devices that convert the motion made by an electronic stylus pressing on a touch-sensitive tablet screen into digital form.
Digital scanner	Device that translates images, such as pictures or documents, into digital form.
Audio input	Input devices that convert voice, music, or other sounds into digital form for processing by the computer.
Sensors	Devices that collect data directly from the environment for input into a computer system. For instance, farmers can use sensors to monitor the moisture of the soil in their fields.
Output Device	Description
Display	Often a flat-panel (LCD) display screen.
Printers	Devices that produce a printed hard copy of information output. They include impact printers (such as dot matrix printers) and nonimpact printers (such as laser, inkjet, and thermal transfer printers).
Audio output	Output devices that convert digital output data back into intelligible speech, music, or other sounds.

The Mobile Digital Platform

Chapter 1 pointed out that new mobile digital computing platforms have emerged as alternatives to PCs and larger computers. Mobile devices such as 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 new mobile platform also includes small, lightweight subnotebooks called *netbooks* optimized for wireless communication and Internet access, **tablet computers** such as the iPad, car infotainment systems, wearable devices, and digital e-book readers such as Amazon's Kindle with some web access capabilities.

Smartphones and tablet computers are becoming the primary means of accessing the Internet. These devices are increasingly used for business computing as well as for consumer applications. For example, senior executives at General Motors are using smartphone applications that drill down into vehicle sales information, financial performance, manufacturing metrics, and project management status.

Wearable computing devices are a recent addition to the mobile digital platform. These include smartwatches, smart glasses, smart badges, and activity trackers. Wearable computing technology is still in its infancy, but it already has business uses.

Open source software (OSS) is computer software whose source code is made available to the public to be distributed freely and modified by anyone. The open source software movement started as a response to the high cost and restrictions on proprietary software, and such software was traditionally created by a large number of users or by communities. Famous examples of OSS are Linux, Apache, and Firefox.

More recently, however, there has been a trend toward taking company-built proprietary software and making it available to the public as open source. This phenomenon, popularly known as open innovation, aims to increase the pace of innovation at companies by relying on many more users for new ideas and features instead of just having a small, internal group doing R&D. This is also aligned with the broader Internet trend of Web 2.0, in which people are both users and contributors. This is 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 fifth-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 is relying more and more on AI. In 2016, in a move that took the IT world by surprise, Baidu released the source code of its AI software, PaddlePaddle (PArallel Distributed Deep LEarning), which had taken three years to develop. The source code was released along with documentation on the platform GitHub with an open invitation to English-speaking developers.

PaddlePaddle is a framework based on deep learning, which is 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. In November 2019, Baidu released PaddlePaddle version 1.6, with 21 new features, including Paddle Lite 2.0, a module for mobile, embedded, and Internet of Things devices. According to Baidu, over 1.5 million developers have used PaddlePaddle since its release. 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.

A similar example comes from tech giant Fujitsu, a leading Japanese multinational information and communication technology company employing around 132,000 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 OSS.

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), an 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 OSS 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. Fujitsu, on the other hand, adopted the OSS strategy because keeping the 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.

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. The companies partnered to create Biometrics-as-a-Service,

offering a cloud-based biometric identity management suite called GoVerifyID.

Sources: Stacy Fisher. "The Top 10 Most Popular Sites of 2020." Lifewire.com, January 2, 2020; Kyle Wiggers. "Baidu Releases PaddlePaddle 1.6 with Federated Learning Tools and More." Venturebeat.com, November 14, 2019; "Fujitsu at a Glance," Fujitsu.com, June 2019; John Ribeiro, "Baidu Open Sources Its Deep Learning Platform PaddlePaddle," *PC World*, September 1, 2016; Serdar Yegulalp, "Baidu Open-Sources Python-Driven Machine Learning Framework," *InfoWorld*, September 1, 2016; "Baidu: Investors: Company Overview," Baidu.com; James Vincent, "Baidu Follows U.S. Tech Giants and Open Sources Its Deep Learning Tools," *The Verge*, September 1, 2016; "Fujitsu Upgrades Biometrics-as-a-Service with Latest Catalog Manager Marketplace and ImageWare's GoVerifyID," Fujitsu.com, July 14, 2016; Libby Clark, "Fujitsu Open Source Project Aims to Be Front End for Cloud Foundry Service-Broker API," Linux.com, October 11, 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 had motivated Baidu to open source its AI software? 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

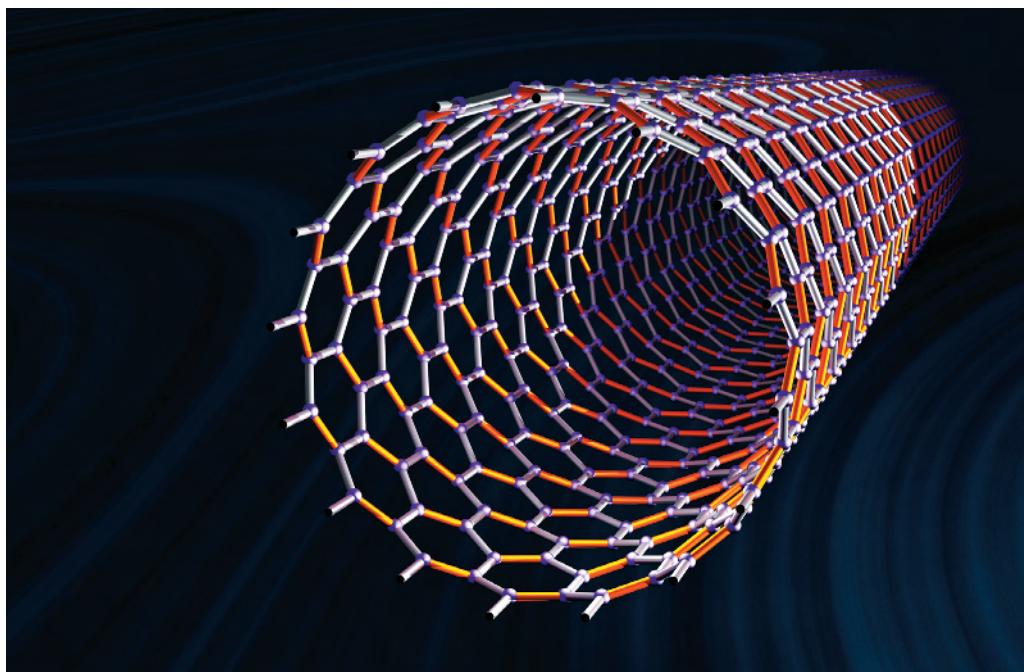
Consumerization of IT and BYOD

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, 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 controlled selection and management of the firm's hardware and software. This ensured that information systems were protected and served the purposes of the firm. 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 mobile devices to access the corporate network. Although consumer technologies provide new tools to foster creativity, collaboration, and productivity, they are more difficult for firms to manage and control. We provide more detail on this topic in Section 5-3 and in the chapter-ending case study.

Nanotechnology and Quantum Computing

Over the years, microprocessor manufacturers have been able to increase processing power exponentially while shrinking chip size by finding ways to pack more transistors into less space. They are now turning to nanotechnology to shrink the size of transistors to the width of several atoms. **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 looking for ways to produce nanotube processors economically.



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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 and have potential uses as minuscule wires or in ultrasmall electronic devices and are very powerful conductors of electrical current.

Another new way of enhancing computer processing power is to use **quantum computing**, which uses the principles of quantum physics to represent data and perform operations on these data. While conventional computers handle bits of data either as 0 or 1 but not both, quantum computing can process bits 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, Volkswagen, and Lockheed Martin are experimenting with quantum technology.

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 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 overutilization 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. Cloud computing is the fastest-growing form of computing, with worldwide public cloud computing expenditures reaching \$266 billion by 2021. Gartner Research has predicted that by 2025, 80 percent of enterprises will replace their traditional on-premises data centers with cloud computing services (Gartner, 2018). Figure 5.4 illustrates the cloud computing concept.

Consumers use cloud services such as Apple's iCloud or Google Drive to store documents, photos, videos, and email. Cloud-based software powers social networks, streamed video and music, and online games. Private and public organizations are turning to cloud services to replace internally run data centers and software applications. Amazon, Google, IBM, Oracle, and Microsoft operate huge, scalable cloud computing centers offering computing power, data storage, and high-speed Internet connections to firms that want to maintain their IT infrastructures remotely. Google, Microsoft, SAP, Oracle, and Salesforce.com sell software applications as cloud services delivered over the Internet.

The US National Institute of Standards and Technology (NIST) defines cloud computing as having the following essential characteristics:

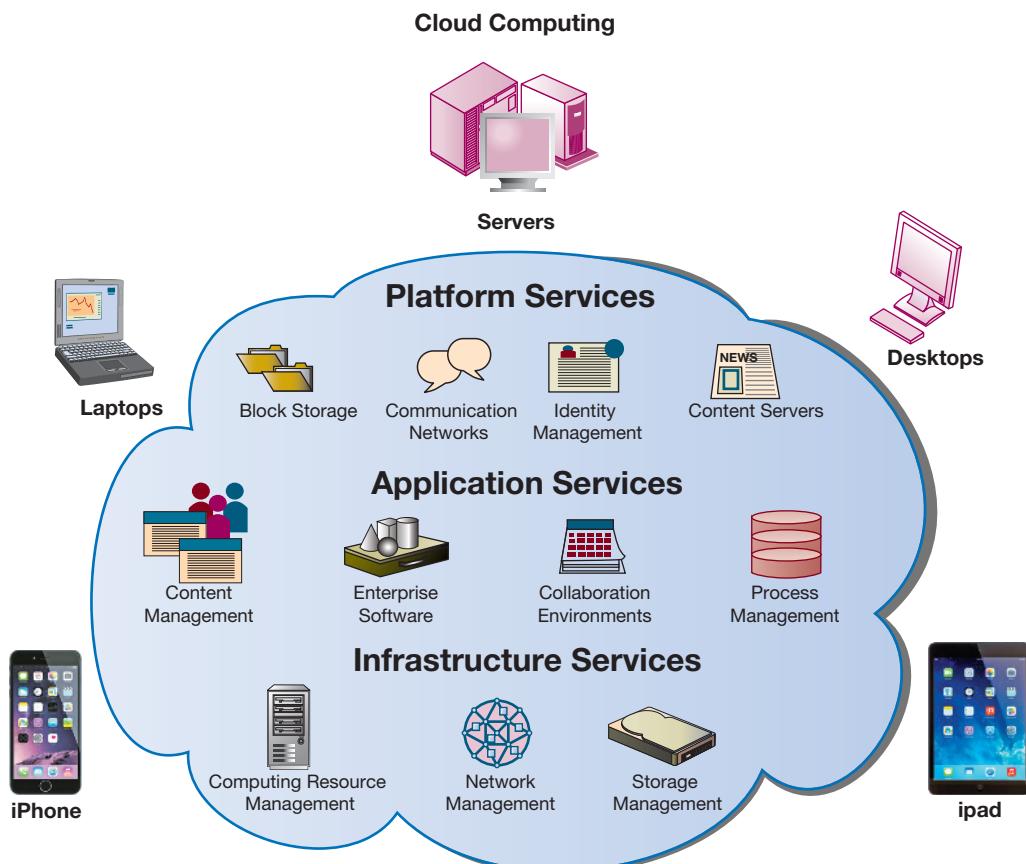
- **On-demand self-service:** Consumers can obtain computing capabilities such as server time or network storage as needed automatically on their own.
- **Ubiquitous network access:** Cloud resources can be accessed using standard network and Internet devices, including mobile platforms.
- **Location-independent 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.

Figure 5.4

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 and at any time.



- **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 number of resources actually used.

Cloud computing consists of three 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 5.5 shows some of the major services Amazon Web Services offers.
- **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 also 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 G Suite, 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, providing customer relationship management (CRM) and other application software solutions as software services leased over the Internet. Its Sales Cloud and Service Cloud offer applications for improving



Figure 5.5
Major Amazon Web Services.

Amazon Web Services (AWS) is a collection of web services that Amazon provides to users of its cloud platform. AWS now offers over 90 services and is the largest provider of public cloud-based services.

If you want to see where computing is taking place, look to the cloud. Cloud computing is now the fastest-growing form of computing. According to Cisco Systems, 94 percent of all computing workloads will run in some form of cloud environment by 2021. This includes both public and private cloud platforms. Gartner Research has predicted that 80 percent of enterprises will retire their traditional data centers by 2025.

Cloud computing has become an affordable and sensible option for companies of all sizes, ranging from tiny Internet startups to established companies like Netflix and FedEx. For example, Amazon Web Services (AWS) provides subscribing companies with flexible computing power and data storage as well as data management, messaging, payment, and other services that can be used together or individually, as the business requires. Anyone with an Internet connection and a little bit of money can harness the same computing systems that Amazon itself uses to run its retail business. If customers provide specifications on the amount of server space, bandwidth, storage, and any other services they require, AWS can automatically allocate those resources. You don't pay a monthly or yearly fee to use Amazon's computing resources—instead, you pay for exactly what you use. Economies of scale keep costs low.

Cloud computing also appeals to many businesses because the cloud services provider will handle all of the maintenance and upkeep of their IT infrastructures, allowing these businesses to spend more time on higher-value work. Start-up companies and smaller companies are finding that they no longer need to build their own data center. With cloud infrastructures like Amazon's readily available, they have access to technical capability that was formerly available only to much larger businesses.

San Francisco-based 99designs runs an online marketplace that connects companies or individuals who have design needs for logos, brochures, clothing, and packaging with designers who can provide those services. It has over 1.6 million registered users and receives two new design submissions every second. Designers compete for work by responding to customer design briefs posted on the website. The company uses AWS to host its information systems because it can easily accommodate the computing needs posed by its rapid year-to-year growth in traffic and users without high up-front investments in new information technology.

99designs uses AWS for data management, hosting applications, and storing a very high volume of design data (over 100 terabytes). AWS helped 99designs reduce the amount of IT infrastructure it needed to manage directly, producing ongoing operational cost savings.

Although cloud computing has been touted as a less expensive yet more flexible alternative to buying and owning information technology, this isn't always the case. For large companies, paying a public cloud provider a monthly service fee for 10,000 or more employees may actually be more expensive than having the company maintain its own IT infrastructure and staff. Companies also worry about unexpected "runaway costs" from using a pay-per-use model. Integrating cloud services with existing IT infrastructures, errors, mismanagement, or unusually high volumes of web traffic will run up the bill for cloud service users.

Densify, a cloud optimization firm serving large companies, recently surveyed 70 global companies and 200 cloud-industry professionals, and found that companies across all industries may be overspending on cloud services by as much as 42 percent. These companies have been estimating more cloud computing capacity than they actually need or buying reserve capacity in advance that they never use. This can translate into hundreds of thousands or even millions of lost dollars in IT budgets a year.

A major barrier to widespread cloud adoption has been concerns about cloud reliability and security. A Salesforce outage on May 17, 2019, caused by a faulty software update triggered a shutdown of Salesforce Marketing Cloud services for 15 hours into the weekend. Hardware shutdowns due to severe weather in September 2018 caused a Microsoft Azure cloud outage that impacted three dozen cloud services. It took up to two days for some services to restore operations. Problems with the AWS Direct Connect service took down several large customers on the morning of March 2, 2018, including enterprise software tool provider Atlassian, Capital One, and Amazon's own Alexa personal assistant. (AWS Direct Connect is used by hybrid cloud customers to set up a secure connection between AWS infrastructure and the customer's on-premises infrastructure.) There have also been significant Amazon cloud outages in the preceding five years.

As cloud computing continues to mature and the major cloud infrastructure providers gain more experience, cloud service and reliability have steadily

improved. Experts recommend that companies for whom an outage would be a major risk consider using another computing service as a backup.

In February 2016 Netflix completed a decade-long project to shut down its own data centers and use Amazon's cloud exclusively to run its business. Management appreciated not having to guess months beforehand about the firm's hardware, storage, and networking needs or to tie down company resources securing and maintaining hardware. AWS would provide whatever hardware Netflix needed at the moment, while Netflix owned its own software, which is more important for a content-driven business.

Although Netflix, Intuit, and Juniper Networks are among the companies that have embraced a "cloud first" strategy in which all their computing work takes place in the cloud, others are dialing back their cloud computing investments. These companies found they lacked the in-house expertise to effectively manage the move to public cloud services like Amazon Web Services and Microsoft Azure. Costs soared exponentially if they had to restore, move, or access their information. The cloud introduces new complexity.

Online file hosting company Dropbox had been an early AWS success story, but it had never run all of its systems on AWS. Dropbox's strategy to build one of the largest data stores in the world depended on owning its computing resources. Dropbox removed most of the systems it ran with AWS to build systems better

suited to its needs, saving nearly \$75 million in infrastructure costs over three years. However, that transition was costly. The company spent more than \$53 million for custom architectures in three colocation facilities to accommodate exabytes of storage. Dropbox stores the remaining 10 percent of user data on AWS, in part to localize data in the US and Europe.

Many large companies moving more of their computing to the cloud are unable to migrate completely. Legacy systems are the most difficult to switch over. Most midsized and large companies will gravitate toward a hybrid approach. The top cloud providers themselves—Amazon, Google, Microsoft, and IBM—use their own public cloud services for some purposes, but they continue to keep certain functions on private servers. Worries about reliability, security, and risks of change have made it difficult for them to move critical computing tasks to the public cloud.

Sources: Don Fluckinger, "Salesforce Outage Exposes Pardot Marketing Automation Data," *SearchCustomer Experience*, May 22, 2019; "AWS Case Study: 99Designs," <https://aws.amazon.com>, accessed April 30, 2019; Chris Preimesberger, "How Cloud Environments Will Evolve Over the Next Few Years," *eWeek*, March 12, 2019; Sarah Neenan, "A Look Back at the Top Cloud Computing News of 2018," searchcloudcomputing.com, December 2018; Angus Loten, "Rush to the Cloud Creates Risk of Overspending," *Wall Street Journal*, July 25, 2018; Clint Boulton, "How Public Cloud Powers Digital Transformation: 8 Real-World Examples," *CIO*, August 3, 2018; Trevor Jones, "Dropbox Is Likely an Outlier with Its Successful Cloud Data Migration off AWS," searchaws.com, February 28, 2018; Andy Patrizio, "Cisco Says Almost All Workloads Will Be Cloud-Based Within 3 Years," *Network World*, February 5, 2018; and Tom Krazit, "Widespread Outage at Amazon Web Services' U.S. East Region Takes down Alexa, Atlassian Developer Tools," *GeekWire*, March 2, 2018.

CASE STUDY QUESTIONS

- 1.** What business benefits do cloud computing services provide? What problems do they solve?
- 2.** What are the disadvantages of cloud computing?
- 3.** What kinds of businesses are most likely to benefit from using cloud computing? Why?

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, an Analytics Cloud platform to enable users to visualize and analyze data on many different kinds of devices without having to toggle among applications, and a Health Cloud for patient care management. A new IoT (Internet of Things) Cloud transmits data about product usage and customer behavior generated by Internet-connected devices to the Salesforce platform to improve customer relationship management.

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, new application development and testing, and consumer services such as online storage of data, music, and photos. Google Drive, Dropbox, and Apple iCloud are leading examples of these consumer cloud services.

A **private cloud** is operated solely for an organization. It might be managed by the organization or a third party and hosted either internally or externally. Like public clouds, private clouds can 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. (Review the Interactive Session on Organizations.)

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. Start-ups and small companies that do not have ample IT resources or budgets will find public cloud services especially helpful.

Large firms are most likely to adopt a **hybrid cloud** computing model, in which 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 cloud 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 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

Type of Cloud	Description	Managed By	Uses
Public cloud	Third-party service offering computing, storage, and software services to multiple customers and that is available to the public	Third-party service providers	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

TABLE 5.2

Cloud Computing Models Compared

could compile the data and send daily reports to a central data center or cloud for long-term storage. By sending only 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 helpful for situations where delays of milliseconds can be untenable, such as in financial services, manufacturing, or online gaming. For example, Network Next, which specializes in making the Internet better for gaming, uses edge computing to reduce delays in data transmission and response time for real-time online multiplayer games.

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 in order 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 is about 1.5 percent of all energy use in the world. Reducing computer power consumption has been a very high green priority. A corporate data center can easily consume more than 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 such as Microsoft, Google, Facebook, and Apple are starting to reduce their carbon footprint with clean energy-powered data centers, including 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. Some of today's processors are also designed to handle intensive data-processing requirements for machine learning applications (AI processors), which we discuss in Chapter 11.

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 the A10, A11 Bionic, and A12 Bionic processors found in Apple's iPhone and iPad, and Intel's Atom processor, are used in lightweight smartphones and tablets, intelligent cars, and health care devices. Apple's A12 processor for the iPhone Xs has two performance cores for heavy computational tasks, four efficiency cores for everyday tasks, and a four-core GPU (graphics processing unit). The efficiency cores make it possible for the A12 to use up to 50 percent less power than its A11 Bionic predecessor.

5-3 What are the major types of computer software used in business and the major software trends?

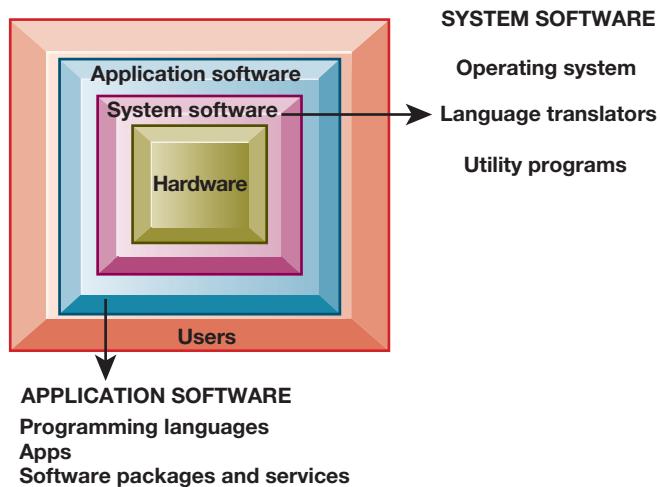
To use computer hardware, you need software, which provides the detailed instructions that direct the computer's work. System software and application software are interrelated and can be thought of as a set of nested boxes, each of which must interact closely with the other boxes surrounding it. Figure 5.6 illustrates this relationship. The system software surrounds and controls access to the hardware. Application software must work through the system software to operate. End users work primarily with application software. Each type of software must be designed for a specific machine to ensure its compatibility.

OPERATING SYSTEM SOFTWARE

The system software that manages and controls the computer's activities is called the **operating system**. Other system software consists of computer language translation programs that convert programming languages into machine language that can be understood by the computer and utility programs that perform common processing tasks, such as copying, sorting, or computing a square root. The operating system

Figure 5.6
The Major Types of Software.

The relationship between the system software, application software, and users can be illustrated by a series of nested boxes. System software—consisting of operating systems, language translators, and utility programs—controls access to the hardware. Application software, including programming languages and software packages, must work through the system software to operate. The user interacts primarily with the application software.



allocates and assigns system resources, schedules the use of computer resources and computer jobs, and monitors computer system activities. The operating system provides locations in primary memory for data and programs and controls the input and output devices, such as printers, displays, and telecommunication links. The operating system also coordinates the scheduling of work in various areas of the computer so that different parts of different jobs can be worked on simultaneously.

PC, Server, and Mobile Operating Systems

The operating system controls the way users interact with the computer. Contemporary PC operating systems and application software use a **graphical user interface**, often called a **GUI**, which makes extensive use of icons, buttons, bars, and boxes to perform tasks.

Conventional client operating system software was designed around the mouse and keyboard, but it is increasingly becoming more natural and intuitive by using **multitouch** technology. The multitouch interface on smartphones, tablet computers, and some PC models allows you to use one or more fingers to perform special gestures to manipulate lists or objects on a screen without using a mouse or a keyboard.

Table 5.3 compares leading PC and server operating systems. These include the Windows family of operating systems (Windows 10 and Windows Server), UNIX, Linux, and the operating system for the Macintosh computer.

The Microsoft Windows family of operating systems has both client and server versions and a streamlined GUI that now works with touch screens and mobile devices as well as with keyboards and traditional PCs. At the client level, most PCs use some form of the Microsoft Windows or Apple operating systems. The latest Windows client version is **Windows 10**.

Windows operating systems for servers provide network management functions, including support for virtualization and cloud computing. Windows Server has multiple versions for small, medium, and large businesses.

Today there is a much greater variety of 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 or mobile device. Programs are not stored on the user's computing device 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.

UNIX is a multiuser, multitasking operating system developed by Bell Laboratories in 1969 to connect various machines and is highly supportive of communications and networking. UNIX is often used on workstations and servers and provides the

Operating System	Features
Windows 10	Most recent Windows client operating system, which supports multitouch and mobile devices as well as traditional PCs and includes voice search capabilities.
Windows Server	Windows operating system for servers.
UNIX	Used for PCs, workstations, and network servers. Supports multitasking, multiuser processing, and networking. Is portable to different models of computer hardware.
Linux	Open source, reliable alternative to UNIX and Windows operating systems that runs on many types of computer hardware and can be modified by software developers.
macOS	Operating system for the Macintosh computer that is highly visual and user-friendly, with support for multitouch. Most recent version is macOS Catalina.

TABLE 5.3

Leading PC and Server Operating Systems

reliability and scalability for running large systems on high-end servers. UNIX can run on many kinds of computers and can be easily customized. Application programs that run under UNIX can be ported from one computer to run on a different computer with little modification. Graphical user interfaces have been developed for UNIX. Vendors have developed different versions of UNIX that are incompatible, thereby limiting software portability.

Linux is a UNIX-like operating system that can be downloaded from the Internet free of charge or purchased for a small fee from companies that provide additional tools for the software. It is free, reliable, compactly designed, and capable of running on many hardware platforms, including servers, handheld computers, and consumer electronics.

Linux has become popular as a robust, low-cost alternative to UNIX and the Windows operating systems. For example, E*Trade Financial has saved \$13 million annually with improved computer performance by running Linux on a series of small, inexpensive IBM servers instead of large, expensive Oracle Sun servers running a proprietary version of UNIX.

Linux plays a major role in the back office, running web servers and local area networks in about 35 percent of the worldwide server market. IBM, HP, Dell, and Oracle have made Linux part of their offerings to corporations, and major software vendors offer versions of their products that can run on Linux.

APPLICATION SOFTWARE AND DESKTOP PRODUCTIVITY TOOLS

Today, businesses have access to an array of tools for developing their application software. These include traditional programming languages, application software packages, and desktop productivity tools; software for developing Internet applications; and software for enterprise integration. It is important to know which software tools and programming languages are appropriate for the work your business wants to accomplish.

Programming Languages for Business

Popular programming languages for business applications include C, C++, Visual Basic, and Java. **C** is a powerful and efficient language developed in the early 1970s that combines machine portability with tight control and efficient use of computer resources. It is used primarily by professional programmers to create operating systems and application software, especially for PCs. **C++** is a newer version of C that has all the capabilities of C plus additional features for working with software objects. Unlike traditional programs, which separate data from the actions to be taken on the data, a software **object** combines data and procedures. (See the Chapter 12 Learning Track on object-oriented development.) **Visual Basic** is a widely used visual programming tool and environment for creating applications that run on Microsoft Windows operating systems. A **visual programming language** allows users to manipulate graphic or iconic elements to create programs. COBOL (COmmon Business Oriented Language) was developed in the early 1960s for business processing and can still be found in large legacy systems in banking, insurance, and retail.

Java has become the leading interactive programming environment for the web. The Java platform has migrated into mobile phones, smartphones, automobiles, music players, game machines, and finally, into set-top cable television systems serving interactive content and pay-per-view services. 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.

Other popular programming tools for web applications include Ruby, Python, and PHP. Ruby is an object-oriented programming language known for speed and ease of use in building web applications, and Python (praised for its clarity) is being used for building cloud computing applications.

Software Packages and Desktop Productivity Tools

Much of the software used in businesses today is not custom programmed but consists of application software packages and desktop productivity tools. A **software package** is a prewritten, precoded, commercially available set of programs that eliminates the need for individuals or organizations to write their own software programs for certain functions. Software packages that run on mainframes and larger computers usually require professional programmers for their installation and support, but desktop productivity software packages for consumer users can easily be installed and run by the users themselves. Table 5.4 describes the major desktop productivity software tools.

Software Suites The major desktop productivity tools are bundled together as a software suite. Microsoft Office is an example. Core office tools include Word processing software, Excel **spreadsheet software**, Access database software, PowerPoint presentation graphics software, and Outlook, a set of tools for email, scheduling, and contact management. Microsoft now offers a hosted cloud version of its productivity and collaboration tools as a subscription service called **Office 365**. Competing with Microsoft Office are low-cost office productivity suites such as the open source OpenOffice (downloadable free over the Internet) and cloud-based Google Docs and G Suite (see Chapter 2).

Web Browsers Easy-to-use software called **web browsers** is used for displaying web pages and for accessing the web and other Internet resources. Browsers can display or present graphics, audio, and video information as well as traditional text, and they allow you to click (or touch) on-screen buttons or highlighted words to link to related websites. Web browsers have become the primary interface for accessing the Internet or for using networked systems based on Internet technology. The leading web browsers today are Microsoft Internet Explorer, Microsoft Edge, Mozilla Firefox, Apple Safari, and Google Chrome.

Software Tool	Capabilities	Example
Word processing	Allows the user to make changes in a document electronically, with various formatting options.	Microsoft Word iWork Pages
Spreadsheet	Organizes data into a grid of columns and rows. When the user changes a value or values, all other related values on the spreadsheet are automatically recalculated. Used for modeling and what-if analysis and can also present numeric data graphically.	Microsoft Excel iWork Numbers
Data management	Creates files and databases in which users can store, manipulate, and retrieve related data. Suitable for building small information systems.	Microsoft Access
Presentation graphics	Creates professional-quality electronic graphics presentations and computerized slide shows; can include multimedia displays of sound, animation, photos, and video clips.	Microsoft PowerPoint iWork Keynote
Personal information management	Creates and maintains appointments, calendars, to-do lists, and business contact information; also used for email.	Microsoft Outlook
Desktop publishing	Creates professional-looking documents, brochures, or books.	Adobe InDesign

TABLE 5.4

Desktop Productivity Software

TABLE 5.5

Examples of HTML

Plain English	HTML
Subcompact	<TITLE>Subcompact</TITLE>
4 passenger	4 passenger
\$16,800	\$16,800

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 it, and immediately be transported to another web page. Table 5.5 illustrates some sample HTML statements.

HTML programs can be custom written, but they also can be created using the HTML authoring capabilities of web browsers or of popular word processing, spreadsheet, data management, and presentation graphics software packages. HTML editors, such as Adobe Dreamweaver, are more powerful HTML authoring programs for creating web pages.

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. Third-party plug-in applications such as Flash, Silverlight, and Java have been required to integrate these rich media with web pages. However, these add-ons require additional programming and put strains on computer processing. The most recent version 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 also makes it easier for web pages to function across different display devices, including mobile devices as well as desktops. Web pages will execute more quickly, and web-based mobile apps will work like web pages.

WEB SERVICES

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 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 different organizations, and they can be used to create applications that link disparate systems within a single company. Different applications can use them 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 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 5.6 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. XML provides a standard format for data exchange, enabling web services to pass data from one process to another.

Plain English	XML
Subcompact	<AUTOMOBILETYPE="Subcompact">
4 passenger	<PASSENGERUNIT="PASS">4</PASSENGER>
\$16,800	<PRICE CURRENCY="USD">\$16,800</PRICE>

TABLE 5.6

Examples of XML

Web services communicate through XML messages over standard web protocols. Companies discover and locate web services through a directory much as they would locate services in the Yellow Pages of a telephone book. Using web protocols, a software application can connect freely to other applications without custom programming for each 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 set of self-contained services that communicate with each other to create a working software application. Software developers reuse these services in other combinations to assemble other applications as needed. Virtually all major software vendors, such as IBM, Microsoft, Oracle, and HP, provide tools and entire platforms for building and integrating software applications using web services.

Dollar Rent-A-Car's systems use web services to link its online booking system with the 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 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 Dollar's computers can understand.

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 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 mobile phones. It does not have to write new software code for each new partner's information systems or each new wireless device (see Figure 5.7).

SOFTWARE TRENDS

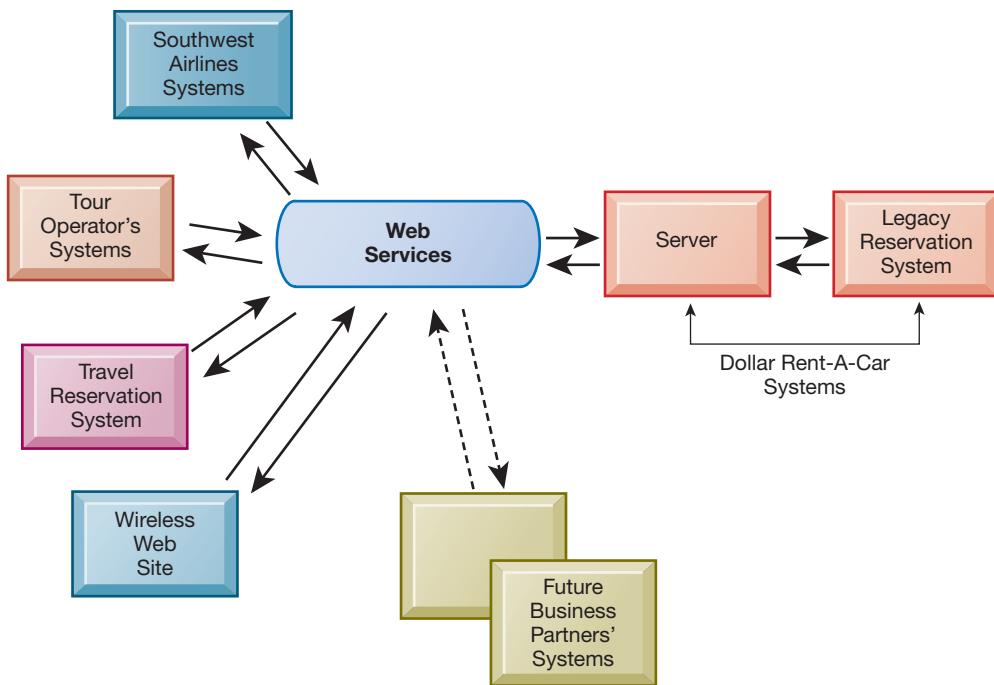
Today there are many more sources for obtaining software and many more capabilities for users to create their own customized software applications. Expanding use of open source software and cloud-based software tools and services exemplify this trend.

Open Source Software

Open source software provides all computer users with free access to its program code, so they can modify the code to fix errors or to make improvements. Open source software is not owned by any company or individual. A global network of programmers and users manages and modifies the software, usually without being paid to do so. Popular open source software tools include the Linux operating system (described earlier in this chapter), 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 code. Today you can find thousands of open source computer programs to accomplish everything from e-commerce shopping carts and funds clearance to sales force management.

Figure 5.7
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.



Cloud-Based Software Services and Tools

In the past, software such as Microsoft Word or Adobe Acrobat 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 use the software as a cloud service delivered over the Internet. (Review our discussion of SaaS in Section 5-2.) In addition to free or low-cost tools for individuals and small businesses provided by Google and Yahoo, enterprise software and other software for running larger businesses are available as cloud services from the major commercial software vendors.

Mashups and Apps The software you use for both personal and business tasks may consist of large self-contained programs, or it 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 produce from different sources 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 online real estate database Zillow.com to display a complete list of multiple listing service (MLS) real estate listings for any zip code the user specifies.

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 other mobile handheld devices 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. They feature a streamlined, nonbrowser pathway for users to experience the web and perform a number of tasks, ranging from reading

the newspaper to shopping, searching, and buying. 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 because 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. There are already 1.9 million apps for the Apple iPhone and iPad platform and a similar number that run on devices using the Android operating system. 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.

The most frequently downloaded apps include 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. There are also a huge number of e-commerce apps for researching and buying goods and services online.

5-4 What are the principal issues in managing hardware and software technology?

Selection and use of computer hardware and software technology have a profound impact on business performance. We now describe the most important issues you will face when managing hardware and software technology: capacity planning and scalability; determining the total cost of technology assets; determining whether to own and maintain your own hardware, software, and other infrastructure components or lease them from an external technology service provider; and managing mobile platforms and software localization.

CAPACITY PLANNING AND SCALABILITY

E-commerce and e-business need much larger processing and storage resources to handle the surging digital transactions flowing between different parts of the firm and between the firm and its customers and suppliers. Many people using a website simultaneously place strains on a computer system, as does hosting large numbers of interactive web pages with data-intensive graphics or video.

Managers and information systems specialists now need to pay more attention to hardware capacity planning and scalability than before. From an IT perspective, **capacity planning** is the process of predicting when a computer hardware system becomes saturated. It considers factors such as the maximum number of users that the system can accommodate at one time, the impact of existing and future software applications, and performance measures, such as minimum response time for processing business transactions. Capacity planning ensures that the firm has enough computing power for its current and future needs. For example, the NASDAQ stock market performs ongoing capacity planning to identify peaks in the volume of stock trading transactions and to ensure that it has enough computing capacity to handle large surges in volume when trading is very heavy.

Scalability refers to the ability of a computer, product, or system to expand to serve a large number of users without breaking down. Electronic commerce and electronic business both call for scalable IT infrastructures that have the capacity to grow with the business as the size of a website and number of visitors increase. Organizations must make sure they have sufficient computer processing, storage, and network resources to handle surging volumes of digital transactions and to make such data immediately available online.

TOTAL COST OF OWNERSHIP (TCO) OF TECHNOLOGY ASSETS

When you calculate how much your hardware and software cost, their purchase price is only the beginning. You must also consider ongoing administration costs for hardware and software upgrades, maintenance, technical support, training, and even utility and real estate costs for running and housing the technology. The **total cost of ownership (TCO)** model can be used to analyze these direct and indirect costs to help determine the actual cost of owning a specific technology. Table 5.7 describes the most important TCO components to consider in a TCO analysis.

When all these cost components are considered, the hidden costs for support staff, downtime, and additional network management could make distributed client/server architectures—especially those incorporating handheld computers and wireless devices—more expensive than centralized mainframe architectures.

Many large firms are saddled with redundant, incompatible hardware and software because of poor planning. 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 minimized the number of computer models and pieces of software that employees are allowed to use.

USING TECHNOLOGY SERVICE PROVIDERS

Some of the most important questions facing managers are: “How should we acquire and maintain our technology assets?” “Should we build software applications ourselves or outsource them to an external contractor?” “Should we purchase and run them ourselves or rent them from external service providers?” In the past, most companies ran their own computer facilities and developed their own software. Today, more and more companies are obtaining their hardware and software technology from external service vendors.

Outsourcing

A number of firms are **outsourcing** the maintenance of their IT infrastructures and the development of new systems to external vendors. They may contract with an external service provider to run their computer center and networks, to develop new software, or to manage all the components of their IT infrastructures. For example, FedEx outsourced 30 percent of its IT system operations and software development to external IT service providers.

TABLE 5.7

TCO Components

Hardware acquisition	Purchase price of computer hardware equipment, including computers, displays, 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 to 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	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

Specialized web hosting services are available for companies that lack the financial or technical resources to operate their own websites. A **web hosting service** maintains a large web server, or a series of servers, and provides fee-paying subscribers with space to maintain their websites. The subscribing companies may create their own web pages or have the hosting service, or a web design firm, create them. Some services offer *co-location*, in which the firm actually purchases and owns the server computer housing its website but locates the server in the physical facility of the hosting service.

Firms often retain control over their hardware resources but outsource custom software development or maintenance to outside firms, frequently firms that operate offshore in low-wage areas of the world. When firms outsource software work outside their national borders, the practice is called **offshore software outsourcing**. Until recently, this type of software development involved lower-level maintenance, data entry, and call center operations, but with the growing sophistication and experience of offshore firms, particularly in India, more and more new program development is taking place offshore. Chapter 12 discusses offshore software outsourcing in more detail.

To manage their relationship with an outsourcer or technology service provider, firms will 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 the customer expects. 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.

Choosing Cloud Services

Firms now have the option of maintaining their own IT infrastructures or using cloud-based hardware and software services, and they are steadily gravitating toward cloud-based services and tools. Companies considering the cloud computing model need to identify and assess the costs and benefits of external services carefully, weighing all management, organizational, and technology issues. These include the level of service and performance that is acceptable for the business and the expertise required to deploy and manage a new cloud-based IT infrastructure. New cloud users often overlook additional costs for networking, data transfer and storage, and the work required to upgrade or replace business application systems to run in a cloud environment. After moving workloads from on-premises to the cloud, a firm might find computing costs higher than original estimations.

MANAGING MOBILE PLATFORMS

Gains in productivity from equipping employees with mobile computing devices must be balanced against increased costs from integrating these devices into the firm's IT infrastructure and providing technical support. This is especially true when the organization allows employees to use their own personal devices for their jobs (BYOD). (See the chapter-ending case study.)

For personal mobile devices to access company information, the company's networks must be configured to receive connections from that device. Firms need an efficient inventory management system that keeps track of which devices employees are using, where each device is, and what software is installed on it. They also need to know what pieces of corporate data are on those personal devices, and this is not always easy to determine. It is more difficult to protect the company's network and data when employees access them from their privately owned devices.

If a device is stolen or compromised, companies need to ensure that sensitive or confidential company information isn't exposed. Companies often use technologies that allow them to wipe data from devices remotely or encrypt data so that, if stolen, they cannot be used. You'll find out more about mobile security issues in Chapter 8.

Many companies allow employee mobile devices access only to a limited set of applications and noncritical corporate data. For more critical business systems, more company control is required, and firms often turn to **mobile device management (MDM)** software, which monitors, manages, and secures mobile devices that are deployed across the enterprise. It can be employed for multiple mobile service providers and across multiple mobile operating systems 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.

MANAGING SOFTWARE LOCALIZATION FOR GLOBAL BUSINESS

If you are operating a global company, all the management issues we have just described will be affected by the need to create systems that can be realistically used by multiple business units in different countries. 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 worldwide.

These interfaces can be costly and messy to build. Menu bars, commands, error messages, reports, queries, online data entry forms, and system documentation may need to be translated into all the languages of the countries where the system will be used. To be truly useful for enhancing productivity of a global workforce, the software interfaces must be easily understood and mastered quickly. The entire process of converting software to operate in a second language is called *software localization*.

Global systems must also consider differences in local cultures and business processes. Cross-functional systems such as enterprise and supply chain management systems are not always compatible with differences in languages, cultural heritages, and business processes in other countries. In a global systems environment, all these factors add to the TCO and will influence decisions about whether to outsource or use technology service providers.



5-5 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 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-size 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 to 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
- Strong organizational, presentation, and writing skills
- Ability to work in a fast-paced environment and collaborate effectively as a team member
- Proficiency in Microsoft Office (Word, Excel, and PowerPoint)

INTERVIEW QUESTIONS

1. What do you know about cloud computing and managed IT services? Are you familiar with common operating system, 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 6–8 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 as 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 (including some from your Digital Portfolio described in MyLab MIS) 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 the company works with.
5. Review postings on the company's LinkedIn page and Facebook and Twitter channels to learn about strategic trends and important topics for the company.

Review Summary

5-1 **What are the components of IT infrastructure?** IT infrastructure consists of the shared technology resources that provide the platform for the firm's specific information system applications. Major IT infrastructure components include computer hardware, software, data management technology, networking and telecommunications technology, and technology services.

5-2 **What are the major computer hardware, data storage, input, and output technologies used in business and the major hardware trends?** Computers are categorized as mainframes, midrange computers, PCs, workstations, or supercomputers. Mainframes are the largest computers, midrange computers are primarily servers, PCs are desktop or laptop machines, workstations are desktop machines with

powerful mathematical and graphic capabilities, and supercomputers are sophisticated, powerful computers that can perform numerous and complex computations rapidly. Computing power can be further increased by creating a computational grid that combines the computing power of all the computers on a network. In the client/server model of computing, computer processing is split between clients and servers connected by a network. The exact division of tasks between client and server depends on the application.

Secondary storage technologies include magnetic disk, optical disc, solid state drives, USB flash drives, and magnetic tape. Cloud-based storage services are increasingly being used for personal and corporate data. The principal input devices are keyboards, computer mice, touch screens (including those with multitouch), magnetic ink and optical character recognition devices, pen-based instruments, digital scanners, audio input devices, and sensors. The principal output devices are display screens, printers, and audio output devices.

Major hardware trends include the mobile digital platform, nanotechnology, quantum computers, consumerization of IT, virtualization, cloud computing, edge computing, green computing, and high-performance/power-saving processors. Cloud computing provides computer processing, storage, software, and other services as virtualized resources over a network, primarily the Internet, on an as-needed basis.

5-3 What are the major types of computer software used in business and the major software trends? The two major types of software are system software and application software. System software coordinates the various parts of the computer system and mediates between application software and computer hardware. Application software is used to develop specific business applications.

The system software that manages and controls the activities of the computer is called the operating system. Leading PC and server operating systems include Windows 10, Windows Server, UNIX, Linux, and the Macintosh operating system. Android, iOS and Chrome are leading operating systems for mobile devices and the web.

The principal programming languages used in business application software include Java, C, C++, and Visual Basic. PC and cloud-based productivity tools include word processing, spreadsheet, data management, presentation graphics, and web browser software. Java is an operating system-independent and hardware-independent programming language that is the leading interactive programming environment for the web. Ruby and Python are used in web and cloud computing applications. HTML is a page description language for creating web pages.

Web services are loosely coupled software components based on XML and open web standards that can work with any application software and operating system. They can be used as components of applications to link the systems of two organizations or to link disparate systems of a single company.

Software trends include the expanding use of open source software and cloud-based software tools and services (including SaaS, mashups, and apps).

5-4 What are the principal issues in managing hardware and software technology? Managers and information systems specialists need to pay special attention to hardware capacity planning and scalability to ensure that the firm has enough computing power for its current and future needs. Businesses also need to balance the costs and benefits of building and maintaining their own hardware and software versus outsourcing or using an on-demand cloud computing model. The total cost of ownership (TCO) of the organization's technology assets includes not only the original cost of computer hardware and software but also costs for hardware and software upgrades, maintenance, technical support, and training, including the costs for managing and maintaining mobile devices. Companies with global operations need to manage software localization.

Key Terms

Android, 199	Hypertext Markup Language (HTML), 202	Scalability, 205
Application server, 186	Input devices, 187	Server, 185
Application software, 183	iOS, 199	Service level agreement (SLA), 207
Apps, 204	Java, 200	Service-oriented architecture (SOA), 203
BYOD, 190	Legacy systems, 184	Software as a service (SaaS), 193
C, 200	Linux, 200	Software package, 201
C++, 200	Mainframe, 185	Software-defined storage (SDS), 191
Capacity planning, 205	Mashups, 204	Solid state drive (SSD), 187
Centralized processing, 186	Mobile device management (MDM), 208	Spreadsheet software, 201
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Data center, 182	Office 365, 201	Virtualization, 191
Data management software, 184	Offshore software outsourcing, 207	Visual Basic, 200
Distributed processing, 186	On-demand computing, 196	Visual programming language, 200
Edge computing, 196	Open source software, 203	Web browsers, 201
Extensible Markup Language (XML), 202	Operating system, 198	Web hosting service, 207
Graphical user interface (GUI), 199	Output devices, 187	Web server, 186
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Grid computing, 185	Personal computer (PC), 185	Windows 10, 199
HTML5, 202	Private cloud, 196	Workstation, 185
Hybrid cloud, 196	Public cloud, 196	
	Quantum computing, 191	

Review Questions

5-1 What are the components of IT infrastructure?

- Define information technology (IT) infrastructure and describe each of its components.

5-2 What are the major computer hardware, data storage, input, and output technologies used in business and the major hardware trends?

- Explain why a small business might opt for a PC and why a larger business might opt for workstations and a server.
- Identify the type of business that is likely to use grid computing and explain why this is a good option.
- Define and describe the essential characteristics of cloud computing and why these are important to users.

5-3 What are the major types of computer software used in business and the major software trends?

- Distinguish between application software and system software and explain the role the operating system of a computer plays.
- List and describe the major PC, server, mobile, and cloud operating systems.
- Describe what is meant by the term scalability.
- Explain how Java and HTML are used in building applications for the web.
- Define web services, describe the technologies they use, and explain how web services benefit businesses.
- Explain why open source software is so important today and its benefits for business.
- Define and describe cloud computing software services, mashups, and apps and explain how they benefit individuals and businesses.

- 5-4** What are the principal issues in managing hardware and software technology?
- Explain why managers need to pay attention to capacity planning and scalability of technology resources.
 - Describe the cost components used to calculate the TCO of technology assets.
 - Identify the benefits and challenges of using outsourcing, cloud computing services, and mobile platforms.
 - Explain why software localization has become an important management issue for global companies.

MyLab MIS™

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

Discussion Questions

- 5-5** Why is selecting computer hardware **MyLab MIS** and software for the organization an important business decision? What people, organization, and technology issues should be considered when selecting computer hardware and software?
- 5-6** Should organizations use software **MyLab MIS** service providers (including cloud
- services) for all their software needs? Why or why not? What people, organization, and technology factors should be considered when making this decision?
- 5-7** What are the advantages and **MyLab MIS** 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

- 5-8** 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 operating systems, including several versions of UNIX and Windows. UPMC had to manage technologies from many vendors, including Hewlett-Packard (HP), Oracle Sun, 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?
- 5-9** 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 Qantas management consider 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

- 5-10** 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 purposes of this exercise, ignore the fact that desktop systems usually come with preloaded software packages.) Obtain pricing on 15 desktop printers manufactured by HP and Canon. Each desktop system must satisfy the minimum specifications shown in tables that you can find in MyLab MIST™. Also, obtain pricing on 30 licenses or copies of the most recent versions of Microsoft Office Business and Apache OpenOffice and on 30 copies of Windows 10 Pro. Each desktop productivity package should contain programs for word processing, spreadsheets, database, and presentations. Prepare a spreadsheet showing your research results for the software and the desktop system, printer, and software combination offering the best performance and pricing per worker. 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

- 5-11** In this exercise, you'll use software at various online travel sites to obtain pricing for total travel and lodging costs for a sales conference.

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 total) and the other able to hold half the force. Management has set a budget of \$300,000 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 (53), San Francisco (31), Seattle (21), Chicago (18), and Pittsburgh (13). 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

- 5-12** Form a group with three or four of your classmates. Choose two 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.

BUSINESS PROBLEM-SOLVING CASE

WHAT SHOULD FIRMS DO ABOUT BYOD?

Just about everyone who has a smartphone wants to be able to bring it to work and use it on the job, and many employers would like workers to do so. A survey of BYOD trends by MarketsandMarkets found that adoption rates among North American companies approached 50 percent by the start of 2018. Research from Sapho workplace productivity experts found the average worker saves 81 minutes per week in productivity by using a personal device at work.

Will BYOD become the new normal? Not necessarily. Half of all enterprises believe that BYOD represents a growing problem for their organizations, according to a number of studies. Although BYOD can improve employee job satisfaction and productivity, it also can cause a number of problems if not managed properly. Support for personally owned devices is more difficult than it is for company-supplied devices, the cost of managing mobile devices can increase, and protecting corporate data and networks becomes more difficult.

When every employee brings his or her own device to use at work, IT departments risk losing control over the hardware. Without policies or tools for managing mobile devices, the organization can't control what apps or programs are installed, how the devices are secured, or what files are downloaded. In the past, the firm was able to control who had what technology employees used in order to prevent privacy breaches, hacking, and unauthorized access to corporate information. Inability to control the hardware means more vulnerabilities. That is the big trade-off with BYOD: offering employees greater flexibility while potentially exposing the company to more risk.

BYOD advocates have argued that it increases employee productivity, but that is not always the case. When employees bring their own devices to work, they may be tempted to use them for on the job for entertainment or catching up with friends. It's incredibly easy for employees to get sucked into an endless black hole of text messaging, YouTube videos, and checking Facebook updates. Productivity will suffer.

BYOD requires a significant portion of corporate IT resources dedicated to managing and maintaining a large number of devices within the organization. Companies initially tried to manage mobility by limiting business smartphone use to a single platform. This made it easier to keep track of each mobile device and to roll out software upgrades or fixes because all employees were using the same devices or, at the very least, the same operating system.

Today, the mobile digital landscape is much more complicated, with a variety of devices and operating systems on the market that do not have well-developed tools for administration and security. Android has over 80 percent of the worldwide smartphone market. iOS is considered a closed system and runs only on a limited number of different Apple mobile devices. In contrast, Android's fragmentation makes it more difficult and costly for corporate IT to manage. There are many thousands of different models of Android-based devices available around the world. Android's huge consumer market share attracts many hackers. Android is also vulnerable because it has an open source architecture and comes in multiple versions.

If employees are allowed to work with more than one type of mobile device and operating system, companies need an effective way to keep track of all the devices employees are using. To access company information, the company's networks must be configured to receive connections from that device. When employees make changes to their personal phone, such as switching cellular carriers, changing their phone number, or buying a new mobile device altogether, companies will need to quickly and flexibly ensure that their employees are still able to remain productive. Firms need a system that keeps track of which devices employees are using, where the device is located, whether it is being used, and what software it is equipped with. For unprepared companies, keeping track of who gets access to what data could be a nightmare.

With the large variety of mobile devices and operating systems available, providing adequate technical support for every employee could be difficult. When employees are not able to access critical data or they encounter other problems with their mobile devices, they will need assistance from the information systems department. Companies that rely on desktop computers tend to have many of the same computers with the same specs and operating systems, making tech support that much easier. Mobility introduces a new layer of variety and complexity to tech support that companies need to be prepared to handle.

There are significant concerns with securing company information accessed with mobile devices. If a device is stolen or compromised, companies need ways to ensure that sensitive or confidential information isn't freely available to anyone. Mobility puts assets and data at greater risk than if they were only located within company walls and on company machines.

Companies often use technologies that allow them to wipe data from devices remotely or encrypt data so that if the device is stolen, it cannot be used. You'll find a detailed discussion of mobile security issues in Chapter 8.

The global reinsurance giant Swiss Re believes every employee should be able to work in the way they choose and has more and more staff using their own smartphones and tablets to access its intranet and personal information management (PIM) apps. Swiss Re successfully implemented BYOD by choosing a secure, highly scalable Enterprise Mobility Management (EMM) system from MobileIron that could support multiple operating systems, along with a local partner to manage all of its technical and organizational aspects.

Swiss Re's EMM system enables enterprises to secure and manage different mobile devices and operating systems from a single platform. It incorporates identity, context, and privacy enforcement to set the appropriate level of access to enterprise data and services. EMM software prevents unauthorized access to corporate applications and corporate data on mobile devices, centrally managing and enforcing corporate security policies.

Over the past six years, 4,500 employee-owned iPhones and iPads have been added to the Swiss Re system alongside existing company devices. About one-third of the smartphones and tablets are company-owned and the other two-thirds are owned by employees of Swiss Re. Supporting multiple mobile operating systems is a big technical and organizational challenge for Swiss Re, so the company's BYOD program was initially limited to mobile devices using Apple's iOS. However, mobile devices have helped the company experience a significant rise in user productivity, because staff can access documents more quickly, whether they're in the office or traveling on business, so management hopes to extend BYOD to Android devices in the future.

Because of the heavy emphasis on security at Brother Industries, the company's initial foray into BYOD was quite restrictive. Brother is a Japanese-headquartered global manufacturer of printing devices. Brother made iPhones and iPads the company standard for mobile devices in 2012. However, this early BYOD program did not allow access to Apple's App Store. Employees wishing to download business applications directly from Apple had to ask management for permission. Brother then loosened up these rigid restrictions by adopting a mobile management platform that allowed

employees to install apps they needed while securely protecting the corporate network and servers. Users remained dissatisfied because they still couldn't read password-protected files attached to emails, and email and calendars wouldn't display correctly. Employees in the field were forced to return to the office in order to view file attachments. These problems were alleviated when Brother adopted MobileIron for enterprise mobility management for the company and its subsidiaries. It became possible to view password-protected files attached to emails and to expand the use of apps that complied with company rules. Management can monitor what apps are being used and how. Brother has not yet standardized on a single mobile device management solution for the entire company. Brother Industries, its Japanese and US subsidiaries, and factories in Asia are using MobileIron, but other Asian sales companies and European subsidiaries are using different solutions. This variation was allowed because of different preferences and ways mobile devices were being used at these other locations.

Arup Group Limited, a multinational professional services firm headquartered in London, uses MobileIron to manage a wider array of devices based on the iOS, Android, and Windows mobile operating systems. Arup provides engineering, planning, project management, and consulting services for buildings and other man-made environments, with over 13,000 staff based in 35 countries. Many Arup employees use mobile devices and apps in their work activities, which are often in the field, and mobility has increased their productivity. Arup encouraged employees to enroll their devices in its BYOD program by highlighting a list of productivity apps and the company's ability to support BYOD. Arup's mobile policies vary by region. In the Americas and Europe, many employees are outfitted with company-owned mobile devices, but they are still able to enroll their personal devices through a self-service portal. Employees in Asia, however, select mobile devices from a company-approved list. Arup's BYOD program encompasses thousands of mobile devices, 65 percent of which are based on iOS, 30 percent on Android, and the remainder on Windows for mobile devices.

Sources: "Brother Industries Switches to MobileIron for Optimal Mobile Business Technology," "Arup Builds a Mobile-First Future with MobileIron," and "Swiss Re Chooses MobileIron 'Bring Your Own Device' Technology," www.mobileiron.com, accessed May 1, 2019; "5 BYOD Management Case Studies," Sunviewsoftware.com, accessed March 9, 2018; Stasmayer Incorporated, "The 'Bring Your Own Device' Trend: Is It Worth It?" www.stasmayer.com, accessed March 10, 2018; and Lisa Phifer, "The Challenges of a Bring Your Own Device (BYOD) Policy," *Simple MDM*, January 5, 2017.

CASE STUDY QUESTIONS

- 5-13** What are the advantages and disadvantages of allowing employees to use their personal mobile devices for work?
- 5-14** What people, organization, and technology factors should be addressed when deciding whether to allow employees to use their personal mobile devices for work?
- 5-15** Compare and evaluate how the companies described in this case study dealt with the challenges of BYOD.
- 5-16** Allowing employees to use their own smartphones for work will save a company money. Do you agree? Why or why not?

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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 is a database, and how does a relational database organize data?
- 6-2 What are the principles of a database management system?
- 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
- The Paradise Papers and Big Data Journalism
- DEWA: Evolving Utilities for a Smart City
- Does Big Data Provide the Answer?

VIDEO CASES

- Dubuque Uses Cloud Computing and Sensors to Build a Smarter City
- 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

ASTRO: LEVERAGING DATA FOR CUSTOMER-DRIVEN SERVICE

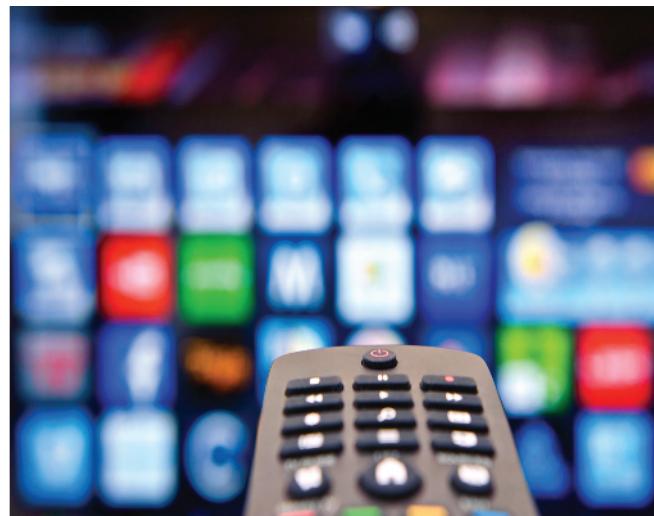
Astro is the leading Malaysian satellite television broadcaster, with an active subscriber list of nearly 5 million, or about 71 percent of Malaysian households. The growth and success of the company has been based on satisfying its customers' taste for Western, Indian, and Korean programming across 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. Locally, 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. Additionally, Astro is 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 base data lake. The Astro Data Lake is 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 via Amazon Elasticsearch and Amazon Cognito, respectively; and data transformation and analytics through the use of AWS Glue and Amazon Athena. These



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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.

Sources: Astro, "Transforming Our Technology Landscape to Deliver Exceptional Customer Experiences," July 7 2017, Astro.com; Digital News Asia, "Astro Accelerates Digital, Business Transformation With Amazon Web Services," April 19, 2017; Goh Thean Eu, "5 Interesting Takeaways from Astro's Q1 2016 Results," Digital News Asia, June 15, 2016; "Astro Inks Deal with Amazon Web Services as Part of Its Digital Strategy," Marketing-Interactive.com, April 18, 2017; Srishti Deoras, "Now Amazon Is a Front Runner in the Lucrative Data Lake Market," *Analytics India Magazine*.

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.

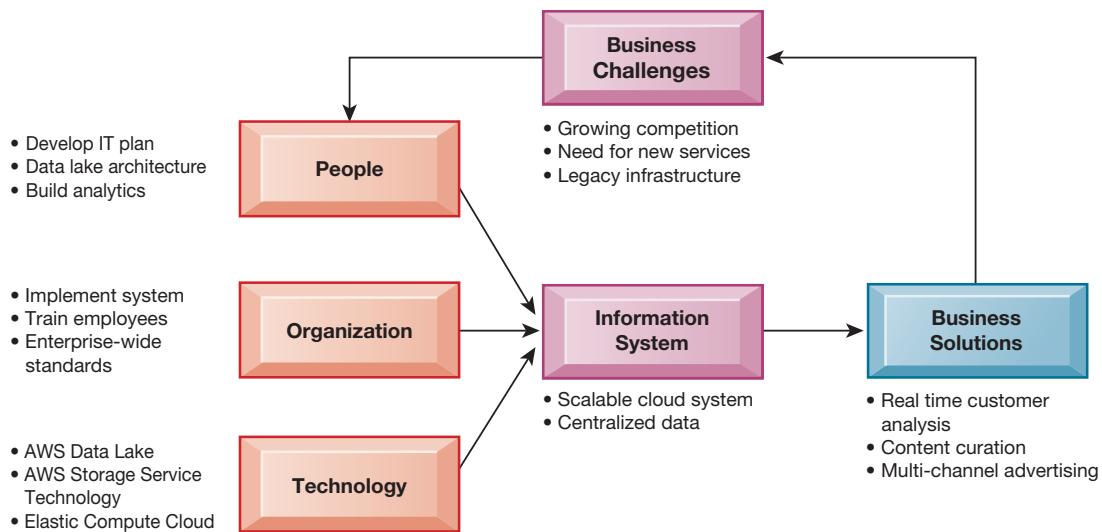
Part of this change involves training and upskilling of employees as well as reengineering business processes to align with the capabilities of a centralized repository. Employees need to be educated about cloud security and agile operations to fully exploit the automation potential of the cloud environment. 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 is a database, and how does a relational database organize data?

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 a student's identification number (**ID**), the course taken, the date, and the grade, comprises a **record**; a group of records of the same type is called a **file**. 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. Databases are at the heart of all information systems because they keep track of the people, places, and things that a business must deal with on a continuing, often instant basis.

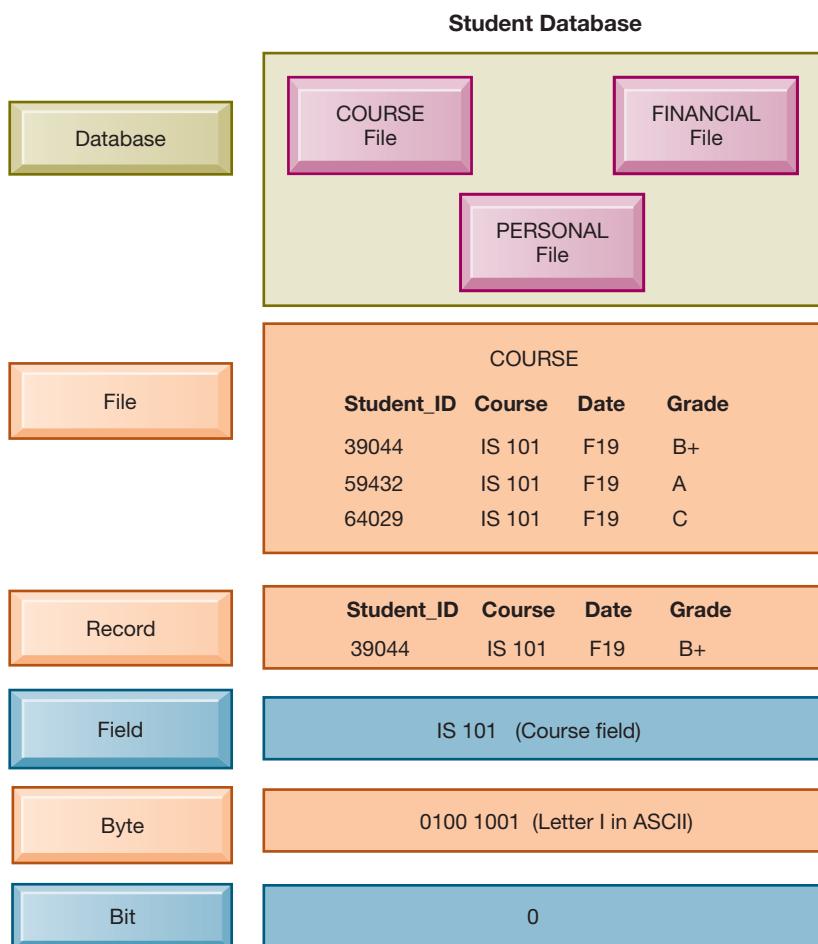


Figure 6.1
The Data Hierarchy.

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**.

ENTITIES AND ATTRIBUTES

To run a business, you most likely will be using data about categories of information such as customers, suppliers, employees, orders, products, shippers, and perhaps parts. Each of these generalized categories representing a person, place, or thing on which we store information is called an **entity**. Each entity has specific characteristics called **attributes**. For example, in Figure 6.1, COURSE would be an entity, and Student_ID, Course, Date, and Grade would be its attributes. If you were a business keeping track of parts you used and their suppliers, the entity SUPPLIER would have attributes such as the supplier's name and address, which would most likely include the street, city, state, and zip code. The entity PART would typically have attributes such as part description, price of each part (unit price), and the supplier who produced the part.

ORGANIZING DATA IN A RELATIONAL DATABASE

If you stored this information in paper files, you would probably have a file on each entity and its attributes. In an information system, a database organizes the data much the same way, grouping related pieces of data. The **relational database** is the most common type of database today. Relational databases organize data into two-dimensional tables (called *relations*) with columns and rows. Each table contains data about an entity and its attributes. For the most part, there is one table for each business entity, so, at the most basic level, you will have one table for customers and a table each for suppliers, parts in inventory, employees, and sales transactions.

Let's look at how a relational database would organize data about suppliers and parts. Look at the SUPPLIER table illustrated in Figure 6.2. It consists of a grid of columns and rows of data. Each element of data about a supplier, such as the supplier name, street, city, state, and zip code, is stored as a separate field within the SUPPLIER table. Each field represents an attribute for the entity SUPPLIER. Fields in a relational database are also called *columns*.

The actual information about a single supplier that resides in a table is called a *row*. Rows are commonly referred to as records.

Note that there is a field for Supplier_Number in this table. This field uniquely identifies each record so that the record can be retrieved, updated, or sorted, and it is called a **key field**. Each table in a relational database has one field 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						Columns (Attributes, Fields)
Supplier_Number	Supplier_Name	Supplier_Street	Supplier_City	Supplier_State	Supplier_Zip	Rows (Records)
8259	CBM Inc.	74 5 th Avenue	Dayton	OH	45220	
8261	B. R. Molds	1277 Gandolly Street	Cleveland	OH	49345	
8263	Jackson Composites	8233 Micklin Street	Lexington	KY	56723	
8444	Bryant Corporation	4315 Mill Drive	Rochester	NY	11344	

Key Field
(Primary Key)

Figure 6.2
A Relational Database Table.

A relational database organizes data in the form of two-dimensional tables. Illustrated here is a table for the entity SUPPLIER showing how it represents the entity and its attributes. Supplier_Number is the key field.

We could use the supplier's name as a key field. However, if two suppliers had the same name (which does happen from time to time), supplier name would not uniquely identify each, so it is necessary to assign a special identifier field for this purpose. For example, if you had two suppliers, both named "CBM," but one was based in Dayton and the other in St. Louis, it would be easy to confuse them. However, if each has a unique supplier number, such confusion is prevented.

We also see that the address information has been separated into four fields: Supplier_Street, Supplier_City, Supplier_State, and Supplier_Zip. Data are separated into the smallest elements that one would want to access separately to make it easy to select only the rows in the table that match the contents of one field, such as all the suppliers in Ohio (OH). The rows of data can also be sorted by the contents of the Supplier_State field to get a list of suppliers by state regardless of their cities.

So far, the SUPPLIER table does not have any information about the parts that a particular supplier provides for your company. PART is a separate entity from SUPPLIER, and fields with information about parts should be stored in a separate PART table (see Figure 6.3).

Why not keep information on parts in the same table as suppliers? If we did that, each row of the table would contain the attributes of both PART and SUPPLIER. Because one supplier could supply more than one part, the table would need many extra rows for a single supplier to show all the parts that supplier provided. We would be maintaining a great deal of redundant data about suppliers, and it would be difficult to search for the information on any individual part because you would not know whether this part is the first or fiftieth part in this supplier's record. A separate table, PART, should be created to store these three fields and solve this problem.

The PART table would also have to contain another field, Supplier_Number, so that you would know the supplier for each part. It would not be necessary to keep repeating all the information about a supplier in each PART record because having a Supplier_Number field in the PART table allows you to look up the data in the fields of the SUPPLIER table.

Notice 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 look-up field to find data about the supplier of a specific part. Note that the PART table would itself have its own primary key field, Part_Number, to identify each part uniquely. This key is not used to link PART with SUPPLIER but could be used to link PART with a different entity.

As we organize data into tables, it is important to make sure that all the attributes for a particular entity apply only to that entity. If you were to keep the supplier's address with the PART record, that information would not really relate only to PART; it would relate to both PART and SUPPLIER. If the supplier's address were to change,

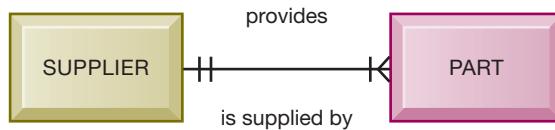
PART

Part_Number	Part_Name	Unit_Price	Supplier_Number
137	Door latch	22.00	8259
145	Side mirror	12.00	8444
150	Door molding	6.00	8263
152	Door lock	31.00	8259
155	Compressor	54.00	8261
178	Door handle	10.00	8259

The diagram shows the PART table with a blue border. Two arrows point from below the table to the columns: one arrow points to the 'Part_Number' column with the label 'Primary Key', and another arrow points to the 'Supplier_Number' column with the label 'Foreign Key'.

Figure 6.3
The PART Table.

Data for the entity PART have their own separate table. Part_Number is the primary key and Supplier_Number is the foreign key, enabling users to find related information from the SUPPLIER table about the supplier for each part.

**Figure 6.4**

A Simple Entity-Relationship Diagram.

This diagram shows the relationship between the entities SUPPLIER and PART.

it would be necessary to alter the data in every PART record rather than only once in the SUPPLIER record.

ESTABLISHING RELATIONSHIPS

Now that we've broken down our data into a SUPPLIER table and a PART table, we must make sure we understand the relationship between them. A schematic called an **entity-relationship diagram** clarifies table relationships in a relational database. The most important piece of information an entity-relationship diagram provides is the manner in which two tables are related to each other. Tables in a relational database may have one-to-one, one-to-many, and many-to-many relationships.

An example of a one-to-one relationship is a human resources system that stores confidential data about employees. The system stores data, such as the employee name, date of birth, address, and job position, in one table and confidential data about that employee, such as salary or pension benefits, in another table. These two tables pertaining to a single employee would have a one-to-one relationship because each record in the EMPLOYEE table with basic employee data has only one related record in the table storing confidential data.

The relationship between the SUPPLIER and PART entities in our database is a one-to-many relationship. Each supplier can supply more than one part, but each part has only one supplier. For every record in the SUPPLIER table, many related records might be in the PART table.

Figure 6.4 illustrates how an entity-relationship diagram would depict this one-to-many relationship. 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 preceded by a short mark indicates a one-to-many relationship. Figure 6.4 shows that each part has only one supplier, but the same supplier can provide many parts.

We would also see a one-to-many relationship if we wanted to add a table about orders to our database because one supplier services many orders. The ORDER table would contain only the Order_Number and Order_Date fields. Figure 6.5 illustrates a

Figure 6.5
Sample Order Report.
The shaded areas show which data came from the ORDER, SUPPLIER, and LINE_ITEM tables. The database does not maintain data on extended price or order total because they can be derived from other data in the tables.

Order Number: 3502 Order Date: 1/15/2020																								
Supplier Number: 8259 Supplier Name: CBM Inc. Supplier Address: 74 5th Avenue, Dayton, OH 45220																								
<table border="1"> <thead> <tr> <th>Order_Number</th> <th>Part_Number</th> <th>Part_Quantity</th> <th>Part_Name</th> <th>Unit_Price</th> <th>Extended Price</th> </tr> </thead> <tbody> <tr> <td>3502</td> <td>137</td> <td>10</td> <td>Door latch</td> <td>22.00</td> <td>\$220.00</td> </tr> <tr> <td>3502</td> <td>152</td> <td>20</td> <td>Door lock</td> <td>31.00</td> <td>620.00</td> </tr> <tr> <td>3502</td> <td>178</td> <td>5</td> <td>Door handle</td> <td>10.00</td> <td>50.00</td> </tr> </tbody> </table>	Order_Number	Part_Number	Part_Quantity	Part_Name	Unit_Price	Extended Price	3502	137	10	Door latch	22.00	\$220.00	3502	152	20	Door lock	31.00	620.00	3502	178	5	Door handle	10.00	50.00
Order_Number	Part_Number	Part_Quantity	Part_Name	Unit_Price	Extended Price																			
3502	137	10	Door latch	22.00	\$220.00																			
3502	152	20	Door lock	31.00	620.00																			
3502	178	5	Door handle	10.00	50.00																			

Order Total: \$890.00

PART

Part_Number	Part_Name	Unit_Price	Supplier_Number
137	Door latch	22.00	8259
145	Side mirror	12.00	8444
150	Door molding	6.00	8263
152	Door lock	31.00	8259
155	Compressor	54.00	8261
178	Door handle	10.00	8259

LINE_ITEM

Order_Number	Part_Number	Part_Quantity
3502	137	10
3502	152	20
3502	178	5

ORDER

Order_Number	Order_Date
3502	1/15/2020
3503	1/16/2020
3504	1/17/2020

SUPPLIER

Supplier_Number	Supplier_Name	Supplier_Street	Supplier_City	Supplier_State	Supplier_Zip
8259	CBM Inc.	74 5th Avenue	Dayton	OH	45220
8261	B. R. Molds	1277 Gandolly Street	Cleveland	OH	49345
8263	Jackson Components	8233 Micklin Street	Lexington	KY	56723
8444	Bryant Corporation	4315 Mill Drive	Rochester	NY	11344

Figure 6.6

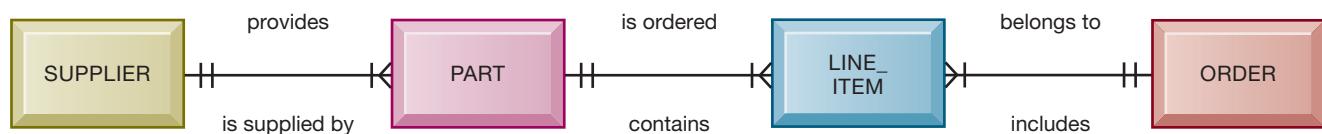
The Final Database Design with Sample Records.

The final design of the database for suppliers, parts, and orders has four tables. The LINE_ITEM table is a join table that eliminates the many-to-many relationship between ORDER and PART.

report showing an order of parts from a supplier. If you look at the report, you can see that the information on the top-right portion of the report comes from the ORDER table. The actual line items ordered are listed in the lower portion of the report.

Because one order can be for many parts from a supplier, and a single part can be ordered many times on different orders, this creates a many-to-many relationship between the PART and ORDER tables. Whenever a many-to-many relationship exists between two tables, it is necessary to link these two tables in a table that joins this information. Creating a separate table for a line item in the order would serve this purpose. This table is often called a *join table* or an *intersection relation*. This join table contains only three fields: Order_Number and Part_Number, which are used only to link the ORDER and PART tables, and Part_Quantity. If you look at the bottom-left part of the report, this is the information coming from the LINE_ITEM table.

We would thus wind up with a total of four tables in our database. Figure 6.6 illustrates the final set of tables, and Figure 6.7 shows what the entity-relationship diagram for this set of tables would look like. Note that the ORDER table does not contain data on the extended price because that value can be calculated by

**Figure 6.7**

Entity-Relationship Diagram for the Database with Four Tables.

This diagram shows the relationship between the SUPPLIER, PART, LINE_ITEM, and ORDER entities.

multiplying Unit_Price by Part_Quantity. This data element can be derived when needed, using information that already exists in the PART and LINE_ITEM tables. Order_Total is another derived field, calculated by totaling the extended prices for items ordered.

The process of streamlining complex groups of data to minimize redundant data elements and awkward many-to-many relationships and increase stability and flexibility is called **normalization**. A properly designed and normalized database is easy to maintain and minimizes duplicate data. The Learning Tracks for this chapter direct you to more-detailed discussions of database design, normalization, and entity-relationship diagramming.

Relational database systems 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 have just created, 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!

The example provided here for parts, orders, and suppliers is a simple one. Even in a small business, you will have tables for other important entities such as customers, shippers, and employees. A large corporation typically has databases with thousands of entities (tables) to maintain. What is important for any business, large or small, is to have a good data model that includes all its entities and the relationships among them, one that is organized to minimize redundancy, maximize accuracy, and make data easily accessible for reporting and analysis.

It cannot be emphasized enough: If the business does not get its data model right, the system will not be able to serve the business properly. The company's systems will not be as effective as they could be because they will 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 a very important lesson you can learn from this course.

For example, Famous Footwear, a shoe store chain with more than 1,100 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 a rapidly adjusting store inventory. The company had a database that 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 that organized the sales and inventory data better for analysis and inventory management.

6-2 What are the principles of a database management system?

Now that you have started creating the files and identifying the data your business requires, you will need a database management system to help you manage and use the data. A **database management system (DBMS)** is a specific type of software for creating, storing, organizing, and accessing data from a database. Microsoft Access is a DBMS for desktop systems, whereas DB2, Oracle Database, and Microsoft SQL Server are DBMS for large mainframes and midrange computers. MySQL is a popular open-source DBMS. All these products are relational DBMS that support a relational database.

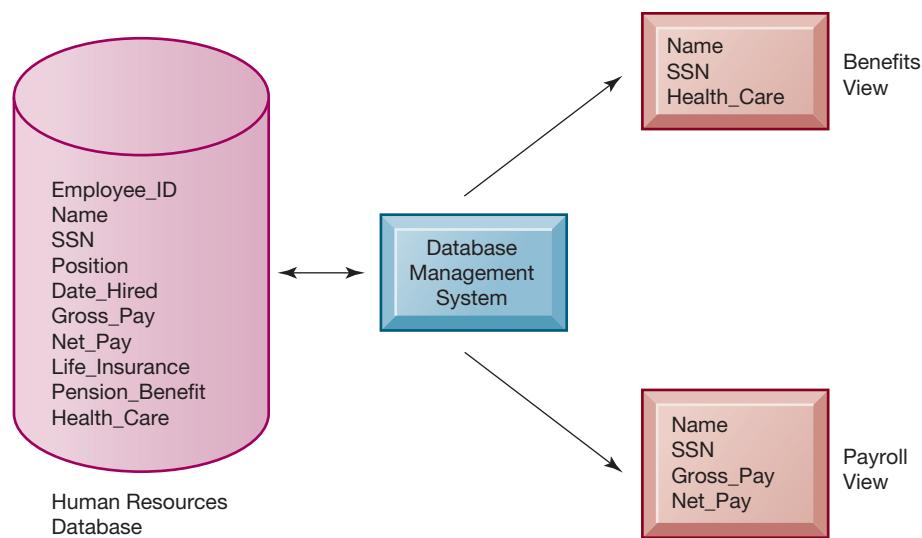


Figure 6.8
Human Resources Database with Multiple Views.

A single human resources database provides many 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.

The DBMS relieves the end user or programmer 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 end users or business specialists would perceive them, whereas the *physical view* shows how data are actually organized and structured on physical storage media, such as a hard disk.

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 6.8, a benefits specialist typically will require a view consisting of the employee's name, social security number, and health insurance coverage. A payroll department member will need data such as the employee's name, social security number, gross pay, and net pay. The data for all of these views is stored in a single database, where the organization can manage it more easily.

OPERATIONS OF A RELATIONAL DBMS

In a relational database, tables can be easily combined to deliver data that users require, provided that any two tables share a common data element. Let's return to the database we set up earlier with PART and SUPPLIER tables illustrated in Figures 6.2 and 6.3.

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 tables have a shared data element: Supplier_Number.

In a relational database, three basic operations, as shown in Figure 6.9, are used to develop useful sets of data: select, project, and join. The *select* 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 are 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 (see Figure 6.9).

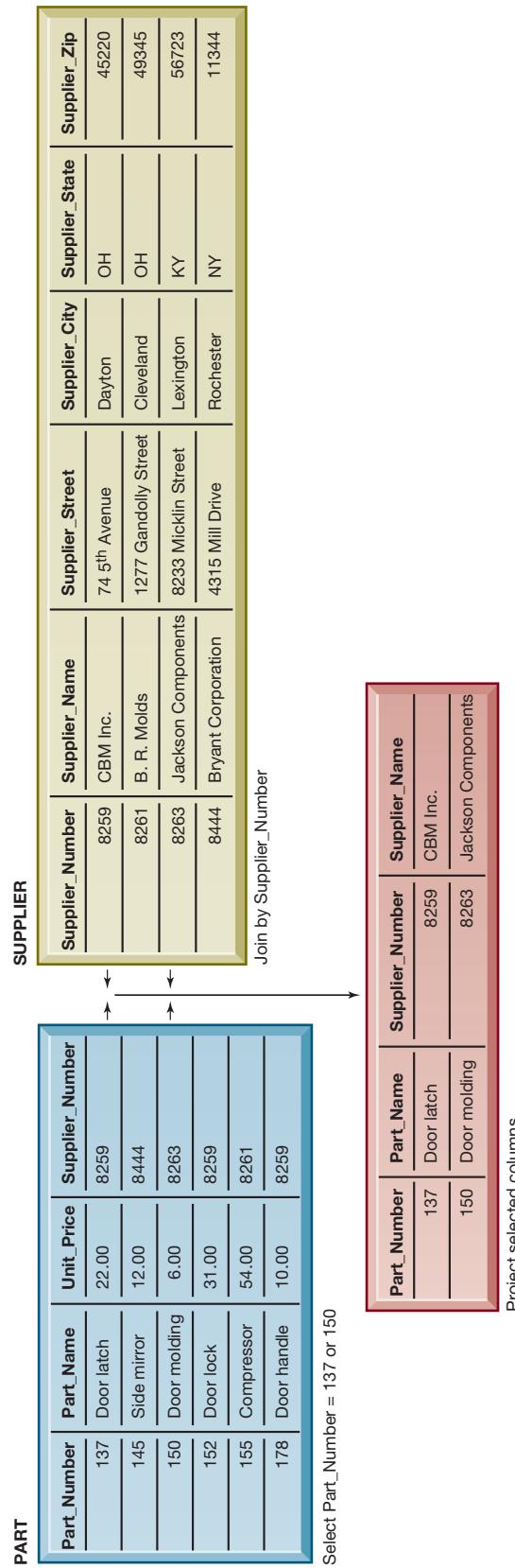


Figure 6.9
The Three Basic Operations of a Relational DBMS.
The select, join, and project operations enable data from two tables to be combined and only selected attributes to be displayed.

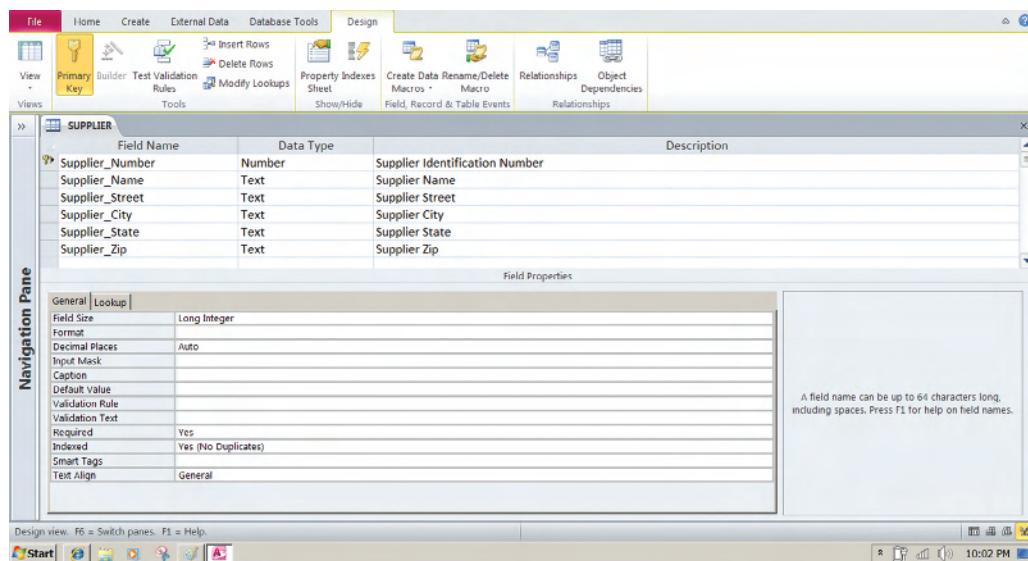


Figure 6.10
Access Data Dictionary Features.

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.

Source: Courtesy of Microsoft Corporation

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 capability, data dictionary, and data manipulation language.

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 6.10). 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 include 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**. Figure 6.11 illustrates the **SQL query** that would produce the new resultant table in Figure 6.9. A query is a request for data from a database. You can find out more about how to perform SQL queries in our Learning Tracks for this chapter.

```
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 6.11

Example of a SQL Query.

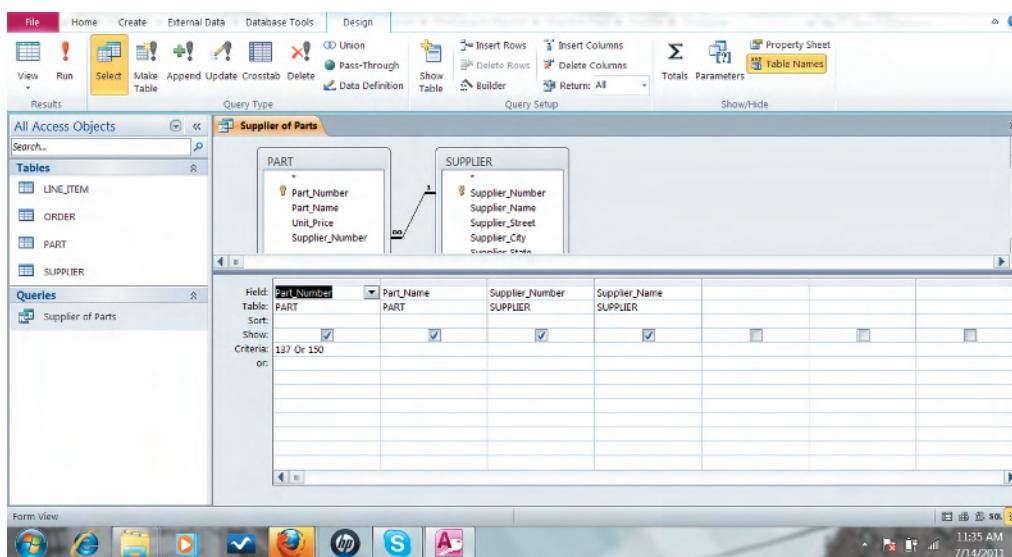
Illustrated here are the SQL statements for a query to select suppliers for parts 137 or 150. They produce a list with the same results as Figure 6.9.

Figure 6.12

An Access Query.

Illustrated here is how the query in Figure 6.11 would be constructed using Microsoft Access query-building tools. It shows the tables, fields, and selection criteria used for the query.

Source: Courtesy of Microsoft Corporation



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.

Microsoft Access has capabilities to help users 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 6.12 illustrates how the SQL query to select parts and suppliers in Figure 6.11 would be constructed using Microsoft Access.

DBMS typically 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 Microsoft Access.

Microsoft Access also has capabilities for developing desktop system applications. These include tools for creating data entry screens and reports and developing the logic for processing transactions. Information systems specialists primarily use these capabilities.

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” nonrelational 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.

MetLife's MongoDB open source NoSQL database brings together data from more than 70 separate administrative systems, claims systems, and other data sources, including semistructured and unstructured data, such as images of health records and death certificates. The NoSQL database can handle structured, semistructured, and unstructured information without requiring tedious, expensive, and time-consuming database mapping to normalize all data to a rigid schema, as required by relational databases.

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 Service 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 web-focused startups or small to medium-sized businesses seeking database capabilities at a lower cost than in-house database products.

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, with special time-keeping tools 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, including Google Photos, AdWords (Google's online ad system), and Gmail, and is now making the technology available to other companies that might need such capabilities to run a global business.

Blockchain

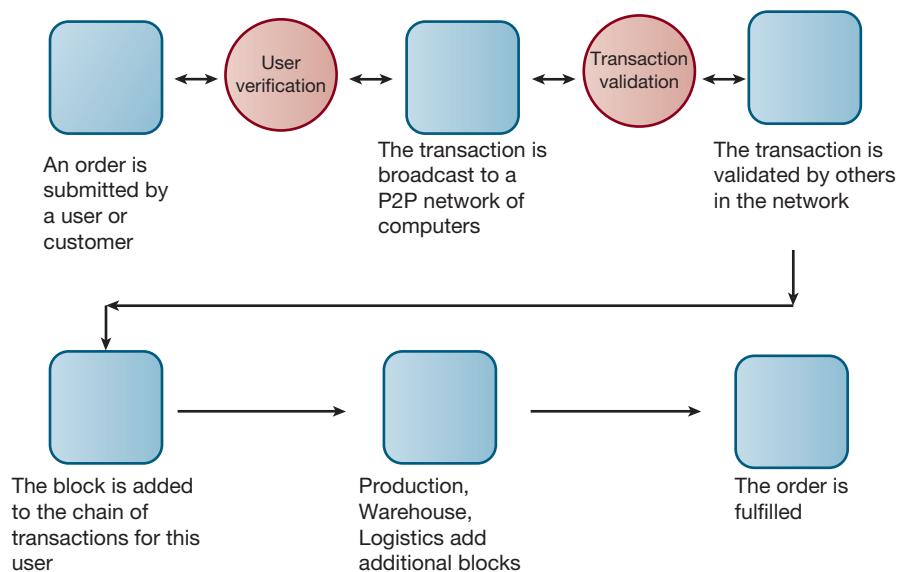
Blockchain is a distributed database technology that enables firms and organizations to create and verify transactions on a network nearly instantaneously without a central authority. The system stores transactions as a distributed ledger among a network of computers. The information held in the database is continually reconciled by the computers in the network.

The blockchain maintains a continuously growing list of records called blocks. Each block contains a timestamp and 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 ensure only legitimate actors can enter information, and only validated transactions are accepted. Once recorded, the transaction cannot be changed. Figure 6.13 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.

Figure 6.13
How Blockchain Works.

A blockchain system is a distributed database that records transactions in a peer-to-peer network of computers.



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, e.g., 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, serving 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 of the data that organizations collected was transaction data that could easily fit into rows and columns of relational database management systems. There has been an explosion of data from many different sources, including web traffic, email messages, and social media content (tweets, status messages) as well as machine-generated data from sensors. 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.

In the last months of 2017, the news cycle around the world was dominated by reports of tax neutralization by the rich and powerful. This was the result of a thorough analysis by news outlets of 13.4 million leaked documents that detailed the tax-avoidance strategies of wealthy individuals and companies. The leaked documents, in large part originating from tax consultancy firm Appleby, were dubbed the “Paradise Papers” after the idyllic islands that had served as tax havens, such as Bermuda, where Appleby’s headquarters are based.

These documents came into the possession of the German newspaper *Süddeutsche Zeitung*, whose managers quickly realized that they would be unable to analyze all the data by themselves. They reached out to other news organizations, including *The Guardian* and the BBC in the United Kingdom. No one knows for certain how many journalists and data analysts combed through the emails, reports, and accounts weighing in at over 1,400 gigabytes—there were likely hundreds of them. But all their efforts proved worthwhile, yielding a long list of scoops.

The star of the Irish band U2, Bono, turned out to be part owner of a shopping center in Lithuania that was being investigated for dodging taxes. A member of the British House of Lords, Baron Ashcroft, proved to have retained residency status outside the United Kingdom to evade taxes despite his protestations that he was a UK resident. The list of revelations went on. Most of those named in the Paradise Papers denied the accusations or stated that the tax neutralization methods they used were perfectly legal. Bono claimed ignorance of the shopping mall in Lithuania and said that he welcomed the insights provided by the analysis of the Paradise Papers.

The Paradise Papers reports were a triumph of what has come to be known as big data journalism. Few readers recognized what a major feat it had been, not least because the methods used were closely guarded. The International Consortium of Investigative Journalists, which played a major role in coordinating the analysis of the data, recognized that computer scientists would have to play a vital role in this enterprise. A chief technology officer was appointed to supervise the efforts along with six software developers. Access to the files was restricted; for one thing, the identity of the whistleblower had to be protected. At the instigation of the Consortium,

all systems used by the journalists while studying the files were encrypted and a two-factor authentication system was applied. Many journalists were not well versed in security issues and had to be taught before they could work on the documents.

Not only did the leaked documents number in the millions, but they came in various formats too—some of these files were even in PSP (Paint Shop Pro). One reason for this was that Appleby was not the only source of the documents; in total, there were at least 19 data sources. A big challenge, thus, was devising a system that allowed easy access to all the files. However, the documents included emails, handwritten notes, photos, etc.—files that could not be read by machines, an absolutely necessary precondition for establishing a database.

A software company named Nuix stepped in and assisted in transforming all of these documents into a readable format through advanced optical character recognition software that could recognize text based on combinations of words that often occur together. Ingenious solutions like this allowed the journalists to finally put all the files in one database. Data analysts then devised algorithms that could cut across the many coding systems used in the 13.4 million documents and create links between companies and individuals and the data relevant to them.

This was perhaps the most difficult part of the enterprise, as it required close cooperation between the computer scientists and the journalists. To create a successful and efficient algorithm, the journalists needed to provide the data specialists with lists of the terms that were used in the Paradise Papers to refer to individuals and companies. As there are many of these—and they sometimes appear only as numerical codes—there was a strong need for cooperation between the journalists on the one hand and the data analysts on the other. Generally speaking, the success of big data journalism is contingent on close cooperation between data analysts and journalists; the challenge for journalists is to provide the data experts with clear information, while the challenge for the data experts is to create a knowledge center that journalists, many of whom are decidedly not computer wizards, can easily use.

The reporting on the Paradise Papers has been universally acclaimed as an outstanding

example of how new technology and techniques can be used to journalism's advantage. The news outlets won many awards for their work, including a prestigious Investigative Reporters and Editors award recognizing the innovative use of big data.

Sources: "Paradise Papers," BBC News, <https://www.bbc.com/news/paradisepapers>; "Paradise Papers: Secrets of the Global Elite," ICIJ, <https://www.icij.org/investigations/paradise-papers/>; "Paradise Papers: Das ist das Leak," Süddeutsche Zeitung, <https://projekte.sueddeutsche.de/paradisepapers/politik/das-ist-das-leak-e229478/>, all accessed December 1, 2019.

CASE STUDY QUESTIONS

1. Why was it a challenge to place all the documents from the Paradise Papers in one database?
2. Protecting the identity of a whistleblower or whistleblowers is of vital importance to journalists. Give at least one reason why this is so important.
3. Explain why cooperation between data experts and journalists was vital to the efficient analysis of data.
4. News outlets have been experiencing a severe crisis of profitability. What do you think are the causes of this crisis? What role can big data analytics play in countering it?

Case contributed by Bernard Bouwman, Avans University of Applied Sciences

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 the 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, respectively, 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 there are more than 25,000 airline flights each day. Twitter generates more than 8 terabytes of data daily. Digital information is growing exponentially, to an expected 35 zettabytes in 2020. According to the International Data Center (IDC) technology research firm, the world's data are more than doubling every two years.

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 and adds 10,000 more each day. To find ways to optimize the Shutterstock experience, it 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, city governments are using big data to manage traffic flows and fight crime. The Interactive Session on People shows how journalism uses big data to investigate stories of enormous scope.

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 the 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 problems big data will solve for the business. The chapter-ending case explores these issues.

BUSINESS INTELLIGENCE TECHNOLOGY 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 technology 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 for the past three decades 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 systems inside the organization. These data are combined with data from external sources and transformed by correcting inaccurate and incomplete data and structuring the data in a common repository for management reporting and analysis.

The data warehouse makes the data available for anyone to access as needed, but it cannot be altered. A data warehouse system also provides a range of ad hoc and standardized query tools, analytical tools, and graphical reporting facilities. A data warehouse can be deployed on premises, in the cloud, or in a hybrid cloud environment (review Chapter 5).

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 very large 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, do a search on Google, or connect with a friend on Facebook.

Hadoop consists of several key services: 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 user 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

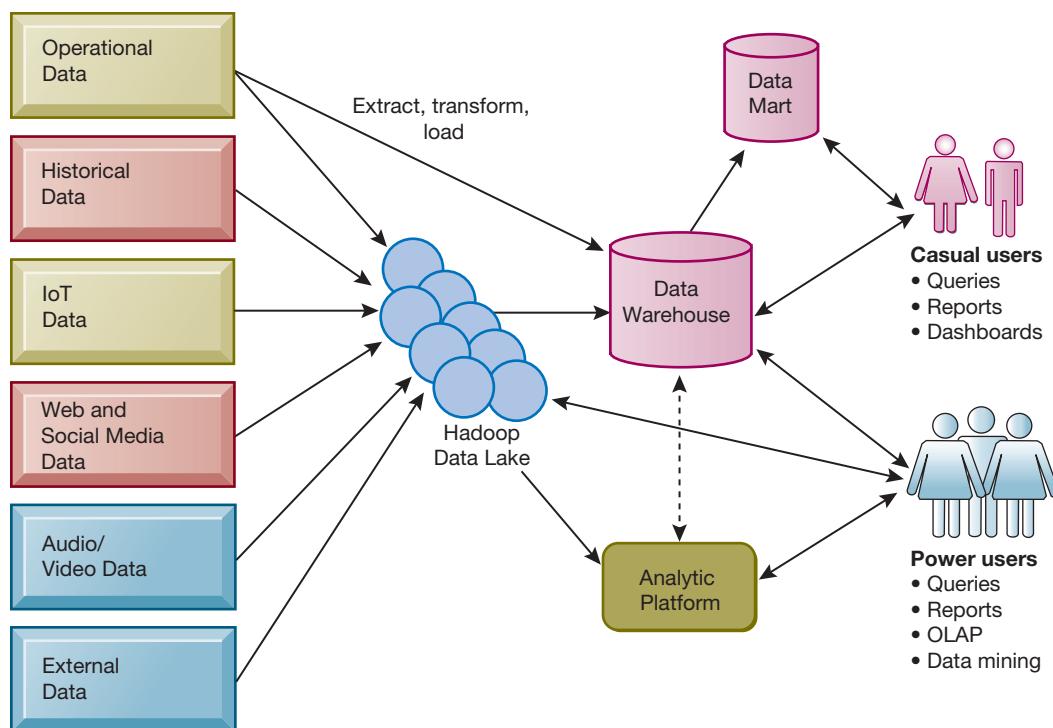
Another way of facilitating big data analysis is to use **in-memory computing**, which relies primarily on a computer's main memory (RAM) for data storage. (Conventional DBMS use disk storage systems.) Users access data stored in system's primary memory, thereby eliminating bottlenecks from retrieving 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 be accomplished even on 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 preconfigured hardware-software systems that are specifically designed for query processing and analytics. For example, 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. Analytic platforms are now available as cloud services.

Figure 6.14 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 have 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 11 discusses the various types of BI users and BI reporting in greater detail.

**Figure 6.14**

Business Intelligence Technology Infrastructure.

A contemporary business intelligence technology 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

When data have been captured and organized using the business intelligence technologies we have just described, they are available for further analysis by 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 11.

Online Analytical Processing (OLAP)

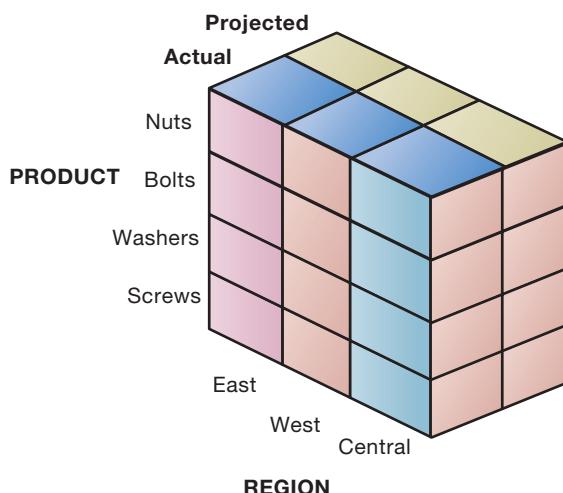
Suppose your company sells four products—nuts, bolts, washers, and screws—in the East, West, and Central regions. If you wanted to ask a straightforward question, such as how many washers sold during the past quarter, you could easily find the answer by querying your sales database. However, what if you wanted to know how many washers 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. 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 rapid time, even when the data are stored in very large databases, such as sales figures for multiple years.

Figure 6.15 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

Figure 6.15
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.



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 2019?” 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 tells Caesars 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' profits so much that it became the centerpiece of the firm's business strategy, and customer data are Caesars' most valuable asset.

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 can extract key elements from unstructured big data sets, 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 can mine text comments in an email message, blog, social media conversation, or survey form 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 web is 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 Google Trends, 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;

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 a web server records 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

Many companies are using the web to make some of the information in their internal databases available to customers and business partners. Prospective customers might use a company's website to view the company's product catalog or to place an order. The company in turn might use the web to check inventory availability for that product from its supplier.

These actions involve accessing and (in the case of ordering) updating corporate databases through the web. Suppose, for example, a customer with a web browser wants to search an online retailer's database for pricing information. Figure 6.16 illustrates how that customer might access the retailer's internal database over the web. The user would access the retailer's website over the Internet using web browser software on his or her client PC or mobile device. The user's web browser software would request data from the organization's database, using HTML commands to communicate with the web server.

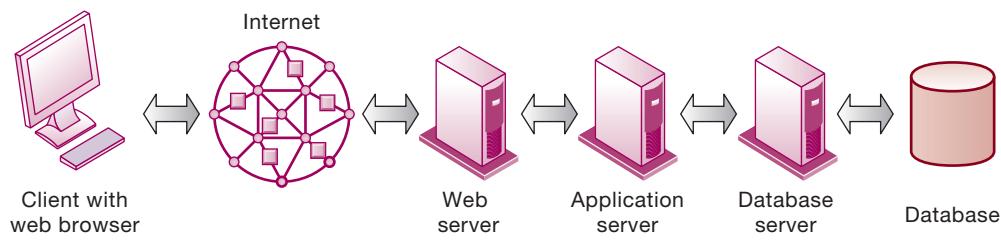
Because many back-end databases cannot interpret commands written in HTML, the web server would pass these requests for data to software that translates HTML commands into SQL so the DBMS working with the database can process them. In a client/server environment, the DBMS often resides on a dedicated computer called a **database server**. The DBMS receives the SQL requests and provides the required data. The information is transferred from the organization's internal database back to the web server for delivery in the form of a web page to the user.

Figure 6.16 shows that the software working between the web server and the DBMS could be on an application server running on its own dedicated computer (see Chapter 5). 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.

There are a number of advantages to using the web to access an organization's internal databases. First, everyone knows how to use web browser software, and employees require much less training than if they used proprietary query tools. Second, the web interface requires few or no changes to the internal database. Companies leverage their investments in older systems because 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 and opportunities, and, in some cases, it is even changing the way business is being done. ThomasNet.com provides an up-to-date directory of information from more than 500,000 suppliers of industrial products such as chemicals, metals, plastics, rubber,

Figure 6.16
Linking Internal
Databases to the Web.
Users access an
organization's internal
database through the web,
using their desktop PCs or
mobile devices and web
browser software.



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 on its website and has become a smaller, leaner company. Facebook is an example of an entirely new business based on access to large databases through the web. Facebook maintains a massive database to house and manage all the data it collects about its 2.2 billion active users and their interests, friends, and photos.

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 have received several pieces of the same direct mail advertising on the same day. This is very likely the result of your name being maintained multiple times in a database. Your name may have been misspelled, or you used your

The Dubai Electricity and Water Authority (DEWA) has been the sole provider of electricity and water services in Dubai since 1992, when the Dubai Electricity Company merged with the Dubai Water Department. Across the emirate, its 9,700 employees manage the generation and distribution of electricity to 652,200 customers and water to 580,678 customers. DEWA's mission is to provide its users with electricity and water in a sustainable way while maintaining high efficiency standards.

DEWA has a substantial generation capacity of around 10,000MW and water production of around 500 million imperial gallons per day. Utility companies measure their efficiency in customer minutes lost (CML), which stands for the average number of minutes a customer's supply has been interrupted. In 2019, the CML at DEWA was an impressive 2.39 minutes compared to the global standard of 15 minutes, and energy loss during transmission and distribution of electricity was 3.3 percent compared to 6–7 percent in Europe and the United States. Interruption of water supply, which indicates either low water quality or a situation where the customer has either not received water, was slightly higher, at 6.5 percent, compared to 15 percent in North America in 2018.

Dubai sits in the middle of a hot and sandy desert with a harsh climate and very few natural water sources. Its phenomenal growth over the last two decades has come with several costs, not least of which is the task of providing uninterrupted power and water to nearly 2 million people. In 2014, water connections increased by nearly 30 percent; in 2015, the demand for power shot up by 5–6 percent.

DEWA recognized that it had to deal with a range of problems. In addition to broader issues of inefficient processes, delays in upstream and downstream activities, and frequent mismatches between system inventory and physical stock, data management needed a complete overhaul. Information was still widely being stored on paper, which caused major delays in decision making. Employees had little access to information in the field via mobile; in fact, finding the information they needed sometimes required several trips to the field or the respective office. Furthermore, there was a lack of variety in payment options for customers and no scope for "smart" monitoring of electricity and water.

DEWA identified two main challenges: inventory-related matters and smart monitoring. The authority began working with SAP in 2012 for the former and with Honeywell in 2018 for the latter. To implement SAP Inventory Manager, DEWA collaborated with Wavelogix and On Device Solutions.

SAP Inventory Manager is a mobile application for wireless inventory management, including tracking of assets, tools, and parts. It automates stock functions like issues, transfers, returns, and audits, enabling an organization to respond appropriately to any fluctuations in demand. It does so by checking the availability of materials remotely using mobile devices, accepting and distributing incoming materials by purchase order, and pre-picking materials based on these orders.

SAP Inventory Manager's implementation led to several changes at DEWA. Goods receipts were made against reservations and inbound delivery of goods to the warehouse; likewise, issuance of goods was done against reservations. This enabled goods to be seamlessly transferred internally between plants within the organization. Employees were able to efficiently pick, store, and track inventory in the stores through the SAP Material Master database, an application that contains information on all the materials that DEWA procures, produces, stores, and sells, information that can also be retrieved and edited through handheld devices.

The time between the purchase request and the purchase order cycle was reduced from 60 to 15 days, which led to savings of \$3.4 million and 160,000 fewer sheets of paper wasted each year. The CML was brought down to 2.39 minutes from 5.62 minutes; water line losses, to 6.5 percent from 10.4 percent; and electricity losses, to 3.3 percent from 3.46 percent.

This and other, similar initiatives improved DEWA's cumulative efficiency by 29.68 percent over the course of a decade. In November 2012, DEWA won the bronze Quality Award in the Large Implementation category at the SAP EMEA Quality Awards, where it competed against organizations in Europe, the Middle East, and Africa; soon after, Dubai was ranked seventh in the world in the World Bank's Doing Business 2013 report for ease of access to electricity.

Dubai has invested heavily in its Smart Dubai initiative to transform into a pioneering smart city. Supporting this is DEWA's Smart Applications via

Smart Grid and Meters initiative, now collaborating with International conglomerate Honeywell in its third phase with the aim of installing a million smart meters by 2020. A smart infrastructure for electricity transmission and distribution networks would improve the speed with which power reconnects if any disruption occurs.

Honeywell's smart meters, equipped with wireless technology, sends detailed data from automatic readings to DEWA, which can adjust its supply as necessary, and directly to consumers as well, allowing them to make more informed decisions about their power usage. By using smart

solutions to closely monitor electricity consumption and increase energy efficiency, DEWA also fulfills the Dubai government's twin objectives of true sustainability and satisfaction of its citizens and residents.

Sources: Navdeep Singla, "SAP Inventory Manager Case Study—DEWA," On Device Solutions, August 23, 2019; Dubai Electricity & Water Authority, "DEWA Sustainability Report 2018," www.dewa.gov.ae; Project Management Institute, "How DEWA Increased Efficiencies and Value Using Streamlined Project Management Processes" (2018), www.pmi.org; Jason Saundarkar, "DEWA Appoints Honeywell to Install 270,000 Smart Meters," *Middle East Construction News*, October 25, 2018; Edward Banda, "Dubai Electricity and Water Authority Continues Smart Transformation and Tests Blockchain," *Computer Weekly*, November 8, 2017.

CASE STUDY QUESTIONS

- 1.** Identify the main challenge faced by DEWA in this case study.
- 2.** Explain how people-based, organizational, and technological factors were involved in this challenge.
- 3.** Why is accurate and consistent data particularly important for DEWA?

*Case contributed by Saadat Alhashmi,
University of Sharjah*

middle initial on one occasion and not on another, or the information was initially entered on 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 data but also enforces consistency among different sets of data that originated in separate information systems. Specialized data-cleansing software is available to survey data files automatically, 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. And as the Interactive Session on Organizations shows, incomplete or inaccessible databases can cripple public authorities' ability to provide basic utilities to their citizens.



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 sales and marketing assistant for a global data services company.

THE COMPANY

Global Online Stats, a leading global provider of quantitative data, statistics, and market research products, has an open position for an entry-level sales and marketing assistant. The company has more than 500 employees and offices in Boston, London, and Paris. 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. 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?
2. Did you work with quantitative data in your college courses or at a prior job? What did you do with the data?
3. What is your level of expertise with Microsoft Office tools—Word, Excel, PowerPoint, Access?
4. What sales and marketing experience have you had?
5. Do you have any foreign language proficiency?
6. What challenges would you anticipate trying to sell our products and services to non-US organizations?

AUTHOR TIPS

1. Review this chapter and the discussion of business intelligence and analytics in Chapter 11.
2. Use the web to research the company, its products, services, and customers, and the way it operates. Try to find out more about the company's online quantitative database.
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

6-1 **What is a database, and how does a relational database organize data?** A database is a group of related files that keeps track of people, places, and things (entities) about which organizations maintain information. The relational database is the primary method for organizing and maintaining data today in information systems. It organizes data in two-dimensional tables with rows and columns called relations. 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 identify each record uniquely for retrieval or manipulation. An entity-relationship diagram graphically depicts the relationship between entities (tables) in a relational database. The process of breaking down complex groupings of data and streamlining them to minimize redundancy and awkward many-to-many relationships is called normalization.

6-2 **What are the principles of a database management system?** A DBMS consists of software that permits centralization of data and data management so that businesses have a single, consistent source for all their data needs. A single database services multiple applications. The DBMS separates the logical and physical views of data so that the user does not have to be concerned with the data's physical location. The principal capabilities of a DBMS include a data definition capability, a data dictionary capability, and a data manipulation language. Nonrelational databases are becoming popular for managing types of data that can't be handled easily by the relational data model.

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 types of data businesses use today, including semistructured and unstructured big data in very large quantities from many different sources. 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. 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 analyzing useful patterns and information from the World Wide Web, examining the structure of websites, activities of website users, and the contents of web pages. Conventional databases can be linked 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 if they lead to bad decisions about the actions the firm should take. Assuring data quality involves using enterprise-wide data standards, databases designed to minimize inconsistent and redundant data, data quality audits, and data cleansing software.

Key Terms

Analytic platform, 236	Data warehouse, 235	Nonrelational database management systems, 230
Attributes, 222	Database, 221	Normalization, 226
Big data, 232	Database management system (DBMS), 226	Online analytical processing (OLAP), 237
Bit, 220	Database server, 240	Primary key, 222
Blockchain, 231	Distributed database, 231	Query, 229
Byte, 220	Entity, 222	Record, 221
Data cleansing, 243	Entity-relationship diagram, 224	Referential integrity, 226
Data definition, 229	Field, 220	Relational database, 222
Data dictionary, 229	File, 221	Report generator, 230
Data governance, 241	Foreign key, 223	Sentiment analysis, 239
Data lake, 236	Hadoop, 235	Structured Query Language (SQL), 229
Data manipulation language, 229	In-memory computing, 236	Text mining, 239
Data mart, 235	Key field, 222	Web mining, 239
Data mining, 238		
Data quality audit, 243		

Review Questions

- 6-1** What is a database, and how does a relational database organize data?
- Define a database.
 - Define and explain the significance of entities, attributes, and key fields.
 - Define a relational database and explain how it organizes and stores information.
 - Explain the role of entity-relationship diagrams and normalization in database design.
- 6-2** What are the principles of a database management system?
- Define a database management system (DBMS), describe how it works, and explain how it benefits organizations.
 - Define and compare the logical and physical views of data.
 - Define and describe the three operations of a relational database management system.
 - Name and describe the three major capabilities of a DBMS.
 - Define a nonrelational database management system and explain how it differs from a relational DBMS.
- 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?
- Why is ensuring data quality important, and what might be involved in this?
 - What is involved in a data quality audit?
 - Identify individuals or organizations that might be affected by poor data quality.

MyLab MIS™

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

Discussion Questions

- 6-5** It has been said that you do not **MyLab MIS** need database management software to create a database environment. Discuss.

- 6-6** To what extent should end users **MyLab MIS** be involved in the selection of a

database management system and database design?

- 6-7** What are the consequences of an **MyLab MIS** organization not having an information policy?

Hands-On MIS Projects

MANAGEMENT DECISION PROBLEMS

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.

- 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 quote, 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 from which management can obtain a single corporate-wide view of critical sales information to identify bestselling products, key customers, and sales trends. Your sales and product information are stored in several 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. MyLab MIS contains more details about the specifications for the database.

After 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. Within each supplier category, 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 identified items.
- Write a brief description of how the database could be enhanced to improve management of the business further. 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 online 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 attorneys, 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, Australiatradenow, 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 students, select an online database to explore, such as Best Buy or the Internet Movie Database. Explore one of these websites to see what information it provides. List the entities and attributes that the company running the website must keep track of in its databases. Diagram the relationships 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.

BUSINESS PROBLEM-SOLVING CASE

DOES BIG DATA PROVIDE THE ANSWER?

Today's companies are dealing with an avalanche of data from social media, search, and sensors, as well as from traditional sources. According to one estimate, 2.5 quintillion bytes of data per day are generated around the world. Making sense of "big data" to improve decision making and business performance has become one of the primary opportunities for organizations of all shapes and sizes, but it also represents big challenges.

Businesses such as Amazon, YouTube, and Spotify have flourished by analyzing the big data they collect about customer interests and purchases to create millions of personalized recommendations for books, films, and music. A number of online services analyze big data to help consumers, including services for finding the lowest price on autos, computers, mobile phone plans, clothing, airfare, hotel rooms, and many other types of goods and services. Big data is also providing benefits in sports, education, science, health care, and law enforcement.

Healthcare companies are currently analyzing big data to determine the most effective and economical treatments for chronic illnesses and common diseases and provide personalized care recommendations to patients. Analyzing billions of data points collected on patients, healthcare providers, and the effectiveness of prescriptions and treatments has helped the U.K. National Health Service (NHS) save about 581 million pounds (US \$784 million). The data are housed in an Oracle Exadata Database Machine, which can quickly analyze very large volumes of data (review this chapter's discussion of analytic platforms). NHS has used its findings from big data analysis to create dashboards identifying patients taking 10 or more medications at once, and which patients are taking too many antibiotics. Compiling large amounts of data about drugs and treatments given to cancer patients and correlating that information with patient outcomes has helped NHS identify more effective treatment protocols.

New York City analyzes all the crime-related data it collects to lower the crime rate. Its CompStat crime-mapping program uses a comprehensive citywide database of all reported crimes or complaints, arrests, and summonses in each of the city's 76 precincts to report weekly on crime complaint and arrest activity at the precinct, patrol borough, and citywide levels. CompStat data can be displayed on maps showing crime and arrest locations, crime hot spots, and other

relevant information to help precinct commanders quickly identify patterns and trends and deploy police personnel where they are most needed.

There are limits to using big data. A number of companies have rushed to start big data projects without first establishing a business goal for this new information or key performance metrics to measure success. Swimming in numbers doesn't necessarily mean that the right information is being collected or that people will make smarter decisions. Experts in big data analysis believe that too many companies, seduced by the promise of big data, jump into big data projects with nothing to show for their efforts. They start amassing mountains of data with no clear objective or understanding of exactly how analyzing big data will achieve their goal or what questions they are trying to answer. Organizations also won't benefit from big data that has not been properly cleansed, organized, and managed—think data quality.

Big Data does not always reflect emotions or intuitive feelings. For example, when LEGO faced bankruptcy in 2002–2003 the company used big data to determine that Millennials have short attention spans and get easily bored. The message from the data led LEGO to deemphasize their small iconic bricks in favor of large simplistic building blocks. This change only accelerated LEGO's decline, so the company decided to go into consumers' homes to try and reconnect with once-loyal customers. After meeting with an 11-year-old German boy, LEGO discovered that for children, playing and showing mastery in something were more valuable than receiving instant gratification. LEGO then pivoted again to emerge after its successful 2014 movie into the world's largest toy maker. Patterns and trends can sometimes be misleading.

Huge volumes of data do not necessarily provide more reliable insights. Sometimes the data being analyzed are not a truly representative sample of the data required. For example, election pollsters in the United States have struggled to obtain representative samples of the population because a majority of people do not have landline phones. It is more time-consuming and expensive for pollsters to contact mobile phone users, which now constitute 75 percent of some samples. U.S. law bans cell phone autodialing, so pollsters have to dial numbers by hand individually and make more calls, since mobile users tend to screen out unknown callers. Opinions on Twitter do not reflect the opinions

of the US population as a whole. The elderly, poor people or introverts, who tend not to use social media—or even computers—often get excluded.

Although big data is very good at detecting correlations, especially subtle correlations that an analysis of smaller data sets might miss, big data analysis doesn't necessarily show causation or which correlations are meaningful. For example, examining big data might show that the decline in United States crime rate was highly correlated with the decline in the market share of video rental stores such as Blockbuster. But that doesn't necessarily mean there is any meaningful connection between the two phenomena. Data analysts need some business knowledge of the problem they are trying to solve with big data.

Just because something can be measured doesn't mean it should be measured. Suppose, for instance, that a large company wants to measure its website traffic in relation to the number of mentions on Twitter. It builds a digital dashboard to display the results continuously. In the past, the company had generated most of its sales leads and eventual sales from trade shows and conferences. Switching to Twitter mentions as the key metric to measure changes the sales department's focus. The department pours its energy and resources into monitoring website clicks and social media traffic, which produce many unqualified leads that never lead to sales.

All data sets and data-driven forecasting models reflect the biases of the people selecting the data and performing the analysis. Several years ago, Google developed what it thought was a leading-edge algorithm using data it collected from web searches to determine exactly how many people had influenza and how the disease was spreading. It tried to calculate the number of people with flu in the United States by relating people's location to flu-related search queries on Google. Google consistently overestimated flu rates, when compared to conventional data collected afterward by the U.S. Centers for Disease Control (CDC). Several scientists suggested that Google was "tricked" by widespread media coverage of that year's severe flu season in the United States, which was further amplified by social media coverage. The model developed for forecasting flu trends was based on a flawed assumption—that the incidence of flu-related searches on Google was a precise indicator of the number of people who actually came down with the flu. Google's algorithm only looked at numbers, not the context of the search results.

The New York Police Department (NYPD) recently developed a tool called Patternizr, which uses pattern recognition to identify potential criminals. The software searches through hundreds of thousands of crime records across 77 precincts in the NYPD database to find a series of crimes likely to have been committed

by the same individual or individuals, based on a set of identifying characteristics. In the past, analysts had to manually review reports to identify patterns, a very time-consuming and inefficient process. Some experts worry that Patternizr inadvertently perpetuates bias. The NYPD used 10 years of manually identified pattern data to train Patternizr, removing attributes such as gender, race, and specific location from the data. Nevertheless such efforts may not eliminate racial and gender bias in Patternizr if race and gender played any role in past police actions used to model predictions. According to Gartner Inc. analyst Darin Stewart, Patternizr will sweep up individuals who fit a profile inferred by the system. At best, Stewart says, some people identified by Patternizr will be inconvenienced and insulted. At worst, innocent people will be incarcerated.

Companies are now aggressively collecting and mining massive data sets on people's shopping habits, incomes, hobbies, residences, and (via mobile devices) movements from place to place. They are using such big data to discover new facts about people, to classify them based on subtle patterns, to flag them as "risks" (for example, loan default risks or health risks), to predict their behavior, and to manipulate them for maximum profit. Privacy experts worry that people will be tagged and suffer adverse consequences without due process, the ability to fight back, or even knowledge that they have been discriminated against.

Insurance companies such as Progressive offer a small device to install in your car to analyze your driving habits, ostensibly to give you a better insurance rate. However, some of the criteria for lower auto insurance rates are considered discriminatory. For example, insurance companies like people who don't drive late at night and don't spend much time in their cars. However, poorer people are more likely to work a late shift and to have longer commutes to work, which might increase their auto insurance rates.

More and more companies are turning to computerized systems to filter and hire job applicants, especially for lower-wage, service-sector jobs. The algorithms these systems use to evaluate job candidates may be preventing qualified applicants from obtaining these jobs. For example, some of these algorithms have determined that, statistically, people with shorter commutes are more likely to stay in a job longer than those with longer commutes or less reliable transportation or those who haven't been at their address for very long. If asked, "How long is your commute?" applicants with long commuting times will be scored lower for the job. Although such considerations may be statistically accurate, is it fair to screen job applicants this way?

Sources: Brian Holak, "NYPD's Patternizr Crime Analysis Tool Raises AI Bias Concerns," searchbusinessanalytics.com, March 14, 2019; Linda Currey Post, "Big Data Helps UK National Health Service Lower Costs, Improve Treatments," *Forbes*, February 7, 2018; Michael Jude, Rajkumar Venkatesan and Christina Black, "Using Big Data: 3 Reasons It Fails and 4 Ways to Make It Work," University of Virginia Darden School of Business

Press Release, February 2018; Alex Bekker, "Big Data: A Highway to Hell or a Stairway to Heaven? Exploring Big Data Problems," *ScienceSoft*, May 19, 2018; Ernest Davis, "The Problems of Big Data, and What to Do About Them," World Economic Forum, February 15, 2017; and Gary Marcus and Ernest Davis, "Eight (No, Nine!) Problems With Big Data," *New York Times*, April 6, 2014.

CASE STUDY QUESTIONS

- 6-13** What business benefits did the organizations described in this case achieve by analyzing and using big data?
- 6-14** Identify two decisions at the organizations described in this case that were improved by using big data and two decisions that big data did not improve.
- 6-15** Describe the limitations to using big data.
- 6-16** Should all organizations try to collect and analyze big data? Why or why not? What people, organization, and technology issues should be addressed before a company decides to work with big data?

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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

- Tour de France Wins with Wireless Technology
- Singapore Shuts Down 2G Network
- 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

TOUR DE FRANCE WINS WITH WIRELESS TECHNOLOGY

Every July about two hundred cyclists race across 2,200 miles of the most difficult terrain in France, including steep roads in the Pyrenees and Alps. The Tour de France is considered the world's greatest bicycle race.

The first Tour de France took place in 1903 as a way of promoting sales of *L'Auto* newspapers, initially attracting mostly local competitors and spectators. Thanks to newspapers, radio, and television, coverage and prestige of the event expanded. As with other competitive sports, such as football, baseball, tennis, and soccer, today's Tour de France fans don't just want to just watch a sport; they want to engage with it, and they expect more information and interaction—data-enhanced viewing, live streaming, video on demand, mobile apps, and social media interaction. Digital technology has become essential for attracting fans, athletes, sponsors, and broadcasters.

Up until 2014, Tour de France was a technology laggard. The sport doesn't easily generate real-time statistics. The only source of real-time information was a chalkboard held up by a race executive sitting as a passenger on a motorbike ahead of the cyclists. TV viewers could see timings and the race from numerous camera angles, but little more.

Today, data from Tour de France racing bikes are relayed to TV viewers within two seconds. A small, lightweight tracking sensor is attached to a clip below the saddle of every competing rider's bike. The sensor contains a global positioning system (GPS) chip, a radio frequency (RF) chip, and a rechargeable battery. Each sensor transmits data about the bike's GPS position and speed every second, generating over 3 billion data points during the course of the race. These real-time data are combined with feeds from other sources, such as weather services, road gradients, and historical race data from the past few years. Race organizers, broadcasters, teams, TV viewers, and fans using the Tour de France mobile app can now access detailed statistics on the progress of the race and individual riders. Riders wear earpiece radios that relay real-time data to them as they are cycling. The system does not include biometric data to monitor riders' physical performance—the teams keep these data private.

Dimension Data, a global IT services firm headquartered in South Africa, built and operates Tour de France's digital infrastructure. The sensor data from each racing bike are relayed to planes and helicopters flying overhead to cover the race for television. Race data are transmitted to Dimension Data's



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cloud service, hosted in remote data centers in London and Amsterdam, where powerful algorithms developed by cycling experts analyze the data, including external feeds, to generate real-time information for broadcasters, social media, and the Tour de France race app. Getting the data from bike to viewer takes only two seconds. The system is able to make predictions before and during the race based on current and historic data about riders and the state of the race; for example, the likelihood that the main body of riders might catch up to breakaway riders. The system can also generate rider profiles showing each rider's strengths and weaknesses across different race conditions based on historical race results and performance.

Digital technology has dramatically increased Tour de France fan involvement. Fans are able to see live performance information on their TVs and discuss the results on social media. In 2014, there were only 6 million views of video clips put out by the Tour de France organization. By 2016, that number had soared to 55 million. Seventeen million people access the live-tracking website. The goal is to pull you, the fan, into the race, and it appears Tour de France has succeeded.

Sources: www.letour.fr/en, accessed May 20, 2019; www.dimensiondata.com, accessed May 30, 2019; Bryan Glick, "Tour de France Pumps Tech," *Computer Weekly*, August 15–21, 2017; "Tour de France Behind the Scenes: How Dimension Data Rider Live Tracking Works," *DCRainmaker*, July 13, 2017; Dave Michels, "Adding an IoT Dimension to the Tour de France," *Network World*, May 23, 2017; and Scott Gibson, "5 Ways Tour de France Is Winning the Digital Race in 2017," *Dimension Data*, June 29, 2017.

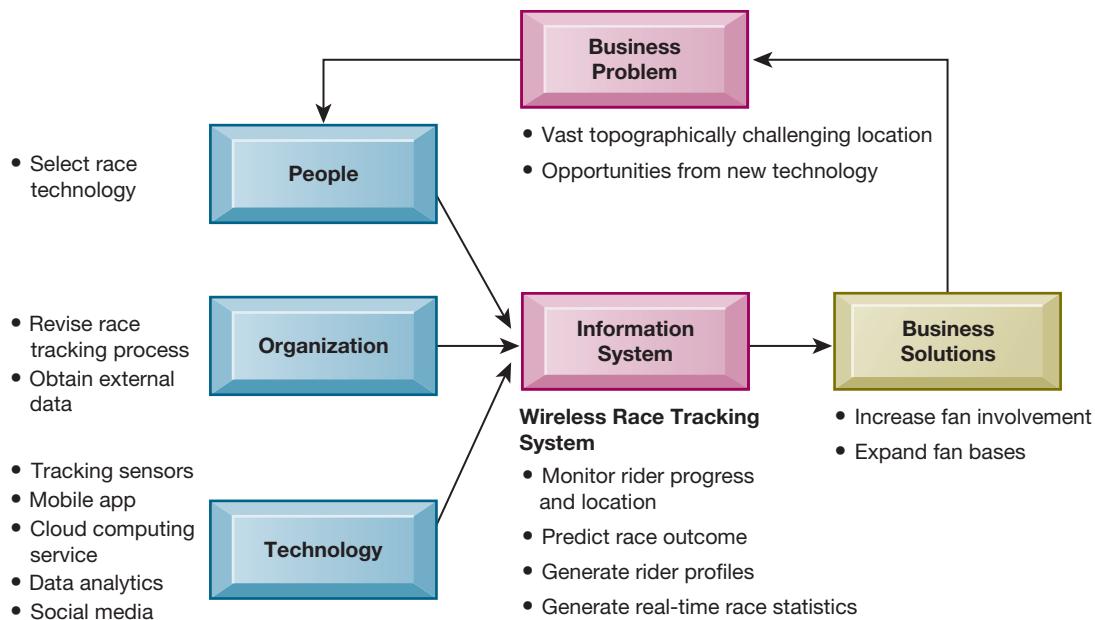
The experience of the Tour de France illustrates some of the powerful capabilities and opportunities provided by contemporary networking technology. The annual Tour de France bicycle race now uses wireless networking and wireless sensor technology to closely track cyclists' speed and position in relation to other variables affecting race outcome, and to deliver race information instantaneously to fans and broadcasters.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. The Tour de France race takes place over a vast and topographically challenging terrain, where it is difficult to track riders and generate real-time race statistics. This legendary race has many fans, but management realized it could expand its fan base and deepen fan engagement by taking advantage of opportunities presented by wireless networking technology and the Internet of Things (IoT). The Tour de France is thus able to provide real-time race statistics, rider profiles, predictions about race outcomes, and content for TV broadcasts and social media, increasing the popularity of the sport and fans' interest. Tour de France cyclists and teams can use this information to improve their performance.

Here are some questions to think about: Why has wireless technology played such a key role at the Tour de France? Describe how the technology changed the way the Tour de France provided and used data from its races.

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 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 Vodafone, offer data transmission, Internet access, mobile phone service, and television programming as well as voice service. Cable companies, such as Kabel and British Telecom, 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 US households have high-speed **broadband** connections provided by telephone and cable TV companies running at 3 to 20 megabits (millions of bits 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. More than 70 percent of Internet users in the United States use smartphones and tablets to access the Internet.

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.

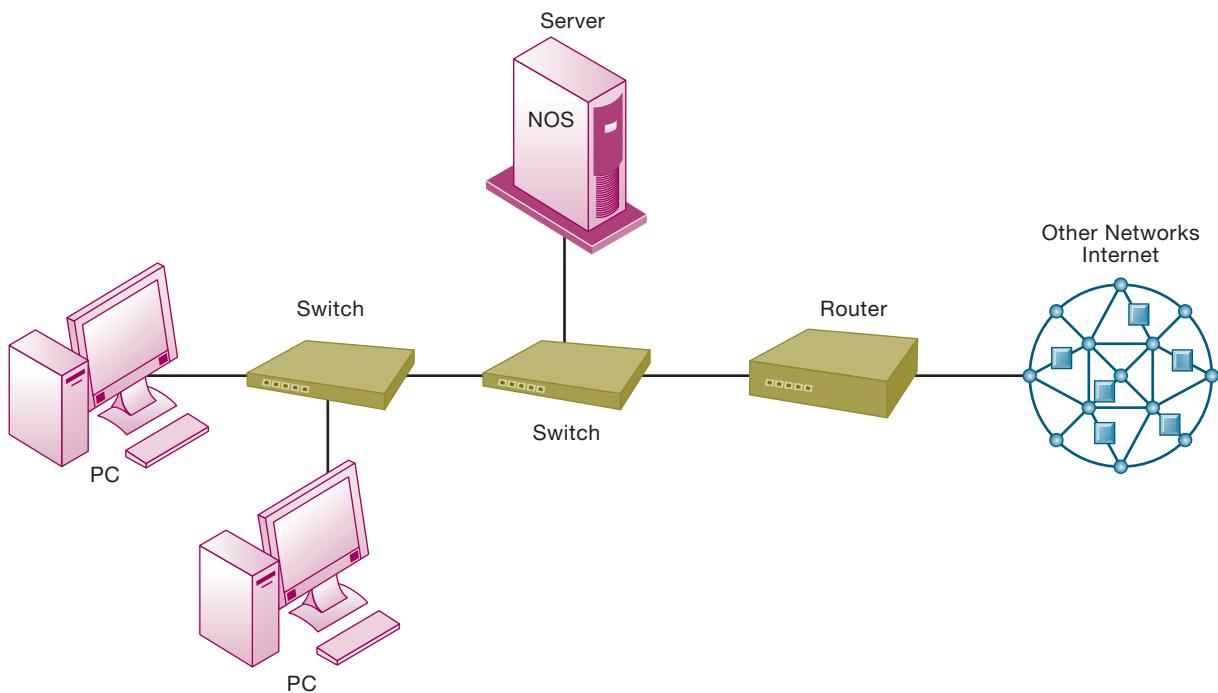


Figure 7.1

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.

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.

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

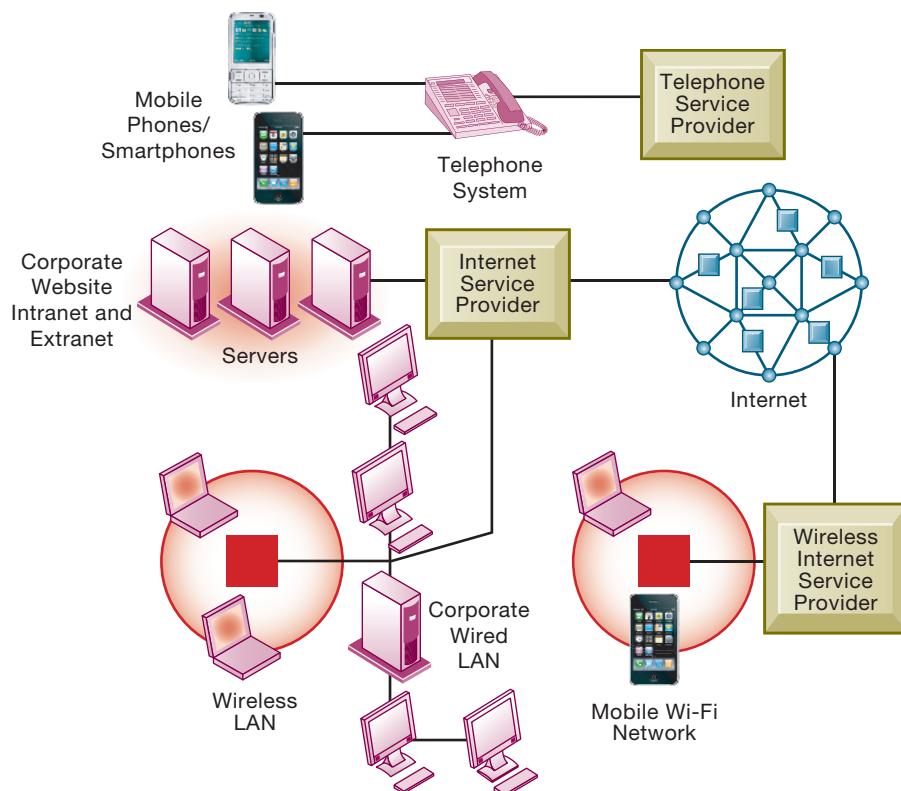


Figure 7.2
Corporate Network Infrastructure.

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.

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 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.

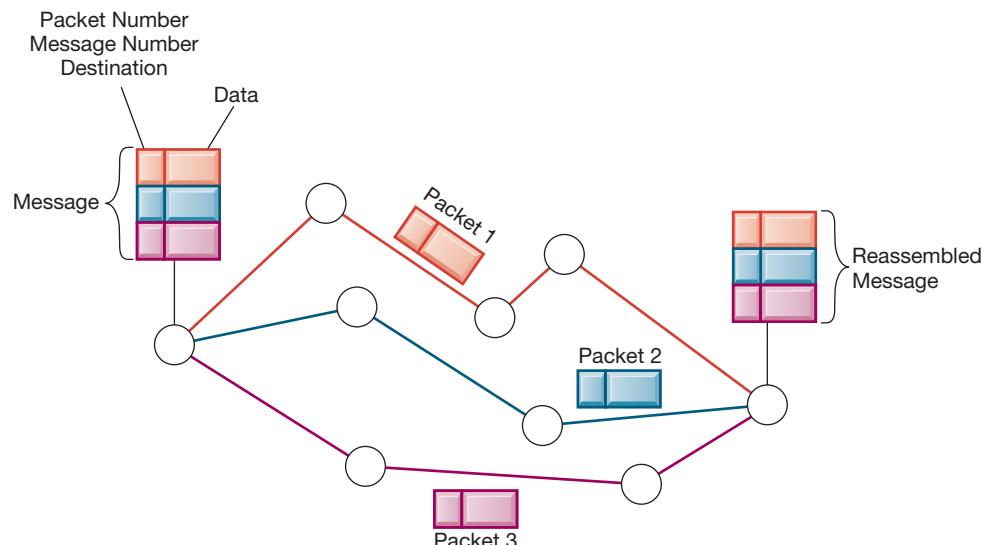
Client/server computing has largely replaced centralized mainframe computing in which nearly all the processing takes place on a central large mainframe computer. Client/server computing has extended computing to departments, workgroups, factory floors, and other parts of the business that could not 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.

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.

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.



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. Today, however, 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 US 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 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.

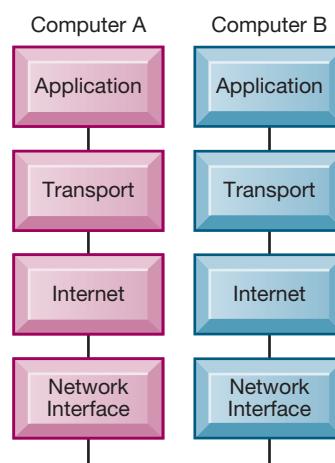


Figure 7.4
The Transmission Control Protocol/Internet Protocol (TCP/IP) Reference Model.

This figure illustrates the four layers of the TCP/IP reference model for communications.

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, 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.

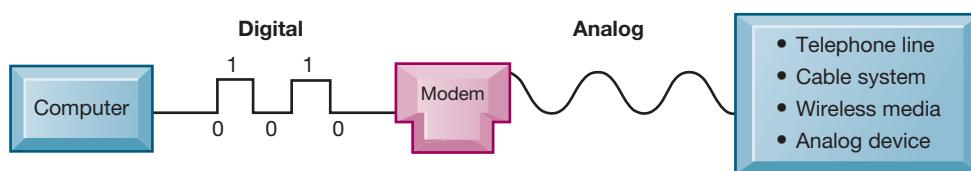
The server determines who gets access to what and in which sequence. The router connects the LAN to other networks, which could be the Internet, or another corporate network, so that the LAN can exchange information with networks external to it. The most common LAN operating systems are Windows and Linux.

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).

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.



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

TABLE 7.1
Types of Networks

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.

Transmission Medium	Description	Speed
Twisted pair wire (CAT 5)	Strands of copper wire twisted in pairs for voice and data communications. CAT 5 is the most common 10 Mbps LAN cable. Maximum recommended run of 100 meters.	10–100+ Mbps
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

TABLE 7.2
Physical Transmission Media

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 US 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 all the way up to 3 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 of up to 50 Mbps, although most providers offer service ranging from 3 Mbps to 20 Mbps. 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,

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 US government agencies
- .mil US military
- .net Network computers

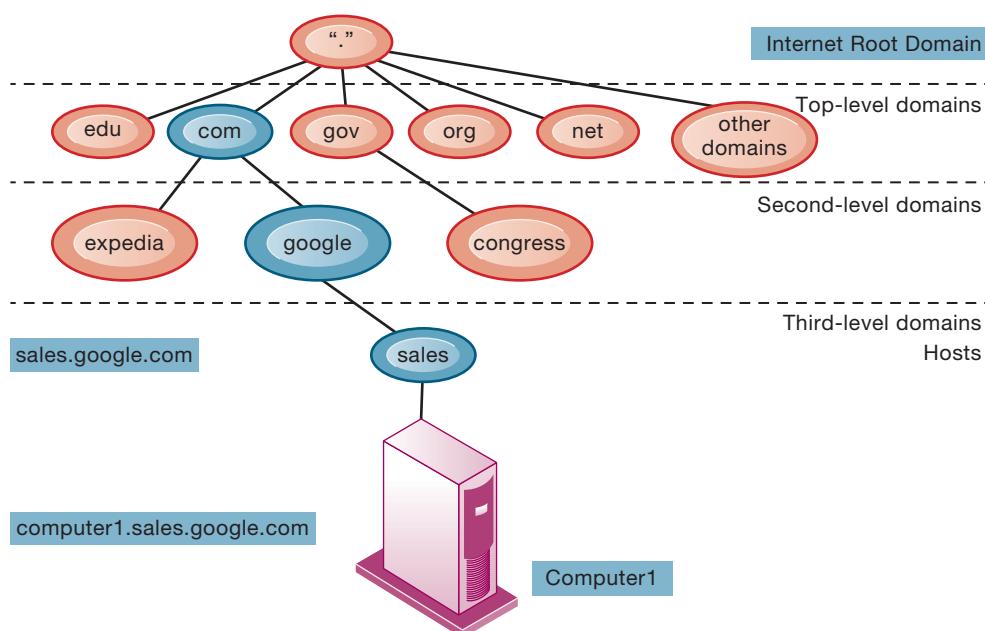


Figure 7.6
The Domain Name System.
The Domain Name System is a hierarchical system with a root domain, top-level domains, second-level domains, and host computers at the third level.

- .org Any type of organization
- .biz Business firms
- .info Information providers

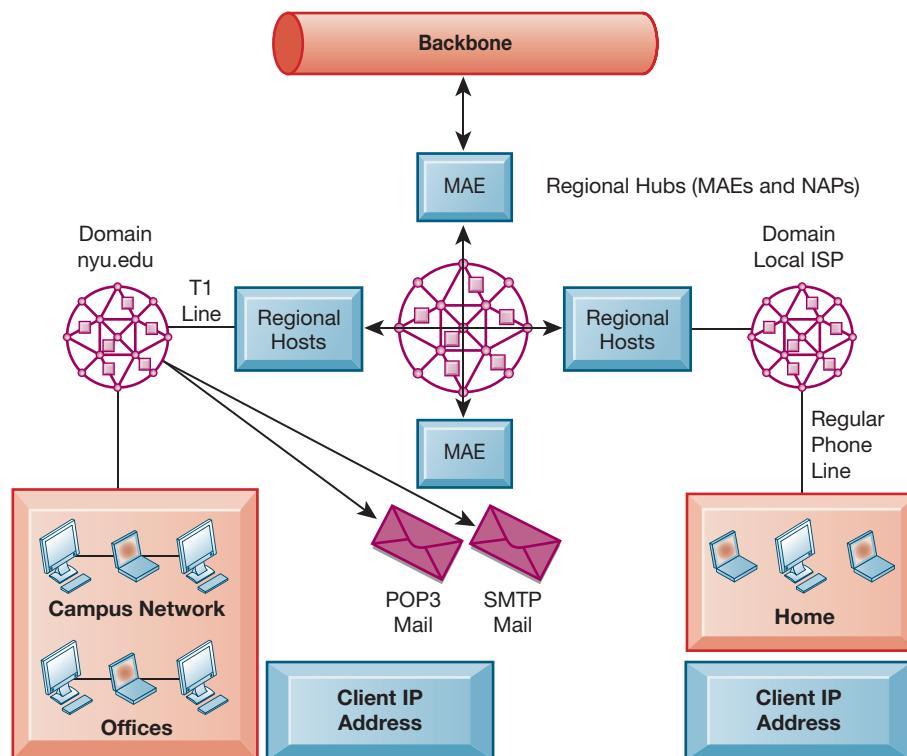
Internet Architecture and Governance

Internet data traffic is carried over transcontinental high-speed backbone networks that generally operate in the range of 155 Mbps to 2.5 Gbps (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 little legislative or executive interference, this situation is changing as the Internet plays a growing role in the distribution of information and knowledge, including content that some find objectionable.

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.



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 US universities, 60 government agencies, 43 regional and state education networks, 59 leading corporations, and 70 national research and education network partners that represent 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.

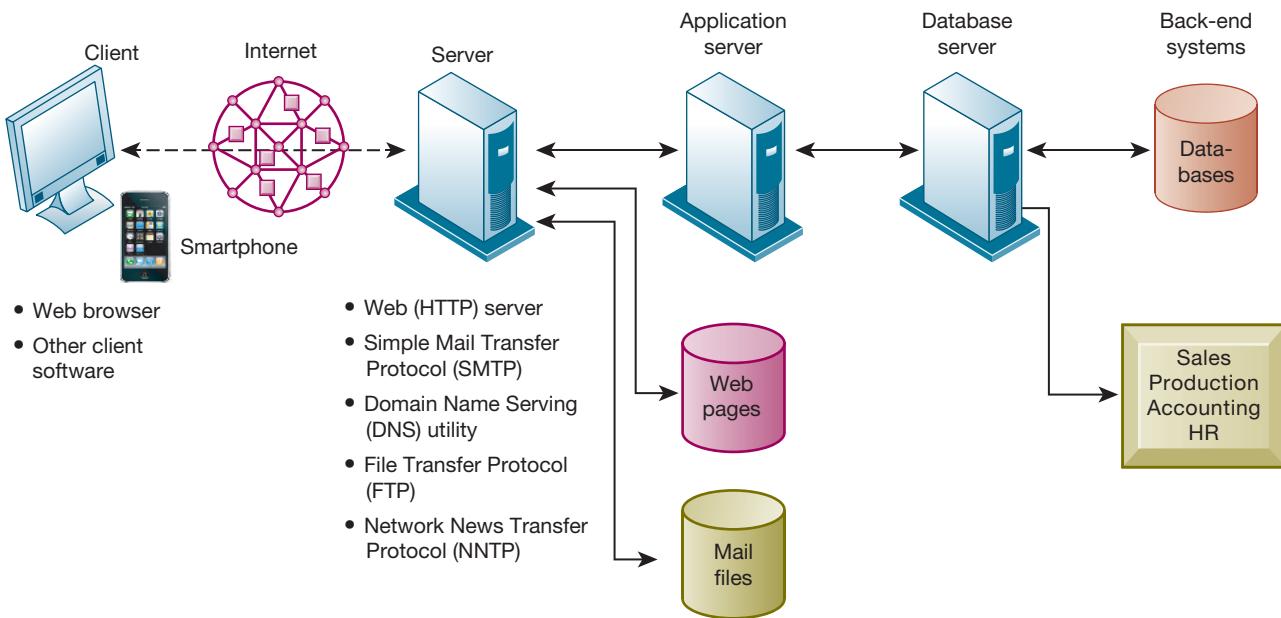
Each Internet service is implemented by one or more software programs. All the services may run on a single server computer, or different services may be allocated to different machines. Figure 7.8 illustrates one way these services can be arranged in a multitiered client/server architecture.

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.

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

TABLE 7.3

Major Internet Services

**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.

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.

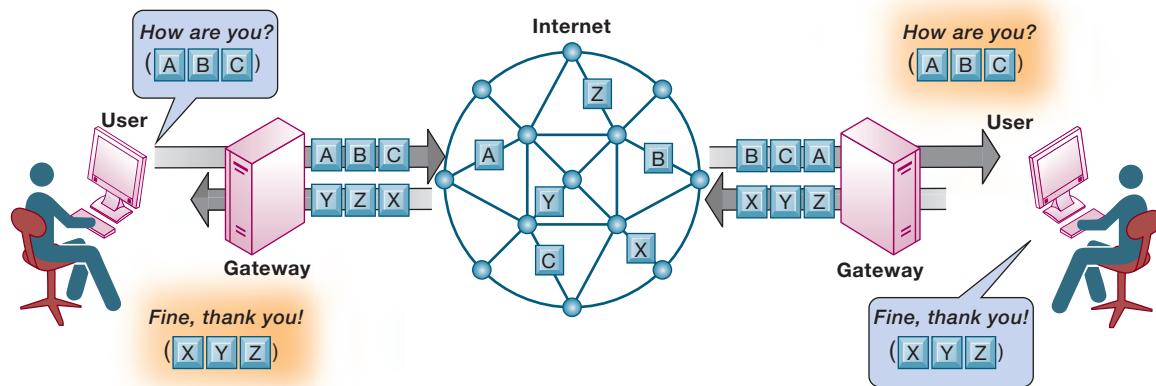
Newsgroups are worldwide discussion groups posted on Internet electronic bulletin boards on which people share information and ideas on a defined topic such as radiology or rock bands. Anyone can post messages on these bulletin boards for others to read.

Employee use of email, instant messaging, and the Internet is supposed to increase worker productivity, but 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.

Cable firms such as Time Warner and Cablevision provide VoIP service bundled with their 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.

**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 or the IP address of the receiving computer.

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.

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.

CenterPoint Properties, a major Chicago area industrial real estate company, used unified communications technology to create collaborative websites for each of its real estate deals. Each website provides a single point for accessing structured and unstructured data. Integrated presence technology lets team members email, instant message, call, or videoconference with one click.

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.

With 4.7 million smartphone users and a mobile phone penetration rate of over 84 percent of the population, Singapore continues to lead Southeast Asia in the telecommunications industry. The main challenge facing the industry has been spectrum crunch, which relates to the availability of radio waves to carry wireless signals. Radio spectrum demand has grown exponentially, driven by the explosion of wireless devices such as smartphones, tablets, and computers, and more recently, by the emergence of the Internet of Things—everyday objects collecting data through sensors and transmitting them over the Internet. The radio spectrum is finite, but global mobile data traffic is not; it is expected to hit over 77 exabytes per month by 2022, almost seven times that of 2017.

Singapore implemented several measures to combat the spectrum crunch. In 2009, unused radio spectra called white spaces, then used for TV broadcasting, were taken over and allocated to wireless communications. Further, the Infocomm Media Development Authority (IMDA), Singapore's regulatory authority, has been actively promoting light fidelity (Li-Fi) to tap the visible light spectrum in the frequency range 400–800THz to alleviate spectrum congestion. In addition, in a landmark announcement, Singapore's large telecom companies announced that they would be shutting down 2G mobile services by April 1, 2017. The main reason was to reallocate the 2G spectrum for 3G, 4G, and even 5G services, which are about to be launched.

Although the decision to shutter 2G was widely applauded, the implementation was challenging and required many key decisions on the part of the telecoms companies and the government to ensure that 2G users—about 123,000 subscribers—would not be adversely affected, especially as they constituted some of the most vulnerable in society. These included foreign workers and domestic workers living in Singapore, who used 2G phones because they are cheaper and have a longer battery life. Many of the elderly use a phone only for basic services such as voice calls, and many children were given 2G phones by their parents for use in emergencies. Getting these stakeholders to move to 3G or 4G phones and services was a significant economic and educational challenge.

Singapore took several measures to help and encourage the 123,000 2G mobile subscribers to switch to smartphones. One was to allow the

sale of basic smartphones such as the SGINO 3G phone for elderly people, which was much cheaper than a normal 3G phone. This addressed the issue of affordability. Then came education programs. The government and telecoms companies together organized various outreach programs like roadshows in neighborhoods; advertisements on the radio, in newspapers, and on television; and posters and brochures at community centers, libraries, and foreign workers' dormitories. One major initiative by the People's Association (a Singapore grassroots communities and social organization) was the Seniors for Smart Nation program, which offers 25 IT courses to help those aged 50 and above. Others included the Senior Academy program, offering courses such as Smartphone 101 and IT Learning Hubs (also known as Silver Infocomm Junctions), offering affordable and customized IT lessons to senior citizens.

Meanwhile, the major telecoms companies—Singtel, Starhub, and M1—actively promoted the smartphones to 2G users with special promotions and discounts. For example, a Samsung Galaxy J1, which normally sold at \$208, was offered by Singtel at \$148 with a 2G phone trade-in, and it came bundled with \$30 free local talk-time. Similarly, Starhub set up various roadshows at several SingPost locations to offer upgrade packages, while M1 started to rent out 3G phones, with ownership to be transferred at end of 12 months. Such deep discounts and offers were unusual, but the telecom companies likely took the long-term view that they were gaining valuable 2G spectrum that they could use for more lucrative mobile services.

The community also played a vital role in the migration. As an example, a non-profit organization, Transient Workers Count Too (TWC2), appealed to the public to donate their used 3G phones to help migrant workers. During their donation campaign, they received approximately 350 handsets worth about \$11,500, exceeding their goal of 200 phones. The donations were given to migrant workers who were unable to afford 3G handsets.

In summary, the decision to shut down 2G was easy technically but hard in terms of implementation. It required concerted action by the private sector, the public sector, as well as the people—the PPP partnership. Private telecom companies were willing to give deep discounts to gain valuable spectrum in the long run, the government rolled out many education and awareness programs to

educate and encourage the elderly and the young, and the entire community stepped up to help foreign and domestic workers.

These “acts of kindness” were also strategic, for they became the springboard for Singapore to push its Smart Nation initiative, which requires 5G networks to make available such services as smart homes, autonomous cars, virtual reality, wearable technology, video conferencing, and telemedicine. This next-generation infrastructure is a win for all concerned, and the new 5G foundation, which is still being built, will not have been possible without the many managerial decisions taken by the public and private sectors that kept in view the needs of all stakeholders. In 2019, other

countries such as Norway also began shutting down slower networks, such as 3G networks, in an effort to make more resources available for faster 4G and 5G services.

Sources: J. Clement, “Global Mobile Data Traffic from 2017 to 2022 (in Exabytes per Month),” Statista.com, December 17, 2019; “What Telecoms Need to Plan Before Shutting Down 3G Network,” Telecomlead.com, December 3, 2019; eMarketer, “Mobile Phone Users and Penetration in Singapore,” April 2019; eMarketer, “Smartphone Users and Penetration in Singapore,” April 2019; “Global Mobile Data Traffic from 2017 to 2022 (in Exabytes per Month),” Statista, accessed 2018; “Spectrum Management and Coordination,” Infocomm Media Development Authority, December 20, 2017; Loke Kok Fai, “100,000 Mobile Subscribers Still on 2G Despite Start of the Network’s Shutdown,” Channel NewsAsia, April 2, 2017; Vincent Chang, “All You Need to Know about 2G Network Shutdown,” *The Straits Times*, March 28, 2017; “Donation Campaign a Huge Success, Distribution of 3G Phones Begins,” TWC2, March 22, 2017; “Silver Infocomm Junctions,” Infocomm Media Development Authority, September 24, 2018, <https://www.imda.gov.sg/SIJ>.

CASE STUDY QUESTIONS

1. What do 2G, 3G, and 4G refer to? Explain one difference among them.
2. What is meant by “wireless spectrum” and “spectrum crunch”? What measures were taken to alleviate the spectrum scarcity?
3. The decision to shut down 2G was easy technically but hard in terms of implementation.” Do you agree with this statement? Why or why not?

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

A **virtual private network (VPN)** is a secure, encrypted, private network that has been configured within a public network to take advantage of 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

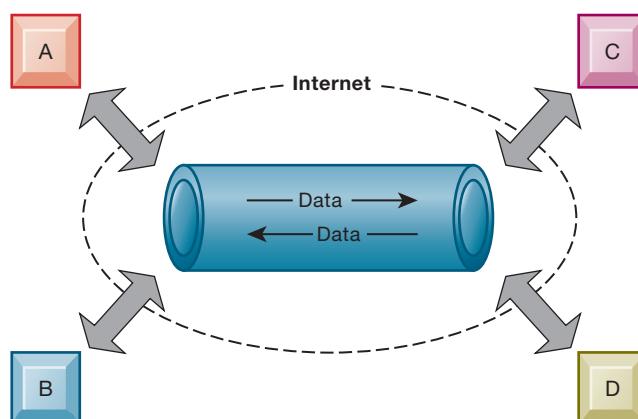


Figure 7.10
A Virtual Private Network Using the Internet.
This VPN is a private network of computers linked using a secure tunnel connection over the Internet. It protects data transmitted over the public Internet by encoding the data and wrapping them within the Internet protocol. By adding a wrapper around a network message to hide its content, organizations can create a private connection that travels through the public Internet.

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 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 130 trillion pages in 2018, 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 *Wall Street Journal Online*, which cannot be visited without an 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 total 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.

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.

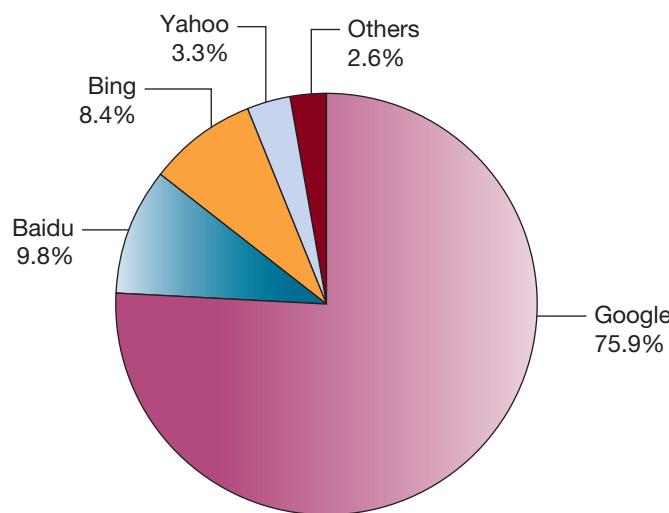


Figure 7.11
Top Desktop/Laptop
Web Search Engines
Worldwide.
Google is the world's most popular search engine.
Source: Based on data from Net Market Share, May 2019

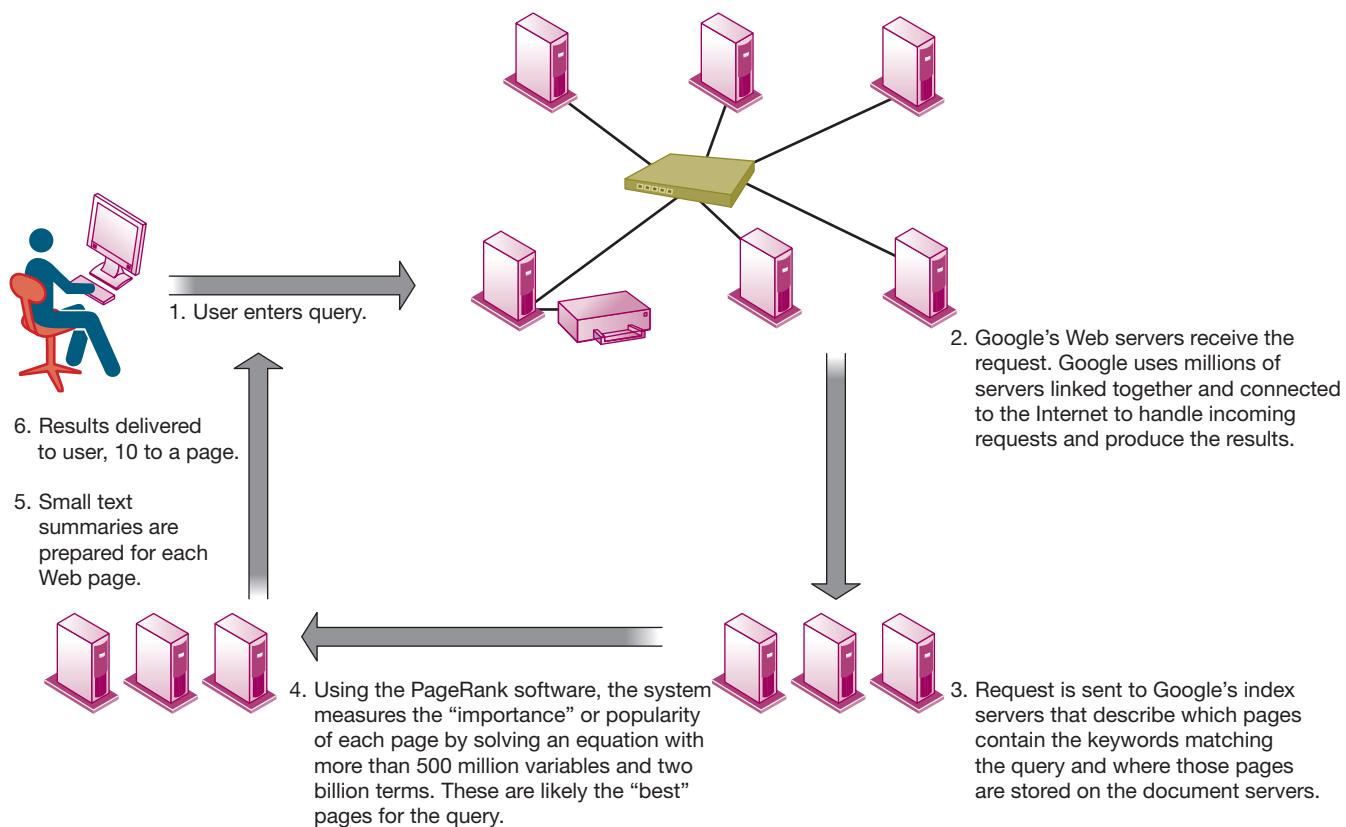


Figure 7.12
How Google Works.

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.

Mobile Search Mobile search from smartphones and tablets makes up more than 55 percent of all searches and continues to expand. 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 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 2019," Hummingbird should be able to figure out that you really want Google's parent company Alphabet's SEC Form 10K report filed with the Securities and Exchange Commission in February 2019.

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 Tahoe," the search engine will return basic facts about Tahoe (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.

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 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 over 290 million active monthly users worldwide in 2019. 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 2019, Instagram had 1 billion monthly 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; it is estimated that 242 million people in the United States used search engines in 2019, and 215 million used mobile search at that time. 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. In 2019, search engine marketing is expected to generate \$48 billion, or 44.2 percent of digital ad spending, nearly half of all online advertising (\$125 billion) (eMarketer, 2019a). About 90 percent of Google's revenue of \$136 billion in 2018 came from online advertising, and 90 percent of that ad revenue came from search engine marketing (Alphabet, 2019).

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 in 2012 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 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. The totality of blog-related websites is often referred to as the **blogosphere**. 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 US 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 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. Firms such as General Electric, IBM, HP, and Oracle, and hundreds of smaller startups, are building smart machines, factories, and cities through extensive use of remote sensors and fast cloud computing. There were over 26 billion active IoT devices worldwide in 2019, and this number will rise to 75 billion by 2025 (Bera, 2019). 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 Tour de France race-tracking system described in the chapter-opening case is an IoT application, as is the vehicle-to-everything technology discussed in the Interactive Session on Technology. You’ll find more examples of the Internet of Things in Chapters 2 and 11.

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, such as poor function in extreme weather and blind spots, by getting cars to talk to one another. The system allows a vehicle's on-board computer to perform vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) wireless communication—collectively known as vehicle-to-everything (V2X) wireless communication—continuously with other vehicles and with roadside infrastructure (lamp poles and traffic light poles). It collects this information, analyzes it, and then responds automatically or gives instant audio or visual safety information to the driver accordingly.

Using an international vehicular communication standard called dedicated short-range communications (DSRC), ITS Connect allows effective communication within a radius of up to 300 meters at a frequency of 760 MHz. A V2V message in the ITS Connect is quite small in size (36 bytes to 100 bytes) with free fields reserved for service expansion, but it must contain information about the position, speed, heading, acceleration, type, and size of the vehicle; it may also contain extra data about the nearest intersection ahead as well as information defined by individual applications. Additionally, each message must be appended with a timestamp.

The ITS Connect system is designed to avoid collisions with other vehicles, pedestrians, and cyclists. 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 technology also enables cooperative adaptive cruise control (CACC), which uses information obtained from V2V messages to automatically change 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 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 through the cellular network.

One of the advocates of C-V2X, German-based Continental AG, is a pioneer in applying the technology in automotive parts and has been carrying out field trials in several countries. In late 2018, Continental AG carried out a joint trial of C-V2X in Japan using 5.8 GHz as the experimental radio frequency. The test involved several avoid-collision scenarios; the results showed that the average latency was 20 milliseconds, and throughout the tests the error rate was nearly 0 percent over a distance as long as 1.2 kilometers.

It is believed that V2X will reduce the incidence of 80 percent of traffic accidents, particularly of collisions. In addition, V2X can increase efficiency in coordination of traffic flow through platooning and green wave. 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, which has been controversial for the same road safety issues that V2X seeks to eliminate. 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: K. Momota, "Connectivity Technologies Attracting Attention Due to Frequent Traffic Accidents," Furuno.com, May 31, 2019; Autotalks website, <https://www.aut-talks.com>; Continental AG, <https://www.continental.com/en>; Kristen Hall-Geisler, "In Japan, Priuses Can Talk to Other Priuses," TechCrunch, August 17, 2016; ITS Connect Promotion Consortium, <https://www.itsconnect-pc.org>; Toyota Motor Corporation, Official Global website, <https://global.toyota/en/>.

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

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.

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

Today 96 percent of US adults own mobile phones, and 81 percent own smartphones (He, 2019). Worldwide, there are almost 2.9 billion smartphone users (eMarketer, 2019b). Mobile is now the leading digital platform, with total activity on smartphones and tablets accounting for two-thirds of digital media time spent, and smartphone apps alone capturing more than half of digital media time.

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 that 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 dense networks of 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. AT&T, Verizon, and other carriers are starting to launch 5G networks, which will also improve the speed and intensive data-handling capabilities 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 100 Mbps. Today's PCs and tablets have built-in support for Wi-Fi, as do the iPhone, iPad, and other smartphones.

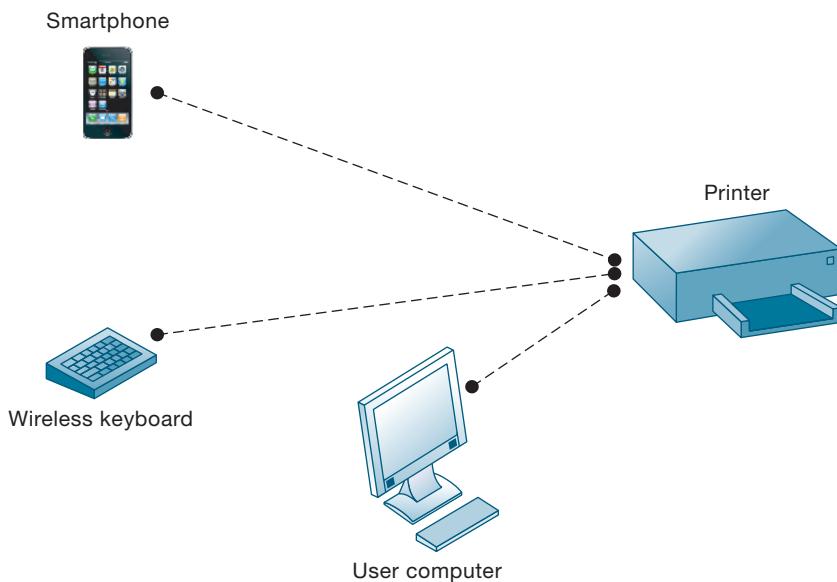


Figure 7.13
A Bluetooth Network (PAN).

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.

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

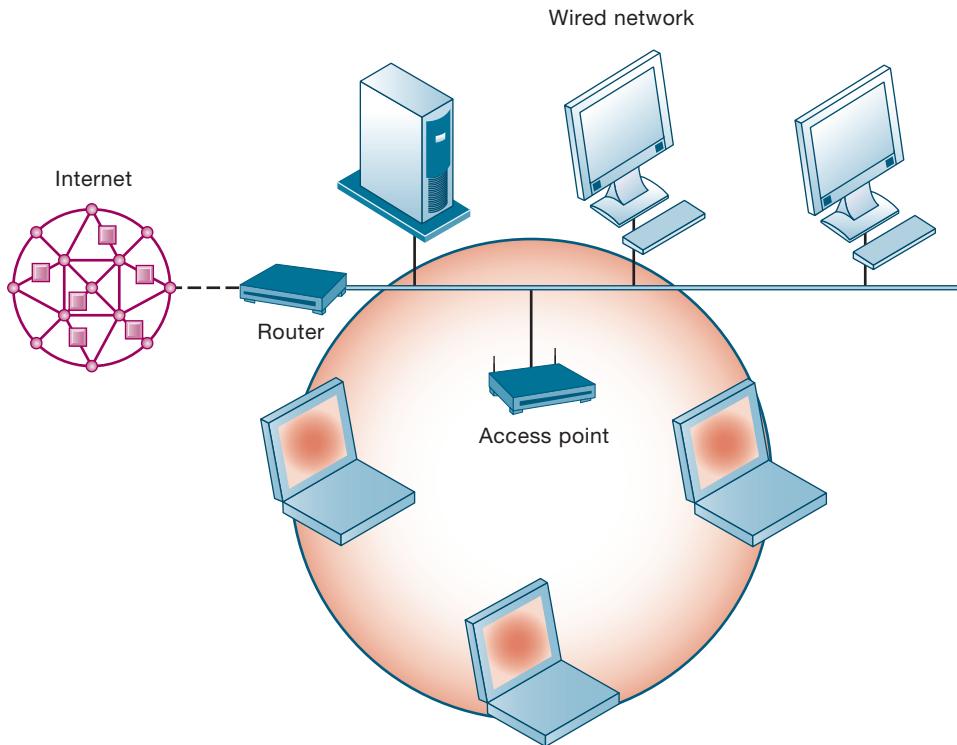


Figure 7.14
An 802.11 Wireless LAN.

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.

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. Dartmouth College 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.

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. Wireless networks based on the 802.11n standard, however, 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 that 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

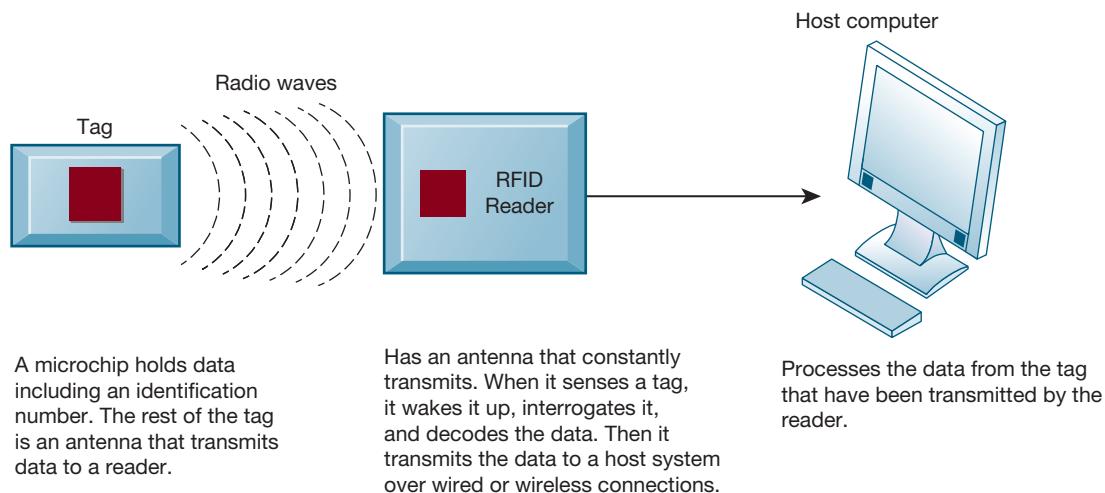


Figure 7.15
How RFID Works.

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.

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 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. Output from RFID systems and wireless networks is fueling the Internet of Things (IoT), introduced earlier in this chapter, in which sensors in machines such as jet engines, power plant turbines, or agricultural equipment constantly gather data and send the data over the Internet for analysis.

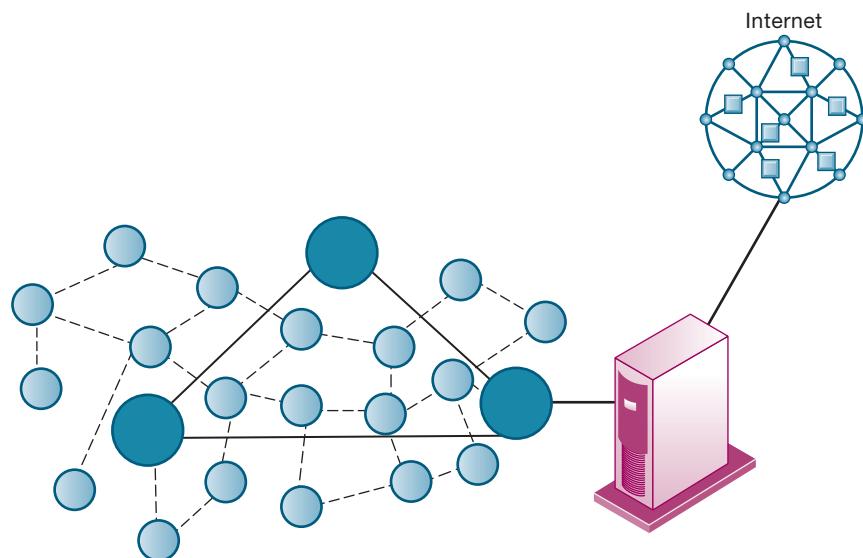
7-5 How will MIS help my career?



Here is how Chapter 7 and this book can help you find a job as an automotive digital advisor.

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.



THE COMPANY

Autoworld is a large and fast-growing automobile dealership in Singapore. The company 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?
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 that 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 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, 280	Internet Protocol (IP) address, 265	Search engines, 273
4G networks, 280	Internet service provider (ISP), 264	Semantic search, 274
5G networks, 280	Internet2, 267	Shopping bots, 275
Bandwidth, 264	IPv6, 267	Smartphones, 279
Blog, 276	Local area network (LAN), 262	Social networking, 277
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Chat, 268	Network operating system (NOS), 258	Transmission Control Protocol/Internet Protocol (TCP/IP), 261
Dark web, 273	Packet switching, 260	Unified communications, 269
Digital subscriber line (DSL), 264	Peer-to-peer, 263	Uniform resource locator (URL), 272
Domain name, 265	Personal area networks (PANs), 280	Virtual private network (VPN), 271
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Email, 267	Protocol, 261	Voice over IP (VoIP), 268
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Instant messaging, 268		Wireless sensor networks (WSNs), 284
Internet of Things (IoT), 277		

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?
- Explain the role of a Tier 1 Internet Service Provider (ISP).
 - Explain the differences between instant messaging, emails, and chat services.
 - Define and describe the purpose of unified communications.

- Explain what the term tunneling means and why it might be important to businesses.
- Explain the purpose and the value of search engine optimization.
- 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 WSNs, explain how they work, and describe the kinds of applications that use them.

MyLab MIS™

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

Discussion Questions

7-5 It has been said that within the **MyLab MIS** 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 **MyLab MIS** manufacturing companies switch to RFID? Why or why not?

7-7 What are some of the issues to **MyLab MIS** 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 in western and midwestern states, 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 Cincinnati, Ohio, 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 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.

BUSINESS PROBLEM-SOLVING CASE

GOOGLE, APPLE, AND FACEBOOK BATTLE FOR YOUR INTERNET EXPERIENCE

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 1.4 billion active devices in circulation, 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 at a double-digit rate. Revenue from Apple's services business grew 33 percent in 2018 to nearly \$40 billion—accounting for about 15 percent of the company's total revenue.

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 about 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 80 percent of smartphones worldwide; is the most common operating system for tablets; and runs on watches, car dashboards, and TVs—more than 4,000 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). These technologies already have been implemented in applications such as voice search, Google Translate, and spam filtering. 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 2.4 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 2019, 96 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.

At the end of the first quarter of 2018, 98 percent of Facebook's global revenue came from advertising, and 89 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 even 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 order a ride from Uber, get news updates, check your flight status, or use augmented reality to imagine what a new Nike sneaker looks like by superimposing a 3-D model of that sneaker atop images or video. 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, such as the Free Basics service designed to get 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, and the US Justice Department has launched a formal antitrust review of these big tech giants. 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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CHAPTER

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

- The Electric Power Grid Becomes a Cyberwarfare Battleground
- Meltdown and Spectre Haunt the World's Computers
- Phishing for Money: Dangerous Emails
- 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

THE ELECTRIC POWER GRID BECOMES A CYBERWARFARE BATTLEGROUND

The US electricity grid is a complex digital and physical system critical to commerce and daily life. It consists of more than 7,000 power plants, 55,000 electrical substations, 160,000 miles of high-voltage transmission lines, and 5.5 million miles of low-voltage distribution lines. This web of generators, substations, and power lines is organized into three major interconnections operated by 66 balancing authorities and 5,000 different utilities. The grid has many points of vulnerability, which can be abused by hackers who penetrate computer systems. Incursions into the US electric grid have been going on since at least 2013.

These hacker attacks have the capability to bring down all or part of electricity service throughout the United States. A cyberattack could black out a large region of the nation for weeks or even months, resulting in loss of life support systems in hospitals, disruption of clean water supplies and sanitation, and massive breakdowns of financial and transportation systems. A 2015 Lloyds of London study found that a cyberattack on 50 generators in the Northeast could leave 93 million people without power and cost the economy over \$234 billion.

Over the past several years Russian hackers have targeted a Vermont utility, power grids in Ukraine and Ireland, a US nuclear plant, and US energy companies. Russian hacking activity against the United States has been rising as the overall US–Russia relationship hits new lows, evidenced most dramatically by Russian hacker interference in the 2016 presidential election. According to the Department of Homeland Security (DHS) and the FBI, Russia now appears to be laying a foundation for a large-scale cyberattack on US infrastructure. The DHS has identified the electric power grid hackers as a group with Russian government ties known as Dragonfly or Energetic Bear.

The North American Electric Reliability Corporation, which oversees the grid in the United States and Canada, has issued standards and guidelines for how electric companies should protect the power grid physically and electronically. These standards and guidelines have helped power plants and high-voltage transmission networks become more secure, but security still lags at low-voltage distribution networks supplying power directly to homes and workplaces.

Especially vulnerable are systems used by contractors and subcontractors to service the power grid, which are less prepared for hacker intrusions. Russian hackers were able to access these smaller systems as



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a backdoor into the US electric grid. To obtain user names and passwords for accessing grid networks, the hackers planted malicious software on websites catering to utility engineers and sent out emails with tainted attachments. In some cases the hackers were able to penetrate systems that monitor and control electricity flows. Some big utility systems, such as the Bonneville Power Administration and PacifiCorp, were targeted, as well as several energy companies that build systems supplying emergency power to Army bases.

The United States and other countries may be vulnerable, but they have not been sitting still. Since 2012 the United States has put reconnaissance probes inside the control systems of the Russian electric power grid. In June 2019 the United States ramped up its digital power grid incursions to signal the Trump administration's willingness to deploy cybertools more aggressively. The United States inserted potentially crippling malware inside Russia's grid and other targets in addition to more public actions directed at Russia's misinformation and hacking activities during US elections. These new cyberincursions serve partially as a warning but also as preparation for future cyberstrikes if a major US–Russian conflict erupts. They also increase the chances of a major cyberconfrontation.

Sources: Rebecca Smith and Bob Barry, "America's Electric Grid Has a Vulnerable Back Door—and Russia Walked Through It," *Wall Street Journal*, January 10, 2019; David E. Sanger and Nicole Perlroth, "U.S. Escalates Online Attacks on Russia's Power Grid," *New York Times*, June 15, 2019; Shelby Lin Erdman, "How Vulnerable Is the U.S. Power Grid to a Cyberattack? 5 Things to Know," *AJC*, March 19, 2018; Melanie Kenderdine and David Jermain, "U.S. Power Grid Needs Defense against Looming Cyberattacks," *The Hill*, March 23, 2018; and Manimaran Govindarasu and Adam Hahn, "Cybersecurity and the Power Grid: A Growing Challenge," *The Conversation*, February 23, 2017.

Foreign hacker efforts to penetrate and disrupt the US electric power grid illustrate some of the reasons why organizations need to pay special attention to information systems security. The IT security breaches that enabled Russian hackers to break into information systems used in the US power grid have the potential to shut down critical infrastructure throughout the country, paralyzing business, government, and daily life. Weak IT security has been responsible for many billions of dollars of corporate and consumer financial losses in other areas as well.

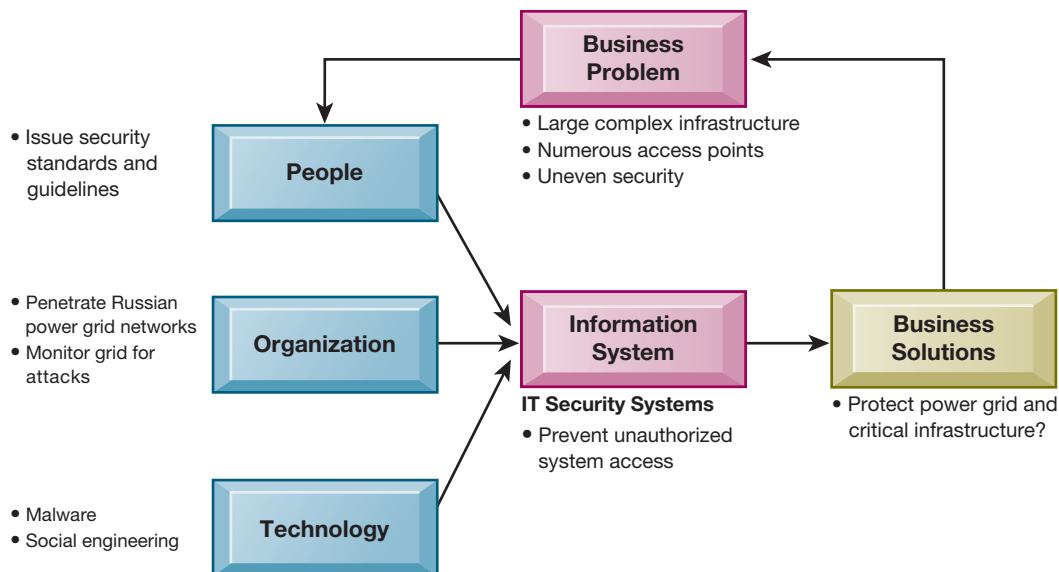
The chapter-opening diagram calls attention to important points raised by this case and this chapter. The US electric power grid is large and complex, with many unguarded points of entry for malicious intruders. Smaller organizations using the power grid lacked the awareness, resources, and tools to prevent employees from naively responding to hacker ploys to obtain authentication information for accessing power grid systems.

The United States has taken countermeasures to break into Russian power grid systems, but needs better technology, education, and procedures for unprotected portions of its own grid. What has happened so far is serious and most likely a preview of future incursions into critical systems. Equally disturbing, the security vulnerabilities that facilitated the US power grid hacks are commonplace in businesses and other organizations as well.

Here are some questions to think about: What security vulnerabilities were exploited by the hackers? What people, organizational, and technological factors contributed to these security weaknesses? What was the business impact of these problems? Could the US power grid hacking have been prevented?

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 against contemporary

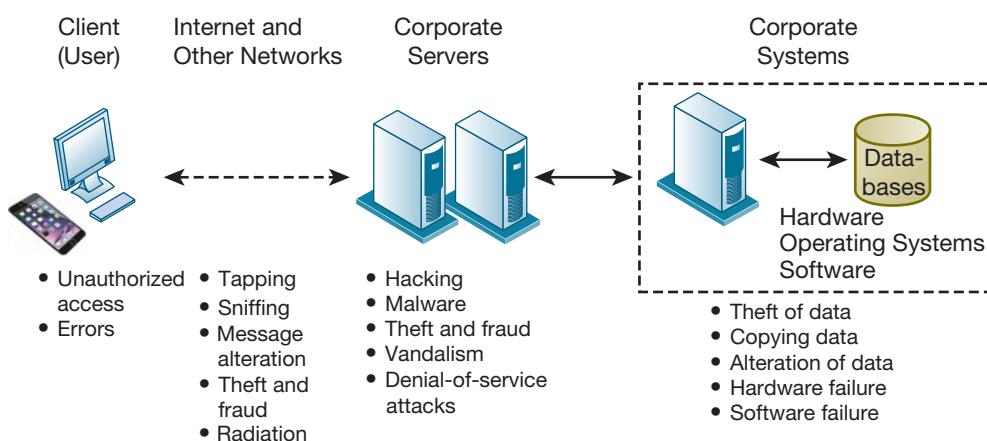


Figure 8.1
Contemporary
Security Challenges
and Vulnerabilities.
The architecture of a web-based application typically includes a web client, a server, and corporate information systems linked to databases. Each of these components presents security challenges and vulnerabilities. Floods, fires, power failures, and other electrical problems can cause disruptions at any point in the network.

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 the Internet and other 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 mobile phones 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. Data stored in some cloud systems can be at risk if the systems are not used or configured properly.

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. Wireless networks in many locations do not have basic protections against **war driving**, in which eavesdroppers drive by buildings or park outside and try to intercept wireless network traffic.

Intruders can use the information they have gleaned from a Wi-Fi network to set up rogue access points on a different radio channel in a nearby physical location to force a Wi-Fi user 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.) It is estimated that 350,000 new malware variants are discovered every day (Akamai, 2019). 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; from compromised email messages, online ads, or instant messaging; and from public cloud data storage services. Especially prevalent today are **drive-by downloads**, 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

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 more than 5 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.

TABLE 8.1

Examples of Malicious Code

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, a malware strain called FaceXWorm appeared inside Facebook Messenger in 2018. Clicking a link via Facebook Messenger takes the victim to a fake YouTube page, which tries to trick the user into installing a YouTube extension for the popular Chrome browser. From there the malware can steal passwords or try to steal cryptocurrency funds such as Bitcoin.

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. Additional 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, the ransomware called WannaCry that attacked computers in more than 150 countries in May 2017 encrypts an infected computer's files, forcing users to pay hundreds of dollars to regain access. In 2019, twenty-two Texas cities were held hostage for millions of dollars after a hacker or hacker group infiltrated their computer systems and encrypted their data (Fernandez, Sanger, and Martinez, 2019). 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. 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 **cybervandalism**, 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 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 numerous 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 zombie 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. The infected computer then becomes a slave, or zombie, serving a master computer belonging to someone else. 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. An 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.

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.

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

Computer crime is defined by the US 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 the Ponemon Institute’s 2018 Annual Cost of Cyber Crime Study, the average annualized cost of cybercrime security for benchmarked companies in 11 different countries and 16 industries was \$13 million (Ponemon Institute, 2019). Many companies are reluctant to report computer crimes because the crimes may involve employees or the companies fear 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 (see the chapter-ending case study). According to the 2019 Identity Fraud Study by Javelin Strategy & Research, identity fraud affected 14.4 million consumers in 2018 (Javelin, 2019).

One increasingly 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 asking users for confidential personal data, such as Social Security numbers or bank and credit card information, 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 that 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's 2018 Cost of a Data Breach Study, the average global cost of a data breach among the companies it surveyed was \$3.86 million (Ponemon, 2018). 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 US 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.

Country	Description of Data Breach
United Kingdom	British Airways experienced a data breach in 2018 in which hackers stole the personal and financial details of customers who made, or changed, bookings on ba.com or its app during that time. Names, email addresses and credit card information were stolen, including card numbers, expiration dates and the three digit CVC code required to authorize payments. Around 380,000 transactions were affected..
United Arab Emirates	In 2018 cybercriminals stole data from 14 million customer records from ride-hailing firm Careem and an unnamed airline customer, including names, email addresses, phone numbers and trip details in the Middle East, North Africa and South Asia..
Sweden	In 2018, the government announced a huge data breach of personal records from the Swedish Transport Agency's project with IBM to update Sweden's vehicle registration system. The breach was not caused by hackers but by failure to install security safeguards by IBM. The breach was not announced for 18 months after it occurred.
Singapore	In 2018, SingHealth, the country's largest group of healthcare institutions, reported a data breach, compromising personal data of 1.5 million healthcare patients, including that of its Prime Minister Lee Hsien Loong. The stolen data for each patient included name, national identification number, address, gender, race, and date of birth.
Malaysia	The Malaysian government revealed the largest data breach in Asia in 2017 involving 46 million mobile phone accounts, larger than the entire Malaysian population. The data leaked included mobile phone numbers, ID card numbers, home addresses and SIM card data from at least 12 mobile phone and network operators in Malaysia..

TABLE 8.3

Major Data Breaches

US 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 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. A proposed federal Data Security and Breach Notification Act would mandate organizations that possess personal information to put in place “reasonable” security procedures to keep the data secure and notify anyone affected by a data breach, but it has not been enacted.

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. 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 the efforts of Russian hackers to disrupt the US 2016 presidential elections and to penetrate the US power grid, described in the chapter-opening case. 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 even 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 for the oil and water pipelines and power grid of the United States and have 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 US 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. US 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. For example, in July 2019 a former employee at Amazon Web Services used her knowledge of Amazon cloud security to steal 106 million Capital One Financial records stored by Amazon's cloud computing service (McMilan, 2019a).

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-messaging application that allowed attackers to install spyware on mobile phones (McMillan, 2019b).

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. For example, in December 2018 Microsoft had to release an emergency update for a zero-day vulnerability in its Internet Explorer web browser software that gives an outside intruder access to a computer's memory. The memory corruption could have enabled an attacker to have the same access to a computer system as a valid logged-in user (Kerner, 2018). 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 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

The Interactive Session on Technology describes newly discovered vulnerabilities stemming 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.

8-2 What is the business value of security and control?

Companies have 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 weapons 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, Target had to pay \$39 million to several US 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 for the retention and storage of electronic records as well as for privacy protection.

In early January 2018, computer users all over the world were shocked to learn that nearly every computer chip manufactured in the last 20 years contained fundamental security flaws that make it possible for attackers to obtain access to data that were thought to be completely protected. Security researchers had discovered the flaws in late 2017. The flaws arise from features built into the chips that help them run faster. The vulnerability enables a malicious program to gain access to data it should never be able to see.

There are two specific variations of these flaws, called Meltdown and Spectre. Meltdown was so named because it “melts” security boundaries normally enforced by hardware. By exploiting Meltdown, an attacker can use a program running on a computer to gain access to data from all over that machine that the program shouldn’t normally be able to see, including data belonging to other programs and data to which only administrators should have access. (A system administrator is responsible for the upkeep, configuration, and reliable operation of computer systems.) Meltdown affects only specific kinds of Intel chips produced since 1995.

Spectre is not manufacturer-specific and affects nearly all modern processors. It requires more intimate knowledge of the victim program’s inner workings. Spectre’s name comes from speculative execution, in which a chip is able to start work on predicted future operations in order to work faster. In this case, the system is tricked into incorrectly anticipating application behavior. The name also suggests that Spectre will be much more difficult to neutralize. Other attacks in the same family will no doubt be discovered, and Spectre will be haunting us for some time.

With both Meltdown and Spectre, an attacker can make a program reveal some of its own data that should have been kept secret. For example, Spectre could harness JavaScript code on a website to trick a web browser into revealing user and password information. Meltdown could be exploited to view data owned by other users and also virtual servers hosted on the same hardware, which is especially dangerous for cloud computing host computers. The most worrisome aspect of Meltdown and Spectre is that security vulnerabilities are not from flawed software but from the fundamental design of hardware platforms beneath the software.

There is no evidence that Spectre and Meltdown have been exploited, but this would be difficult to detect. Moreover, the security flaws are so fundamental and widespread that they could become catastrophic, especially for cloud computing services where many users share machines. According to researchers at global security software firm McAfee, these vulnerabilities are especially attractive to malicious actors because the attack surface is so unprecedented and the impacts of leaking highly sensitive data are so harmful. According to Forester, performance of laptops, desktops, tablets, and smartphones will be less affected. The fundamental vulnerability behind Meltdown and Spectre is at the hardware level, and thus cannot be patched directly.

Major technology vendors are only able to release software fixes that work around the problems. Such fixes mitigate vulnerabilities by altering or disabling the way software code makes use of speculative execution and caching features built into the underlying hardware. (Caching is a technique to speed computer memory access by locating a small amount of memory storage on the CPU chip rather than from a separate RAM chip for memory.) Since these features were designed to improve system performance, working around them can slow systems down. Experts initially predicted system performance could be degraded as much as 30 percent, but a slowdown of 5 to 10 percent seems more typical.

Cloud vendors have taken measures to patch their underlying infrastructures, with their customers expected to install the patches for their operating systems and applications. Microsoft released operating system patches for Windows 7 and all later versions, which also apply to Microsoft’s Internet Explorer and Edge browsers. Apple released patched versions of its Safari browser and iOS, macOS, and tvOS operating systems. Google provided a list of which Chromebook models will or won’t need patches and released a patch for its Chrome browser. Older operating systems such as Windows XP and millions of third-party low-cost Android phones that don’t get security updates from Google will most likely never be patched. Organizations should apply updates and patches to browser software as soon as they are available. And since these vulnerabilities could enable attackers to steal passwords from user device memory when running JavaScript from a web page, it

is recommended that users be instructed to always close their web browsers when not in use. Forrester also recommends that enterprises should use other techniques to protect data from users and organizations that have not applied the fixes.

Chip manufacturer Intel has issued a number of work-around updates for its processors. These microcode patches have been installed on every Intel CPU sold since the new code's release, but there are still hundreds of millions of systems in the field that might need the update. The only way to truly fix Meltdown and Spectre is to replace affected processors. Redesigning and producing

new processors and architectures may take five to ten years to hit the market. If anything good can be said about Spectre and Meltdown, it is that they have focused more global attention on software and hardware security and the need to develop more robust system architectures for secure computing.

Sources: Curtis Franklin Jr., "How Intel Has Responded to Spectre and Meltdown," *Information Week*, January 4, 2019; James Senders, "Spectre and Meltdown Explained: A Comprehensive Guide for Professionals." *TechRepublic*, May 15, 2019; Josh Fruhlinger, "Spectre and Meltdown Explained: What They Are, How They Work, What's at Risk," *CSO*, January 15, 2018; and Warwick Ashford, "Meltdown and Spectre a Big Deal for Enterprises," *Computer Weekly*, January 9, 2018.

CASE STUDY QUESTIONS

- 1.** How dangerous are Spectre and Meltdown? Explain your answer.
- 2.** Compare the threats of Spectre and Meltdown to cloud computing centers, corporate data centers, and individual computer and smartphone users.

- 3.** How would you protect against Spectre and Meltdown if you were running a public cloud computing center, if you ran a corporate data center, and if you were an individual computer user?

If you work in the U.S. healthcare industry, your firm will need to comply with the Health Insurance Portability and Accountability Act (HIPAA) of 1996. **HIPAA** outlines medical 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 requires members of the healthcare industry to retain patient information for six years and ensure the confidentiality of those records. It specifies privacy, security, and electronic transaction standards for healthcare providers handling patient information, providing penalties for breaches of medical privacy, disclosure of patient records by email, or unauthorized network access. In the European Union new regulations impose similar requirements on health care providers (Regulation 679).

If you work in a firm providing financial services, your firm will need to comply with the Financial Services Modernization Act of 1999, better known as the **Gramm-Leach-Bliley Act** after its congressional sponsors. This 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.

If you work in a publicly traded company, your company will need to comply with the Public Company Accounting Reform and Investor Protection Act of 2002, better known as the **Sarbanes-Oxley Act** after its sponsors Senator Paul Sarbanes of Maryland and Representative Michael Oxley of Ohio. This act was designed to protect investors after the financial scandals at Enron, WorldCom, and other 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.

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, CDs, and computer hard disk drives as well as in email, instant 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.

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 \$1,000 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

Exposure	Probability of Occurrence (%)	Loss Range/Average (\$)	Expected Annual Loss (\$)
Power failure	30 percent	\$5,000–\$200,000 (\$102,500)	\$30,750
Embezzlement	5 percent	\$1,000–\$50,000 (\$25,500)	\$1,275
User error	98 percent	\$200–\$40,000 (\$20,100)	\$19,698

TABLE 8.5

Online Order Processing Risk Assessment

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 8.2 shows 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 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

Figure 8.2

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

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. For example, Healthways, a well-being improvement company headquartered in Franklin, Tennessee, implemented a business continuity plan that identified the business processes of nearly 70 departments across the enterprise and the impact of system downtime on those processes. Healthways pinpointed its most critical processes and worked with each department to devise an action plan.

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 8.3 is a sample auditor's listing of control weaknesses for 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

Figure 8.3

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	Yes	Leaves system open to unauthorized outsiders or attackers	5/10/20	Eliminate accounts without passwords	
	Yes	Exposes critical system files to hostile parties connected to the network	5/10/20	Ensure only required directories are shared and that they are protected with strong passwords	
	No	All production programs require management approval; Standards and Controls group assigns such cases to a temporary production status			

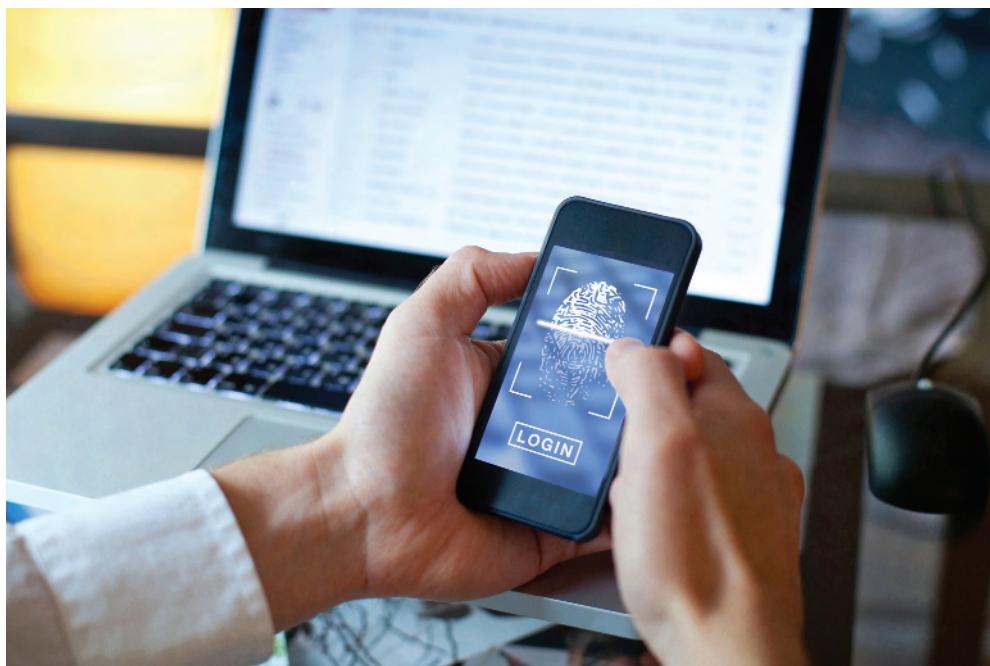
digital identity for accessing each system. It also includes tools for authenticating users, protecting user identities, and controlling access to system resources.

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. 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 a multistep process. To



This smartphone has a biometric fingerprint reader for fast yet secure access to files and networks. PCs and smartphones are starting to use biometric identification to authenticate users.

© Anyaokerkut / iStock

be authenticated, a user must provide two means of identification, one of which is typically 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 8.4).

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 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.

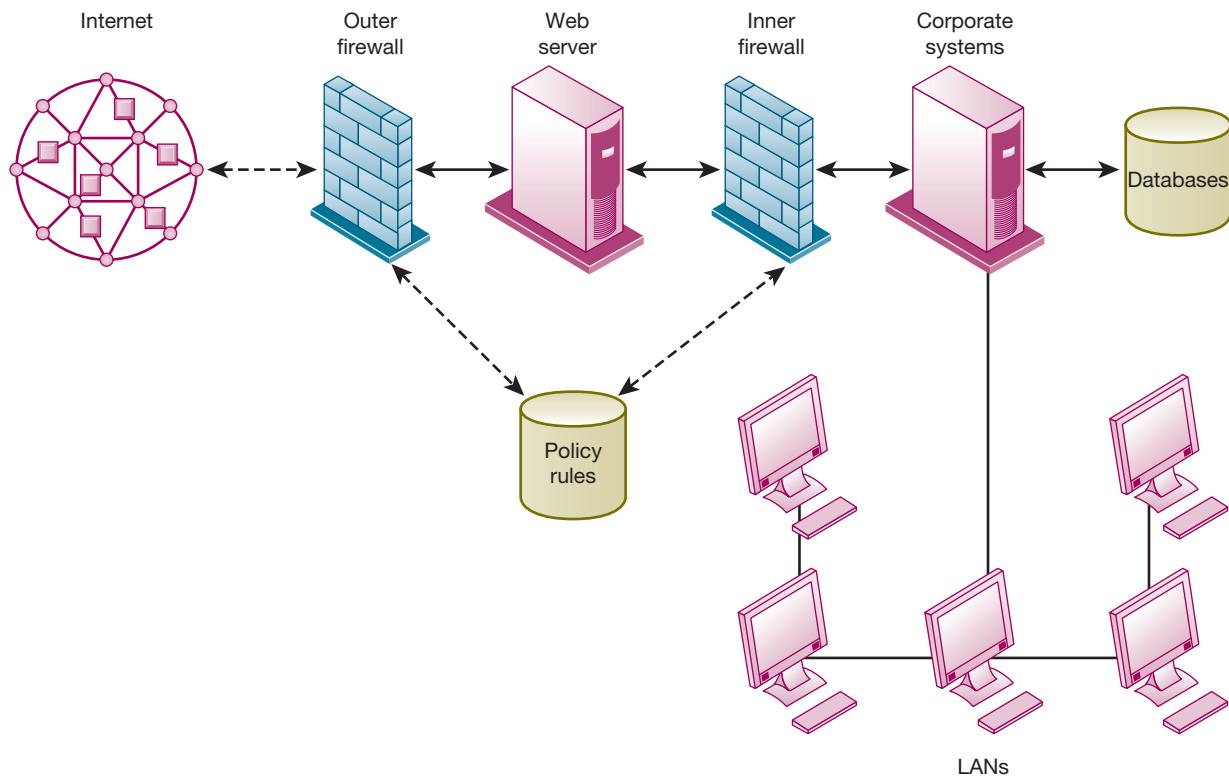


Figure 8.4
A Corporate Firewall.

The firewall is placed between the firm's private network and the public Internet or another distrusted network to protect against unauthorized traffic.

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 or cloud service 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. Leading UTM vendors include Fortinet, Sophos, and Check Point, and networking vendors such as Cisco Systems and Juniper Networks provide UTM capabilities in their products.

SECURING WIRELESS NETWORKS

The initial security standard developed for Wi-Fi, called Wired Equivalent Privacy (WEP), was not very effective because its encryption keys were relatively easy to crack. 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 replaced WEP with stronger security standards. The most recent version is WPA3, introduced in 2018. The new standard makes passwords even harder to crack and strengthens user privacy in public networks through individualised data encryption. Corporations can further improve Wi-Fi security by using it in conjunction with virtual private network (VPN) technology when accessing internal corporate data.

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 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 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 8.5. 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 8.6). 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.

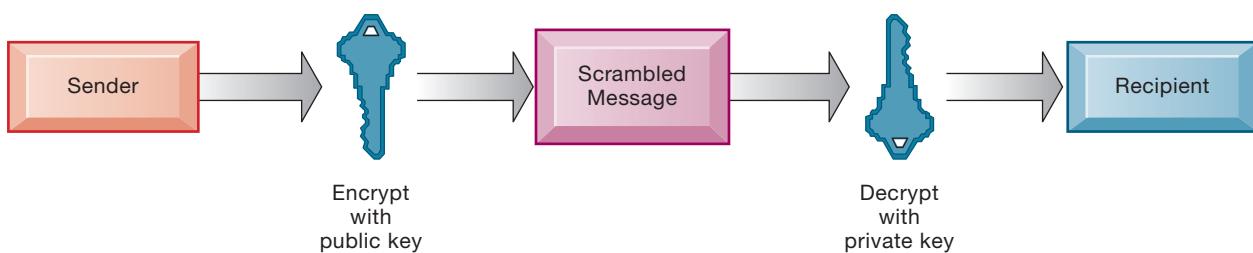


Figure 8.5
Public Key Encryption.

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.

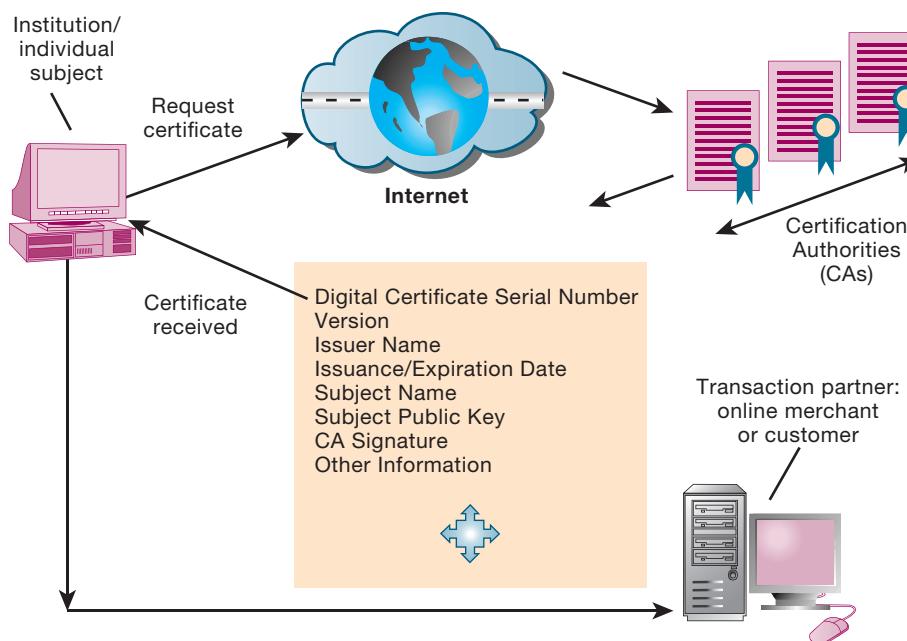


Figure 8.6
Digital Certificates.
Digital certificates help establish the identity of people or electronic assets. They protect online transactions by providing secure, encrypted, online communication.

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. Blockchain is especially suitable for environments with high security requirements and mutually unknown actors.

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 to deliver uninterrupted service, despite one or more components failing. Fault-tolerant computers are able to detect hardware or software failures and automatically switch to a backup capability. Components can be 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, manage firewalls, and perform vulnerability testing and and antiviral and intrusion detection. SecureWorks, AT&T, Verizon, IBM, and Symantec are leading providers of MSSP services.

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. Understanding how the cloud computing provider organizes its services and manages the data is critical.

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. When you use the cloud, you may not know precisely where your data are being hosted.

Virtually all cloud providers use encryption to secure the data they handle while the data are being transmitted. However, if the data are stored on devices that also store other companies' data, it's important to ensure that these stored data are encrypted as well. DDoS attacks are especially harmful because they render cloud services unavailable to legitimate customers.

Companies expect their systems to be running 24/7. Cloud providers still experience occasional outages, but their reliability has increased to the point where a number of large companies are using cloud services for part of their IT infrastructures. Most keep their critical systems in-house or in private clouds.

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 out 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

In 2018, the Dutch branch of Pathé received an email from the cinema conglomerate's headquarters in France. A manager at the French office told the Dutch director and her chief financial officer that there were plans to buy a company in Dubai. Would they transfer the necessary funds? The email certainly looked legitimate. The two Dutch managers made the payment. And again, and again. All in all, they sent \$21.7 million. Sadly, the money only ended up in the pockets of digital con artists.

This is an example of “phishing,” whereby criminals angle for personal information that they can use for their scams. There are several ways to classify phishing, but a distinction is often made between spear phishing and bulk phishing. The former relates to a phishing attack that is specifically directed at one or two persons—in our example, the director and chief financial officer of Pathé. It would be easy to dismiss these two officials as just exceedingly careless, but in reality, the situation is often more complicated. Many of those who perpetrate phishing attacks do their homework before sending their emails. They often hack the website of the company concerned and study the activity and emails in its system to find out how to make an email more credible. The really dedicated ones even study the writing style of the CEO.

Instances of CEO fraud are usually not publicly revealed, but they can potentially be very successful, according to Ken Bagnall, the head of FireEye, a company that focuses on securing emails. He points to the “CEO fraud test” that was sent to a number of companies. The result was stunning: 90 percent of the companies contacted took the bait. Given this success rate, it may seem surprising that few successful attacks are reported in the news, but it is likely that many go unreported. Data hacks have very negative effects on the reputation of companies; clients trust them less and may take their business elsewhere. Companies are more likely to cut their losses rather than report the fraud to the police. If a phishing attack is successful, the long-term damage to a company likely to be huge.

In the other type of phishing—bulk phishing—emails are sent to thousands, sometimes even millions of people. Many of these emails are easily recognizable as fraudulent; they often, for instance, contain basic language errors. Sometimes, however, even bulk emails look surprisingly professional.

In 2019, Retruster, a company offering anti-phishing software and services, compiled some disturbing statistical data regarding phishing and its

incidence. In 2018, phishing attacks increased by 65 percent. According to the company, 30 percent of phishing messages are opened by the recipients and 15 percent of people successfully phished are targeted again within a year. In addition, almost 1.5 million new malicious sites related to phishing are being created every month.

The big problem is that phishing has become much more professional as well as cheaper. Most links in the phishing emails are to malicious websites that may replicate the website of an actual bank. For instance, Dutch state broadcaster NOS discovered in 2018 that a Russian site called Boris was selling fake copies of a Dutch bank’s website for only \$296.

What can companies and individuals do to protect themselves against phishing attacks? The first answer to that question is very simple: be cautious. Even today, phishing emails contain telltale mistakes in grammar. A threat or warning is also a sign that something is amiss; in such instances, banks advise customers to call in just to check if the email was really sent by the bank.

The second answer is to use security software and update it regularly. Antivirus software programs typically include a list of suspicious websites. Once the recipient of a phishing email is directed toward a malicious site, the antivirus will block it.

Some security experts suggest a third and more extreme answer: make sure that emails never have attachments. Phishing emails often rely on them to make sure that the scam is successful, so in theory this is a good precaution; unfortunately, in practice, it is virtually impossible to send out emails without attachments.

However, even if all possible measures are taken, phishing emails may yet be successful, and it only takes one to cause real trouble for the company. Ken Bagnall, the CEO of The Email Laundry, highlights the dangerous situation that is created once the email account of a CEO is hacked: cybercriminals could then send out emails with every appearance of being the real thing, potentially doing enormous damage.

Sources: “Phishing and Email Fraud Statistics 2019,” retruster.com, accessed January 2020; “Pathé Verliest 19 Miljoen Door Ceo-Fraude,” Avrotros, November 12, 2018, opgelicht.avrotros.nl, accessed January 12, 2019; “Boris’ Verkoop Nagemaakte Nederlandse Banksites Voor 262 Euro,” NOS, November 25, 2018, nos.nl, accessed January 12, 2019; Eitan Katz, “Phishing Statistics: What Every Business Needs to Know,” Dashlane, January 17, 2018, blog.dashlane.com; Joost Schellevis, “OUCH! Newsletter: CEO Fraud,” SANS Security Awareness, July 2016, www.sans.org; Eleanor Dallaway, “#ISC2CongressEMEA: Why CEO Fraud Works and How to Stop It,” *Infosecurity Magazine*, October 19, 2016, www.infosecurity-magazine.com.

CASE STUDY QUESTIONS

- 1.** Explain the difference between spear phishing and bulk phishing. Which of the two forms of phishing do you think is most difficult to spot by victims, and why?
- 2.** The CEO of your company received a fraudulent email and made a payment to digital criminals. He wonders now whether he should contact the police. What factors should he take into consideration before taking a decision?
- 3.** Dashlane advises clients to send emails without attachments. Do you think that not adding attachments to emails will help protect companies against phishing attacks?
- 4.** Give two pieces of advice to a company or individual on increasing protection against a phishing attack.

Case contributed by Bernard Bouwman

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 stored, 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 12. 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 is a major supermarket grocery store chain located in the UK. They are looking to fill an entry-level position for an identity access and management support specialist. The company over 500 stores, more than 8,000 workers, and nearly a million weekly 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.

Key Terms

Acceptable use policy (AUP), 312	Encryption, 317	Public key encryption, 318
Anti-malware software, 317	Evil twin, 303	Public key infrastructure (PKI), 318
Application controls, 310	Fault-tolerant computer systems, 319	Ransomware, 300
Authentication, 314	Firewall, 315	Risk assessment, 311
Biometric authentication, 314	General controls, 310	Sarbanes–Oxley Act, 308
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Drive-by download, 299		Worm, 299
		Zero-day vulnerabilities, 305

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?
- Distinguish between implementation and administrative controls.
 - What are general controls, and what do they apply to in information systems?
 - Describe how systems builders decide which controls are necessary.
 - 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 identification 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.

MyLab MIS™

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

Discussion Questions

- 8-5** **Information system** security isn't simply a technology issue, it's a business issue. Discuss.
- 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?
- 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?

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.

BUSINESS PROBLEM-SOLVING CASE

BULGARIA: A WHOLE NATION HACKED

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 are still 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 million. Analysts quickly concluded that almost everyone who pays taxes in the country had been hacked. The precise data that were accessed is not entirely clear, but it is 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 has yet to be adequately answered. The Bulgarian police, undoubtedly under severe pressure to produce a suspect, briefly detained Kristiyan 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 continue to insist that he is the main culprit, conceding only that others may have been involved as well. They point 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? A final answer can only be given once a thorough investigation of the hack is concluded, but 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, 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 injections 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 not the only one to have been perpetrated by using an SQL injection; in 2017, as many as 20 percent of all cyberattacks 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,” they 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 February 2016, causing the Central Bank of Bangladesh to lose more than \$100 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 this hack are still ongoing.

In January 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 had targeted data from almost everyone in the country who pays 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 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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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, Avans University of Applied Sciences

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Chapter 9

Achieving Operational Excellence and Customer Intimacy: Enterprise Applications

Chapter 10

E-commerce: Digital Markets, Digital Goods

Chapter 11

Improving Decision Making and Managing Artificial Intelligence

Key System Applications for the Digital Age

Part III 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, and artificial intelligence; e-commerce applications; and business intelligence systems to enhance decision making. This part answers questions such as these: 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?

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

- Warehouse Management at Norauto: Conversational Commerce
- Soma Bay Prospers with ERP in the Cloud
- CRM Helps Adidas Know Its Customers One Shoe Buyer at a Time
- Fast Fashion, Big Data, and Zara

VIDEO CASES

- Maersk Develops a Global Shipping Management System
Instructional Video:
- GSMS Protects Patients by Serializing Every Bottle of Drugs

MyLab MIS

- Discussion Questions:
9-5, 9-6, 9-7
- Hands-on MIS Projects:
9-8, 9-9, 9-10, 9-11

WAREHOUSE MANAGEMENT AT NORAUTO: CONVERSATIONAL COMMERCE

Norauto is one of the leading international companies in the auto maintenance and equipment market. The group has its headquarters in Northern France, and since the turn of the millennium, it has expanded considerably into Western Europe and South America. It did so by acquiring a number of brands, including Midas, Auto5, and Maxauto, and by establishing the brand Carter Cash, which sells cost-effective tires, auto parts, and accessories.

As a result of all these moves, Norauto's points of sale mushroomed and its turnover sped up. Given the volume and diversity of its product range, Norauto decided in 2004 to acquire a new supply chain execution application for better management of product flow from its five warehouses to its 350 automotive stores. The objectives included boosting operational productivity in logistics and minimizing the error rate in order fulfillment.

Norauto turned to Manhattan Associates for a scalable substitution for its legacy warehouse management system. The new system was compatible with the automotive traceability standards and integrated seamlessly with the company's back-end ERP system from SAP for data exchange.

The initiative was first launched in the distribution center at Lesquin in Northern France, which managed 60,000 lines of orders and 250,000 products per week in a space of 13,000 square meters. The warehouse adopted a voice recognition solution by Vocollect whereby work assignments are recomposed as synthesized speech and transmitted to the headset of one of 30 order-pickers via a battery-powered wearable computer. A warehouse associate follows the instructions and goes to the correct aisle, then states the pre-assigned check code at the product's location into the headset. The voice recognition software on the pocket computer converts the words to text and sends the data back to the warehouse management system. The worker must read out the correct code before the server will give further instructions, such as which models and quantities to pick.

Compared with paper-based and scanner-based systems, voice-based order picking is an ergonomic, hands-free operation that allows workers to pay full attention to the task at hand and be more alert to the environment, thus decreasing mistakes and unproductive time and



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increasing safety levels. Verbal order confirmation further lowers the error rate. The system is so easy to use that any warehouse worker can quickly master the tool with a little training and practice. This flexibility allows the company to employ temporary warehouse workers during peak seasons with relatively low overhead.

The new system reduced the error rates by 75 percent, and the order-fulfilment accuracy level was 99.9 percent in the first four months after the deployment. The project's investment was returned in less than a year. Moreover, the solution enabled Norauto to provide better services to its customers. In 2019, Norauto partnered with Uber to provide maintenance on the rideshare company's 30,000-vehicle French fleet.

With Norauto's expansion in Western Europe and South America, many of its service centers are now operated by franchises. Had it not dealt with the logistics issue in time, the auto maintenance chain would not have been able to expand its scale of operation exponentially.

Sources: "Norauto Has Been Chosen by Uber to Service Its Vehicles," by Justine Perou, Pro.largus.fr, October 8, 2019; "Norauto Optimises Supply Chain Performance by Combining Manhattan Associates Supply Chain Solutions Capability with SAP Enterprise Systems Expertise," *Business Wire*, August 31, 2006; "Norauto Revs up Supply Chain Performance with Manhattan Associates' Solutions, Manhattan Associates," Manh.com, accessed January 12, 2019; "Voice Recognition Technology Is Here! And It Can Hear You," Supply Chain Game Changer, January 4, 2019; "Can Your Supply Chain Hear Me Now?," by Brian Subirana, Sanjay Sarma, James Rice, and Ken Cottrill, *Frontier, MIT Sloan Management Review*, May 7, 2018; "Next-Level Productivity for Voice Directed Picking," by Roberto Michel, July 9, 2018.

Case contributed by Joyce Chan, City University of Hong Kong

Norauto's challenges with warehouse management illustrates the importance of supply chain management to a business's success. The case shows how the implementation of the right supply chain management system can improve the operation and the development of an enterprise.

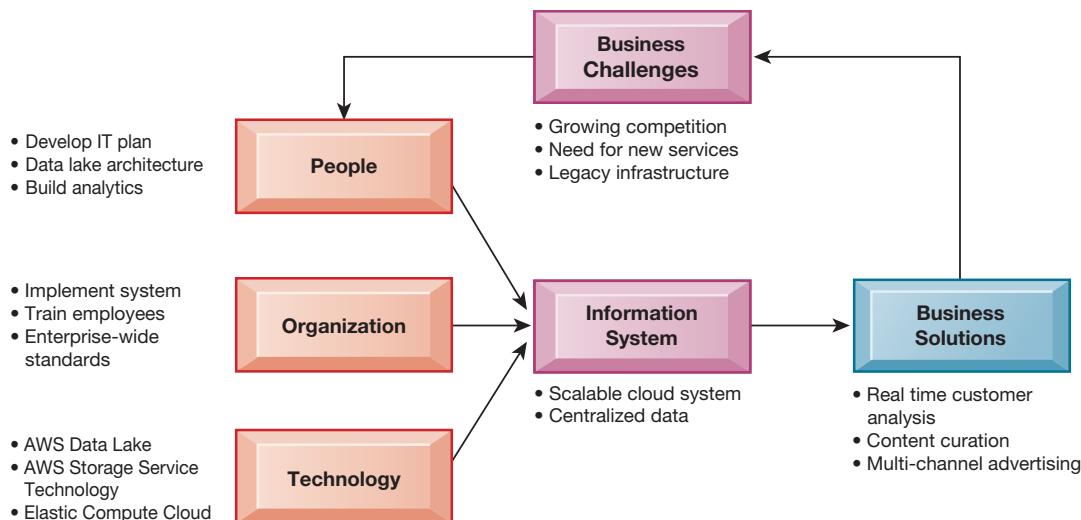
The chapter-opening diagram calls attention to important points raised by this case and this chapter. Norauto operates in several countries and sells products of various types in large quantities. The company needs to trace its products following industry standards. The company's proprietary warehouse management system was too costly to maintain and not efficient enough to cope with its rapid growth. It was crucial for Norauto to revamp its supply chain workflow, especially as it was trying to attract franchisees.

Norauto's management launched a business process reengineering project and looked for a supply chain system that could fulfill their needs and integrate with the ERP system. Slot optimization made the company redesign its stock location management and product-picking process in its warehouses. Implementing the centralized warehouse management system by Manhattan Associates and the voice-based order-picking system by Vocollect allowed Norauto to reduce warehouse administration, decrease operation costs, optimize inventory levels, and streamline the supply chain. The solution contributed to higher labor productivity, higher order-fulfilment accuracy, and workforce scalability in a more efficient work environment.

Here are some questions to think about: How would you evaluate Norauto before it improved its supply chain system and business process? How did the new supply chain solution affect the warehouse workers and the company?

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, one of the enterprise applications introduced in Chapter 2, 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.

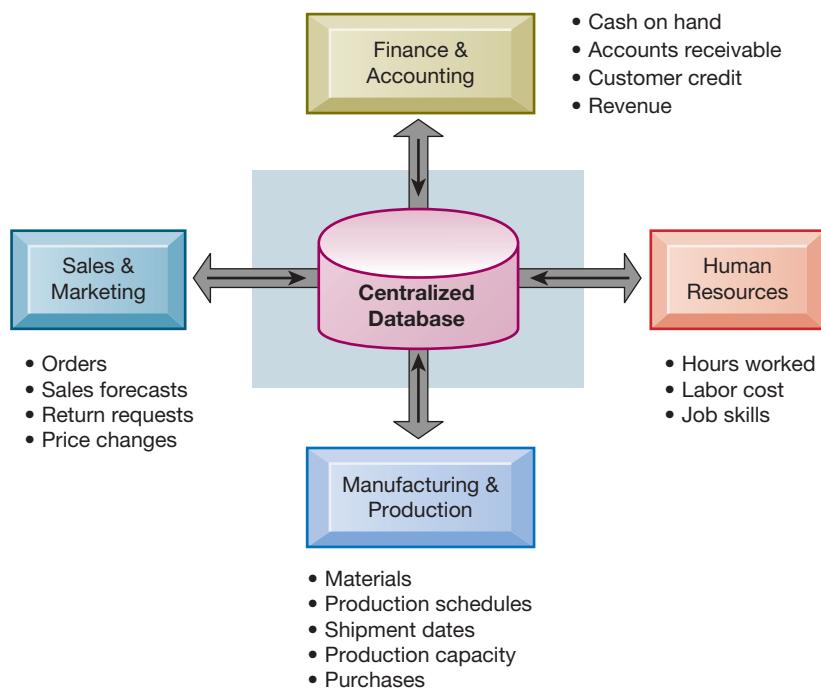
At the very least, your decision making would often be based on manual hard-copy reports, often out of date, and it would be difficult to understand what is happening in the business as a whole. Sales personnel might not be able to tell at the time they place an order whether the ordered items are in 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 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

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.



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. (One of our Learning Tracks shows how SAP enterprise software handles the procurement process for a new piece of equipment.) 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 tables to select whether it wants to track revenue by product line, geographical unit, or distribution channel.

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

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 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. The Interactive Session on Organizations describes more of these benefits in detail.

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 a 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, one of the enterprise applications 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.

Soma Bay is a 10-million-square-mile resort community on the Egyptian shore of the Red Sea. It has many attractions that make it a first-class vacation paradise, including five hotels, a championship golf course, water sport facilities, a world-class spa, and luxury vacation homes. Soma Bay Development Company is headquartered in Hurghada, Egypt, and has more than 2,000 employees.

Unfortunately, political upheavals and economic conditions have taken a toll on occupancy rates and profitability. When President Hosni Mubarak was overthrown during the Egyptian revolution of 2011, there was a sharp devaluation of Egyptian currency. In the years that followed, political conditions stabilized and the Egyptian economy recovered, but the tourism industry lost US \$1.3 billion after the downing of a commercial airliner over the Sinai Desert in late 2015. Soma Bay Development Company's hotel occupancy rates plummeted from more than 50 percent in 2015 to 25 percent in the first quarter of 2016.

Foreign exchange fluctuations and political upheavals are forces beyond Soma Bay's control, but what the company's management can do during downturns is react intelligently by closely monitoring operations and costs. This is possible thanks to the company's use of a JD Edwards Enterprise One ERP system from Oracle with applications and data residing in Oracle's Cloud Infrastructure as a Service (Oracle Cloud IaaS).

In the past, Soma Bay Development Company had tried to run much of the company using unwieldy Excel-based systems. Managers had to manually manipulate spreadsheets to understand the basic drivers of profitability, and it often took too long to obtain the information needed for sound decision making. These systems made it difficult for Soma Bay to manage its aggressive growth plans, which included construction of 1,000 new homes over a five-year period.

Mohammed Serry, Soma Bay Company's CFO, and his team selected JD Edwards Enterprise One for a solution because it could create standardized business processes across functional areas and provide timely reports that explain the profitability of each business unit using a standard chart of accounts. The software can identify the profitability drivers and growth drivers of a business. Enterprise One seamlessly combines data from the general ledger and other financial systems with data from operational systems.

Soma Bay's Enterprise One cloud platform makes it easy to create cash flow reports, project management reports, accounts receivable aging reports, facility management reports, and key performance indicator reports throughout Soma Bay's distributed organization. Company management also appreciates Oracle Cloud IaaS disaster recovery capabilities. Several years ago, water from an upper floor flooded Soma Bay's Cairo data center. The company was able to restore data and resume operations quickly because it had backups stored in Oracle Cloud.

JD Edwards Enterprise One contains more than 80 separate application modules designed to support a wide range of business processes. The software suite also features mobile applications that support both iOS and Android and can be used on smartphones and tablets. Soma Bay uses the JD Edwards Enterprise One modules for Financials, Procurement, Inventory Management, Job Cost, Real Estate Management, Homebuilder Management, Capital Asset Maintenance, Service Management, and Time and Labor. JD Edwards Enterprise One Homebuilder Management helps Soma Bay coordinate activities and analyze profitability throughout its home-building cycle down to the lot level. JD Edwards Enterprise One Real Estate Management streamlines financial, operational, and facilities management processes for finished properties, coordinating tasks among teams and providing a comprehensive management view of each unit. The Job Cost module shows ongoing costs for the real estate business, which helps management allocate expenses for materials, labor, and other needs and also track expenses against the budgets and forecasts established at the outset of each facilities management project. Managers can identify projects with codes and merge them with financial account numbers to determine budget expenses versus actual expenses. They can thereby verify if complex projects are on track and share expense data among divisions.

The Enterprise One software creates currency-neutral financial reports. This helps reconcile revenue from Soma Bay's tourism division (which caters to Germany and other parts of Europe) with its home sales division (which is aimed primarily at Egyptians) to neutralize the effect of different currencies on financial results. Home building accounts for about 25 percent of corporate revenue.

Having a dual revenue stream mitigates risks. If the tourism business is slow, Soma Bay still has revenue from the real estate business, and vice versa. The ERP system provides the data required to closely track costs. For example, in 2017 Soma Bay spent 100 million Egyptian pounds (equivalent to approximately US \$5.7 million) on new construction. The Enterprise One system provided the information about cash management and cash flow for sustaining this level of expansion. Soma Bay can carefully monitor cash flow and payments to contractors.

During the 2016 downturn, Soma Bay used the Enterprise One cost management and profitability capabilities to provide detailed financial data that helped managers carefully control fixed operating expenses, helping to minimize losses. Enterprise One provided a solid understanding of costs and profitability, even though revenue came from different currencies and markets. It was able

to show the impact of falling occupancy rates on the business, excluding foreign exchange effect, to help management measure overall performance by legal entity. This knowledge helped Soma Bay weather the downturn and implement an aggressive turnaround plan.

Today, 95 percent of Soma Bay staff members use the Enterprise One software in some capacity. The company has a more stable operating model. Occupancy rates at its five hotels are rising. Soma Bay Development Company is building 500 vacation homes in six seaside communities. According to Cherif Samir, Financial Controller for Soma Bay, being able to track every penny the company spends on a project has revolutionized the business.

Sources: www.searchoracle.com, accessed January 30, 2019; David Baum, "Destination: Cloud," *Profit Magazine*, Fall 2017; "Destination Cloud: How Oracle IaaS Has Shaped Soma Bay," *Queset Oracle Community*, June 27, 2019; and www.somabay.com, accessed January 31, 2019.

CASE STUDY QUESTIONS

1. Identify and describe the problem discussed in this case. What people, organization, and technology factors contributed to the problem?
2. Why was an ERP system required for a solution? How did having a cloud-based ERP system contribute to the solution?
3. What were the business benefits of Soma Bay's new enterprise system? How did it change decision making and the way the company operated?

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.

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 shows only 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.

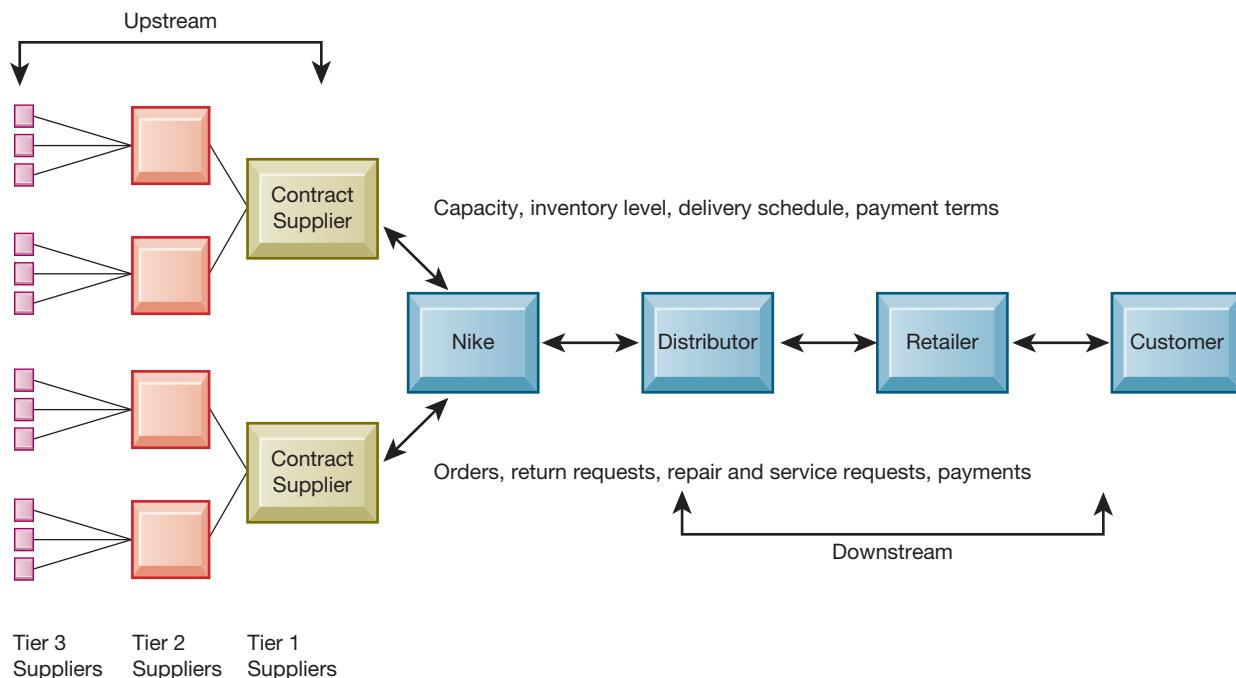


Figure 9.2
Nike's Supply Chain.

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.

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) found it had excessively high inventories of its Pampers disposable diapers at various points along its supply chain because of such 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

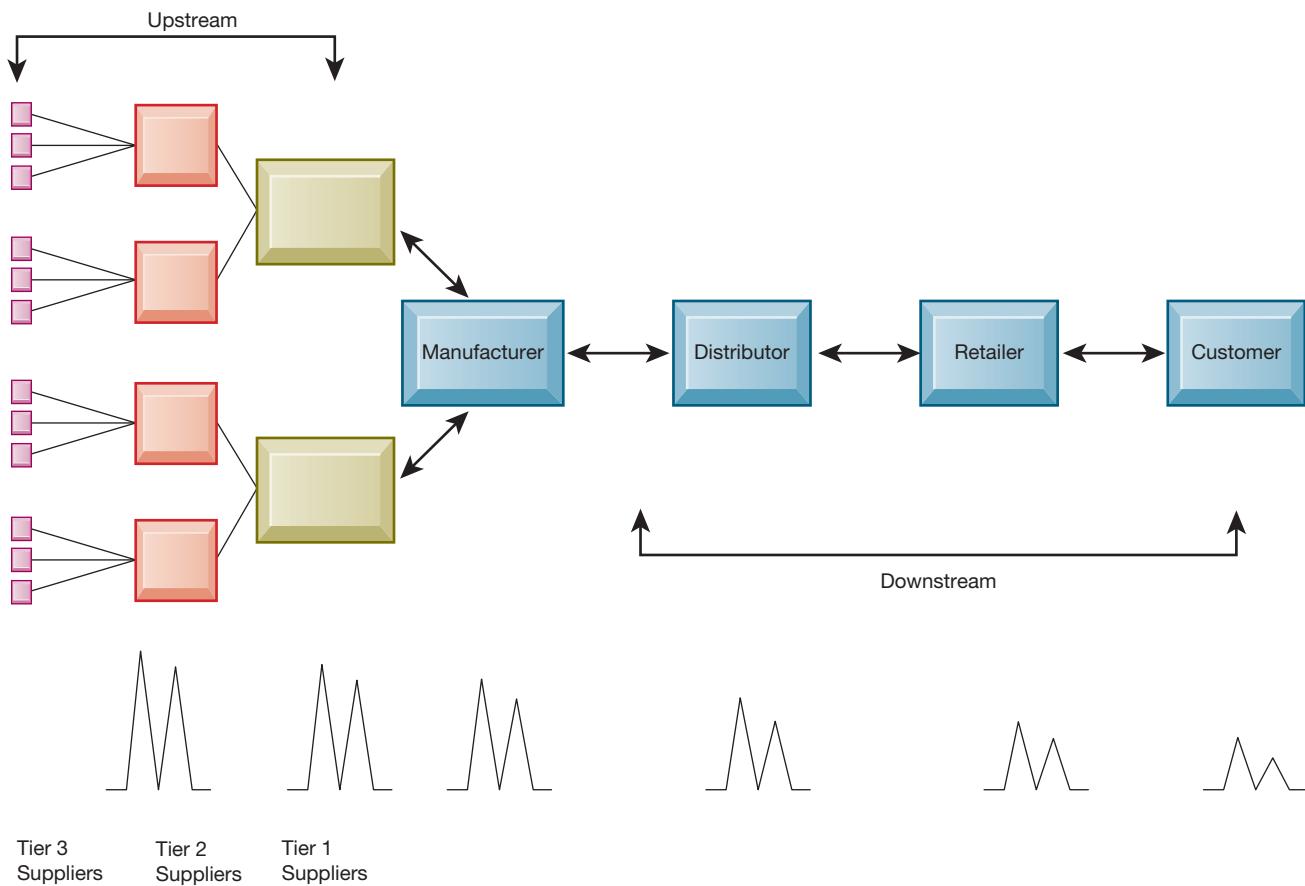


Figure 9.3
The Bullwhip Effect.

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.

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.

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. 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

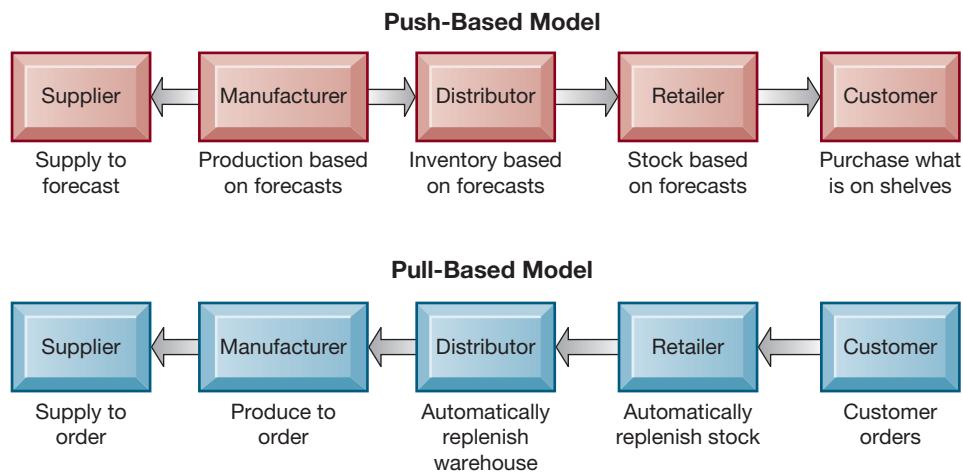
In addition to reducing costs, supply chain management systems facilitate efficient customer response, enabling the workings of the business to be driven more by customer demand. (We introduced efficient customer response systems in Chapter 3.)

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.

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).

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.”



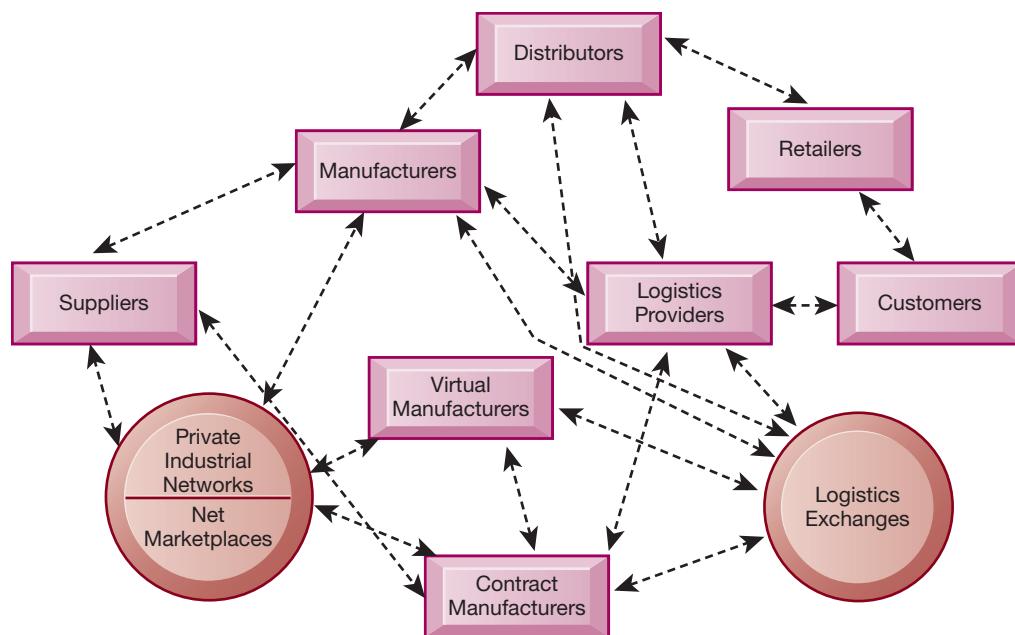


Figure 9.5
The Emerging Internet-Driven Supply Chain.

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.

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. 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, since a large firm's processes for sales, service, and marketing tend to be highly compartmentalized. 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, one of the enterprise applications 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.

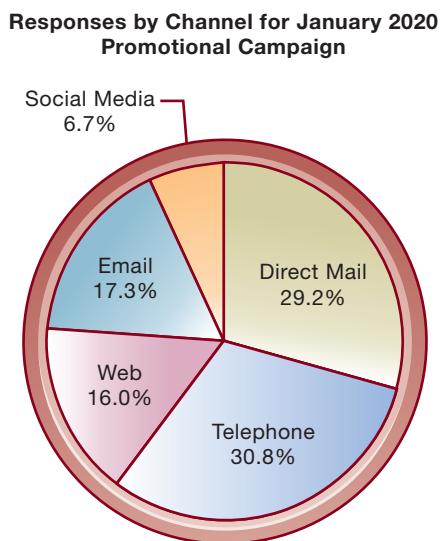
Customer Service

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. The customer is happier because he or she spends less time on the phone restating his or her problem to customer service representatives.

CRM systems may also include web-based self-service capabilities: The company website can be set up to provide inquiring customers personalized support information as well as the option to contact customer service staff by phone for additional assistance.

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.



Marketing

CRM systems support direct-marketing campaigns by providing capabilities for capturing prospect and customer data, for providing product and service information, for qualifying leads for targeted marketing, and for scheduling and tracking 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.

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 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

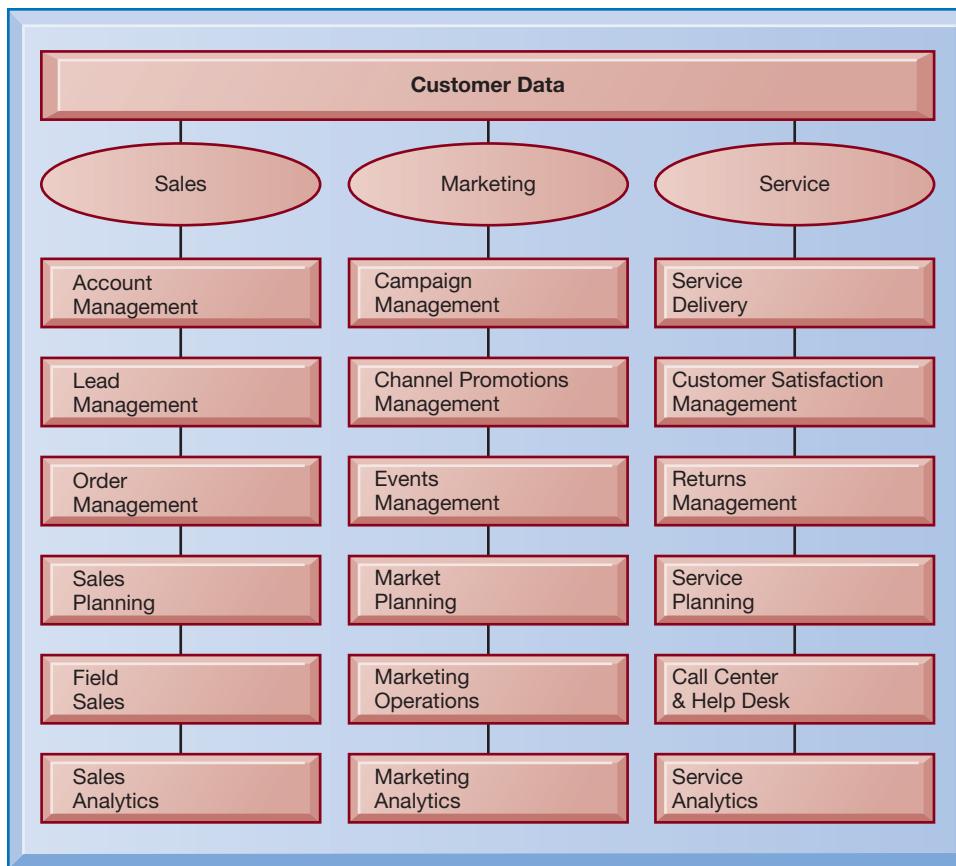


Figure 9.8
CRM Software Capabilities.

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.

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),

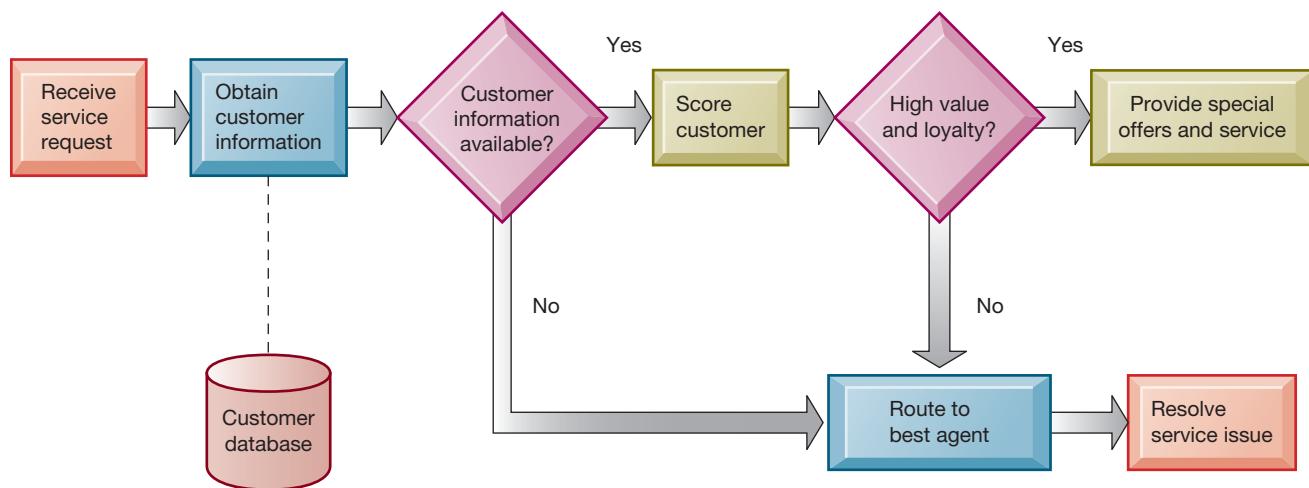
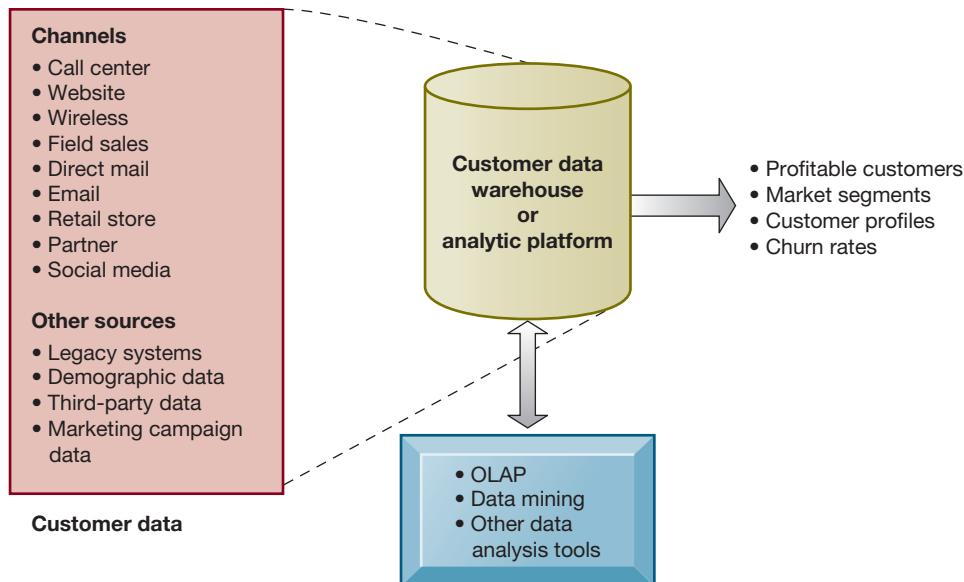


Figure 9.9
Customer Loyalty Management Process Map.

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.

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.



data mining, and other data analysis techniques (see 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 People).

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: PEOPLE

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 about 60,000 employees worldwide, and produced net sales of 21.9 billion euros (US\$24.9 billion) in 2018. 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 expected to reach 4 billion euros (US\$4.5 billion) by 2020.

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 January 11, 2019; "Fact Sheet 2018," www.adidas-group.com, accessed March 20, 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 these enterprise applications 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 2019 survey of 241 ERP users conducted by Panorama Consulting Solutions, 45 percent of ERP projects experienced cost overruns, and these overruns averaged 24 percent over budget. Fifty-eight percent exceeded their initial timelines (Panorama Consulting Solutions, 2019a). 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, a large European retailer 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 the firm's promotion-driven business model, which created sharp spikes in demand for products. 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.

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, a \$2 billion metal-cutting tools company in Germany 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 avoided customization when it moved from in-house systems to the Oracle ERP Cloud. 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. Large enterprise software vendors such as SAP, Oracle, Microsoft, and Epicor now feature cloud versions of their flagship ERP systems and also cloud-based products for small and medium-sized businesses (as described earlier in the Interactive Session on Organizations). 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 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 large global 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 now 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). SAP now makes it possible for its enterprise applications to use HANA in-memory computing technology so that they are capable of 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 machine learning to analyze very large bodies of data, make connections, make predictions, and provide recommendations for operations optimization. For example, SAP created a machine learning and neural network application (see Chapter 11) that recognizes patterns associated with machine performance in the oil and gas industry. The software automatically generates notifications of potential machine failures and sends them to SAP Plant Maintenance, which planners use to schedule machine repair and replacement (Franken, 2018).

The major enterprise application vendors offer portions of their products that work on mobile handhelds. You can find out more about this topic in our Learning Track on Wireless Applications for Customer Relationship Management, Supply Chain Management, and Healthcare.

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

Global Industrial Components is a large 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 their posts over the past 12 months. Are there any key trends in the LinkedIn posts for this company?

2. Review this text's Chapter 9 on enterprise applications, and Chapter 12 on developing systems, and 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, using web services and service-oriented architecture (SOA). 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, 351	Enterprise software, 338	Social CRM, 356
Bullwhip effect, 343	Just-in-time strategy, 343	Supply chain, 340
Churn rate, 352	Operational CRM, 350	Supply chain execution
Cross-selling, 350	Partner relationship management (PRM), 349	systems, 345
Customer lifetime value (CLTV), 352	Pull-based model, 346	Supply chain planning
Demand planning, 345	Push-based model, 346	systems, 344
Employee relationship management (ERM), 349	Sales force automation (SFA), 349	Touch point, 348

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 chains costs can impact on 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 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.

MyLab MIS™

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

Discussion Questions

9-5 Supply chain management is less **MyLab MIS** 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 **MyLab MIS** an enterprise application, it had

better do its homework. Discuss the implications of this statement.

9-7 Which enterprise application should **MyLab MIS** a business install first: ERP, SCM, or CRM? Explain your answer.

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 1,600 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.

BUSINESS PROBLEM-SOLVING CASE

FAST FASHION, BIG DATA, AND ZARA

In 2015, a Japanese woman visited a Zara store in Tokyo to buy a pink scarf. Unfortunately for her, the store didn't sell any. For many retailers, this would be the end of the story—but not for Zara. The company uses big data to study the behavior of its customers to achieve what they call “customer intimacy.” The woman undoubtedly told a store assistant what she was looking for. That assistant wrote down the request and fed it into the data system. Because of this system, Zara's headquarters in Spain learned that the color pink was becoming very popular. Zara reacted quickly. After about seven days, half a million pink scarves were sent to Zara stores all over the world, to be sold out within three days.

This story demonstrates why Zara has been so successful since Amancio Ortega founded it in 1975 in Spain. Ortega has always had a very specific answer to the question of what fashion really is. A piece of clothing is, according to him, an object of love; people wear it as long as they like it and then forget about it or even throw it away. As a result, the company chose not to have one or two collections a year but about twenty. To understand how taste changes, the company needs to read the minds of its customers. Zara uses information systems to do just that and to achieve operational excellence.

Experts often observe that the success of Zara is entirely dependent on Big Data and cloud computing. The company has created a continuous information stream of valuable information that is posted to the firm's cloud-based systems and made easily accessible to employees and managers. One example of this is the way feedback by customers is integrated into the information flow. In many “traditional” stores, shop attendants either do not write down feedback or send it by email to the company headquarters. Attendants in Zara shops have mobile devices that are directly linked to the cloud. Any note that is added to the system is immediately visible in the data room in Zara's headquarters in Spain.

Points of sale, like cash tills, are linked to that information stream as well, and sales can be followed in real time at the headquarters in Spain. Zara is notoriously tight-lipped about the IT technologies it uses, but it is clear that every piece of clothing has a RFID chip. These chips are installed into an alarm system that is connected to every piece of clothing to prevent theft. According to RFID experts, these chips also allow Zara to follow items of clothing from the company's

distribution center to the shop, until the moment they are sold. Some of these experts say that the technology even allows Zara to study how many times individual items of clothing leave the shelves to be tried on in dressing rooms!

By studying all these data, Zara gets a very good idea of what customers like and why. At the data room in Spain, incoming information is continuously analyzed. At traditional clothing companies, the designer is the star of the company; at Zara, it is the data room. Incoming data is continuously being analyzed to find out which fabrics are popular and why, and which colors are preferred by customers. Designers have a supporting role here; they get specifications from the data room and design a product accordingly.

Every new product at Zara is devised by a team that consists of at least three individuals. A commercial manager has strong links to the data room and receives continuous updates on the tastes of the customers. A designer or design team (usually using CAD-CAM technology) rapidly incorporates the feedback of the public into new garment designs. A supply chain manager makes sure that the new designs can be sourced quickly and efficiently so that Zara stores can sell the new pieces of clothing within a short period of time.

All of this has transformed the world of fashion. Traditional fashion brands use a model of “pushing” rather than “pulling”; a collection is designed first, and potential buyers are sought afterwards. Instead, Zara ships pieces of clothing in small quantities to shops; if these garments turn out to be successful, the production is increased immediately. The Zara approach has several advantages. As collections change rapidly, customers visit Zara stores again and again. The average Zara customer visits shops of the Spanish brand 17 times a year (at traditional clothing companies, the average is three or four visits a year). In recent years, Zara has started experimenting with what it calls “location intelligence.” The idea behind this is that shoppers will get personal recommendations once they enter a Zara shop. Because of its “pulling” process, Zara knows what customers want and sells about 80 percent of its products at full price.

Zara works with a supply chain that is fast and lean. As speed is very important in fast fashion, the company sources most of its production to manufacturers in Spain, Turkey, and other European countries. Most traditional clothing companies source heavily in Asia (in countries like Bangladesh) to manufacture products as

cheaply as possible. Zara prefers to work with European companies, as communication is faster and more effective. Production in Europe is more expensive than in Asia, but Zara saves money by spending very little on advertisements and publicity.

The data room is very important here as well. Design teams have direct access to the information stream, so they know which designs are needed. Zara has also standardized a whole range of design features and manufacturing processes. Having such a “lexicon,” so to speak, of basic elements of the design and production processes allows designers to give clear instructions to sourcing companies. Information systems that indicate the stocks of several basic materials at sourcing companies are linked to the big “cloud” at the data room—designers know directly which materials are available, where, and in what quantities. By contrast, traditional companies complete their design first and then source, and it may take them several months to find a company that can produce the designs.

Additionally, thanks to RFID technology, it is possible for IT staff in the data room to follow every piece of clothing from the warehouse to the shop. Zara distribution centers try to speed up delivery by relying on IT systems rather than on human labor. Thus, they use

optical reading devices that are capable of processing tens of thousands of pieces of clothing per hour. This again allows staff in the data room to track what is happening in the distribution centers in real time.

Zara has thus transformed the fashion sector thanks to its heavy use of data analytics. The data room in Spain is the heart of the company: customer behavior is analyzed, sourcing is prepared, distribution processes are monitored. It is this heavy reliance on information systems that has made Zara one of the most successful fashion companies on the planet. In 2018, Zara’s parent company, Inditex, continued to record strong annual sales growth at a time when many of its rivals are struggling, including online sales growth of 27 percent over the course of the year.

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CASE STUDY QUESTIONS

- 9-13** Considering the example of the Japanese customer who wanted to buy a scarf, what methods does Zara use to analyze and predict customer behavior? Does data analytics help Zara know their customers better than they know themselves?
- 9-14** Zara sources its products mostly in Europe. Give a list of advantages and disadvantages of sourcing in countries like Spain and Portugal as opposed to sourcing in, for instance, Bangladesh.

- 9-15** At the headquarters of Zara in Spain, the staff in the data room have an overview of the stocks that sourcing companies have of the fabrics needed to produce its clothes. Explain why this overview is essential for a fast-fashion company like Zara.
- 9-16** What does Zara mean by “location intelligence”? Is this a good way to draw customers to physical shops and convince them to not do their shopping online?

Case contributed by Bernard Bouwman

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CHAPTER 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”
- Small Business Loans from a FinTech App
- Engaging “Socially” with Customers
- Can Uber Be the Uber of Everything?

VIDEO CASES

- Walmart Takes On Amazon: A Battle of IT and Management Systems
 - Groupon: Deals Galore
 - Etsy: A Marketplace and Community
- Instructional Videos:*
- Walmart’s E-commerce Fulfillment Center Network
 - Behind the Scenes of an Amazon Warehouse

MyLab MIS

- Discussion Questions:
10-7, 10-8, 10-9
- Hands-On MIS Projects:
10-10, 10-11, 10-12,
10-13

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.



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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 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.

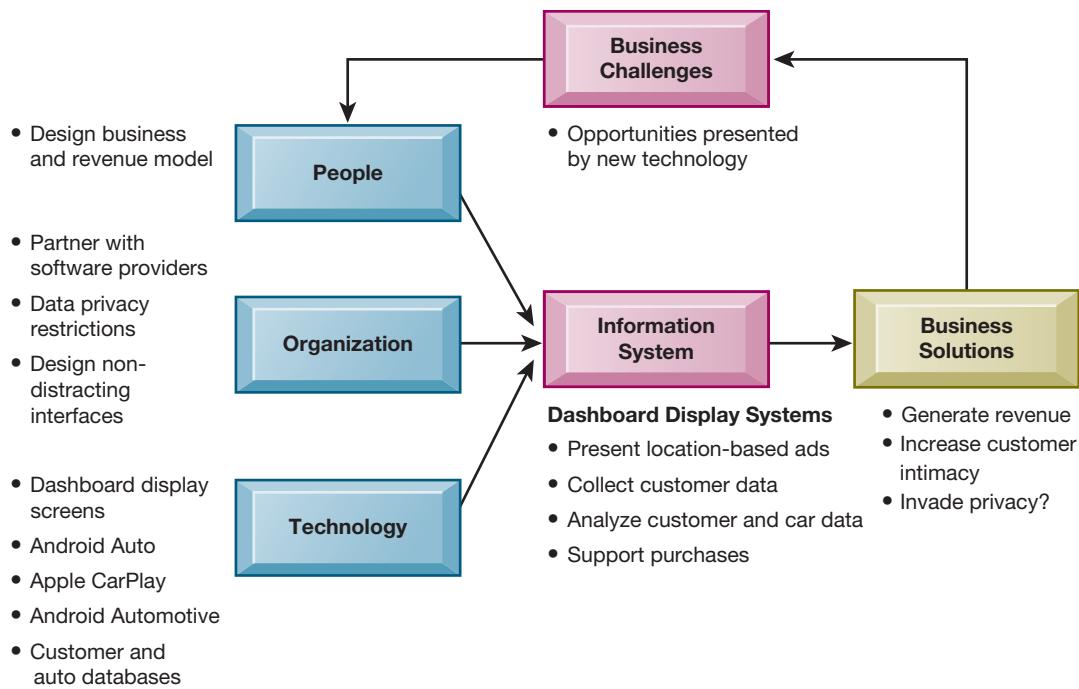
The “fourth screen” also presents challenges for privacy protection because its software is able to collect a large amount of personal data from cars and drivers. This is of special concern for European auto makers, who have stricter data protection standards than the United States. Volkswagen rejected 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: 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?

Purchasing goods and services online by using smartphones, tablets, and desktop computers has become ubiquitous. Although most purchases still take place through traditional channels, e-commerce continues to grow rapidly and to transform the way many companies do business. In 2019, around 2 billion people (almost 55% of all Internet users) purchased something online. (eMarketer, 2019a). In 2019, e-commerce consumer sales of goods (\$3.5 trillion) and travel and services (\$767 billion), totaled almost \$4.3 trillion worldwide. Sales of retail goods alone were about 14 percent of total worldwide retail sales of \$25 trillion and are growing over 20 percent annually (compared with 4 percent for traditional retailers) (eMarketer, 2019h, 2019c). 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. Worldwide, almost 65 percent of all retail e-commerce sales are now mobile, while only about 35 percent occur on the desktop (eMarketer, 2019d). The key words for understanding e-commerce in 2020 are “social, mobile, local.”

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 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.

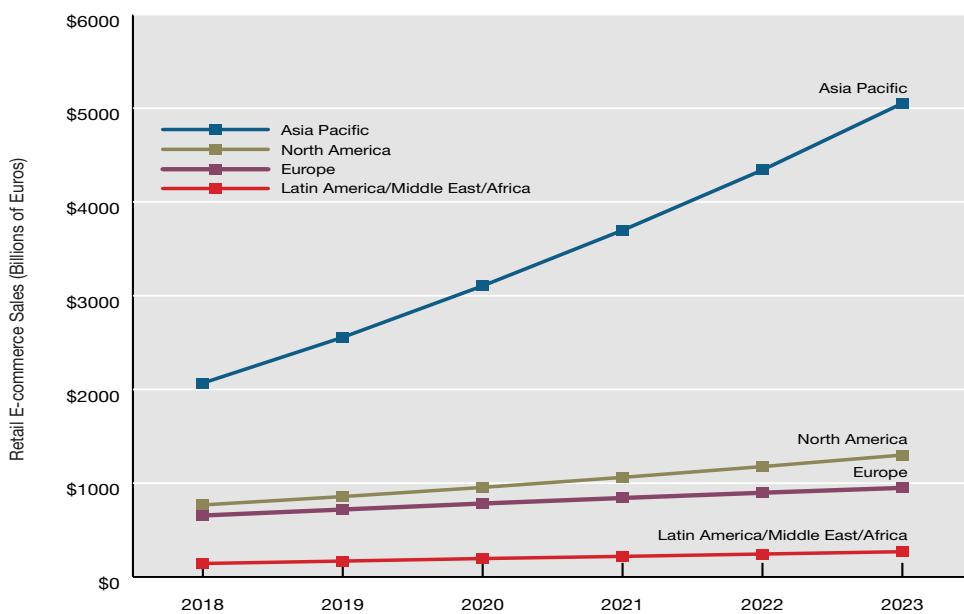


Figure 10.1

The Growth of E-commerce.

B2C e-commerce is growing in all regions. Overall global growth in 2019 was about 20% and even higher in Asia-Pacific.

Sources: Based on data from eMarketer, "Retail Ecommerce Sales, by Country," (October 2019); eMarketer, Inc. "Digital Travel Sales, by Country." (July 2019).

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 grew at double-digit rates in the United States until the recession of 2008–2009, when growth slowed to a crawl and revenues flattened. 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, Facebook, and Google, the results have been more positive: soaring revenues, fine-tuned business models that produce profits, and rising stock prices. For instance:

- Online consumer sales (including travel) worldwide will grow to an estimated \$4.9 trillion in 2020, an increase of more than 18 percent over 2019 with an estimated 2.2 billion people purchasing online (eMarketer, 2019a, 2019b, 2019c). In the United States, the Internet influences more than \$2 trillion in retail commerce that takes place in physical stores, about 40 percent of all retail sales.
- In the world, more than 4.4 billion people are now connected to the Internet. Growth in the overall Internet population has spurred growth in e-commerce (Internet World Stats, 2019).
- Mobile phones and tablets are becoming the most common Internet access device. About 85 percent of all Internet users (3.3 billion people) worldwide accessed the Internet by using a mobile phone at least some of the time in 2019. Mobile e-commerce has begun a rapid growth based on apps, downloaded entertainment, and location-based services. Retail mobile e-commerce worldwide accounted for over \$2.2 billion in 2019, almost 65 percent of all retail e-commerce sales. (eMarketer, 2019e).

- B2B e-commerce (use of the Internet for business-to-business commerce and collaboration among business partners) expanded to about \$27 trillion in transactions worldwide and around \$6.5 trillion in the United States (UNCTAD, 2019; U.S. Census Bureau, 2019). Table 10.1 highlights these new e-commerce developments.

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 of social networking, travel, 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, JCPenney, L.L.Bean, and Macy's, 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 fourth in e-commerce sales of \$20 billion annually, about 3 percent of all online e-commerce in the United States. Amazon, of course, is first with \$258 billion in online sales, about 50 percent of all 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 in the United States with location-based services and entertainment downloads, including e-books, movies, music, and television shows. Mobile e-commerce generated around \$2.2 trillion in 2019.

Technology Foundations

Wireless Internet connections (Wi-Fi, WiMax, and 4G 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. Facebook has 2.3 billion users worldwide and 190 million in the United States (Facebook, 2019).

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

More than 75 percent of the Internet population worldwide (about 2.95 billion people) 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. Social sites have become the primary gateway to the Internet in news, music, and, increasingly, products and services (eMarketer, 2019f).

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.

TABLE 10.1

The Growth of E-commerce

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. The *New York Times* succeeded in capturing more than 4 million subscribers in 2019, growing at 25 percent annually and adding 400,000 new digital subscribers annually. Local newspapers are closing in droves, unable to attract a digital audience. Book publishing continues to grow slowly at nearly 5 percent because of the growth in e-books and the continuing appeal of traditional trade books. The fastest growth segment in trade books is digital audio downloads.

Online entertainment business models offering television, movies, music, and games grow with cooperation among the major copyright owners 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.

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, 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 half of all advertising worldwide. Mobile marketing now constitutes nearly 70 percent of online marketing, and the remainder is browser-based desktop ads, search, display ads, video ads, email, and games (eMarketer, 2019g).

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.

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.

TABLE 10.2

Eight Unique Features of E-commerce Technology

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.

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 more than 3 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 click-stream 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 US 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.

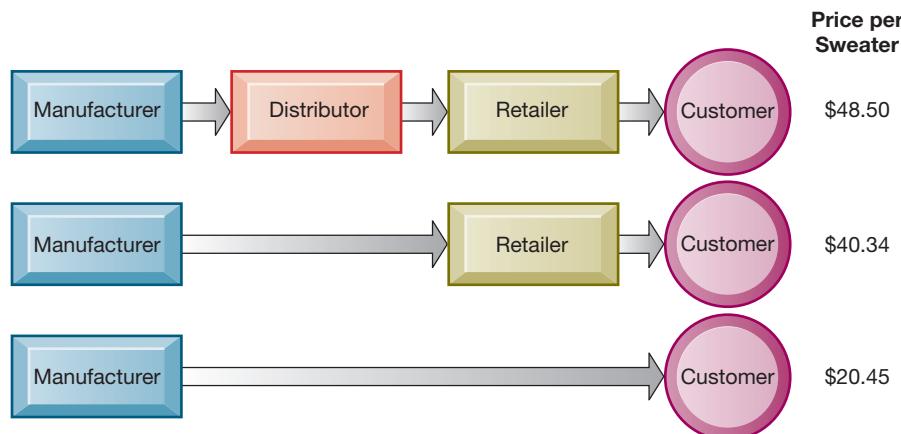
Digital markets are flexible and efficient because they operate with reduced search and transaction costs, lower **menu costs** (merchants' costs of changing prices), greater price discrimination, and the ability to change prices dynamically based on market conditions. In **dynamic pricing**, the price 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

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 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

TABLE 10.3

Digital Markets
Compared with
Traditional Markets

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.

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.

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 2018 by 16 percent to nearly \$10 billion primarily through the growth of paid subscriptions (RIAA.com, 2019). The Apple iTunes Store has sold more than 50 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, down more than 25 percent in recent years, 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) amounted to \$8 billion in 2018. As cloud streaming services expand, illegal downloading will decline further. Digital music sales, both digital download and streaming, account for more than 80 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. Artists' earnings on a streamed song on an ad-supported platform like Spotify are pennies per million streams.

Hollywood 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. Hollywood 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. In 2018 the industry generated \$97 billion in revenues. Arrangements with online distributors have not been enough to compensate entirely for the loss in DVD sales, which fell 60 percent from 2006 to 2018. Digital format streaming and downloads grew by 28 percent in 2018 and now makes up over 75 percent of home entertainment. As with television series, the demand for feature-length Hollywood 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 2019, about 2.6 billion Internet users worldwide viewed digital videos online, over 68 percent of the adult Internet population. 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. (eMarketer, 2019h).

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 commerce. BarnesandNoble.com, which sells books, software, and music to individual consumers, is an example 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. Craigslist is the platform most consumers use to buy from and sell directly to others.

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.

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. In 2018 Americans spent more than half their online time at Facebook, about an hour per day! 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. In 2019, portals (not including Google, Facebook, or Bing) generated an estimated \$10 billion in display ad revenues. Although there are hundreds of portal/search engine sites, the top portals (Yahoo, MSN, and AOL) gather more than 80 percent of the Internet portal traffic because of their superior brand recognition.

TABLE 10.5
Internet Business Models

Category	Description	Examples
E-tailer	Sells physical products directly to consumers or to individual businesses.	Amazon Blue Nile
Transaction broker	Saves users money and time by processing online sales transactions and generating a fee each time a transaction occurs.	ETrade.com Expedia
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 Priceline.com 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.	WSJ.com GettyImages.com 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

E-tailer

Online retail stores, often called **e-tailers**, come in all sizes, from giant Amazon with 2018 retail sales revenues of more than \$207 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) generated about \$3.5 trillion in revenues worldwide in 2019. 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 Walmart.com or Staples.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, but it does not create or commission new music.

The phenomenal popularity of Internet-connected mobile devices such as the iPhone, iPod, 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.

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 Financial Services and Expedia are the largest online 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 (described in the chapter-ending case study) 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. 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, Tumblr, 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 spent an estimated \$330 billion on online advertising in 2019 worldwide (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 15 percent from 2018. About \$240 billion of this was for mobile ads. Mobile ads accounted for about 73% 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 (cutting print ads). In 2019, spending for online advertising constituted about 50 percent of all advertising spending worldwide (eMarketer, 2019i, 2019j).

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. Facebook alone displayed one-third of the trillion display ads shown on all sites in 2019.

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), L.L.Bean.com, and Gap.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 is 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 130 million customers worldwide in 2019. 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

Billy Joe Wilson, owner of Billy Joe's Craft House in Port Aransas, Texas, was cooking up some chicken-fried steak sandwiches in a food truck when an app on his tablet asked if he wanted to borrow \$5,000. The offer came from Square, Inc., which makes devices that Wilson and other small businesses use to process customer credit card payments. As Wilson was using Square to process payments, Square's algorithms had been working quietly behind the scenes to determine whether he was creditworthy. Square's system felt he was. With a few swipes, Wilson then accepted Square's loan terms and received his loan within days. Since then Wilson has borrowed more than \$150,000 to open a nearby gastropub.

Tech firms such as Square are moving onto the turf of traditional banks, not only with online payment services but also in the banks' core business of loans. The tech firms are able to take advantage of their vast troves of customer data. PayPal Holdings, for instance, has made more than \$6 billion in small-business loans since 2013, using data it collected while processing payments for Internet retailers. Amazon has loaned more than \$3 billion to independent merchants that sell goods on its site, using sellers' historical volumes as a basis for granting credit. In 2017 Intuit started offering loans to businesses using its Quickbooks accounting software with data from their accounting statements. Other nonbank online loan providers include LendingClub Corp., OnDeck, CAN Capital, PayPal Working Capital, and Kabbage.

Square has extended more than \$3.5 billion in loans and cash advances to small businesses, and is now moving into consumer lending. It will loan up to \$100,000 to businesses that use Square. Square is also exploring services for personal loans and lines of credit to the more than 7 million users of its Cash App digital money transfer service that competes with Venmo.

In the 12 months ending on September 30, 2019, Square extended about 200,000 business loans, more than three times the number of loans from banks via the Small Business Administration. But Square is still a small player in lending, with its business loans averaging \$6,500. This is much smaller than the typical bank loan.

Square loans are funded by investors, so they charge higher interest rates or fees than loans from banks, which are funded by low-cost deposits. To avoid the regulations required for a conventional

bank, Square outsources the more regulated parts of lending (such as the ability to offer loans at uniform rates and terms nationwide). That enables Square to operate as a niche financial institution that can offer banking services that regulated banks can't offer without oversight from the Federal Reserve.

Square evaluates whether a business can qualify for a loan by analyzing its vast database of credit card transactions. It looks at data on whether a business is attracting repeat customers, the number of chargebacks, business history, and processing volume. The lending process is automated, and makes it easy for customers to obtain and repay a loan. Most customers are not required to fill out a formal application. Application only takes a few clicks, with no long forms. Upon approval, the business loan is deposited into the borrower's bank account as soon as the next business day. Square takes a percentage of a company's daily credit card sales as loan repayments. Instead of charging interest, Square levels a flat fee ranging from 10 to 16 percent of the loan amount. (A \$10,000 loan could have fees ranging from \$1,000 to \$1,600.) The loan is supposed to be repaid in full within 18 months.

Not all businesses are pleased with Square's machine-driven lending. Hardcore Sweets Bakery in Oakville, Connecticut, an "alternative" cupcake shop, borrowed more than \$130,000 from Square between 2014 and 2018 to purchase more kitchen equipment and open a second location. According to co-owner Nicole Braddock, Square has stopped making loan offers to the bakery but wouldn't explain why. No one from Square's customer-service team would return her phone calls, and she got only a generic response to her emails. Sometimes a more personal touch is in order.

There are other tradeoffs. The price for the speed and convenience of online lenders is interest rates higher than those charged by banks. For example, Getting Better Fitness in Chicago had to pay 25 percent interest on a short-term loan from Kabbage. The gym later switched to 11 percent financing from PayPal Working Capital. Tea By Two, a Bel Air Maryland tea room, recently paid an 18 percent interest rate on a \$20,000 loan from OnDeck. Online lenders, however, are more likely to grant loans and to do so much more quickly than conventional banks, often without requiring collateral. This is especially appealing to first-time business owners.

Rapid Brewing of Homewood, Illinois, recently took a loan from Square Capital when it needed an emergency plumbing repair. The company received its loan of \$7,800 within a day. Rapid Brewing's loan terms called for Square to keep 14.8 percent of daily credit-card sales to repay the principal, and the loan had to be repaid within 18 months. Instead of interest, Square charged a flat fee of \$1,008. Brewery co-owner

Raiye Rosado believed that while her experience of obtaining a loan from Square was largely positive, she would probably use a traditional bank for larger loans.

Sources: Becky Yeruk, "Some Small Businesses See Big Benefits in Online Financing," *Wall Street Journal*, May 12, 2019; "Square Capital Review: Merchant Cash Advances by Another Name," www.business.org, accessed July 13, 2019; www.squareup.com, accessed July 13, 2019; and Peter Rudgeair, "A \$150,000 Small Business Loan—from an App," *Wall Street Journal*, December 28, 2018.

CASE STUDY QUESTIONS

1. What distinguishes the FinTech services described in this case from traditional banks? Explain your answer.
2. How do the financial services described here use information technology to innovate?
3. What are the advantages and disadvantages of small businesses obtaining loans from FinTech services?
4. If you were a small business, what factors would you consider in deciding whether to use a FinTech service?

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. E*Trade, an online stockbroker, receives transaction fees each time it executes a stock transaction on behalf of a customer. 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 (see the Interactive Session on Technology). 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 Epinions and 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

TABLE 10.6

Online Ad Spending by Formats (billions)
(revenue figures from the U.S.)

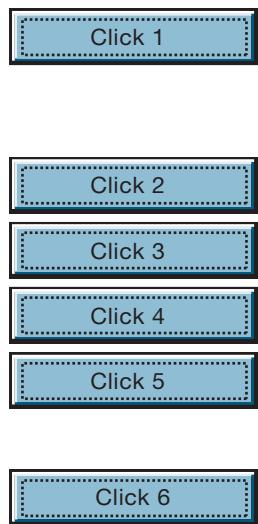
Source: Based on eMarketer, "Digital Ad Spending by Format, 2019," eMarketer, March 2019.

Marketing Format	2019 U.S. Revenue	Description
Search engine	\$53.7	Text ads targeted at precisely what the customer is looking for at the moment of shopping and purchasing. Sales oriented.
Display ads	\$70.0	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	\$36.0	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	\$41.3	Animations, games, and puzzles. Interactive, targeted, and entertaining. Branding orientation.
Lead generation	\$2.6	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	\$0.5	Effective, targeted marketing tool with interactive and rich media potential. Sales oriented.

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 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

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.



The shopper clicks on the home page. The store can tell that the shopper arrived from the Yahoo portal at 2:30 PM (which might help determine staffing for customer service centers) and how long she lingered on the home page (which might indicate trouble navigating the site). Tracking beacons load cookies on the shopper's browser to follow her across the Web.

The shopper clicks on blouses, then clicks to view a woman's pink blouse. The shopper clicks to select this item in a size 10 in pink and clicks to place it in her shopping cart. This information can help the store determine which sizes and colors are most popular. If the visitor moves to a different site, ads for pink blouses will appear from the same or a different vendor.

From the shopping cart page, the shopper clicks to close the browser to leave the website without purchasing the blouse. This action could indicate the shopper changed her mind or that she had a problem with the website's checkout and payment process. Such behavior might signal that the website was not well designed.

Courtesy of Google Inc.

**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.

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.

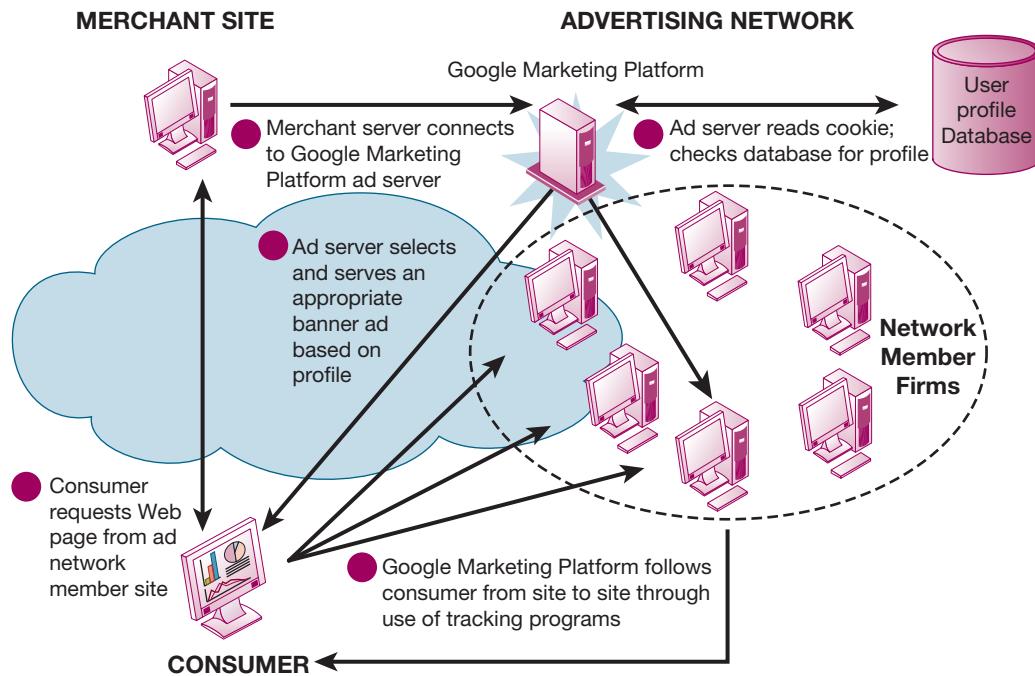
This information enables firms to understand how well their website is working, create unique personalized web pages that display content or ads for products or services of special interest to each user, improve the customer's experience, and create additional value through a better understanding of 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, General Motors will show a Chevrolet banner ad to women emphasizing safety and utility, whereas men will 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.

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 Northeast, in the 18–34 age range who are interested in purchasing a European car? Advertising networks can identify and deliver thousands of people who fit this profile and expose them to ads for European 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

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.



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 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 Internet users disapprove of search engines and websites tracking their online behavior to aim targeted ads at them. A 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).

SOCIAL E-COMMERCE AND SOCIAL NETWORK MARKETING

One of the fastest-growing media for branding and marketing is social media. Companies spent an estimated \$90 billion in 2019 using social networks such as Facebook, Instagram, Pinterest, Twitter, and LinkedIn to reach millions of consumers who spend hours a day on social sites (eMarketer, 2019k). 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, such as Facebook, Instagram, Pinterest, LinkedIn, Twitter, and Tumblr, 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 in the United States and 205 million monthly US visitors in 2019, receives most of the public attention given to social networking. The other top four social sites are also growing, though at slower rates than in the past. LinkedIn had over 300 million monthly users in 2019. Twitter grew to 110 million active users, with stronger offshore growth than in the United States. Pinterest hit the top 50 websites with 86.5 million users. According to analysts,

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.

TABLE 10.7

Features of Social Commerce

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 businesses owners use social media monitoring to 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 \$9 billion in ad revenue in 2018.

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.

Mack Trucks, a leading US truck manufacturer, used a social marketing campaign to attract customers, drivers, and dealers when it launched its new Anthem model. Mack had traditionally used

print ads in trucking publications, brochures, and industry trade shows as its primary marketing channels when rolling out a new product. These channels, however, did not enable Mack to tailor and deliver different messages for different customers. For example, a manager of a large fleet might be most interested in fuel efficiency, while an owner-operator might be more attracted to design style. Mack's marketing team continued to use traditional channels for broad awareness and turned to social marketing to focus on segmentation and metrics.

Starting in July 2017 Mack launched a series of biweekly YouTube videos to build excitement for the Anthem model, followed by a live stream of the Anthem unveiling on YouTube and Facebook in September of that year. Mack netted 7,000 email addresses from the teaser campaign, with 3,700 people viewing the live stream of the launch event. These are considered significant numbers for a product costing over US \$100,000. Mack's marketing team also directed the company social media followers to photos, videos, text summaries, and other content describing every aspect of the new Anthem line. These activities were credited with attracting more than 40,000 new social followers to the Mack brand.

Mack uses Oracle Eloqua Marketing Cloud Service and Oracle Social Cloud to link social activity to 175,000 profiles in its Oracle Eloqua database of customers and prospects. The digital marketing team thus knows if a person in the database clicked on a Facebook post to view an Anthem-related video or looked for other information on the company's website. Compelling personalized content helps engage prospects and move them further along the sales process until they ask to talk to a Mack dealer. At that point, the prospect is considered a qualified lead. Oracle Social Cloud alerts team members when the Mack Anthem is mentioned on various social sites, and they can respond where appropriate.

Mack enlisted celebrity influencers for the Anthem campaign. For example, country music artist Steve Moakler recorded a road song called *Born Ready* for the Anthem launch and dedicated it to drivers. More than 55,000 people viewed Moakler's performance on YouTube. More than 9,300 people opted into some aspect of the Mack Anthem campaign, generating about 1,700 qualified leads. The Anthem landing page has attracted over 146,000 visitors, who can

watch the Moakler video and obtain information on every aspect of the new truck line. Mack's senior management is very pleased with the results and the detail and precision of digital marketing information.

Social media campaigns can be tricky to orchestrate, and the results are not always predictable. For example, when social followers of Donald Trump called for boycotting Nordstrom for dropping Ivanka Trump's clothing line from its stores, Nordstrom's stock price rose, and the company outperformed many of its retail industry rivals

in the months that followed. Nordstrom customers remained loyal to the brand. Previous Trump tweets calling out other brands such as Lockheed Martin had hurt stock share prices.

Sources: "Instagram by the Numbers," *Omniscope*, January 16, 2019; Brad Fay, Ed Keller, Rick Larkin, and Koen Pauwels, "Deriving Value from Conversations about Your Brand," *MIT Sloan Management Review*, Winter 2019; Rob Preston, "Open Road," *Profit Magazine*, Spring 2018; www.Macktrucks.com, accessed April 19, 2019; Tobias Matthews, "How Nike Uses Instagram and Is Winning," *Fourth Source*, January 13, 2018; Karisa Fagan, "6 Social Media Failures & What You Can Learn from Them," *Impact*, May 29, 2018; and Janet Morrissey, "Brands Heed Social Media. They're Advised Not to Forget Word of Mouth," *New York Times*, November 26, 2017.

CASE STUDY QUESTIONS

1. Assess the people, 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?

25 percent of the total time spent online in the United States was spent on social network sites (about 57 minutes a day), and social networking is the most common online activity. The fastest-growing smartphone applications are social network apps; nearly half of smartphone users visit social sites daily. More than 75 percent of all visits to Facebook in 2019 came from smartphones.

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 5 billion likes 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 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 People provides specific examples of companies' social marketing efforts using Facebook and Instagram.

10-4 How has e-commerce affected business-to-business transactions?

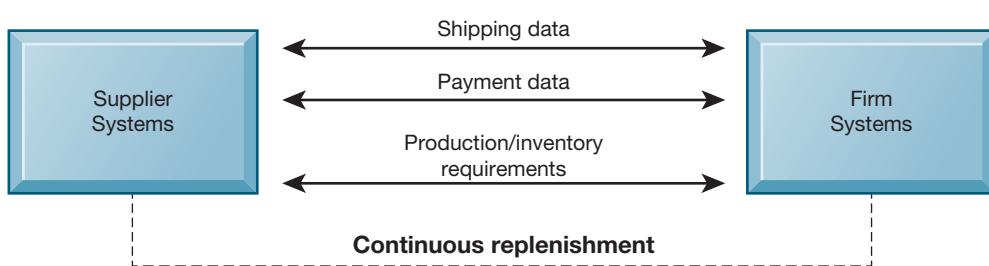
Trade between business firms (business-to-business commerce, or B2B) represents a huge marketplace. The total amount of B2B trade in the United States in 2019 was estimated to be about \$13.5 trillion, with B2B e-commerce (online B2B) contributing about \$6.5 trillion of that amount (U.S. Census Bureau, 2019; authors' estimates). Worldwide, B2B e-commerce transactions generated about \$27 trillion (UNCTAD, 2019).

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 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).

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**.

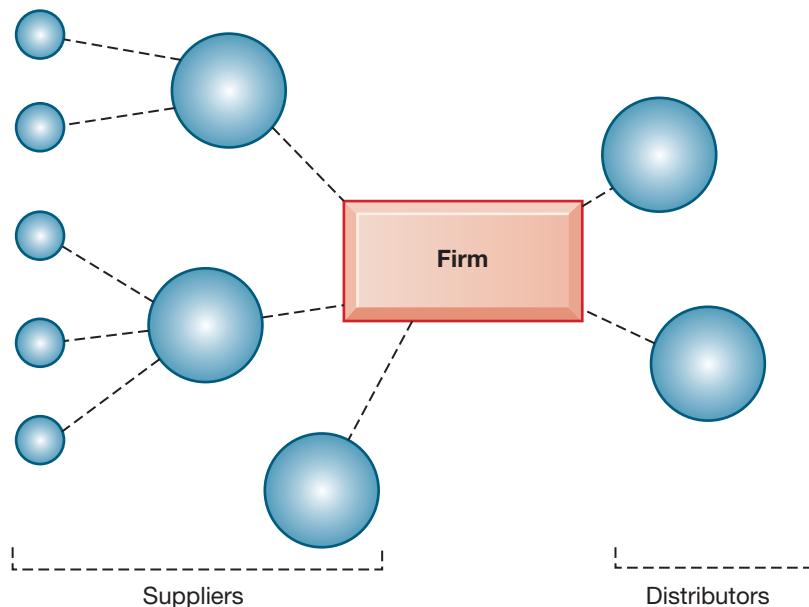
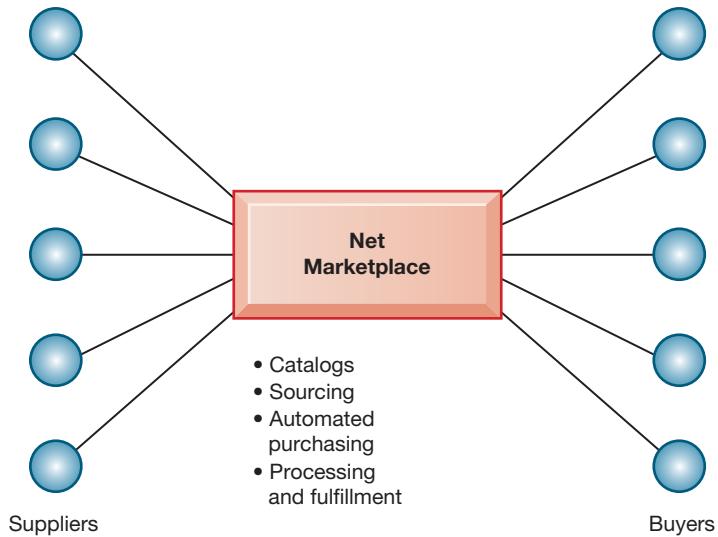


Figure 10.6
Electronic Data Interchange (edi).
Companies use EDI to automate transactions for B2B e-commerce and continuous inventory replenishment. Suppliers can automatically send data about shipments to purchasing firms. The purchasing firms can use EDI to provide production and inventory requirements and payment data to suppliers.

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.

Figure 10.8
A Net Marketplace.
Net marketplaces are online marketplaces where multiple buyers can purchase from multiple sellers.



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.

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 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?

Walk down the street in any major metropolitan area and count how many people are pecking away at their iPhones, Samsungs, or BlackBerrys. Ride the trains or fly the planes, and you'll see fellow travelers reading an online newspaper, watching a video on their phone, or reading a novel on their Kindle. As the mobile audience has expanded in leaps and bounds, mobile advertising and m-commerce have taken off.

In 2019, retail m-commerce worldwide accounted for about 65 percent of all retail e-commerce, with about \$2.2 trillion in annual revenues. M-commerce is the fastest-growing form of e-commerce, expanding at a rate of over 25 percent in 2019, and it is estimated to grow to almost \$4.6 trillion by 2023 (see Figure 10.9) (eMarketer, 2019d).

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 (described in the chapter-ending case) 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.

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

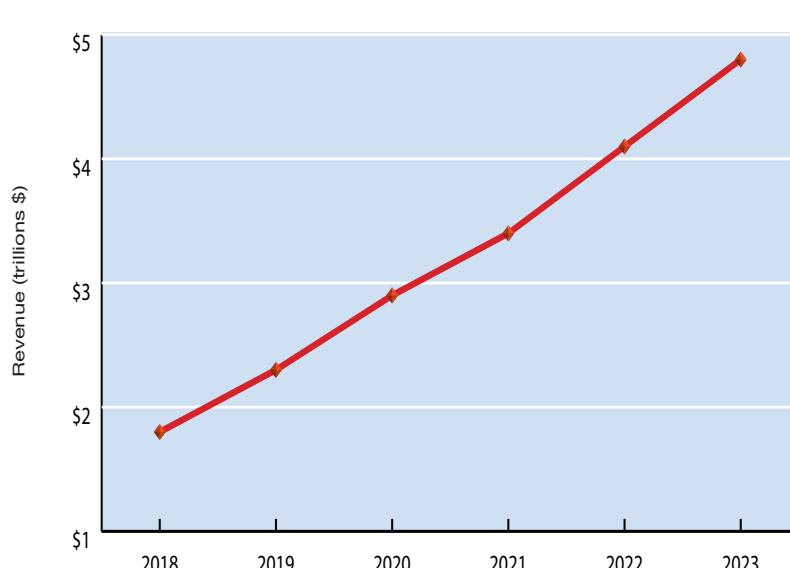


Figure 10.9
Mobile Retail Commerce Revenues.
It is anticipated that retail m-commerce worldwide will continue to grow by over 20% a year through the next several years as consumers become more and more accustomed to using mobile devices to purchase products and services.

Sources: Data from eMarketer chart "Retail Mcommerce Sales by Country 2019-2024, eMarketer 2019d.

you are passing. In 2019, the fastest-growing and most popular location-based services were 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 30 million other drivers in the United States.

Foursquare and new offerings by Facebook and Google are examples of geosocial 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. About 20 percent of smartphone owners use geosocial services.

Foursquare provides a location-based social networking service to over 50 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. JPMorgan Chase and Bank of America 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 models, allow users to charge items to their credit card accounts with a swipe of their phone. (See our Learning Track on mobile payment systems.)

The mobile advertising market is the fastest-growing online ad platform, racking up over \$240 billion in ad revenue in 2019 and growing at over 20 percent annually. Ads eventually move to where the eyeballs are, and increasingly that means mobile phones and, to a lesser extent, tablets. Google is the largest mobile advertising market, generating over \$80 billion in mobile ads worldwide or over 75% percent of its total worldwide ad revenue, with Facebook number two at \$65 billion (90 percent of its total digital ad business). Google is displaying ads linked to cell phone searches by users of the mobile version of its search engine; 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.

Sixty-five percent of online 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. In 2020, more than

66 percent of m-commerce sales will occur within apps rather than mobile web browsers. Browser commerce has, at least for mobile users, become app commerce.

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. Near-field 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 QuickPay are used for transferring money among individuals who have installed a proprietary app. Table 10.8 compares these three types of mobile app payment systems.

Type of Mobile App Payment System	Description	Examples
Near Field Communication (NFC)	System using technology driven by 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	Quick Response (QR) code technology 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 QR 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.	Starbucks, Walmart Target, Dunkin Donuts
Peer-to-peer (P2P) payment system	Technology allowing 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

TABLE 10.8
Types of Mobile App Payment Systems

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, 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.

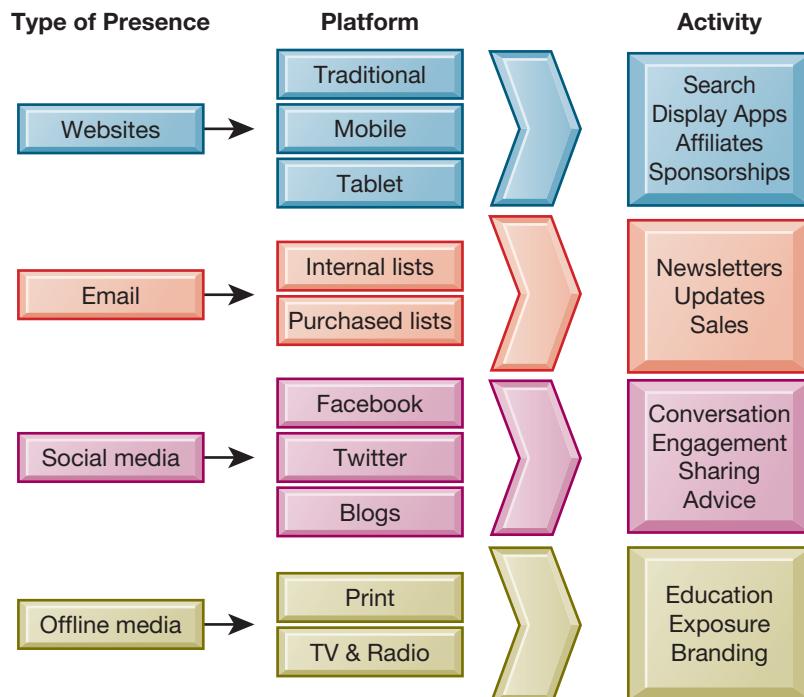
DEVELOP AN E-COMMERCE PRESENCE MAP

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,

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.



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, 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

TABLE 10.9

E-commerce Presence Timeline

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.

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.

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 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. M-commerce requires wireless portals and special digital payment systems that can handle micropayments. 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, Twitter, and other social networking sites and smartphone apps.

Key Terms

Advertising revenue model, 382	Consumer-to-consumer (C2C), 379	Electronic Data Interchange (EDI), 392
Affiliate revenue model, 385	Cost transparency, 375	E-tailer, 380
Behavioral targeting, 385	Crowdsourcing, 392	Exchanges, 394
Business-to-business (B2B), 379	Customization, 375	FinTech, 384
Business-to-consumer (B2C), 379	Digital goods, 377	Free/freemium revenue model, 384
Community providers, 381	Direct goods, 394	Geoadvertising services, 395
	Disintermediation, 376	Geoinformation services, 395
	Dynamic pricing, 376	

Geosocial services, 395	Mobile commerce (m-commerce), 379	Richness, 374
Indirect goods, 394	Native advertising, 388	Sales revenue model, 382
Information asymmetry, 375	Net marketplaces, 394	Search costs, 374
Information density, 374	Personalization, 375	Social graph, 388
Intellectual property, 380	Podcasting, 381	Social shopping, 391
Location-based services, 395	Price discrimination, 375	Streaming, 381
Long tail marketing, 385	Price transparency, 375	Subscription revenue model, 382
Market creator, 381	Private exchange, 393	Transaction costs, 374
Market entry costs, 374	Private industrial networks, 393	Transaction fee revenue model, 384
Marketspace, 373	Revenue model, 382	Wisdom of crowds, 391
Menu costs, 376		
Micropayment systems, 382		

Review Questions

- 10-1** What are the unique features of e-commerce, digital markets, and digital goods?
- Name and describe four business trends and three technology trends shaping e-commerce today.
 - List and describe the eight unique features of e-commerce.
 - Define a digital market and digital goods and describe their distinguishing features.
- 10-2** What are the principal e-commerce business and revenue models?
- Name and describe the principal e-commerce business models.
 - Name and describe the e-commerce revenue models.
- 10-3** How has e-commerce transformed marketing?
- Explain how social networking and the wisdom of crowds help companies improve their marketing.
 - Define behavioral targeting and explain how it works at individual websites and on advertising networks.
 - Define the social graph and explain how it is used in e-commerce marketing.
- 10-4** How has e-commerce affected business-to-business transactions?
- Explain how Internet technology supports business-to-business electronic commerce.
 - Define and describe Net marketplaces and explain how they differ from private industrial networks (private exchanges).
- 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.
- 10-6** What issues must be addressed when building an e-commerce presence?
- List and describe the four types of e-commerce presence.

MyLab MIS™

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

Discussion Questions

- 10-7** How does the Internet change consumer and supplier relationships? **MyLab MIS** their business models. Do you agree? Why or why not?
- 10-8** The Internet may not make corporations obsolete, but the corporations will have to change **MyLab MIS** **10-9** How have social technologies changed e-commerce?

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** As the owner of a small sports store, you have noticed that many customers have a favorite type of golf ball. You figure that golf balls could be of special commercial interest to an online business for several reasons: they are often lost and in need of replacement, there is a big variety of golf balls, because of their small size they are easily shipped worldwide, and many golfers are well-off. Create a strategy for selling the golf balls online and identify the most appropriate Internet business model.
- 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, Yahoo, or Priceline. 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.

BUSINESS PROBLEM SOLVING CASE

CAN UBER BE THE UBER OF EVERYTHING?

You're in New York, Paris, Chicago, or another major city and need a ride. Instead of trying to hail a cab, you pull out your smartphone and tap the Uber app. A Google map pops up displaying your nearby surroundings. You select a spot on the screen designating an available driver, and the app secures the ride, showing how long it will take for the ride to arrive and how much it will cost. Once you reach your destination, the fare is automatically charged to your credit card. No fumbling for money.

Rates take into account the typical factors of time and distance but also demand. Uber's software predicts areas where rides are likely to be in high demand at different times of the day. This information appears on a driver's smartphone so that the driver knows where to linger and, ideally, pick up customers within minutes of a request for a ride. Uber also offers a higher-priced town car service for business executives and a ride-sharing service. Under certain conditions, if demand is high, Uber can be more expensive than taxis, but it still appeals to riders by offering a reliable, fast, convenient alternative to traditional taxi services.

Uber runs much leaner than a traditional taxi company does. Uber does not own taxis and has no maintenance and financing costs. It does not have employees, so it claims, but instead calls the drivers independent contractors, who receive a cut of each fare. Uber is not encumbered with employee costs such as workers' compensation, minimum wage requirements, driver training, health insurance, or commercial licensing costs. Uber has shifted the costs of running a taxi service entirely to the drivers and to the customers using their mobile phones. Drivers pay for their own cars, fuel, and insurance. What Uber does is provide a smartphone-based platform that enables people who want a service—like a taxi—to find a provider who can meet that need.

Uber relies on user reviews of drivers and the ride experience to identify problematic drivers and driver reviews of customers to identify problematic passengers. It also sets standards for cleanliness. It uses the reviews to discipline drivers. Uber does not publicly report how many poorly rated drivers or passengers there are in its system.

Many decisions required for running the business do not require humans, relying instead on finely-tuned computer algorithms. For example, Uber systems use the accelerometer in drivers' phones along with GPS and gyroscope to track drivers' performance and send them safe driving reports. It's Uber's systems that

decide how much to price a ride in periods of peak and slow demand and where drivers should relocate to find more ride-hailing passengers. Uber drivers receive in-app notifications, heat maps, and emails with real-time and predictive information. Uber's driver rating system also is automated. In certain Uber services, if drivers fall below 4.6 stars on a 5-star rating system, they may be "deactivated."

Uber is headquartered in San Francisco and was founded in 2009 by Travis Kalanick and Garrett Camp. In 2018, it had more than 3 million drivers working in 600 cities worldwide, generating revenue of \$11.3 billion that year. After paying for drivers, marketing, and other operating expenses, Uber still operates at a loss, with losses in developing markets swallowing up profits generated in North America, Europe, and elsewhere. Uber's business strategy has been to expand as fast as possible, foregoing short-term profits in favor of laying the groundwork for long-term returns. As of November 2018, Uber had raised over \$24 billion from venture capital investors. In the last several years, Uber has sold its operations in China, Southeast Asia, and Russia, where it had been engaged in costly turf wars with competitors, to free up capital to invest in other markets such as India, Latin America, and the Middle East.

By digitally disrupting a traditional and highly regulated industry, Uber has ignited a firestorm of opposition from existing taxi services in the United States and around the world. Who can compete with an upstart firm offering a 40 percent price reduction when demand for taxis is low? (When demand is high, Uber prices surge.) What city or state wants to give up regulatory control over passenger safety, protection from criminals, driver training, and a healthy revenue stream generated by charging taxi firms for a taxi license?

If Uber is the poster child for the new on-demand economy, it's also an iconic example of the social costs and conflict associated with this new kind of business model. Uber has been accused of denying its drivers the benefits of employee status by classifying them as contractors, violating public transportation laws and regulations throughout the United States and the world, abusing the personal information it has collected on ordinary people, increasing traffic congestion, undermining public transportation, and failing to protect public safety by refusing to perform sufficient criminal, medical, and financial background checks.

on its drivers. Uber's brand image had been further tarnished by negative publicity about its aggressive, unrestrained workplace culture and the behavior of CEO Kalanick.

Uber has taken some remediating steps. It enhanced its app to make it easier for drivers to take breaks while they are on the job. Drivers can now also be paid instantly for each ride they complete rather than weekly and see on the app's dashboard how much they have earned. Uber added an option to its app for passengers to tip its US drivers, and Kalanick resigned as head of Uber in June 2017. (He was replaced by Dara Khosrowshahi.)

Critics fear that Uber and other on-demand firms have the potential for creating a society of part-time, low-paid temp work, displacing traditionally full-time, secure jobs—the so-called Uberization of work. According to one study, half of Uber drivers earn less than the minimum wage in their state. Uber responds by saying it is lowering the cost of transportation, expanding the demand for ride services, and expanding opportunities for car drivers, whose pay is about the same as other taxi drivers.

Does Uber have a sustainable business model? The company is still not profitable. Uber has competitors, including Lyft in the United States and local firms in Asia and Europe. Established taxi firms in New York and other cities are launching their own hailing apps and trumpeting their fixed-rate prices. The onslaught of competition from all sides has intensified recently, causing Uber's losses to balloon to more than \$3.7 billion in the 12 months through March 2019. Startups backed by deep-pocketed investors (including Softbank Group, Uber's biggest shareholder) are using heavy discounts to challenge Uber's food delivery services in the United States, India, and Mexico, as well as Uber's Latin American ride-hailing business. Uber's once-robust revenue growth has lost some of its steam. Latin America, which seemed so promising, went from being Uber's fastest-growing region to its slowest. In 2018 annual revenue growth fell to 22 percent compared to 215 percent the year before. Uber's senior management is counting on the price wars eventually easing, since Uber continues to fight back with low prices.

Uber's principal markets are in dense cities, but over 70 percent of the US population lives in rural or suburban areas where car ownership tends to be more convenient and cheaper. Ride-hailing has lured people away from public transit, contributing to traffic congestion in major cities and spurring calls for more regulation that would limit growth.

CEO Khosrowshahi has been touting Uber as a one-stop shop for disparate categories of

transportation, and has launched new services for same-day deliveries, including food delivery (Uber Eats), shared electric bikes and scooters, and a freight shipping brokerage. He sees Uber as the "Amazon of transportation," with the potential to become the dominant force in all forms of transportation. In Uber's vision of the future, most people won't own cars. People will use electric bikes and scooters for short distances. Takeout dinner will be replaced by on-demand delivered meals. Self-driving cars will shuttle people around the roads and autonomous trucks will roam the highways. In the air drones will make the deliveries. Uber wants to do it all. Can it?

Along with major auto makers such as Ford and Volkswagen, Uber has invested heavily in self-driving cars, which management believes will be key to lowering labor costs and ensuring long-term profitability. (A study conducted by UBS showed a self-driving "robo-taxi" costs about 80 percent less than a traditional taxi.) But self-driving cars are many years away from being able to operate safely on the road under any conditions as humans can. Autonomous vehicles still struggle to anticipate what other drivers and pedestrians will do and cannot operate safely and reliably under all weather conditions and types of terrain.

With radar, sensors, and high-resolution cameras, self-driving vehicles can detect and identify the objects on a street, including other cars, pedestrians, and cyclists. But they can't always correctly anticipate what they're going to do next. Self-driving cars can't always correctly respond to unusual circumstances, such as pedestrians crossing the road when cars have the green light or cars making illegal turns. Today's self-driving cars have about 80 percent of the technology they need to substitute for human drivers. The remaining 20 percent, however, including software that can reliably anticipate what other drivers, pedestrians, and cyclists are going to do, will be much more difficult to perfect. A computer-driven car that can handle any situation as well as a human under all conditions is decades away at best. The Chapter 11-ending case study provides more detail on this issue.

After a self-driving Uber car struck and killed a woman in Tempe, Arizona, in March 2018, Uber scaled back its autonomous vehicle program. Even before the accident, Uber's self-driving cars were having trouble driving through construction zones and near tall vehicles like big truck rigs. Test drivers had to take over the car almost every mile. Uber and others will be wrestling with autonomous vehicle technology for many years to come. In the meantime, Uber still needs to find a way to make money. Will Uber ever be able to make money?

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CASE STUDY QUESTIONS

- 10-15** Analyze Uber using the competitive forces and value chain models. What is its competitive advantage?
- 10-16** What is the relationship between information technology and Uber's business model? Explain your answer.
- 10-17** How disruptive is Uber?
- 10-18** Are any ethical and social issues raised by Uber and its business model? Explain your answer. Does Uber's business model create an ethical dilemma?
- 10-19** Is Uber a viable business? Explain your answer.

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CHAPTER
11

Improving Decision Making and Managing Artificial Intelligence

LEARNING OBJECTIVES

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

- II-1 What are the different types of decisions, and how does the decision-making process work?
- II-2 How do business intelligence and business analytics support decision making?
- II-3 What is artificial intelligence (AI)? How does it differ from human intelligence?
- II-4 What are the major types of AI techniques and how do they benefit organizations?
- II-5 How will MIS help my career?

CHAPTER CASES

- Machine Learning Helps Akershus University Hospital Make Better Treatment Decisions
- Siemens Makes Business Processes More Visible
- Predictive Maintenance in the Oil and Gas Industry
- Can Cars Drive Themselves—And Should They?

VIDEO CASES

- How IBM's Watson Became a Jeopardy Champion
- Business Intelligence Helps the Cincinnati Zoo Work Smarter

MyLab MIS

- Discussion Questions: 11-5, 11-6, 11-7
- Hands-On MIS Projects: 11-8, 11-9, 11-10, 11-11

MACHINE LEARNING HELPS AKERSHUS UNIVERSITY HOSPITAL MAKE BETTER TREATMENT DECISIONS

The healthcare industry is deluged with big data, including patient histories, clinical records, charts, and test results. Medical information is now doubling every three years and will be doubling every 73 days by 2020. How can healthcare professionals keep up with the knowledge in their field, and how can they use this knowledge to make more-informed decisions about treatment options and managing healthcare costs when there is way too much data for humans to easily analyze and absorb?

One of the many health care organizations struggling with this problem is Akershus University Hospital (Ahus), a Norwegian public university hospital serving approximately 500,000 inhabitants around Oslo, Norway, and employing 9,500 people. Ahus had amassed huge volumes of data on patients and treatments, but much of this information was in unstructured, textual reports that made it extremely difficult and time-consuming to extract meaningful information. Combing through thousands of complex clinical documents was impossible to complete manually.

Working with Capgemini consultants, Ahus is trying to solve this problem by using artificial intelligence technology in IBM Watson Explorer. IBM Watson Explorer is a *cognitive computing* platform that can analyze structured and unstructured data to uncover trends and patterns that would be difficult, if not impossible, for humans to discern. It uses natural language processing to search data expressed in everyday language like ordinary speech and machine learning algorithms to improve search results. Natural language processing technology makes it possible for a machine to understand, analyze, and derive meaning from human language. Machine learning software can identify patterns in very large databases without explicit programming, although with significant human training. IBM Watson Explorer is able to rapidly mine large volumes of data, interpret speech and text, pick up on nuances of meaning and context, answer questions, draw conclusions, and learn from its experience. It can make inferences and correlations about the content it ingests and rank potential responses for a user to select.

The hospital's image diagnostic department wanted to improve the use of CT examinations in emergencies. Ahus used IBM Watson Explorer to analyze when its CT scans performed on pediatric



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patients in emergency situations fell within recommended guidelines. CT scans can be life-saving in critical circumstances, but the radiation can also be potentially harmful, so CT scans should not be overused. A large amount of Ahus's CT scan data was in text format. Ahus used Watson Explorer to gather unstructured data from more than 5,000 anonymous CT examination reports and apply machine learning and natural language processing techniques to learn how often CT scans were undertaken and the findings of those scans.

Ahus and Capgemini implemented the project over a period of seven weeks during the summer of 2016. Watson had to learn the language used in medicine and understand the context of how that language is used. Capgemini adapted the technology to the Norwegian language, and Ahus trained Watson to understand medical words and phrases. The project also created a classification schema, teaching Watson to distinguish files that reported positive scan results and those that reported negative results, and categorize the data accordingly.

After several tests, Watson Explorer attained an accuracy level of 99 percent for content classification. The final analysis confirmed that frequency of CT scanning at Ahus was at an acceptable level, and that the hospital was striking the right balance between the probability of positive gains in relation to the potential harmful effects. It would have taken a team of people months and perhaps years to analyze the same amount of data that Watson could process in minutes.

Sources: IBM Corporation. "Akershus University Hospital," and "IBM Watson Explorer," www.ibm.com, accessed June 17, 2019; and "Akershus University Hospital Optimizes the Use of CT Examinations," www.capgemini.com, accessed June 18, 2019.

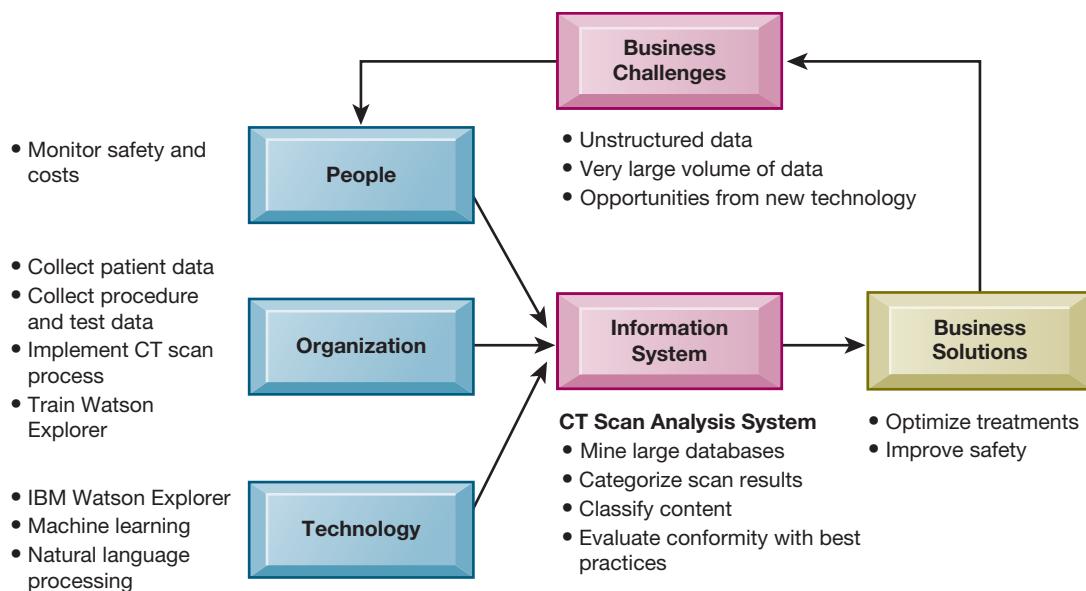
Akershus University Hospital's use of artificial intelligence techniques such as machine learning and natural language processing to determine whether its CT scans fell within recommended guidelines shows how organizational performance can benefit by using technology to facilitate the acquisition and application of knowledge. Facilitating access to knowledge, creating new knowledge, and using that knowledge to improve business processes and decision making 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. Like other medical facilities, Akershus University Hospital was what is termed "data rich but knowledge poor." It had vast quantities of patient and treatment data, but they were largely unstructured and difficult to analyze for information and insights. AI techniques such as machine learning and natural language processing helped Ahus obtain new insights and knowledge from thousands of CT scan records so that it could optimize treatments and ensure doctors and staff were following best practices.

Here are some questions to think about: How did using IBM Watson Explorer help Akershus University Hospital improve its knowledge? What was the impact on the hospital's business processes?

II-I What are the different types of decisions, and how does the decision-making process work?

One of the main contributions of information systems has been to improve decision making for both individuals and groups. 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 organization. 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 a business to be able to make a better decision? What is the monetary value to a business of improved decision making? Table 11.1 measures the monetary value of improved decision making for a small 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.

We can see from Table 11.1 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

Chapter 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 11.1). Decisions are classified as structured, semistructured, and unstructured.

TABLE 11.1

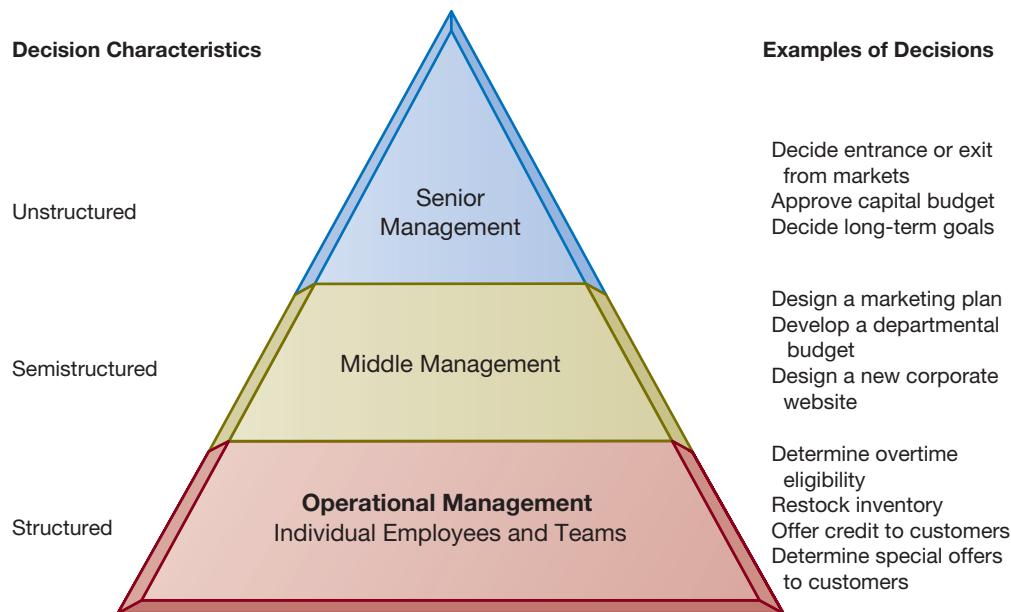
Business Value of Enhanced Decision Making

Example Decision Value	Decision Maker	Number of Annual Decisions	Estimated Value to Firm of a Single Improved Decision	Annual
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

Figure II.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.



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 not routine, 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 and are **semistructured decisions**, when 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 five-year or ten-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. But the answer would also require senior managers to use their own best judgment and poll other managers for their opinions.

Middle management faces 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 showing a decline over the past six months at a distribution center in Minneapolis?" This middle manager could 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 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 specific 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 routinely made thousands of

times each day in most large firms. The answer has been programmed into the firm's payroll and accounts receivable systems.

THE DECISION-MAKING PROCESS

Making a decision is a multistep process. Simon (1960) described four stages in decision making: intelligence, design, choice, and implementation (see Figure 11.2). These stages correspond to the four steps in problem solving used throughout this book.

Intelligence consists of discovering, identifying, and understanding the problems occurring in the organization—why the 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.

What happens if the solution you have chosen does not work? Figure 11.2 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 increase sales, 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.

HIGH-VELOCITY AUTOMATED DECISION MAKING

Today, many decisions organizations make are not made by managers or any humans. For instance, when you enter a query in Google's search engine, Google's computer system has to decide which URLs to display in about half a second on average (500 milliseconds). High-frequency trading programs at electronic stock exchanges in the

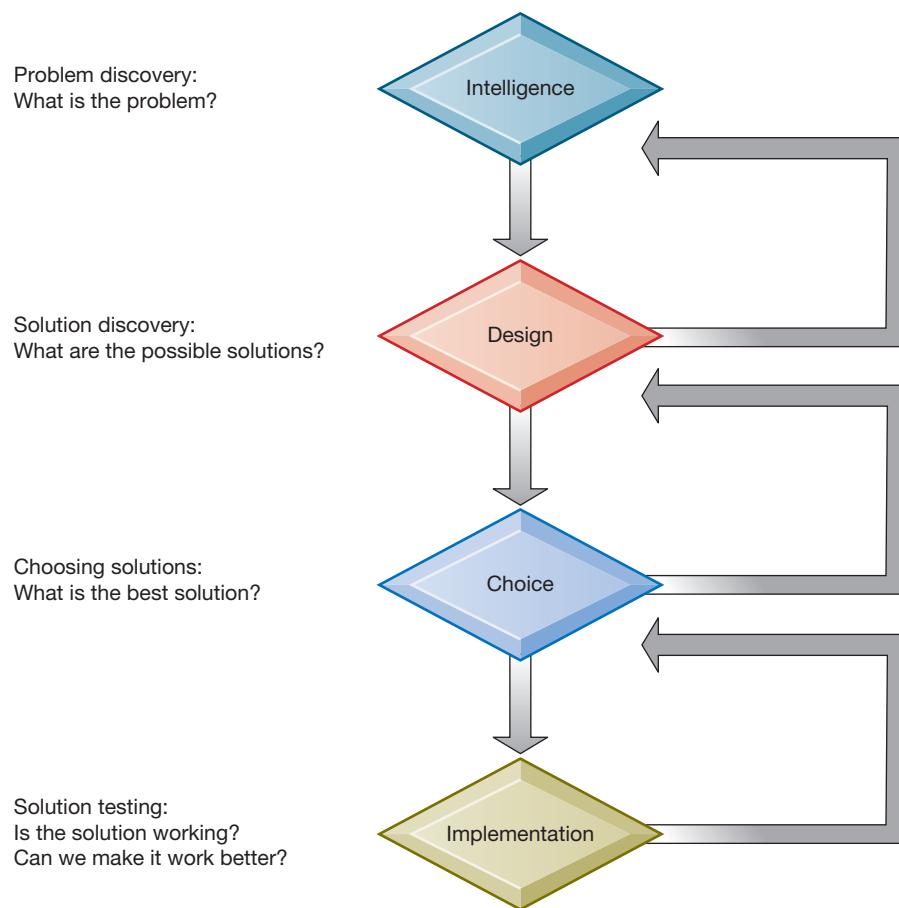


Figure 11.2
Stages in Decision
Making.

The decision-making process can be broken down into four stages.

TABLE 11.2

Qualities of Decisions and the Decision-Making Process

Quality Dimension	Description
Accuracy	Decision reflects reality
Comprehensiveness	Decision reflects a full consideration of the facts and circumstances
Fairness	Decision faithfully reflects the concerns and interests of affected parties
Speed (efficiency)	Decision making is efficient with respect to time and other resources, including the time and resources of affected parties, such as customers
Coherence	Decision reflects a rational process that can be explained to others and made understandable
Due process	Decision is the result of a known process and can be appealed to a higher authority

United States execute their trades within nanoseconds. Humans are eliminated from the decision chain because they are too slow.

In these high-speed automated decisions, the intelligence, design, choice, and implementation parts of the decision-making process are captured by computer algorithms that precisely define the steps to be followed to produce a decision. The people who wrote the software identified the problem, designed a method for finding a solution, defined a range of acceptable solutions, and implemented the 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.

QUALITY OF DECISIONS AND DECISION MAKING

How can you tell whether a decision has become better or the decision-making process has improved? Accuracy is one important dimension of quality; in general, we think decisions are better if they accurately reflect the real-world data. Speed is another dimension; we tend to think that the decision-making process should be efficient, even speedy. For instance, when you apply for car insurance, you want the insurance firm to make a fast and accurate decision. However, there are many other dimensions of quality in decisions and the decision-making process to consider. Which is important for you will depend on the business firm where you work, the various parties involved in the decision, and your own personal values. Table 11.2 describes some quality dimensions for decision making. When we describe how systems “improve decisions and the decision-making process” in this chapter, we are referencing the dimensions in this table.

II-2 How do business intelligence and business analytics support decision making?

Chapter 2 introduced you to different kinds of systems for supporting the levels and types of decisions we have just described. The foundation for all of these systems is a business intelligence and business analytics infrastructure that supplies data and the analytic tools for supporting decision making.

WHAT IS BUSINESS INTELLIGENCE?

“Business intelligence” (BI) is a term that hardware and software vendors and information technology consultants use to describe the infrastructure for warehousing, integrating, reporting, and analyzing data that come from the business environment.

The foundation infrastructure collects, stores, cleans, and makes available relevant data 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; it focuses more on tools and techniques for analyzing and understanding data. Think OLAP (online analytical processing), statistics, models, and data mining, which we also introduced in Chapter 6.

BI and analytics are essentially about integrating all the information streams a firm produces into a single, coherent enterprise-wide set of data and then using modeling, statistical analysis, and data mining tools to make sense out of all these data so managers can make better decisions and better plans.

It is important to remember that BI and analytics are products defined by technology vendors and consulting firms. The largest five providers of these products are SAP, Oracle, IBM, SAS, and Microsoft. A number of BI and BA products now have cloud and mobile versions.

THE BUSINESS INTELLIGENCE ENVIRONMENT

Figure 11.3 gives an overview of a BI 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 BI environment:

- **Data from the business environment:** Businesses must deal with both structured and unstructured data from many 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 BI is a powerful database system that captures all the relevant data to operate the business. The data may be stored in transactional databases or combined and integrated into an enterprise data warehouse, series of interrelated data marts, or analytic platforms.
- **Business analytics toolset:** A set of software tools is used to analyze data and produce reports, respond to questions managers pose, and track the progress of the business by using key indicators of performance.
- **Managerial users and methods:** BI hardware and software are only as intelligent as the human beings who use them. Managers impose order on the analysis of

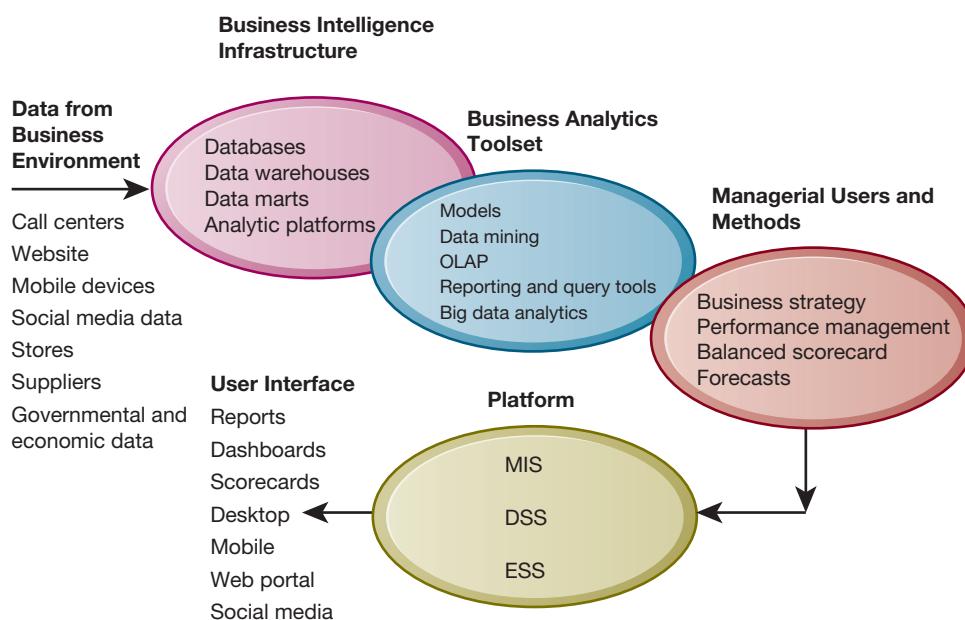


Figure 11.3
Business Intelligence and Analytics for Decision Support.
Business intelligence and analytics require a strong database foundation, a set of analytic tools, and an involved management team that can ask intelligent questions and analyze data.

data by 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 that focus on key performance indicators, with special attention to competitors.

- **Delivery platform—MIS, DSS, ESS:** The results from BI and analytics are delivered to managers and employees in a variety of ways, depending on what they need to know to perform their job. MIS, decision-support systems (DSS), and executive support systems (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 easily share data and operated as independent systems. Today, business intelligence and analytics tools can 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. Today's business analytics software suites feature **data visualization** tools, such as rich graphs, charts, dashboards, and maps. They can deliver reports on mobile phones and tablets as well as on the firm's website. For example, Tableau Software enables nontechnical users to quickly and 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. Another example is the process mining software used by Siemens AG to visualize and analyze its business processes (see the Interactive Session on Technology).

Virtual Reality and Augmented Reality

Virtual reality (VR) systems have powerful capabilities for three-dimensional data visualization. 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.

Virtual reality applications are currently found in entertainment, retail, and manufacturing, where an immersive experience can help customers visualize products or

Data visualization tools facilitate creation of graphs, charts, dashboards, and maps to make it easier for users to obtain insights from data.



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INTERACTIVE SESSION: TECHNOLOGY Siemens Makes Business Processes More Visible

Siemens AG is a German manufacturing conglomerate that produces systems and components for industrial automation, healthcare, energy, building, and transportation markets. The company is headquartered in Munich and Berlin, with 372,000 employees worldwide, and global revenue of €83 billion (approximately US \$99 billion) in fiscal 2017. Siemens is the largest industrial manufacturing company in Europe, with branch offices abroad. This is clearly a company that prizes innovation and continuous improvement of the efficiency and quality of its business processes.

Siemens has thousands of business processes, some of which are very complex. Management was seeking better ways of making the business more efficient and turned to business process mining technology. In 2014 the company established a unit called Process DAsh (which stands for Data Analytics, smart handling) to actively support global process optimization in all Siemens divisions. It started collecting and analyzing ERP data to identify bottlenecks in its production, delivery, and payment processes using Celonis Process Mining analysis and visualization software for this purpose. Celonis partners with SAP, and its software runs on the SAP HANA in-memory database platform.

Process mining software analyzes data in enterprise application event logs to determine how business processes are actually working in order to identify bottlenecks and other areas of inefficiency so that they can be improved. The technology can analyze millions of transaction records and spot deviations from normal workflows. A push of a button produces a snapshot of an entire business process. Process DAsh used the Celonis software to take all the individual data in a large number of information systems and use them to construct logical models of existing business processes and automatically visualize them. The software documents actual processes in real time, as the sequence of events is taking place.

When process mining software is used to analyze the transaction logs of an ERP or CRM system, data visualization capabilities in the software can show users what processes are running at any given time. An organization might use process mining software to find the cause of unexpected delays in invoice processing by examining the logs of the accounts payable module in its ERP system. Users can see at a glance where inefficiencies

occur through bottlenecks, unnecessary detours, and manual interventions, or where compliance issues might arise. Some process mining software, including Celonis, enables users to drill down to view the individual documents associated with a process.

Celonis has capabilities for comparing users' target operating models to the as-is process, providing an automated fit-gap analysis. Celonis analyzes root causes for deviations and performance loss, highlighting the issues that have the greatest impact on process performance. At the touch of a button, the user can see a comparison between the target and actual process and also visualize the main cause of delays and additional expenditure.

If a process model doesn't already exist, the software will try to create one automatically, sometimes using artificial intelligence techniques such as machine learning (see section 11-4). If a process model is available, the process mining software will compare it to the event log to identify discrepancies and their possible causes. For process modeling, Siemens uses a Celonis tool called Pi Conformance and Machine Learning. The software predicts which customer orders are likely to arrive late using algorithms that continuously learn from Siemens' performance.

Siemens started using Celonis analysis and visualization tools to learn how quickly it pays its suppliers. Some suppliers offer discounts for early payment. Siemens was often unable to take advantage of these discounts because it was unable to pay quickly enough. The company used process mining to analyze data from its ERP, accounting, and payment approval systems to understand why this was happening. Siemens also used process mining to study inefficiencies in the way it takes orders from and is paid by its customers (order-to-cash processes).

Before implementing the Celonis software, Siemens had to manage its business processes manually. Individual supervisors were responsible for specific processes. When things did not go as planned, such as when a machine broke down or a parts shipment arrived late, there was no easy way to determine exactly how these occurrences impacted overall operations.

There was some resistance to process mining among some long-term Siemens managers who thought they already knew how to handle processes efficiently. Lars Reinkemeyer, head of

Siemens global process mining services, was able to promote analytics adoption by identifying individuals who were receptive to process mining and enlisting them to promote the new technology. Since Siemens AG implemented process mining, it has been able to identify slowdowns in parts procurement, late product deliveries, and billing inefficiencies that were costing the company millions

of dollars. Siemens AG now has over 2,500 users of Process DAsh worldwide.

Sources: Lindsay Clark, "Siemens Success Sets the Scene for Growth in Process Mining," *Computer Weekly*, April 12, 2018; Julian Baumann, "Siemens Is the World's Biggest User of Process Mining" and "Success Story: Siemens," www.celonis.com, accessed April 22, 2019; Margaret Rouse, "Process Mining Software," searchERP.com, June 30, 2017; and Ed Burns, "Siemens Uses Process Mining Software to Improve Manufacturing Visibility," SearchBusinessAnalytics.com, December 15, 2016.

CASE STUDY QUESTIONS

1. Identify the problem in this case study. What people, organization, and technology factors contributed to the problem?
2. Describe the capabilities of process mining software. Was this an effective solution? Explain your answer.
3. How did process mining change decision making at Siemens?
4. What people, organization, and technology issues need to be addressed when implementing process mining systems?

teach factory workers how to use complex equipment. Audi has used virtual reality technology in its "dealership in a briefcase" program. By donning an Oculus Rift virtual reality headset, prospective buyers can feel as if they are sitting behind the wheel of a car or opening up the trunk. The VR headset displays in 3-D exactly what you'd see if you were looking over a real-life Audi. Volkswagen Group is 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 US 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).

BUSINESS INTELLIGENCE AND ANALYTICS CAPABILITIES

BI 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 11.3).

Business Functional Area	Production Reports
Sales	Sales forecasts, 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

TABLE 11.3

Examples of Predefined Business Intelligence Production Reports

Parameterized reports: Users enter several parameters 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 eastern United States buy most of their coffee in the morning, whereas in the northwest 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 later in this section.)

Dashboards/scorecards: These are visual tools for presenting performance data users define.

Ad hoc query/search/report creation: This allows 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 capabilities for linear forecasting, what-if scenario analysis, and data analysis, using standard statistical tools.

Predictive Analytics

An important capability of BI 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. Georgia State and other colleges and universities are using predictive analytics to examine millions of student academic and personal records to spot students in danger of dropping out.

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 BI applications for sales, marketing, finance, fraud detection, and healthcare. One of the best-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 marketing campaigns and other efforts to cultivate customers. By identifying customers more likely to respond, companies can 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 10 million daily active users, uses predictive analytics to identify customers who are most likely to use its products 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 merchandise to stock. Most of these product recommendations, however, are 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. Now some firms 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 retention rates. Table 11.4 provides examples of companies using big data analytics.

In the public sector, big data analytics are driving the movement toward smart cities, which make intensive use of digital technology and public record data stores to make better decisions about running cities and serving their residents. Municipalities are capturing more data through sensors, location data from mobile phones, and

TABLE 11.4

What Big Data Analytics Can Do

Organization	Big Data Capabilities
Tesco	One of the largest retailers in the world, the firm set up its own subsidiary, Dunnhumby, to provide itself and other retailers with expertise using big data analytics to gain customer insights, reduce inventory waste, and optimize their use of energy. Tesco has detailed data on more than 350 million customers in 28 different countries.
Standard Bank	Uses big data and IBM Watson to speed handling of customer queries, allowing it to identify customers quickly so they can respond in faster time.
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.
eHarmony	Online dating website analyzes personal and behavioral data provided by 20 million users to match couples based on features of compatibility found in thousands of successful relationships. Processes more than 3.5 million matches daily.

targeted smartphone apps. Predictive modeling programs now inform utility management, transportation operation, healthcare delivery, and public safety. For example, irrigation systems built into the city of Barcelona's parks monitor soil moisture and turn on sprinklers when water is needed. The city expects to reduce its water bill by 25 percent per year after installing sensors in local parks.

Operational Intelligence and Analytics

Many decisions deal with how to run cities and businesses 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. Companies can set trigger alerts on events or have them fed into live dashboards to help managers with their decisions.

An example of operational intelligence is the use of data generated by sensors on trucks, trailers, and intermodal containers owned by Schneider National, one of North America's largest truckload, logistics, and intermodal services providers. The sensors monitor location, driving behaviors, fuel levels, and whether a trailer or container is loaded or empty. Data from fuel tank sensors help Schneider identify the optimal location at which a driver should stop for fuel based on how much is left in the tank, the truck's destination, and fuel prices en route. Schneider's sensors also capture hard braking in a moving truck and relay the data to corporate headquarters, where the data are tracked in dashboards monitoring safety metrics. The event initiates a conversation between the driver and that person's supervisor.

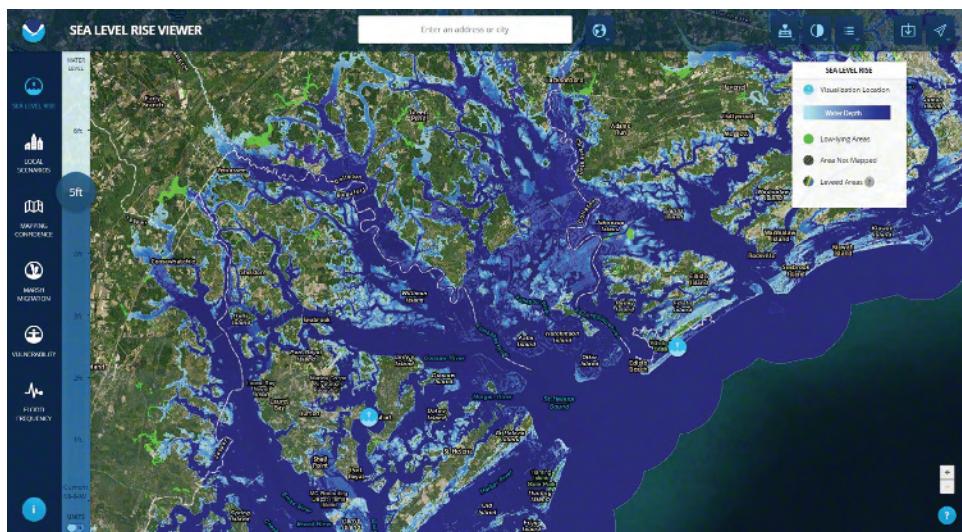
The Interactive Session on Organizations describes how oil and gas companies are using operational intelligence for preventive maintenance, which can predict which pieces of equipment or infrastructure might shortly break down so that maintenance can be scheduled before failure occurs.

Location Analytics and Geographic Information Systems

Big data 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

The US National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management provides a web mapping tool to visualize community-level impacts from coastal flooding or sea level rise up to 6 feet above average high tides. Photo simulations of how future flooding might impact local landmarks are also provided, as well as data related to water depth, connectivity, flood frequency, socioeconomic vulnerability, and wetland loss and migration.

Source: Courtesy of U.S. National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management.



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 midsized 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.predix.io, accessed May 20, 2019; “BP and GE Announce New Offshore Digital Technology with Plans to Deploy Globally,” www.powergenadvancement.com, accessed June 12, 2019; “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; Laura Winig, “GE’s Big Bet on Data and Analytics,” *MIT Sloan Management Review*, February 2016; and Holly Lugassy, “GE Leverages Pivotal Cloud Foundry to Build Predix, First Cloud for Industry,” CloudFoundry.org, May 11, 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.

on in-store visits. Location analytics would help a utility company identify, view, and measure outages and their associated costs as related to customer location to help prioritize marketing, system upgrades, and customer service efforts. UPS’s package tracking and delivery routing systems, described in Chapter 1, use location analytics, as does an application Starbucks uses to determine where to open new stores. (The system identifies geographic locations that will produce a high sales-to-investment ratio and per-store sales volume.)

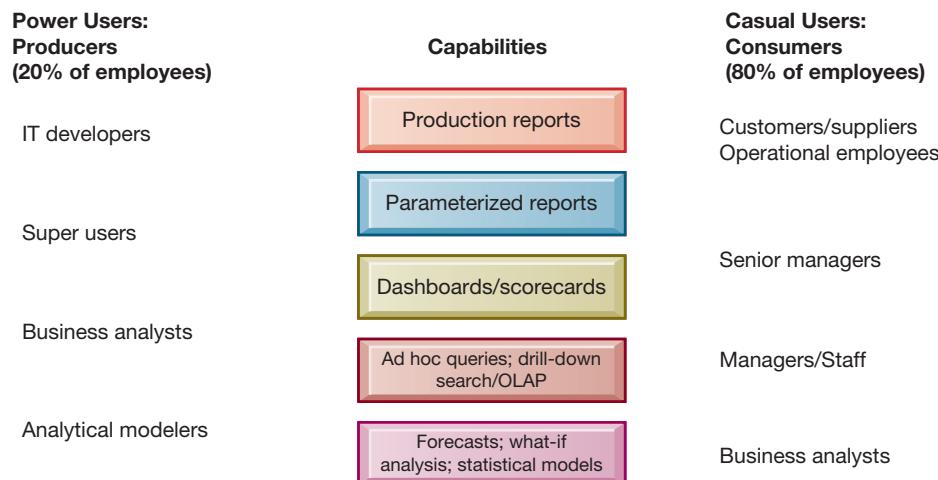
The Starbucks and utility company applications are examples of **geographic information systems (GIS)**. GIS provide tools to help decision makers visualize problems that benefit from mapping. GIS software ties location data about the distribution of people or other resources to points, lines, and areas 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 locations for new branches or ATM terminals, or to help police forces pinpoint locations with the highest incidence of crime.

BUSINESS INTELLIGENCE USERS

Figure 11.4 shows that more than 80 percent of the audience for BI consists of casual users. Senior executives tend to use BI to monitor firm activities by using visual interfaces such as 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.

Figure 11.4
Business Intelligence Users.

Casual users are consumers of BI output, whereas intense power users are the producers of reports, new analyses, models, and forecasts.



Support for Semistructured Decisions

Many BI prepackaged production reports are MIS reports supporting structured decision making for operational and middle managers. We described operational and middle management, and the systems they use, in Chapter 2. Some managers, however, are super users and keen business analysts who want to create their own reports; they use more sophisticated analytics and models to find patterns in data, to model alternative business scenarios, or to test specific hypotheses. 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 to 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 11.5). Backward sensitivity analysis helps 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 one of the key business intelligence technologies. Spreadsheets have a similar feature for multidimensional analysis, called a **pivot table**, which superuser managers and analysts employ to identify and understand patterns in business information that may be useful for semistructured decision making.

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	2111			
16	1357	1462	1583	1727	1900	1900			
17	1267	1357	1462	1583	1727	1727			
18	1188	1267	1357	1462	1583	1583			

Figure 11.5
Sensitivity Analysis.

This table 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?"

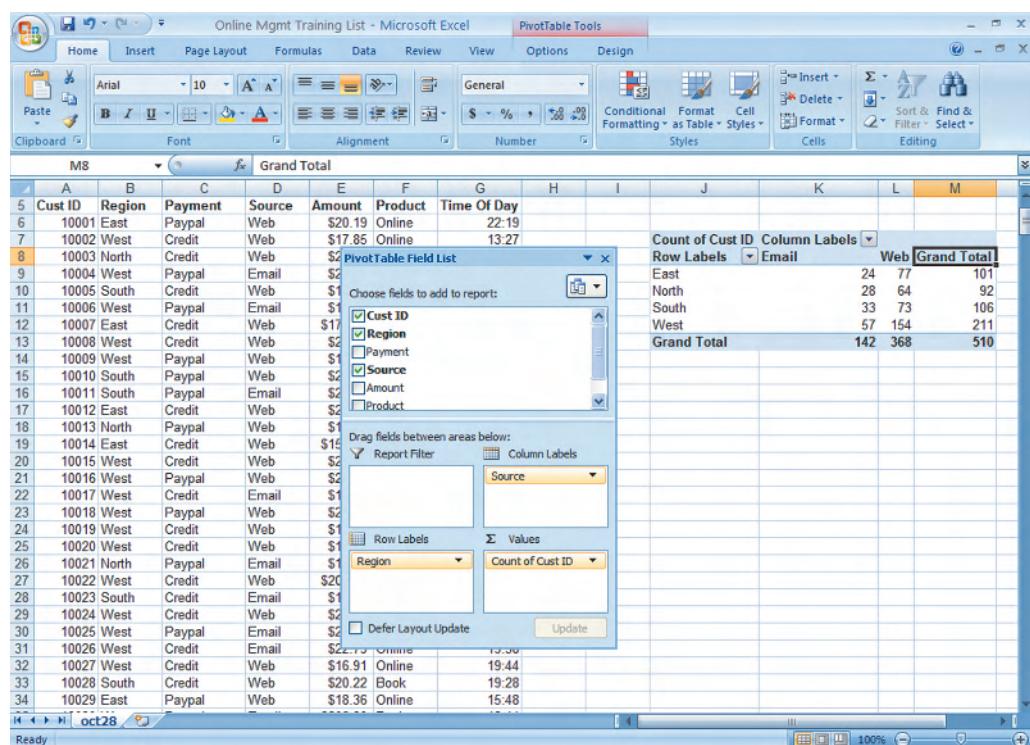


Figure 11.6 illustrates a Microsoft Excel pivot table that examines a large list of order transactions for a company selling online management training videos and books. It shows the relationship between two dimensions: the sales region and the source of contact (web banner ad or email) for each customer order. It answers the question of whether the source of the customer makes 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.

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 by 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 have a Learning Track on creating pivot tables by 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, and they can analyze data from large corporate databases. BI analytics include tools for intensive modeling. 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 aged 30 or older 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 insure customers profitably in traditionally high-risk categories that other insurers would have rejected.

Decision Support for Senior Management: The Balanced Scorecard and Enterprise Performance Management

BI delivered in the form of ESS helps senior executives focus on the most important performance information that affects the overall profitability and success of the firm. A leading methodology for understanding this important information a firm's

Figure 11.6
A Pivot Table That Examines Customer Regional Distribution and Advertising Source.

In this pivot table, we can examine where an online training company's customers come from in terms of region and advertising source.

Source: Courtesy of Microsoft Corporation

Figure 11.7
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.



executives need is called the **balanced scorecard method**. The balanced scorecard is a framework for operationalizing a firm's strategic plan by focusing on measurable outcomes of four dimensions of firm performance: financial, business process, customer, and learning and growth (see Figure 11.7).

Performance of 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 such as 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 can influence today, such as business process efficiency, customer satisfaction, and employee training. Once consultants and senior executives develop a scorecard, the next step is automating a flow of information to executives and other managers for each of the key performance indicators.

Another closely related management methodology is **business performance management (BPM)**. Originally defined by an industry group in 2004 (led by the same companies that sell enterprise and database systems, such as Oracle, SAP, and IBM), BPM attempts to translate a firm's strategies (e.g., differentiation, low-cost producer, market share growth, and scope of operation) systematically into operational targets. Once the strategies and targets are identified, a set of key performance indicators is developed to measure progress toward the targets. The firm's performance is then measured with information drawn from the firm's enterprise database systems.

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 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—readily available and 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.

II-3 What is artificial intelligence (AI)? How does it differ from human intelligence?

“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 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 6 percent; and in translation among common languages, Google’s Translate program achieves about 85 percent accuracy compared to humans. These advances have made possible personal assistants like Siri (Apple), Alexa (Amazon), Cortana (Microsoft), and Now (Google), 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.

II-4 What are the major types of AI techniques and how do they benefit organizations?

Artificial intelligence is a family of programming techniques and technologies, each of which has advantages in select applications. Table 11.5 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.

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

TABLE 11.5

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.

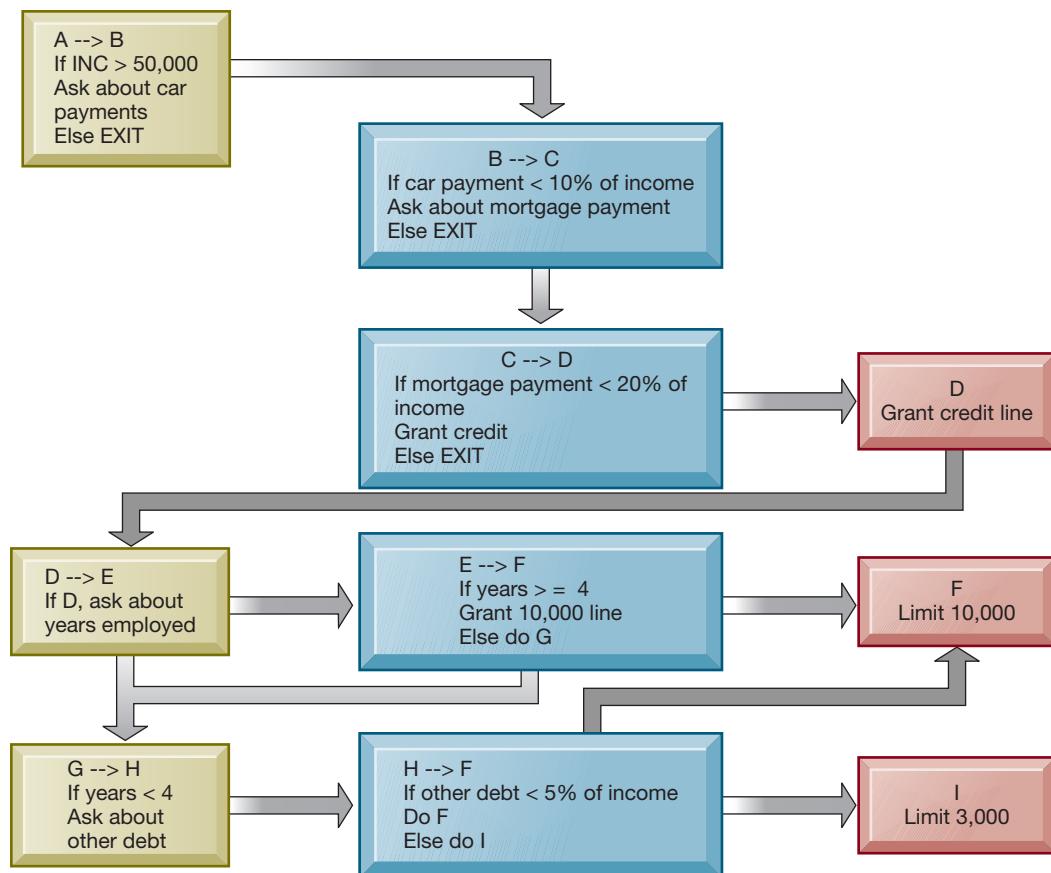


Figure 11.8
Rules in an Expert System.
 An expert system contains a number of rules to be followed. The rules are interconnected, the number of outcomes is known in advance and is limited, there are multiple paths to the same outcome, and the system can consider multiple rules at a single time. The rules illustrated are for simple credit-granting expert systems.

engineering, building maintenance, drawing up building plans, and educational technology (personalized learning and responsive testing) (Maor, 2003). 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 11.8 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 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 in the last decade 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, genetic algorithms, and deep learning networks, 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 finds patterns and relationships in the data by analyzing a large set of examples and making a statistical inference. Many of today's Big Data analytics applications such as Royal Dutch Shell's predictive maintenance system or Siemens' process mining system described in this chapter utilize machine learning. Table 11.6 provides some examples of how leading business firms are using various types of machine learning.

Facebook has over 200 million monthly users in the United States who spend an average of 35 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. Analysts estimate that Facebook uses at least 100,000 servers located in several very large-scale "hyper datacenters" to perform this task. 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 10 million photos posted

TABLE 11.6

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 150 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 170 million customers who generate four billion transactions annually.

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, some of which 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 at an acceptable rate. The machine learning system is then tested using the test database to ensure the algorithms can achieve the same results with a different set of photos. In many cases, but not all, machine learning can come close to or equal human efforts, but on a very much larger scale and much faster. 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 84 billion neurons, each with over 10,000 connections to other neurons (synapses), and over one trillion total connections in its network (brain). The human brain consumes about 7 watts of energy to operate. Modern *homo sapiens* have been programmed (by nature) for an estimated 300,000 years, and their mammalian predecessors for 2.5 million years. For these reasons, machine learning is applicable today in a 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 there is a talented and large group of software and system engineers working the problem. A large power supply measuring up to several hundred thousand watts for large problems or continuous operations like Google or Facebook also is helpful.

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 cancerous tumor, fraudulent credit card transactions, or suspicious telephone calling patterns.

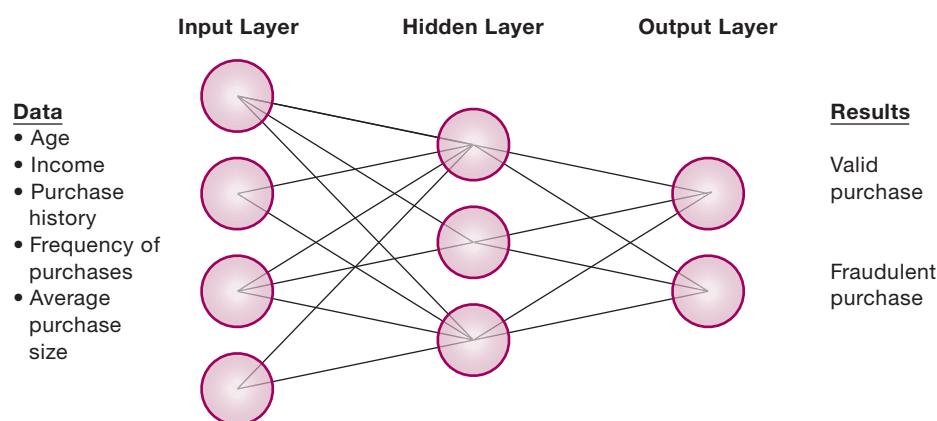
Neural networks find patterns and relationships in very large amounts of data that would be too complicated and difficult for a human being to analyze by using machine learning algorithms and computational models that are loosely based on how the biological human brain is thought to operate. Neural networks 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, 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 cancerous tumors about as well as humans, or even better than humans.

Figure 11.9 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 11.9 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 probabilities, 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. 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 11.7 provides examples of neural networks.

Figure 11.9
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.



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

TABLE 11.7

Examples of Neural Networks

“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. They 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 11.10.

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).

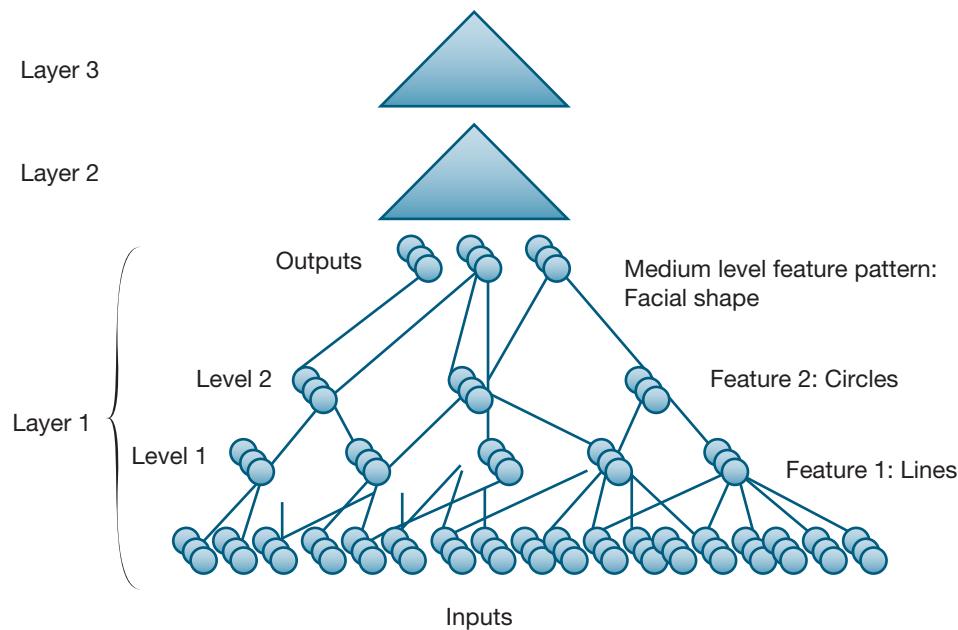
Limitations of Neural Networks and Machine Learning

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 sets. For instance, should you

Figure 11.10

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.



apply to College A or College B? Should we merge with another company? Answers to many important questions are difficult to specify, or describe, and in that sense are only semistructured at best, and depend greatly on human assessments, judgments, and sentiments.

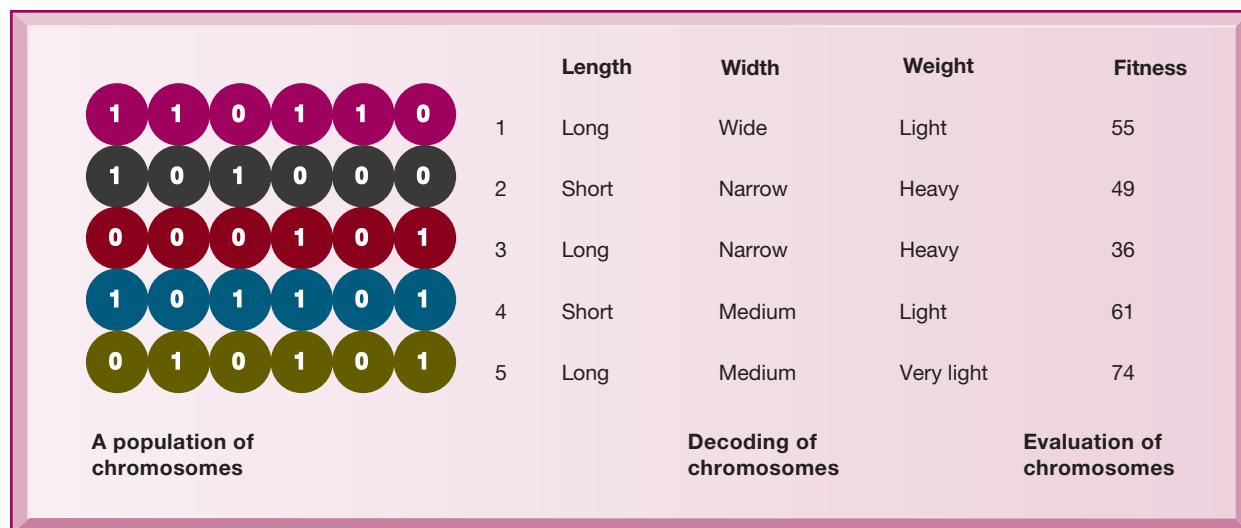
Systems engineers do not know why neural networks and machine learning arrive at conclusions (Olah and Satyanarayan, 2018). For instance, in the case of the IBM Watson computer playing Jeopardy, researchers could not say exactly why Watson chose the answers it did, only that they were either right or 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 in systems where errors do not have catastrophic consequences like death or injury, 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 11.11, 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 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.

**Figure 11.11****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.

Genetic algorithms are used to solve problems that are 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 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. Akershus University Hospital, described in the chapter-opening case, used NLP and IBM Watson Explorer to sift through thousands of medical records with unstructured textual data expressed in everyday language like natural speech. The algorithms could read text on a medical record and classify its meaning. You can also 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, 2019).

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 will help 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 2017, the National Basketball Association (NBA) decided to allow sponsors to place small logo patches representing their brands on player uniforms. This advertising investment turned out to be worth its multimillion-dollar cost. According to GumGum, an AI company focusing on computer vision technology, the image placed by The Goodyear Tire & Rubber Co. on the uniforms of the Cleveland Cavaliers generated \$3.4 million in value from social media exposure alone during the first half of the baseball season. GumGum develops algorithms that enable computers to identify what's happening in imagery. GumGum used computer vision technology to thoroughly analyze broadcast and social media content for placement, exposure, and duration involving Goodyear images that appeared in online or in TV-generated NBA content. Instead of humans trying to monitor the number of times a logo appeared on a screen, GumGum's vision technology tracks and reports the data (Albertson, 2018).

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), manufacturing processes, military operations (drones), and medical procedures (surgical robots). Many employees now worry whether robots will replace people entirely and take away their jobs.

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.

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 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 Google Now, 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. Vodafone, a multinational telecommunications company, uses a chatbot to answer 80,000 questions per month, reducing contact center calls for 75 percent of the customers it chats with. Vodafone staff use the chatbot to access accurate, up-to-date information on Vodafone products and services. Facebook has integrated chatbots into its Messenger messaging app so that an outside company with a Facebook brand page can interact with Facebook users through the chat program. Today's chatbots perform very basic functions. As they become more technologically advanced, people using IT applications will increasingly use these "conversational agents" as a major tool for interacting with systems.

II-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, is looking for an entry-level sales assistant. RMD 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 are the different types of decisions, and how does the decision-making process work?** Decisions may 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.

11-2 **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 the 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.

Management information systems (MIS) producing prepackaged production reports are typically used to support operational and middle management, whose decision making is fairly structured. For making unstructured decisions, analysts and super users employ 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).

11-3 What is artificial intelligence (AI)? How does it differ from human intelligence? The most ambitious vision of 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 in limited domains. AI systems today can perform many tasks that would be impossible for humans to accomplish, and can equal or come close to humans in certain well-defined tasks.

11-4 What are the major types of AI techniques and how do they benefit organizations? 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 emulate the human visual system to 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.

Key Terms

Artificial intelligence (AI), 429	Expert system, 430	Neural networks, 434
Augmented reality (AR), 420	Genetic algorithms, 436	Operational intelligence, 423
Balanced scorecard method, 428	Geographic information systems (GIS), 425	Pivot table, 426
Business performance management (BPM), 428	Implementation, 415	Predictive analytics, 421
Chatbot, 439	Inference engine, 431	Robotics, 438
Choice, 415	Intelligence, 415	Semistructured decisions, 414
Computer vision systems, 438	Intelligent agents, 439	Sensitivity analysis, 426
Data visualization, 418	Key performance indicators (KPIs), 428	Structured decisions, 414
“Deep learning,” 435	Knowledge base, 431	Supervised learning, 432
Design, 415	Location analytics, 423	Unstructured decisions, 414
Drill down, 428	Machine learning (ML), 432	Unsupervised learning, 433
	Natural language processing, 437	Virtual reality (VR) systems, 418

Review Questions

- II-1** What are the different types of decisions, and how does the decision-making process work?
- List and describe the different decision-making levels and groups in organizations and their decision-making requirements.
 - Distinguish among an unstructured, semistructured, and structured decision.
 - List and describe the stages in decision making.
- II-2** How do business intelligence and business analytics support decision making?
- Define and describe business intelligence infrastructure and analytics toolsets.
 - Describe ways that user interfaces make business analytics software suites more usable.
 - Explain the purpose of a parameterized report.
 - Describe how virtual reality and augmented reality enhance data visualization and decision making.
 - Describe how a decision maker might be able to use geographic information systems.
 - Describe a pivot table and suggest who might use it.
 - Explain why predictive analytics are incorporated into BI applications.
- II-3** What is artificial intelligence (AI)? How does it differ from human intelligence?
- Define artificial intelligence (AI).
 - Explain how AI differs from human intelligence.
- II-4** What are the major types of AI techniques and how do they benefit organizations?
- 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.
 - Compare supervised and unsupervised learning
 - 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.
 - Define and describe computer vision systems, natural language processing systems, and robotics and give examples of their applications in organizations.

MyLab MIS™

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

Discussion Questions

- 11-5** If businesses used DSS and ESS more widely, would they make better decisions? Why or why not?
MyLab MIS
- 11-6** How much can business intelligence and business analytics help companies refine their business strategy? Explain your answer.
MyLab MIS
- 11-7** How intelligent are AI techniques?
MyLab MIS Explain your answer.

Hands-On MIS Projects

The projects in this section give you hands-on experience identifying opportunities for business intelligence, using a spreadsheet pivot table to analyze sales data, 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** Dealerships for Toyota 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 a mileage of 130,000 instead of 30,000? How would it affect decision making? Assess its business impact.
- 11-9** Applebee's is the largest casual dining chain in the world, with more than 1,800 locations throughout the United States and 20 other 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 gasoline and 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 about 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

- 11-10** This project gives you an opportunity to learn how to use Excel's PivotTable functionality 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 products while at work (likely during the day) or at home (likely in the evening)?

- What's the relationship among 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 INTELLIGENT AGENTS FOR COMPARISON SHOPPING

Software skills: Web browser and shopping bot software

Business skills: Product evaluation and selection

- II-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 SX530 or the Olympus Tough TG-5. Visit MySimon, BizRate.com, 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 in making your decision?

COLLABORATION AND TEAMWORK PROJECT

Investigating Data-Driven Analytics in Sports

- II-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.

BUSINESS PROBLEM-SOLVING CASE

CAN CARS DRIVE THEMSELVES—AND SHOULD THEY?

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 the following:

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 rear-view 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 US 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.

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 the elderly and disabled 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. Cadillac Super Cruise, Nissan ProPILOT Assist, and Tesla Autopilot are capable of keeping a car in its lane and a safe distance from other cars, allowing 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 "hand-off 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.

The accidents that self-driving cars have experienced so far point to the need to create a dependable standard for measuring reliability and safety. By 2018, 29 states had enacted legislation regulating autonomous vehicles, with a few states requiring a safety driver always be in the car ready to take control. US federal

regulators have delayed formulating an overarching set of self-driving car standards, leaving a gap for the states to fill. The federal government is still working on autonomous vehicle legislation. H.R. 3388, a bill passed by voice vote last year, would help create uniform standards for the development of driverless cars.

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CASE STUDY QUESTIONS

- 11-13** What are the people, 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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Chapter 12

Making the Business Case
for Information Systems and
Managing Projects

Building and Managing Systems

Part IV 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 managers select systems projects and technologies that will deliver the greatest value to the firm? 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?

CHAPTER
12

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:

- I2-1** How should managers build a business case for the acquisition and development of a new information system?
- I2-2** What are the core problem-solving steps for developing a new information system?
- I2-3** What are the alternative methods for building information systems?
- I2-4** How should information systems projects be managed?
- I2-5** How will MIS help my career?

CHAPTER CASES

- Angostura Builds a Mobile Sales System
- Systems Development Is Different for Mobile Apps
- Arup Moves Project Management to the Cloud
- Maersk's TradeLens: Digitizing the Global Supply Chain

VIDEO CASES

- NASA Project Management Challenges
 - IBM: Business Process Management in a SaaS Environment
 - IBM Helps the City of Madrid with Real-Time BPM Software
- Instructional Videos:*
- What Is PaaS? What Is Predix?
 - BPM: Business Process Management Customer Story

MyLab MIS

- Discussion Questions:
12-5, 12-6, 12-7
- Hands-On MIS Projects:
12-8, 12-9, 12-10,
12-11

ANGOSTURA BUILDS A MOBILE SALES SYSTEM

House of Angostura (also known as Angostura Limited), headquartered in Laventille, Trinidad, is one of the Caribbean's leading rum producers and the world market leader for bitters used in many cocktails. Angostura has 330 full-time employees and an annual revenue of approximately \$100 million.

Angostura still takes care of local distribution of its products in Trinidad and Tobago, with a team of 16 sales representatives taking orders out in the field. Although this arrangement worked well in the past, the process was heavily manual, tedious, and time-consuming and sometimes produced inaccurate orders.

Each day, the 16 sales reps in the field had to copy the orders on paper and return to the office to hand off the order forms to a customer service representative, who would then manually input the order data into Angostura's SAP enterprise resource planning (ERP) system. Because the orders were handwritten, information could be read and entered incorrectly, which could result in the wrong goods being sent to a customer. Such inaccurate orders were often returned, creating more paperwork and higher costs. Angostura also used manual processes for reporting and tracking invoices and accounts receivable information, which could create additional delays and errors.

The sales representatives were also working with data on product availability that might be out of date. If the sales reps were away from the office, they would not be able to tell whether an order could actually be fulfilled. They would have to call Angostura's warehouse to find out if fulfilling an order was possible.

In 2012 Angostura's management decided that the sales process needed to be more streamlined and efficient and that it should use mobile technology. The company identified a set of detailed information requirements for the improved sales process and spent more than a year evaluating system solutions from five mobile vendors. One important requirement was that the application should be able to automatically update the availability of purchased products from the company's overall inventory and integrate with the firm's back-end SAP ERP system. Another requirement was that the mobile system be able to operate offline so that a sales representative could still input an order on a mobile device even if there



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was no online connectivity. Once online, the device could then send the order through to the ERP system.

The vendor selected was the one that could best develop the mobile application to the company's specifications and stay within the budget established by management. In 2013 Angostura partnered with IDS Scheer and itCampus consultants to develop a mobile sales solution running on Apple iPads. The solution includes an offline customer database, product catalog, customer-specific pricing, order entry, order preview, and integration with Bluetooth wireless printers. It was quickly created using SAP NetWeaver Gateway technology to connect various devices and platforms to SAP software. A pilot application was ready for testing that June, and the entire application went live January 2014.

Each of Angostura's 16 sales representatives was issued an iPad that includes not only the order application but other mobile apps to make the sales process more efficient, such as email, Google Maps, and a video and PDF document uploader to display the Angostura product line. The sales application integrates with the corporate ERP system, providing the sales reps with up-to-date information on the availability of products in the warehouse.

With the Angostura Mobile Sales App, an order can be created in less than 30 seconds, depending on the size of the order, making the ordering process two times faster. There is a 20 percent time savings per salesperson because the sales reps now have the ability to send orders remotely as they place them rather than waiting until they return to the office. The amount of time customer service representatives would typically spend on data entry—which was considerable—has been reduced by 75 percent, freeing up time for more useful tasks. Returned orders have been reduced by 30 percent.

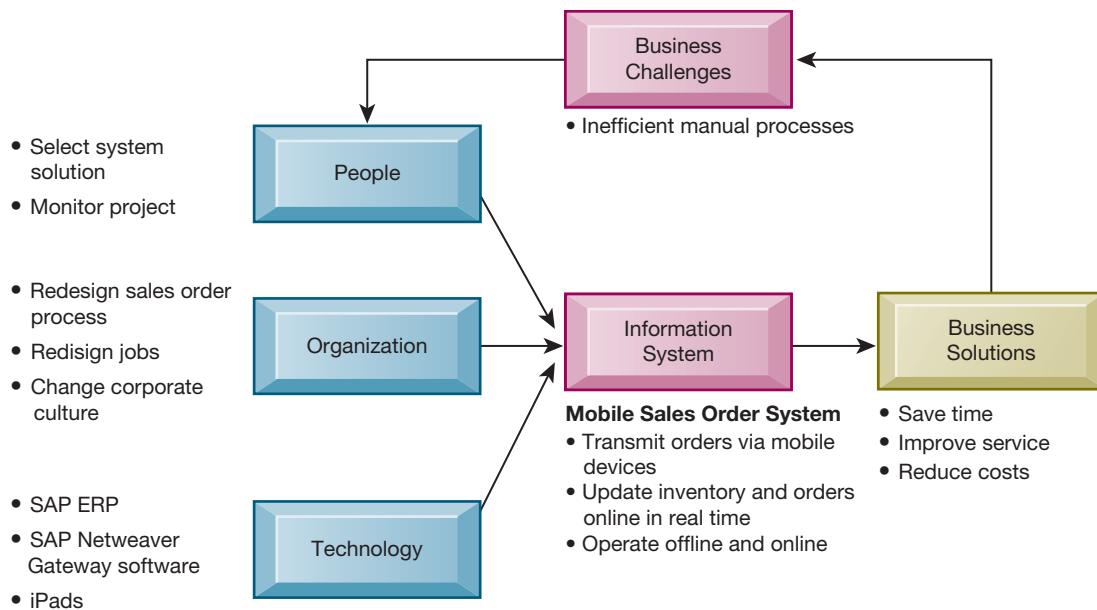
Sources: Natalie Miller, "Generations-Old Company with a Modern Twist on Sales," *SAP Insider Profiles*, January 2016; www.angostura.com, accessed February 10, 2019; and IDS Scheer Consulting Group, "Angostura's iPad-Based SAP Mobile Sales Solution," 2014.

Angostura's experience illustrates some of the steps required to plan, build, and implement new information systems. Building a new system for mobile sales orders entailed analyzing the organization's problems with existing systems, assessing information requirements, selecting appropriate technology, and redesigning business processes and jobs. Angostura's system builders had to make a convincing business case for investing in a new sales system, namely that it would solve the firm's order entry problems. 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. Angostura succeeded with this project because its management clearly understood that strong project management and attention to organizational change were essential to success.

The chapter-opening case calls attention to important points raised by this case and this chapter. Angostura's ability to handle sales orders was hampered by outdated and inefficient manual processes, which raised costs, slowed down work, and limited the company's ability to serve its customers.

The solution was to redesign the sales order process to use mobile devices and software and allow orders to be entered through iPads and transmitted to the firm's back-end ERP system. Angostura's information requirements were incorporated into the system design. The solution encompassed not just the application of new technology but changes to corporate culture, business processes, and job functions. Angostura's sales operations have become much more efficient and far less error prone.

Here are some questions to think about: How did Angostura's Mobile Sales App meet its information requirements? How effective a solution was Angostura's Mobile Sales App? Why? How much did the new system change the way Angostura ran its business?



12-1 How should managers build a business case for the acquisition and development of a new information system?

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 investment 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 when 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 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. A good business case will also describe how the proposed solution may require changes in organizational culture, systems, processes, and jobs.

Figure 12.1 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, like the Angostura mobile order entry system described in the opening

Figure 12.1
Factors to Consider
in Making the Business
Case.

There are seven major factors that should be addressed when making the business case for a new information system.



case, 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 (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 12.1). 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 11). 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.

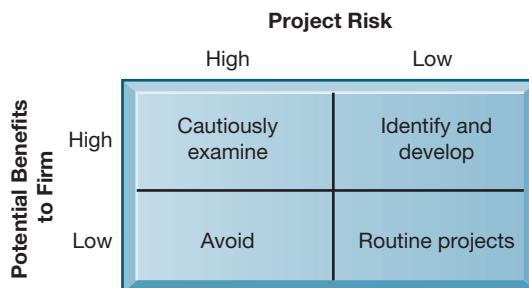
<p>1. Purpose of the Plan</p> <ul style="list-style-type: none"> Overview of plan contents Current business organization and future organization Key business processes Management strategy <p>2. Strategic Business Plan Rationale</p> <ul style="list-style-type: none"> Current situation Current business organization Changing environments Major goals of the business plan Firm's strategic plan <p>3. Current Systems</p> <ul style="list-style-type: none"> Major systems supporting business functions and processes Current infrastructure capabilities <ul style="list-style-type: none"> Hardware Software Database Networking and Internet Cloud services Difficulties meeting business requirements Anticipated future demands <p>4. New Developments</p> <ul style="list-style-type: none"> New system projects <ul style="list-style-type: none"> Project descriptions Business rationale Applications' role in strategy New infrastructure capabilities required <ul style="list-style-type: none"> Hardware Software Database Networking and Internet Cloud services <p>5. Management Strategy</p> <ul style="list-style-type: none"> Acquisition plans Organizational realignment Management controls Major training initiatives Human Resources strategy <p>6. Implementation of the Plan</p> <ul style="list-style-type: none"> Anticipated difficulties in implementation Progress reports and milestones <p>7. Budget Requirements</p> <ul style="list-style-type: none"> Resources Potential savings Financing Acquisition cycle 	<p>TABLE 12.1</p> <p>Information Systems Plan</p>
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PORTRFOLIO ANALYSIS AND SCORING MODELS

Once you have determined the overall direction of systems development in the firm by establishing a firm-wide IS Plan, **portfolio analysis** is one tool that can help you evaluate alternative system projects. Portfolio analysis inventories all of the firm's information systems projects and assets, including infrastructure, outsourcing contracts,

Figure 12.2

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 information systems needs.



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 12.2), similar to a financial portfolio. Each information systems project carries its own set of risks and benefits. Firms try to improve the return on their information system portfolios by balancing the risk and return from their systems investments.

Obviously, you begin first by focusing on systems of 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.

Another method for evaluating alternative system solutions is a **scoring model**. Scoring models give alternative systems a single score based on the extent to which they meet selected objectives. Table 12.2 shows part of a simple scoring model that Angostura could have used in evaluating proposed system solutions for improving the sales process. The first column lists the criteria that decision makers use to evaluate the systems. Table 12.2 shows that Angostura attaches the most importance to capabilities for sales order processing, ease of use, ability to support individual sales reps taking orders, and system access from mobile platforms. The second column in Table 12.2 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 system solution meets. Each alternative's score is calculated by multiplying the percentage of requirements met for each function by the weight attached to that function. Solution alternative 2 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?

Table 12.3 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, 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). Some of the tangible benefits Angostura obtained were increased productivity and lower operational costs resulting from streamlining the ordering process and reduced errors. Intangible benefits included customer satisfaction, more timely information, and improved operations.

TABLE 12.2

Example of a Scoring Model for the Angostura Mobile Sales System

Criteria	Weight	Alternative 1 (%)	Alternative 1 Score	Alternative 2 (%)	Alternative 2 Score
1.1 Order processing					
1.2 Online order entry	5	67	335	83	415
1.3 Order tracking by sales rep	5	81	405	75	375
1.4 Order tracking by customer	5	30	150	80	400
Total order processing			890		1,190
2.1 Ease of use					
2.2 System access from mobile platforms	5	55	275	92	460
2.3 Short training time	4	79	316	85	340
2.4 User-friendly online screens and data entry	4	65	260	87	348
Total ease of use			851		1,148
3.1 Costs					
3.2 Software costs	3	51	153	65	195
3.3 Hardware (cloud services) costs	4	57	228	90	360
3.4 Maintenance and support costs	4	42	168	89	356
Total costs			549		911
Grand Total			2,290		3,249

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

TABLE 12.3

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
Higher client satisfaction
Better corporate image

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, and the internal rate of return (IRR). Figure 12.3 illustrates part of the capital budgeting analysis for an online ordering system similar to Angostura's. 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. You can find out more about how these capital budgeting methods are used to justify information system investments in our Learning Tracks.

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		\$5,000	\$5,000	\$5,000	\$5,000	\$5,000
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%					

Figure 12.3

Capital Budgeting for an Information System Investment.

This worksheet illustrates a simplified capital budgeting analysis for a mobile sales ordering system

12-2 What are the core problem-solving steps for developing a new information system?

A new information system is built as a solution to a problem or set of problems the organization perceives it is facing. The problem may be one in which managers and employees believe that the business is not performing as well as expected, or it may come from the realization that the organization should take advantage of new opportunities to perform more effectively.

The problem-solving process introduced in Chapter 1 provides the facts and findings needed to develop a strong business case and to implement the right solution. Figure 12.4 illustrates the four steps we would need to take: (1) define and understand the problem, (2) develop alternative solutions, (3) choose the best solution, and (4) implement the solution.

Before a problem can be solved, first it must be properly defined. Members of the organization must agree that a problem actually exists and that it is serious. The problem must be investigated so that it can be better understood. Next comes a period of devising alternative solutions, then one of evaluating each alternative and selecting the best solution. The final stage is one of implementing the solution, in which a detailed design for the solution is specified, translated into a physical system, tested, introduced to the organization, and further refined as it is used over time.

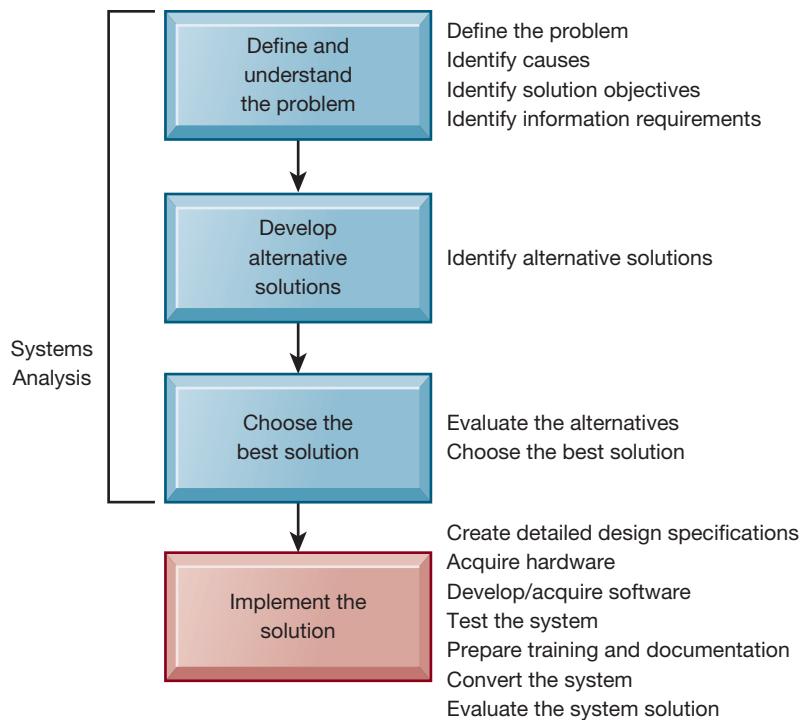
In the information systems world, we have a special name for these activities. Figure 12.4 shows that the first three problem-solving steps, when we identify the problem, gather information, devise alternative solutions, and make a decision about the best solution, are called **systems analysis**.

DEFINING AND UNDERSTANDING THE PROBLEM

Defining the problem may take some work because various members of the company may have different ideas about the nature of the problem and its severity. What caused the problem? Why is it still around? Why wasn't it solved long ago? Systems analysts typically gather facts about existing systems and problems by examining documents, work papers, procedures, and system operations and by

Figure 12.4
Developing an
Information System
Solution.

Developing an information system solution is based on the problem-solving process.



interviewing key users of the system, including employees, managers, and customers if they will be users of the system.

Information systems problems in the business world typically result from a combination of people, organization, and technology factors. When identifying a key issue or problem, ask what kind of problem it is: Is it a people problem, an organizational problem, a technology problem, or a combination of these? What people, organizational, and technological factors contributed to the problem?

Once the problem has been defined and analyzed, it is possible to make some decisions about what should and can be done. What are the objectives of a solution to the problem? Are they to reduce costs, increase sales, or improve relationships with customers, suppliers, or employees? Do managers have sufficient information for decision making? What information is required to achieve these objectives?

At the most basic level, the **information requirements** of a new system identify 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. 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 12-2 describes alternative approaches to eliciting requirements that help minimize this problem. In the case of Angostura, the problem is that the traditional ordering process has been excessively manual and time-consuming, with high error rates.

The objectives of a solution for Angostura would be to reduce the amount of time, effort, and errors in the ordering process while making it possible to submit orders online from any location. Information requirements for the solution include the ability to take orders instantly, the ability to track orders by type of product or account, the ability to track the status of orders, and the ability to interact with the company's ERP system.

DEVELOPING ALTERNATIVE SOLUTIONS

What alternative solutions are possible for achieving these objectives and meeting these information requirements? The systems analysis lays out the most likely paths to follow given the nature of the problem. Some possible solutions do not require an information

system solution but instead call for an adjustment in management, additional training, or refinement of existing organizational procedures. Some, however, do require modifications of the firm's existing information systems or an entirely new information system.

EVALUATING AND CHOOSING SOLUTIONS

The systems analysis includes a **feasibility study** to determine whether each proposed solution is feasible, or achievable, from financial, technical, and organizational standpoints. The feasibility study establishes whether each alternative solution is a good investment, whether the technology needed for the system is available and can be handled by the firm's information systems staff, and whether the organization is capable of accommodating the changes the system introduces.

A written systems proposal report describes the costs and benefits and advantages and disadvantages of each alternative solution. Which solution is best in a financial sense? Which works best for the organization? The systems analysis will detail the costs and benefits of each alternative and the changes that the organization will have to make to use the solution effectively. We provide a detailed discussion of how to manage change in the following section. On the basis of this report, management will select what it believes is the best solution for the company.

IMPLEMENTING THE SOLUTION

The first step in implementing a system solution is to create detailed design specifications. **Systems design** shows how the chosen solution should be realized. The system design is the model or blueprint for an information system solution and consists of all the specifications that will deliver the functions identified during systems analysis. These specifications should address all the technical, organizational, and people components of the system solution.

Table 12.4 shows some of the design specifications for the online ordering system discussed earlier, which were based on information requirements for the solution that was selected. These design specifications apply to both the web and mobile app platforms.

Completing Implementation

In the final steps of implementing a system solution, the following activities would be performed:

- *Hardware selection and acquisition.* System builders select appropriate hardware for the application. They would either purchase the necessary computers and mobile devices, lease them from a technology provider, or lease processing services from a cloud computing vendor.
- *Software development and programming.* Software for ordering may be custom programmed in-house or purchased from an external source such as an outsourcing vendor, an application software package vendor, or an online software service provider. The core ordering system and databases are in corporate data centers or in remote servers accessed through the Internet.
- *Testing.* The system is thoroughly tested to ensure that it produces the right results. The testing process requires detailed testing of individual computer programs, called **unit testing** as well as **system testing**, which tests the performance of the information system as a whole. **Acceptance testing** provides the final certification that the system is ready to be used in a production setting. Information 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.

TABLE 12.4

Design Specifications for
Online Ordering System

Output	Online reports Hard-copy reports Online queries Order transactions
Input	Order entry forms Order status request screen
Database	Database with order file, customer file,
Processing	Calculate order totals by type of product Transmit orders to distribution centers Track orders by customer Track orders by sales rep Schedule deliveries Update customer data for account changes
Manual procedures	Sales reps contact customers by phone, email, text message
Security and controls	Online passwords Only authorized sales reps and company employees can access the system Only company-owned mobile devices can be used for entering orders or accessing corporate data
Conversion	Input Input customer data Test system
Training and documentation	System guide for users Online training sessions and tutorials

The systems development team works with users to devise a systematic test plan. The **test plan** includes all the preparations for the series of tests we have just described. Figure 12.5 shows a sample from a test plan that could be used for a mobile ordering system. The condition being tested is online access of the system by an authorized user.

- *Training and documentation.* End users and information system specialists require training so that they will be able to use the new system. Detailed **documentation** in the form of hard copy training manuals or online tutorials showing how the system works from both a technical and end-user standpoint must be prepared.
- *Conversion* is the process of changing from the old to the new system. There are four main conversion strategies: 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 correctly. The old system remains available as a backup in case of problems. The **direct cutover strategy** replaces the old system entirely with the new system on an appointed day, carrying the risk that there is no system to fall back on if problems arise. The **pilot study** strategy introduces a new system to only a limited area of the organization, such as a single department or operating unit. Once this pilot version is working smoothly, it is installed throughout the rest of the organization. A **phased approach** introduces the system in stages, such as first implementing payroll processing for hourly workers who are paid weekly and later for salaried employees paid monthly.

Test Case Number: GS02-010	
Prepared by: A. Patterson	Date: February 19, 2020
Objective: This subtest checks for an authorized user accessing the system.	
Platform: iOS	
<p>Procedure Description: Select Sign In Select Username Enter Username Select Password Enter Password Select Submit</p> <p>Expected Result: When user selects Sign In, the Sign In menu appears When user selects User Name, the cursor moves to the User Name field When user enters that person's system user name the user name appears on the screen When user selects Password, the cursor moves to the Password field. When user enters that person's password, the password appears on the screen as asterisks When user selects Submit, the system verifies the entered data and allows the user to access the system When user enters an incorrect (or unauthorized) username or password, the error message "Wrong User Name or Password" appears</p>	
<p>Test Results: All OK</p>	

Figure 12.5

A Sample Test Plan for a Mobile Ordering System.

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.

Illustrated here is a test case for accessing the mobile ordering system for an authorized user.

- *Production and maintenance.* After the new system is installed and conversion is complete, the system is said to be in **production**. During this stage, users and technical specialists review the solution to determine how well it has met its original objectives and to decide whether any revisions or modifications are in order. Changes in hardware, software, documentation, or procedures to a production system to correct errors, meet new requirements, or improve processing efficiency are termed **maintenance**.

Managing the Change

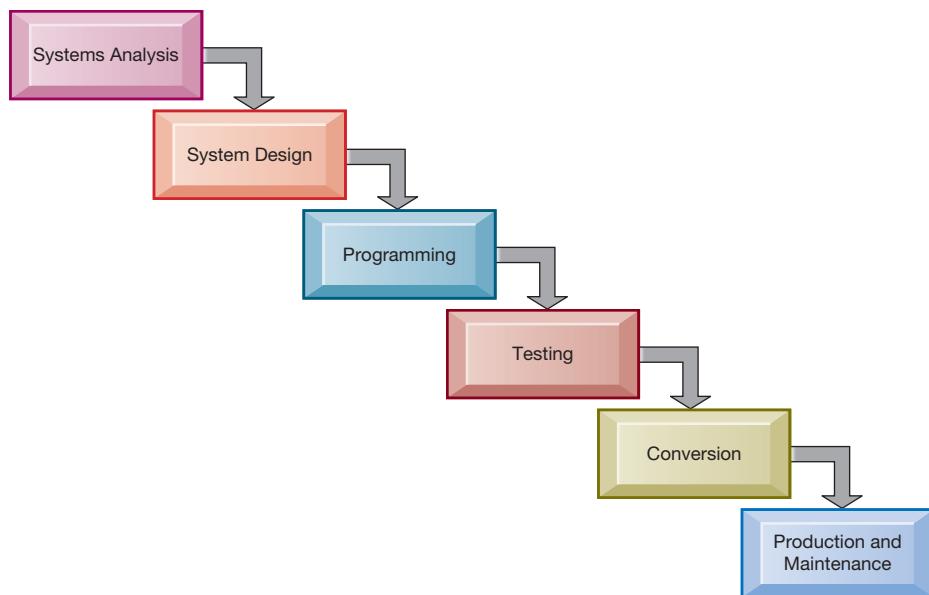
Developing a new information systems solution is not merely a matter of installing hardware and software. The business must also deal with the organizational changes that the new solution will bring about—new information, new business processes, and perhaps new reporting relationships and decision-making power. A well-designed solution may not work unless it is introduced to the organization very carefully. The process of planning change in an organization so that it is implemented in an orderly and effective manner is so critical to the success or failure of information system solutions that we devote Section 12-4 to a detailed discussion of this topic.

12-3 What are the alternative methods for building information systems?

There are alternative methods for creating system solutions by using the basic problem-solving model we have just described. These alternative methods include the traditional systems life cycle, prototyping, end-user development, application software packages, and outsourcing.

Figure 12.6
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.



TRADITIONAL SYSTEMS DEVELOPMENT LIFE CYCLE

The **systems development life cycle (SDLC)** is the oldest method for building information systems. The life cycle methodology is a phased approach to building a system, dividing systems development into a series of formal stages, as illustrated in Figure 12.6. 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.

This approach 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 rigorous and formal requirements analysis, predefined specifications, and tight controls over the systems-building process. However, this approach is also time-consuming and expensive to use. Tasks in one stage are supposed to be 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 and apps, which tend to be less structured and more individualized.

PROTOTYPING

Prototyping consists of building an experimental system rapidly and inexpensively for end users to evaluate, and then revising the prototype based on user feedback. The prototype is a working version of an information system or part of the system, but it is intended as only a preliminary model. Users interact with the prototype to get a better idea of their information requirements, refining the prototype multiple times. When the design is finalized, the prototype will be converted to a polished production system. Figure 12.7 shows a four-step model of the prototyping process.

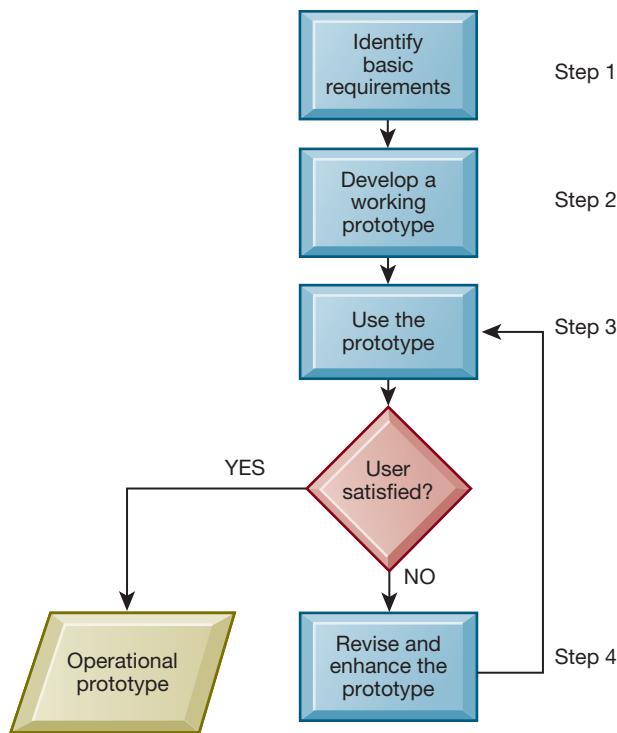


Figure 12.7
The Prototyping Process.

The process of developing a prototype consists of 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.

Step 1: *Identify the user's basic requirements.* The system 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 system 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 whether the prototype meets his or her needs and to suggest improvements for 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.

Prototyping is especially useful in designing an information system's user interface. Because prototyping encourages intense end-user involvement throughout the systems development process, it is more likely to produce systems that fulfill user requirements.

However, rapid prototyping may gloss over essential steps in systems development, such as thorough testing and documentation. If the completed prototype works reasonably well, management may not see the need to build a polished production system. Some hastily constructed systems do not easily accommodate large quantities of data or a large number of users in a production environment.

END-USER DEVELOPMENT

End-user development allows end users, with little or no formal assistance from technical specialists, to create simple information systems, reducing the time and steps required to produce a finished application. Using user-friendly query, reporting, website development, graphics, and PC software tools such as Excel or Access, end users can access data, create reports, and develop simple applications on their own with little or no help from professional systems analysts or programmers. For example, CEMEX,

an international supplier of products for the construction industry, used InformationBuilders' WebFOCUS to create a self-service reporting portal to visualize financial and operational data.

On the whole, end-user-developed systems are completed more rapidly than those developed with conventional programming tools. Allowing users to specify their own business needs improves requirements gathering and often leads to a higher level of user involvement and satisfaction with the system. End-user development tools, however, still cannot replace conventional tools for some business applications because they cannot easily handle the processing of large numbers of transactions or applications with extensive procedural logic and updating requirements.

End-user development also poses organizational risks because systems are created rapidly, without a formal development methodology, testing, and documentation. To help organizations maximize the benefits of end-user applications development, management should require cost justification of end-user information system projects and establish hardware, software, and quality standards for user-developed applications.

APPLICATION SOFTWARE PACKAGES, SOFTWARE SERVICES, AND OUTSOURCING

Chapter 5 points out that much of the software underlying contemporary information systems is not developed in-house but is acquired from external sources. Firms can rent the software from an online software service provider, purchase a software package from a commercial vendor to run in-house, or have an in-house application developed by an external outsourcing firm. Selection of the software or software service is often based on a **Request for Proposal (RFP)**, which is a detailed list of questions submitted to external vendors to see how well they meet the requirements for the proposed system.

Application Software Packages and Cloud Software Services

Systems are increasingly 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.

If a cloud software service or software package can fulfill most of an organization's requirements, the company does not have to write its own software. The company saves time and money by using the prewritten, predesigned, pretested software programs from the package and SaaS vendors, who also provide ongoing maintenance and upgrades for the system. Many packages include capabilities for customization to meet unique requirements not addressed by the prewritten software. **Customization** features allow prewritten software to be modified to meet an organization's unique requirements without destroying the integrity of the software. If extensive customization is required, however, additional programming and customization work may become so expensive and time-consuming that it negates many of the advantages of software packages or services. If the software cannot be customized, the organization will have to adapt by changing 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. 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. Rather than hire permanent new employees 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 tends to be driven by cost. A skilled programmer in India or Russia earns about US \$10,000 to \$20,000 per year, compared to \$80,000 or more per year for a comparable programmer in the EU and United States. The Internet and low-cost communications technology have drastically reduced the expense and difficulty of coordinating the work of global teams in faraway locations. In addition to cost savings, many offshore outsourcing firms offer world-class technology assets and skills. For example, leading companies such as Hilton, NBC, Fox News, and Yahoo have outsourced website design and development work to India-based Profit By Outsourcing, which provides expertise in areas such as custom programmed content management, e-commerce solutions, mobile application development, and application development using Java and other tools that are not available internally in most companies. However, wage inflation outside the United States has eroded some of these advantages, and some jobs have moved back to the United States.

Your firm is most likely to benefit from outsourcing if it takes the time to evaluate all the risks and 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, source of expected 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. 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. These hidden costs undercut some of the anticipated benefits from outsourcing. Firms should be especially cautious when using an outsourcer to develop or operate applications that give some type of competitive advantage.

Figure 12.8 shows best- and worst-case scenarios for the total cost of an offshore 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.

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	0.2%	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%

Figure 12.8
Total Cost of Offshore Outsourcing.
If a firm spends \$10 million on offshore outsourcing contracts, that company will spend 15.2 percent in extra costs even in the best-case scenario. In the worst-case scenario, when 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.

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 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 software for 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 through 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 stand-alone 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 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 can also 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 such as Android and Apple's iOS.

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. The Interactive Session on Technology describes how some companies have addressed the challenges of mobile development we have just identified.

Just about all businesses today want to deploy mobile apps and they want these apps developed in a short time frame. That's not so easy.

Developing successful mobile apps poses some unique challenges. The user experience on a mobile device is fundamentally different from that on a PC. There are special features on mobile devices such as location-based services that give firms the potential to interact with customers in meaningful new ways. Firms need to be able to take advantage of those features while delivering an experience that is appropriate to a small screen. There are multiple platforms for mobile software, including iOS, Android, and Windows 10, and a firm may need a different version of an application to run on each of these as well as on devices of different sizes and capabilities. Mobile devices might be tiny and worn on the wrist or they might be large high-definition tablet displays. They might include sensors and audio output and even displays combining real and virtual images. System builders need to understand how, why, and where customers use mobile devices and how these mobile experiences change business interactions and behavior. You can't just port a website or desktop application to a smartphone or tablet. It's a different systems development process. Many enterprises require applications that link to corporate systems and function on the desktop as well as on mobile devices.

Take, for example, Great-West Financial, the second largest retirement services company in the United States with approximately \$461 billion in assets under its administration. Company employees spend more time serving customers in the field rather than in the office and needed a connection to the company's ERP Financials system from wherever they are working to process accounts payable invoice approvals. Great-West decided to deploy the Dolphin Mobile Approvals app for this purpose.

Great-West selected Dolphin because it could handle all of its SAP workflows in a single app, so that employees did not have to go to one place to approve invoices and another to approve everything else. Great-West configured the app to make its look and feel as similar as possible to the application users accessed on their desktops. The user sees the same data fields on the invoice header and line item on a mobile device as on a desktop computer screen, and the steps in the invoice approval process are the same. Given the difficulty of jumping

back and forth between different screens on a mobile device, however, the mobile app incorporates the necessary invoice approval codes into its line-item detail rather than displaying these codes on a PDF attachment. On a desktop, users must sign into the SAP system in order to see an invoice and will receive notification that an invoice is available for approval via email. A pop-up notification on the mobile app eliminates the need for users to log into the app before knowing about an invoice.

Before deploying the mobile app, Great-West had to set up an appropriate mobile infrastructure, considering factors such as security, sign-on, and back-end integration. Since this was the company's first mobile app interfacing to the SAP system, the company had to make sure the mobile app could incorporate the entire workflow from the SAP system and that all the data was encrypted and secure. Great-West purchased 1,000 licenses for the mobile approvals app (which is compatible with both iOS and Android devices) and issued company-owned devices to senior executives and the heaviest invoice users. Remaining users are allowed to use the app on their own devices as long as they conform to the firm's BYOD policy.

For the past few years, United Parcel Service (UPS) has provided customers with a UPS Mobile app to track their shipments and obtain pricing information using smartphones and tablets. UPS developers initially wrote and maintained multiple versions of UPS Mobile, including one for iOS in Objective-C and another for Android in Java. This meant twice the work for UPS mobile developers. The different versions of the app might not be updated at the same time, so customers with different types of devices didn't always have access to the latest features at the same time.

UPS was able to move the UPS Mobile app to a single development platform, but this entailed an enormous amount of work. The company selected Visual Studio Tools for Xamarin for this purpose because it allowed developers to share one C++ code base across platforms and deliver fully native apps to customers. Xamarin also had better integration with mobile devices' unique hardware and capabilities. Although UPS had to rebuild more than 130,000 lines of code that had been written over a four-year period, management realized that rewriting UPS Mobile would produce dramatic time and cost savings in the long run. The company went ahead with developing on a single platform.

Much of the Xamarin code would need to be developed only once and it could support multiple platforms with great efficiency in the years to come. UPS mobile developers rewrote all versions of UPS Mobile with Visual Studio Tools for Xamarin. UPS can now add a new feature across all mobile devices in weeks and days instead of months.

Sources: Rob Bamforth, "Developers at the Mobile Edge," *Computer Weekly*, January 30–February 5, 2018; Mary K. Pratt and Linda Tucci, "Enterprise Mobile App Development: No Easy Answers," searchCIOtechtarget.com, accessed February 20, 2018; Microsoft, "UPS Paves the Way for Better Service with Faster Development and Artificial Intelligence," September 28, 2017; www.greatwest.com, accessed February 20, 2018; and Ken Murphy, "Great-West Financial Establishes Its Mobile Footprint," *SAP Insider Profiles*, October 31, 2016.

CASE STUDY QUESTIONS

1. What people, organization, and technology challenges need to be addressed when building a mobile application?
2. How does user requirement definition for mobile applications differ from traditional systems analysis?
3. Describe how Great-West's invoice approvals process changed after the mobile application was deployed.

RAPID APPLICATION DEVELOPMENT FOR E-BUSINESS

Technologies and business conditions are changing so rapidly that companies are adopting shorter, more informal development processes for many of their mobile and web-based applications. The term **rapid application development (RAD)** refers to the process of creating workable systems in a short period of time. RAD includes the use of visual programming and other tools for building graphical user interfaces, iterative prototyping of key system elements, the 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)** will be 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 development and frequent delivery of working software, with continual user involvement. It breaks down a large project into a series of small subprojects that are completed in short periods of time using iteration and continuous feedback. Improvement or addition of new functionality takes place within the next iteration as developers clarify requirements.

For example, UPS used Agile techniques when it modified its package tracking application (described in the Chapter 1 Interactive Session on Technology). Instead of trying to migrate all legacy applications off the corporate mainframe, project scope was limited to the tracking application, which constituted a small portion of the total UPS IT infrastructure. The work took place in iterative phases. The first phase captured tracking data stored using IBM's Db2 DBMS on the mainframe and transformed them for storage in an open source Couchbase database. While addressing data transformation, the UPS team broke the project down further to work on the mobile version of the tracking app first, which offered faster feedback on features. The team first updated international customers' mobile app interfaces, followed by US mobile customers. From there, the team moved on to update the desktop version of the package-tracking app (Pariseau, 2019).

Component-Based Development, Web Services, and Cloud-Based Development

To expedite software creation further, groups of objects have been assembled into software components for common functions, such as a graphical user interface or online ordering capability, and these components can be combined to create large-scale business applications. This approach to software development is called **component-based development**. Businesses are using component-based development to create their e-commerce applications by combining commercially available components for shopping carts, user authentication, search engines, and catalogs with pieces of software for their own unique business requirements.

Chapter 5 introduced web services as loosely coupled, reusable software components based on Extensible Markup Language (XML) and other open protocols and standards that enable one application to communicate with another with no custom programming required. In addition to supporting internal and external integration of systems, web services provide nonproprietary tools for building new information system applications or enhancing existing systems.

Platform as a service (PaaS), introduced in the Chapter 5 discussion of cloud computing, also holds considerable potential for helping system developers quickly write and test customer- or employee-facing applications. These online development environments come from a range of vendors, including Oracle, IBM, Salesforce.com (Force.com), and Microsoft (Azure). These platforms automate tasks such as setting up a newly composed application as a web service or linking to other applications and services. Some also offer a cloud infrastructure service, or links to cloud vendors such as Amazon, so that developers can launch what they build in a cloud infrastructure.

I2-4 How should information systems projects be managed?

Your company might have developed what appears to be an excellent system solution. Yet when the system is in use, it does not work properly or it doesn't deliver the benefits that were promised. If this occurs, your firm is not alone. There is a high failure rate among information systems projects because they have not been properly managed. 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 portfolio management provider Innatas in 2016 had experienced an IT project failure within the previous 12 months (Florentine, 2016). Firms may have incorrectly assessed the business value of the new system or were unable to manage the organizational change the new technology required. That's why it's essential to know how to manage information systems projects and the reasons they succeed or fail.

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 projects for replacing or upgrading 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 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 daily 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 result of a project satisfies the objectives management specified. 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 the new system produces 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. We discuss the most important risk factors for information systems projects later in this section.

MANAGING PROJECT RISK AND SYSTEM-RELATED CHANGE

Some systems development projects are more likely to run into problems 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. The larger the project—as indicated by the dollars spent, project team size, and how many parts of the organization will be affected by the new system—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. Risks are also higher for systems where information requirements are not clear and straightforward or the project team must master new technology.

Implementation and Change Management

Dealing with these project risks requires an understanding of the implementation process and change management. A broader definition of **implementation** refers to all the organizational activities working toward the adoption and management of an innovation, such as a new information system. Successful implementation requires a high level of user involvement in a project and management support.

If users are heavily involved in the development of a system, they have more opportunities to mold the system according to their priorities and business requirements and to control the outcome. They also are more likely to react positively to the completed system because they have been active participants in the change process.

The relationship between end users and information systems specialists has traditionally been a problem area for information systems implementation efforts because of differing backgrounds, interests, and priorities. These differences create a **user–designer communications gap**. Information systems specialists often have a highly

User Concerns	Designer Concerns
Will the system deliver the information I need for my work?	What demands will this system put on our servers?
Can we access the data on our mobile phones, 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?

TABLE 12.5

The User–Designer Communications Gap

technical orientation to problem solving, focusing on technical solutions in which hardware and software efficiency is optimized at the expense of ease of use or organizational effectiveness. End 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 12.5.

If an information systems project has the backing and commitment of management at various levels, it is more likely to receive higher priority from both users and the technical information systems staff. Management backing also ensures that a systems 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. According to the Project Management Institute, having executive sponsors who are actively engaged is the leading factor in project success (Project Management Institute, 2014).

Controlling Risk Factors

There are strategies you can follow to deal with project risk and increase the chances of a successful system solution. If the new system involves challenging and complex technology, you can recruit project leaders with strong technical and administrative experience. Outsourcing or using external consultants are options if your firm does not have staff with the required technical skills or expertise.

Large projects benefit from appropriate use of **formal planning and 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 12.9). 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 when **PERT charts** are useful. PERT stands for Program Evaluation and Review Technique, a methodology the US Navy developed 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 12.10.

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.

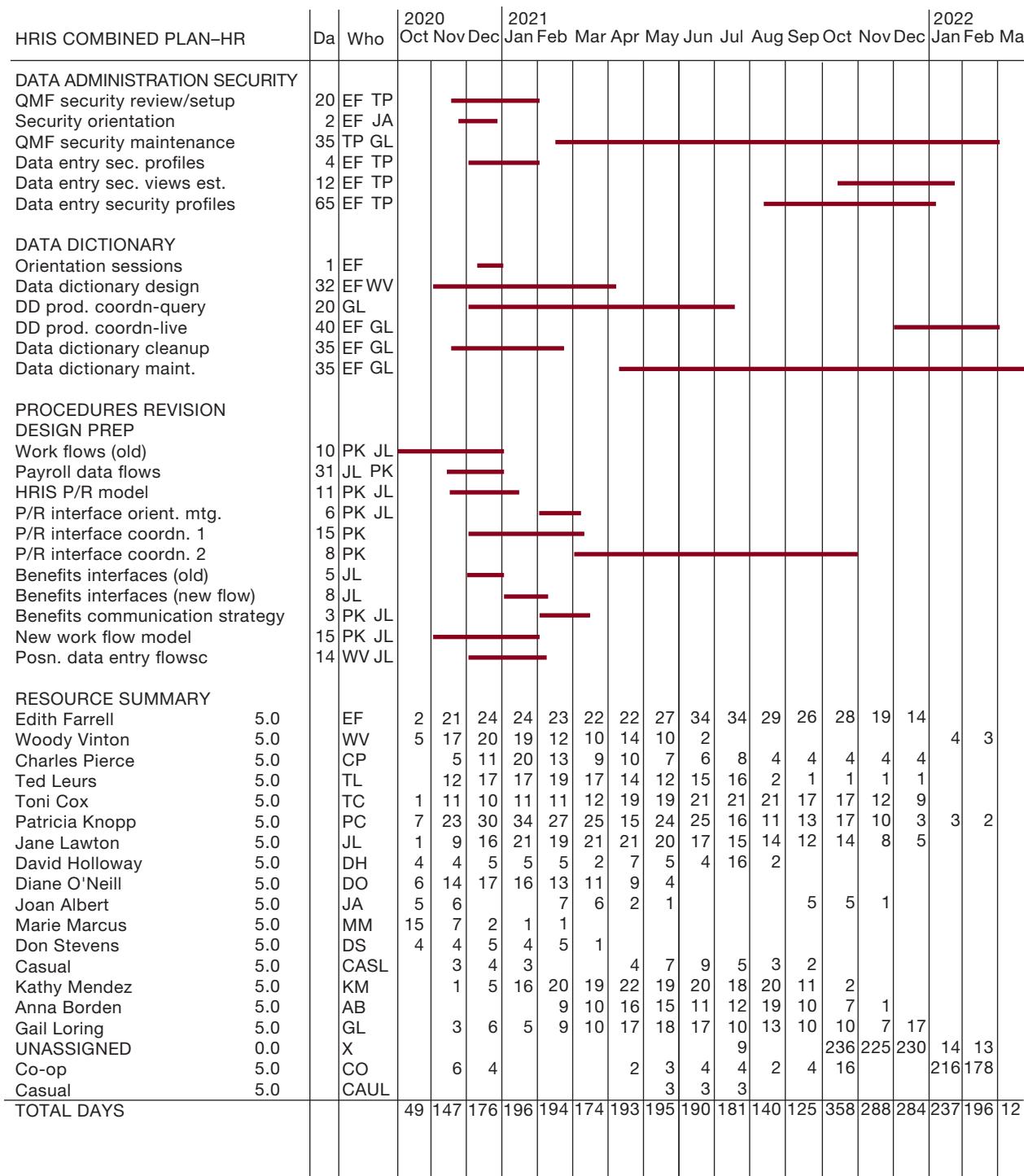
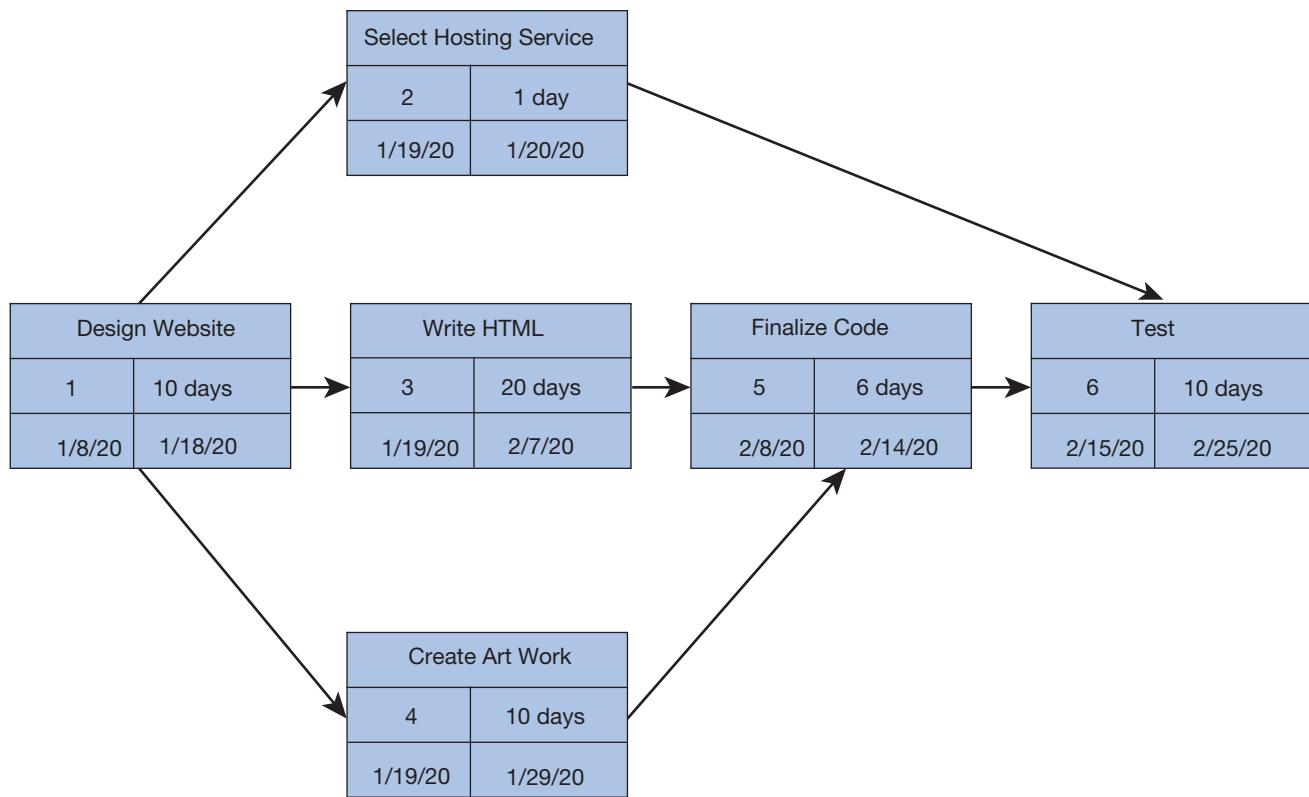


Figure 12.9
A Gantt Chart.

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 management project.

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 12.10, the tasks in nodes 2, 3, and 4 do not depend on each other and can be undertaken simultaneously, but each depends on completion of the first task.

**Figure 12.10****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.

Project Management Software

Commercial software tools are available to automate the creation of Gantt and PERT charts and 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 for tasks, tracking progress, and facilitating modifications to tasks and resources. The most widely used project management tool today is Microsoft Project, but there are also lower-cost tools for small projects and small businesses. Many of today's project management tools are cloud-based. The Interactive Session on Organizations describes some capabilities of Microsoft Project Online. We should also point out that these traditional project management tools are being supplemented with some of the social business tools described in Chapter 2.

Overcoming User Resistance

You can overcome user resistance by promoting user participation (to elicit commitment as well as improve design), by making user education and training easily available, and by providing better incentives for users who cooperate. End users can become active members of the project team, take on leadership roles, and take charge of system installation and training.

You should pay special attention to areas where users interface with the system, 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. For instance, if a system has a series of complicated online data entry screens that are extremely difficult or time-consuming to work with, users will reject the system if it increases their workload or level of job stress.

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 13,000 staff based in 85 offices across 35 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, the high-speed railway between London and Paris, and the National Aquatics Center for the 2008 Beijing Olympics.

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 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 January 2, 2018.

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 people, organization, and technology issues did Arup have to address when selecting Project Online as its global project portfolio management tool?

Users will be more cooperative if organizational problems are solved prior to introducing the new system. In addition to procedural changes, transformations in job functions, organizational structure, power relationships, and behavior should be identified during systems analysis, using an **organizational impact analysis**.

12-5 How will MIS help my career?

Here is how Chapter 12 and this book will help you find an entry-level job as an IT project management assistant.



THE COMPANY

XYZ Multimedia Entertainment, a large multinational mass media and entertainment company, headquartered in Paris, is looking for an entry-level IT project management assistant. XYZ 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, 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 process (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?
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 3 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. Try to find information on how projects are managed at this company.
3. 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

12-1 How should managers build a business case for the acquisition and development of a new information system? 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 then 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.

12-2 What are the core problem-solving steps for developing a new information system? The core problem-solving steps for developing new information systems are: (1) define and understand the problem, (2) develop alternative solutions, (3) evaluate and choose the solution, and (4) implement the solution. The third step includes an assessment of the technical, financial, and organizational feasibility of each alternative. The fourth step entails finalizing design specifications, acquiring hardware and software, testing, providing training and documentation, conversion, and evaluating the system solution once it is in production.

12-3 What are the alternative methods for building information systems? The systems life cycle requires information systems to 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 system life cycle is rigid and costly but useful for large projects.

Prototyping consists of building an experimental system rapidly and inexpensively for end users to interact with and evaluate. The prototype is refined and enhanced until users are satisfied that it includes all their requirements and can be used as a template to create the final system. End-user-developed systems can be created rapidly and informally using user-friendly software tools. End-user development can improve requirements determination and reduce application backlog.

Application software packages and SaaS eliminate the need for writing software programs when developing an information system. Application software packages and SaaS are helpful if a firm does not have the internal information systems staff or financial resources to custom-develop a system.

Outsourcing consists of using an external vendor to build (or operate) a firm's information systems. If it is properly managed, outsourcing can save application development costs or enable firms to develop applications without an internal information systems staff.

Rapid application design, agile development, joint application design (JAD), cloud-based platforms, and reusable software components (including web services) can be used to speed up the system's development process. Mobile application development must address multiple platforms, small screen sizes, and the need to conserve resources.

12-4 How should information systems projects be managed? Information systems projects and the entire implementation process should be managed as planned organizational change using an organizational impact analysis. 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 risks are influenced by project size, project structure, and the level of technical expertise of the information systems staff and project team. Formal planning and control tools (including Gantt and PERT charts) track resource allocations and specific project activities. Users can be encouraged to take active roles in systems development and become involved in installation and training.

Key Terms

Acceptance testing, 461	Direct cutover strategy, 462	Gantt chart, 473
Agile development, 470	Documentation, 462	Implementation, 472
Business case, 453	End-user development, 465	Information requirements, 460
Capital budgeting, 457	Ergonomics, 475	Information systems plan, 454
Component-based development, 471	Feasibility study, 461	Intangible benefits, 456
Customization, 466	Formal planning and control tools, 473	

Joint application design (JAD), 470	Portfolio analysis, 455	System testing, 461
Maintenance, 463	Production, 463	Systems analysis, 459
Mobile web app, 468	Project, 471	Systems design, 461
Mobile website, 468	Project management, 471	Systems development life cycle (SDLC), 464
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Parallel strategy, 462	Request for Proposal (RFP), 466	Unit testing, 461
PERT charts, 473	Responsive web design, 468	User–designer communications gap, 472
Phased approach, 462	Scope, 472	
Pilot study, 462	Scoring model, 456	

Review Questions

I2-1 How should managers build a business case for the acquisition and development of a new information system?

- Define and describe the components of a business case for a proposed systems 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 portfolio analysis and scoring models can be used to establish the worth of systems.

I2-2 What are the core problem-solving steps for developing a new information system?

- List and describe the problem-solving steps for building a new system.
- Define information requirements and explain why they are important for developing a system solution.
- List the various types of design specifications required for a new information system.
- Explain why the testing stage of systems development is so important. Name and describe the three stages of testing for an information system.
- Describe the roles of documentation, conversion, production, and maintenance in systems development.

I2-3 What are the alternative methods for building information systems?

- Explain why the systems life cycle is inappropriate for many small businesses.
- Identify the two groups that can work together using joint application design (JAD).
- Identify the aspects that can be addressed by carrying out an organizational impact analysis.
- What is a Request for Proposal? What happens next?
- Explain how customization works when services or packages are designed for a specific business or organization.
- Define and describe component-based development.
- Describe the issues that must be addressed when developing mobile applications.

I2-4 How should information systems projects be managed?

- Explain the importance of implementation for managing the organizational change surrounding a new information system.
- Define the user–designer communications gap and explain the kinds of implementation problems it creates.
- List and describe the factors that influence project risk and describe strategies for minimizing project risks.

MyLab MIS™

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

Discussion Questions

I2-5 Discuss the role of business end users and information system professionals in developing a system solution. How do both roles differ when the solution is developed using prototyping or end-user development?

I2-6 It has been said that systems fail **MyLab MIS** when systems builders ignore people problems. Why might this be so?

I2-7 Why is building a system a form of **MyLab MIS** organizational problem-solving?

Hands-On MIS Projects

The projects in this section give you hands-on experience evaluating information systems projects, designing a customer system for auto sales, and analyzing website information requirements. Visit **MyLab MIS** to access this chapter's Hands-On MIS Projects.

MANAGEMENT DECISION PROBLEMS

I2-8 The Warm and Toasty Heating Oil Company used to deliver heating oil by sending trucks that printed out a ticket with the number of gallons of oil delivered that was placed on customers' doorsteps. Customers received their oil delivery bills in the mail two weeks later. The company recently revised its oil delivery and billing system so that oil truck drivers can calculate and print out a complete bill for each delivery and leave customers with the bill and a return envelope at the time the delivery takes place. Evaluate the business impact of the new system and the people and organizational changes required to implement the new technology.

I2-9 Caterpillar is the world's leading maker of earth-moving machinery and supplier of agricultural equipment. The software for its Dealer Business System (DBS), which it licenses to its dealers to help them run their businesses, is becoming outdated. Senior management wants its dealers to use a hosted version of the software supported by Accenture consultants so that Caterpillar can concentrate on its core business. The system had become a de facto standard for doing business with the company. The majority of the 50 Caterpillar dealers in the EU use some version of DBS, as do about half of the 200 or so Caterpillar dealers in the rest of the world. Before Caterpillar turns the project 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 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

I2-10 This project requires you to perform a systems analysis and then design a system solution using database software.

Dubai Auto Dealers (DAD) specializes in selling new vehicles from Subaru in Dubai. 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.

DAD 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 DAD from newspaper ads, from word of mouth, or from the web?

Prepare a systems analysis report detailing DAD'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 DAD 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

I2-11 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

Identifying Implementation Problems

I2-12 With three or four of your classmates, select a system described in this text. Write a description of the implementation problems you might encounter with such a system and 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.

BUSINESS PROBLEM-SOLVING CASE

MAERSK'S TRADELENS: DIGITIZING THE GLOBAL SUPPLY CHAIN

Maersk is a container logistics company that operates in more than 120 countries and serves more than 300 ports worldwide. It employs over 79,900 people, and its revenue reached \$39 billion in 2018 with an underlying profit of \$220 million. As of May 2019, Maersk has a market capitalization of \$28.1 billion. Maersk offers a range of shipping and cargo, supply chain, and freight-forwarding services, with the stated aim of connecting businesses globally and making shipping simple. The company has the highest ocean capacity market share; along with the other top ten shipping lines, such as MSC, CMA-CGM, and Hapag-Lloyd, it controls more than 87 percent of the fleet capacity in the container shipping industry.

Competition in this industry is intense. Maersk needs to transform itself and improve earnings to maintain its leading role in the market. However, Maersk's legacy system, which relied heavily on paper-based documents, has been one of the company's biggest burdens, reducing shipping efficiency and incurring extra operational costs. For example, shipping a refrigerated container from Kenya to Europe takes approximately 30 days, and the process involves multiple individuals and organizations. The shipping process typically begins with a cargo owner initiating a booking with the company to send goods overseas. Legal documents need to be filled, submitted, and approved before a piece of cargo is allowed to enter or leave a port. The shipping paper trail could end up with hundreds or thousands of pages in documentation processed by different supply chain parties, including agencies, banks, and customs. A host of other factors, including missing documents, miscommunications, and differences in regulations among organizations and countries may further lengthen the shipping process for Maersk.

Against this backdrop, back in 2010, Maersk started to explore the possibilities of digitizing shipping processes. At the time, customs authorities in the Netherlands had introduced measures to remove excessive paperwork from trade. Maersk's initiatives remained at the ideation stage until 2016, when the concept of blockchain has started to proliferate. Maersk has worked with IBM on a digitization project to enhance document-sharing

across the supply chain and reduce complexity for the customers and suppliers. At the initiation stage, Maersk and IBM organized a series of "thinking workshops" to determine the practicability of the blockchain technology in supply chains and to develop pilots. In June 2016, Maersk and IBM carried out their first pilot project in the form of a shipment from Kenya to Holland and followed up in February 2017 when they cooperated with a freight forwarder and a customs authority to test a blockchain-enabled shipment live. In January 2018, encouraged by the success of the pilot tests, Maersk and IBM announced that they were collaborating on a project to build a blockchain-enabled global supply chain solution called TradeLens. In the August of that year, Maersk and IBM announced that TradeLens has been created.

The TradeLens system is capable of enhancing the efficiency and security of global trade, which has been hobbled by data trapped in organizational silos, paper-based processes, and clearance processes that are subject to fraud. TradeLens assumes a strategic role within Maersk and allows it to gather data points to spot inefficiencies within supply chains and suggest solutions to clients. Unlike typical information system projects, TradeLens is meant not only as a solution for Maersk but as a digital revolution in the shipping industry.

However, the implementation of TradeLens and the claims of its benefits to shippers and of improductivity in general have been met with skepticism. Shippers and the broader logistics industry have raised questions about the cost, imminent applicability, and value of this innovation. The success of this blockchain-enabled shipping project heavily relies on the participation of other large carriers who will act as trust anchors and run blockchain nodes on the network—Marvin Erdly, head of TradeLens at IBM Blockchain, emphasized that onboarding other carriers was an necessary condition for TradeLens to succeed. But while TradeLens was being introduced, Maersk and IBM struggled to find partners and succeeded in enticing only one other carrier, Pacific International Lines (PIL), onto the platform. As Maersk is the owner of the joint venture that owns TradeLens, it enjoys a benefit not shared by other participants on this

blockchain solution—so why would Maersks' rivals want to use a platform that would enrich this biggest competitor? Maersk and IBM were aware of these issues during the new system's implementation, and in response they established an operational subsidiary to manage staff on the project and ensure the independence of TradeLens from Maersk's other business units.

Despite this measure, in November 2018, the shipping companies COSCO, CMA CGM, Evergreen Marine, OOCL, and Yang Ming decided to develop their own blockchain solution, named the Global Shipping Business Network (GSBN). Built by CargoSmart, the GSBN has the backing of several terminals and ports worldwide. And there are dozens more global trade-related blockchain initiatives in the pipeline, some of which are backed by Maersk's rivals, raising further doubts about when—or even whether—shippers need to invest in or adopt TradeLens. There have also been questions about the scalability of a blockchain-enabled shipping solution developed by a single liner carrier.

Proponents believe that the blockchain project will allow new and more efficient shipping processes to germinate, but skepticism among shippers still remains. Andrew Nutting, former Director of International Logistics at Bob's Discount Furniture, publicly questioned the claim that the solution could reduce shipping times by 40 percent, while James Stewart, a global account executive with Crane Worldwide Logistics, questioned whether the market can afford it or even needs it. Many other naysayers have predicted that the TradeLens project is doomed to fail.

Despite all the skepticism, Maersk and IBM have had a positive engagement with companies in the industry and have gone on to get more than 100 ecosystem participants actively involved in the project. They sought out scores of participants, including global ports and customs authorities, cargo owners, freight forwarders, and logistics companies, to join the TradeLens platform from other parts of the shipping supply chain. Security concerns and distrust continued to be predominant obstacles to the adoption of the blockchain-based solution, rendering it difficult for Maersk to gain marketing traction for the project. In response, TradeLens is having an audit to certify its compliance with the ISO 27001 family of IT security standards.

To ensure that inputs from the supply chain industry are heard, Maersk and IBM have formed the TradeLens Advisory Board, which provides guidance and feedback to drive open and fair standards.

Through this collaboration model, Maersk and IBM hope to ensure that TradeLens is a solution for the industry that is built through collaboration among all participants and stakeholders.

Maersk and IBM are taking the concerns on equity and governance on board and have worked closely with carriers to address them. TradeLens's commitment to open standards and open governance has won more takers among the carriers and is increasingly being seen as a key project to lead the digital transformation in the shipping industry. Rajesh Krishnamurthy, Executive Vice-president of IT & Transformations at the CMA CGM Group, has come out in support of the onboarding of participants from across the supply chain ecosystem and has stated that TradeLens will deliver significant value.

Maersk and IBM's efforts are paying off. Participants believe that Maersk's history of innovation and IBM's technological prowess give TradeLens a high probability of success against other blockchain projects in the market. By July 2019, 11 months after the introduction of TradeLens, Maersk appeared to have overcome the initial concerns from carriers and garnered more support from big players in the shipping industry, including Zim Lines, PIL, CMA CGM, MSC, Hapag Lloyd, and ONE. Hapag-Lloyd and ONE will each operate a blockchain node and assume a critical role for the network by acting as trust anchors or validators. Both companies are also represented on the TradeLens Advisory Board, joining members across the supply chain to ensure the neutrality and openness in the governance of the TradeLens project.

TradeLens's benefits will grow insofar as the system achieves widespread adoption and develops into a single ecosystem. More participants mean better visibility for trade, allowing traders to provide better customer services with greater confidence. Bringing the leading carriers on board TradeLens helps the members of the global supply chain expand and explore the benefits of digitization as well as deliver new opportunities to participants in the ecosystem. With five of the world's six largest carriers and six of the top ten container lines committing to and signing up to use the TradeLens platform, the digital transformation of the global supply chain has been accelerated, with the promise of greater trust, transparency, and collaboration across participants and promotion of global trade.

Through the implementation of TradeLens, Maersk is now processing more than 10 million discrete shipping events and thousands of documents

each week, providing shippers, carriers, freight forwarders, customs officials, port authorities, and other involved trading partners a consistent and unified view of transactions—ensuring its place as a world-leading container logistics company as well as its role in the global supply chain.

Sources: Maersk Official website, www.maersk.com, accessed November 5, 2019; IBM Official website, www.ibm.com, accessed November 5, 2019; TradeLens Official website, www.tradelens.com, accessed November 5, 2019; “Møller-Maersk on the Forbes World’s Best Employers List,” www.forbes.com, accessed November 5, 2019; MI News Network, “Top 10 Shipping Lines Control Almost 90% of the Deep Sea Market,” [Marine](http://MarineInsight.com)

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CASE STUDY QUESTIONS

- I2-13** Assess the importance of the TradeLens project for Maersk.
- I2-14** What core problem-solving steps has Maersk gone through in developing the new system?
- I2-15** Describe the problems encountered by the TradeLens project. What management,

organization, or technology factors were responsible for these problems?

- I2-16** What has Maersk done to mitigate the problems of the TradeLens project?

Case contributed by Tommy Chan, Northumbria University, and Zach Lee, Durham University.

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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: High-speed cellular networks based on packet-switched technology, enabling users to transmit video, graphics, and other rich media in addition to voice.

4G networks: Ultrahigh-speed wireless networks that are entirely packet switched, with speeds between 1 Mbps and 1 Gbps.

5G: Next generation of wireless networking technology expected to transmit very large amounts of data in the gigabit range over short distances, with fewer transmission delays.

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: E-commerce revenue mode in which websites are paid as affiliates for sending their visitors to other sites in return for a referral fee.

agile development: 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 and continuous feedback.

analytic platform: Preconfigured hardware-software system that is specifically designed for high-speed analysis of large data sets.

analytical CRM: Customer relationship management applications dealing with the analysis of customer data to provide information for improving business performance.

Android: Open source operating system for mobile devices Google and the Open Handset Alliance developed; currently the most popular smartphone operating system worldwide.

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 proxy filtering: Firewall screening technology that uses a proxy server to inspect and transmit data packets flowing into and out of the organization so that all the organization's internal applications communicate with the outside by using a proxy application.

application server: Software that handles all application operations between browser-based computers and a company's back-end business applications or databases.

application software: Programs written for a specific application to perform functions specified by end users.

apps: Small pieces of software that run on the Internet, on a computer, or on a mobile phone and are generally delivered over the Internet.

artificial intelligence (AI): The effort to develop computer-based systems that can behave like humans, with the ability to learn languages, accomplish physical tasks, use a perceptual apparatus, and emulate human expertise and decision making.

attributes: Pieces of information describing a particular entity.

augmented reality: Technology for enhancing visualization that provides a live view of a physical 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.

authorization management systems: Systems for allowing each user access only to those portions of a system or the web that person is permitted to enter, based on information established by a set of access rules.

backbone: Part of a network handling the major traffic and providing the primary path for traffic flowing to or from other networks.

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.

banner ad: A graphic display on a web page used for advertising. The banner is linked to the advertiser's website so that a person clicking it will be transported to the advertiser's website.

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 that stores a permanent and tamperproof record 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:** The 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:** A formal organization whose aim is to produce products or provide services for a profit.
- 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 intelligence (BI):** 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:** Methodology for measuring firm performance by using key performance indicators based on the firm's strategies.
- business process management:** Tools and methodologies for continuously improving and managing business processes.
- business process reengineering (BPR):** The radical redesign of business processes to maximize the benefits of information technology.
- business processes:** The unique ways in which organizations coordinate and organize work activities, information, and knowledge to produce a product or service.
- business strategy:** Set of activities and decisions that determine the products and services the firm produces, the industries in which the firm competes, firm competitors, suppliers, and customers, and the firm's long-term goals.
- 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:** Allowing employees to use their personal mobile devices in the workplace.
- C:** A powerful programming language with tight control and efficiency of execution and portability across different microprocessors.
- cable Internet connections:** Using digital cable coaxial lines to deliver high-speed Internet access to homes and businesses.
- call center:** An organizational department responsible for handling customer service issues by telephone and other channels.
- campus area network (CAN):** An interconnected set of local area networks in a limited geographical area such as a college or corporate campus.
- capacity planning:** The process of predicting when a computer hardware system becomes saturated to ensure that adequate computing resources are available for work of different priorities and that the firm has enough computing power for its current and future needs.
- 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.
- cellular telephones (cell phones):** A device that transmits voice or data, using radio waves to communicate with radio antennas placed within adjacent geographic areas called cells.
- centralized processing:** Processing that is accomplished by one large central computer.
- 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:** Giving proper consideration to the impact of organizational change associated with a new system or alteration of an existing 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):** Individual responsible for enterprise-wide governance and usage 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)**: Responsible for the firm's knowledge management program.
- chief privacy officer (CPO)**: Responsible for ensuring that 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 operating system for cloud computing using a web-connected computer or mobile device.
- 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.
- click fraud**: Fraudulently clicking an online ad in pay-per-click advertising to generate an improper charge per click.
- clickstream tracking**: Tracking data about customer activities at websites and storing them in a log.
- 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 that provides access to a shared pool of computing resources over a network, often the Internet.
- coaxial cable**: A transmission medium consisting of thickly insulated copper wire; can transmit large volumes of data quickly.
- collaboration**: Working with others to achieve shared and explicit goals.
- collaborative filtering**: Tracking users' movements on a website, comparing the information gleaned about a user's behavior against data about other customers with similar interests to predict what the user would like to see next.
- community provider**: Website business model that creates a digital online environment in which people with similar interests can transact; share interests, photos, and videos; and receive interest-related information.
- 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.
- component-based development**: Building large software systems by combining preexisting software components.
- 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 and activates, 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**: Computer systems that try to emulate the human visual system to view and extract information from real-world images.
- computer-aided design (CAD) system**: Information system that automates the creation and revision of designs by using sophisticated graphics software.
- consumerization of IT**: New information technology originating in the consumer market that spreads to business organizations.
- consumer-to-consumer (C2C) electronic commerce**: Consumers selling goods and services electronically to other consumers.
- 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 files deposited on a computer hard drive when an individual visits certain websites; used to identify the visitor and track visits to the website.
- copyright**: A statutory grant that protects creators of intellectual property against copying by others for any purpose during the life of the author plus an additional 70 years after the author's death.
- core competency**: Activity at which a firm excels as a world-class leader.
- cost transparency**: The ability of consumers to discover the actual costs merchants pay for products.
- cost–benefit ratio**: A method for calculating the returns from a capital expenditure by dividing total benefits by total costs.
- critical thinking**: Sustained suspension of judgment with an awareness of multiple perspectives and alternatives.
- 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:** Fundamental set of assumptions, values, and ways of doing things that has been accepted by most members of an organization.
- 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) 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:** In e-commerce, changing a delivered product or service based on a user's preferences or prior behavior.
- customization:** The modification of a software package to meet an organization's unique requirements without destroying the package software's integrity.
- cybervandalism:** Intentional disruption, defacement, or even 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.
- cycle time:** The total elapsed time from the beginning of a process to its end.
- 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 center:** Facility housing computer systems and associated components, such as telecommunications, storage and security systems, and backup power supplies.
- 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:** Specifies the structure of the content of a database.
- data dictionary:** An automated or manual tool for storing and organizing information about the data maintained in a database.
- data governance:** Policies and procedures through which data can be managed as an organizational resource.
- data lake:** Repository for raw unstructured data or structured data that for the most part have not yet been analyzed.
- data management software:** Software used for creating and manipulating lists, creating files and databases to store data, and combining information for reports.
- 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 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 group of related files.
- 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.
- 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.
- deep web:** Closed portion of the web where pages are not completely searchable by Google or other public search engines.
- 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 to crash the network.
- Descartes' rule of change:** A principle that states that if an action cannot be taken repeatedly, then it is not right to be taken at any time.
- design:** Simon's second stage of decision making, when the individual conceives of possible alternative solutions to a problem.
- digital asset management systems:** Classify, store, and distribute digital objects such as photographs, graphic images, video, and audio content.
- digital certificates:** Attachments to an electronic message to verify the identity of the sender and 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 a 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 goods:** Goods that can be delivered over a digital network.
- digital market:** A marketplace that is created by computer and communication technologies that link many buyers and sellers.
- 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 signature:** A digital code that can be attached to an electronically transmitted message to identify its contents and the sender uniquely.
- digital subscriber line (DSL):** A group of technologies providing high-capacity transmission over existing copper telephone lines.
- direct cutover strategy:** A risky conversion approach by which 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:** Attack that uses numerous computers to inundate and overwhelm a network from numerous launch points.
- distributed processing:** The distribution of computer processing work among multiple computers linked by a communications network.
- 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 increasingly granular levels of detail.
- drive-by download:** Malware that comes with a downloaded file a user unintentionally opens.
- due process:** A process by which laws are well known and understood and provide 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 determines what an item is worth at any particular moment.
- 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 to distribution, production, and supply chains.
- e-government:** Use of the Internet and related technologies to enable government and public sector agencies' relationships with citizens, businesses, and other arms of government digitally.
- 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 coordination with suppliers and other business partners.
- electronic commerce (e-commerce):** The process of buying and selling goods and services electronically, involving transactions by 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.
- electronic mail (email):** The computer-to-computer exchange of messages.
- electronic records management (ERM):** Policies, procedures, and tools for managing the retention, destruction, and storage of electronic records.
- 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 them from being read or accessed without authorization.
- end users:** Representatives of departments outside the information systems group for whom applications are developed.
- end-user development:** The development of information systems by end users with little or no formal assistance from technical specialists.
- end-user interface:** The part of an information system through which the end user interacts with the system, such as online screens and commands.
- enterprise applications:** Systems that can coordinate activities, decisions, and knowledge across many functions, levels, and business units in a firm; include enterprise systems, supply chain management systems, customer relationship management

- systems, and knowledge management systems.
- enterprise content management systems:** Systems that 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 systems:** Integrated, enterprise-wide information systems that coordinate key internal processes of the firm. Also known as enterprise resource planning (ERP).
- enterprise-wide knowledge management systems:** General-purpose, firm-wide 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.
- Ethernet:** 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 to carry data over the system.
- 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 Wi-Fi networks to entice participants to log on and reveal passwords or credit card numbers.
- exchanges:** Third-party Net marketplaces that are primarily transaction oriented and that connect 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 systems:** Knowledge-intensive computer programs that capture the expertise of a human in limited domains of knowledge.
- Extensible Markup Language (XML):** A more powerful and flexible markup language than hypertext markup language (HTML) for web pages, allowing data to be manipulated by the computer.
- extranets:** Private intranets that are 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 US 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.
- fiber-optic cable:** A fast, light, and durable transmission medium consisting of thin strands of clear glass fiber bound into cables. Data are transmitted as light pulses.
- 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 transfer protocol (FTP):** Tool for retrieving and transferring files from a remote computer.
- FinTech:** Start-up innovative financial technology firms and services.
- firewalls:** 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 to find related information in another database table.
- formal planning and control tools:** Tools to improve project management by listing the specific activities that make up a project, their duration, and the sequence and timing of 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/freemium revenue model:** E-commerce revenue mode in which a firm offers free basic services or content while charging a premium for advanced or high-value features.
- Gantt chart:** Chart that visually represents the timing, duration, and human resource requirements of project tasks, with each task represented as a horizontal bar whose length is proportional to the time required to complete it.
- 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 systems (GIS): Systems 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.

gigabyte: Approximately one billion bytes.

Golden Rule: Putting oneself in the place of others as the object of a decision.

Google Apps: Google's cloud-based productivity suite for businesses.

Gramm-Leach-Bliley Act: Requires financial institutions to ensure the security and confidentiality of customer data.

graphical user interface (GUI): The part of an operating system users interact with that uses graphic icons and the computer mouse to issue commands and make selections.

green computing: Practices and technologies for producing, using, and disposing of computers and associated devices to minimize impact on the environment.

grid computing: Applying the resources of many computers in a network to a single problem.

group decision-support system (GDSS): An interactive computer-based system to facilitate the solution to unstructured problems by a set of decision makers working together as a group.

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 (Hz) equivalent to 1 cycle per second.

HIPAA: Law outlining medical security and privacy rules and procedures

for simplifying the administration of health care billing and automating the transfer of health care data between health care providers, payers, and plans.

home page: A World Wide Web text and graphical screen display that welcomes the user and explains the organization that has established the page.

hotspots: Specific geographic locations in which an access point provides public Wi-Fi network service.

HTML5: Next evolution of HTML, which will make it possible to embed images, video, and audio directly into a document without using 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 by which firms use both their own IT infrastructure and public cloud computing services.

Hypertext Markup Language (HTML): Page description language for creating web pages and other hypermedia documents.

Hypertext Transport Protocol (HTTP): The communications standard that transfers 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, 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 regular reuse of an innovation, such as a new information system.

implementation: Simon's final stage of decision making, when the individual puts the decision into

effect and reports on the progress of the solution.

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 appliance: Device that has been customized to perform a few specialized computing tasks well with minimal user effort.

information asymmetry: Situation when 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 them.

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 by 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 that a firm needs to use 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.

informed consent: Consent given with knowledge of all the facts needed to make a rational decision.

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.

input: The capture or collection of raw data from within the organization or from its external environment for processing in an information system.

input devices: Device that gathers data and converts them into electronic form for use by the computer.

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 agents: Software programs that use 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 decision makers by capturing individual and collective knowledge, discovering patterns and behaviors in very large quantities of data, and generating solutions to problems that are too large and complex for human beings to solve on their own.

Internet: Global network of networks using universal standards to connect millions of networks.

Internet2: Research network with new protocols and transmission speeds that provides an infrastructure for supporting high-bandwidth Internet applications.

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.

Internet telephony: Technologies that use the Internet Protocol's packet-switched connections for voice service.

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.

internetworking: The linking of separate networks, each of which retains its own identity, into an interconnected network.

interorganizational system: Information systems that automate the flow of information across organizational boundaries and link a company to its customers, distributors, or suppliers.

intranets: Internal networks based on Internet and World Wide Web technology and standards.

intrusion detection systems: 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.

Java: An operating system-independent, processor-independent, object-oriented programming language that has become a leading interactive programming environment for the web.

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 loggers: Spyware that records every keystroke made on a computer.

key performance indicators (KPIs): Measures proposed by senior management for understanding how well the firm is performing along specified dimensions.

knowledge base: Model of human knowledge that expert systems use.

knowledge management: The set of processes developed in an organization to create, gather, store, maintain, and disseminate the firm's knowledge.

knowledge management systems (KMS): Systems that support the creation, capture, storage, and dissemination of firm expertise and knowledge.

knowledge work systems (KWS): Information systems that aid knowledge workers in the creation and integration of new knowledge in the organization.

knowledge workers: People such as engineers or architects who design products or services and create knowledge for the organization.

learning management system (LMS): Tools for the management, delivery, tracking, and assessment of various types of employee learning.

legacy systems: Systems that have been in existence for a long time and that continue to be used to avoid the high cost of replacing or redesigning them.

liability: 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 open-source offshoot of UNIX, can run on many hardware platforms, and is available free or at very low cost.

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 insight 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: Ability of firms to market goods profitably to very small online audiences, largely because of the lower costs of reaching very small market segments.

machine learning (ML): 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 providers (MSSPs): Companies that provide 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.

market creator: 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 simply 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 and are intended to be greater than the sum of their parts.

mass customization: The capacity to offer individually tailored products or services on a large scale.

massive open online course (MOOC): Online course made available on the web to very large numbers of participants.

menu prices: 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 those using Twitter.

microbrowser: Web browser software with a small file size that can work with low-memory constraints, tiny screens of handheld wireless devices, and low bandwidth of wireless networks.

micropayment systems: Systems that facilitate payment for a very small sum of money, often less than \$10.

microprocessor: Very large-scale, integrated circuit technology that integrates the computer's memory, logic, and control on a single chip.

Microsoft Office 365: Hosted cloud version of Office productivity and collaboration tools as a subscription service.

microwave: A high-volume, long-distance, point-to-point transmission in which high-frequency radio signals are transmitted through the atmosphere from one terrestrial transmission station to another.

middle management: People in the middle of the organizational hierarchy who are responsible for carrying out the plans and goals of senior management.

middleware: Software that connects two disparate applications, allowing them to communicate with each other and to exchange data.

midrange computers: Middle-size computers that are capable of supporting the computing needs of smaller organizations or of managing networks of other computers.

minicomputers: Middle-range computers used in systems for universities, factories, or research laboratories.

mobile commerce (m-commerce): The use of wireless devices, such as cell phones or handheld digital information appliances, to conduct both business-to-consumer and business-to-business e-commerce transactions over the Internet.

mobile device management: Software that monitors, manages, and secures mobile devices the organization is using.

mobile web app: Application residing on a server and accessed through the mobile web browser built into a smartphone or tablet computer.

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.

model: An abstract representation that illustrates the components or relationships of a phenomenon.

modem: A device for translating a computer's digital signals into analog form or for translating

- analog signals**: Back into digital form for reception by a computer.
- mouse**: Handheld input device with point-and-click capabilities that is connected to the computer by either a cable or a direct USB port.
- MP3 (MPEG3)**: Standard for compressing audio files for transfer over the Internet.
- 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.
- 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**: Stand-alone application specifically designed to run on a mobile platform.
- natural language processing**: Technology that makes it possible for a machine to understand spoken or written words expressed in human (natural) language and to process that information.
- 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 marketplaces**: Digital marketplaces based on Internet technology linking many buyers to many sellers.
- netbook**: Small, low-cost, lightweight subnotebooks optimized for wireless communication and Internet access.
- network**: The linking of two or more computers to share data or resources such as a printer.
- network address translation (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.
- network economics**: Model of strategic systems at the industry level based on the concept of a network when 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 pieces of hardware and transfer data from one physical location to another.
- neural networks**: Hardware or software that attempts to emulate the processing patterns of the biological brain.
- nonobvious relationship awareness (NORA)**: Technology that can find obscure connections between people or other entities by analyzing information from many sources to correlate relationships.
- nonrelational 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.
- normalization**: The process of creating small, stable data structures from complex groups of data when designing a relational database.
- n-tier client/server architecture**: Client/server arrangement that balances the work of the entire network over multiple levels of servers.
- object**: Software building block that combines data and the procedures acting on the data.
- offshore software 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 they need. 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**: The system software that manages and controls the 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 deliver 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 the data not to be collected.
- organizational impact analysis**: Study of the way a proposed system will affect organizational structure, attitudes, decision making, and operations.
- output**: The distribution of processed information to the people who will use it or to the activities for which it will be used.

output device: Device that displays data after they have been processed.

outsourcing: The practice of contracting computer center operations, telecommunications networks, or applications development to external vendors.

packet filtering: Examines selected fields in the headers of data packets flowing back and forth between the trusted network and the Internet.

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.

parallel processing: Type of processing in which more than one instruction can be processed at a time by breaking down a problem into smaller parts and processing them simultaneously with multiple processors.

parallel strategy: A safe and conservative conversion approach in which both the old system and its potential replacement are run together for a time until everyone is assured that the new one functions correctly.

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.

patches: Small pieces of software that repair flaws in programs 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 17 years; designed to ensure that inventors of new machines or methods are rewarded for their labor while making available widespread use of their inventions.

peer-to-peer: Network architecture that gives equal power to all computers on the network; used primarily in small networks.

people perspective: Consideration of the firm's management, as well as employees, as individuals and their interrelationships in workgroups.

personal computer (PC): Small desktop or portable computer.

personal-area networks (PANs): Computer networks used for communication among digital devices (including telephones and PDAs) that are close to one person.

personalization: Ability of merchants to target their marketing messages to specific individuals by adjusting the message to a person's name, interests, and past purchases.

PERT chart: A chart that graphically depicts project tasks and their interrelationships, showing the specific activities that must be completed before others can start.

pharming: Phishing technique that redirects users to a bogus web page, even when the individual types the correct web page address into his or her browser.

phased approach: Introduces the new system in stages either by functions or by organizational units.

phishing: A form of spoofing involving setting up fake websites or sending email messages that look like those of legitimate businesses to ask users for confidential personal data.

pilot study: A strategy to introduce the new system to a limited area of the organization until it proves 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

podcasting: Method of publishing audio broadcasts through the Internet, allowing subscribing users to download audio files to their personal computers, smartphones, or portable music players.

pop-up ads: Ads that open automatically and do not disappear until the user clicks them.

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.

predictive analytics: Use of data mining techniques, historical data, and assumptions about future conditions to predict outcomes of events.

predictive search: Part of a search algorithm that predicts what a user query is looking for as it is entered, based on popular searches.

presentation graphics: Software to create professional-quality graphics presentations that can incorporate charts, sound, animation, photos, and video clips.

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: Proprietary network or data center that ties together servers, storage, networks, data, and applications as a set of virtualized services that users inside a company share.

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: Specifications that 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.

procurement: Sourcing goods and materials, negotiating with suppliers, paying for goods, and making delivery arrangements.

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: Series of instructions for the computer.

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: A planned series of related activities for achieving a specific business objective.

project management: Application of knowledge, skills, tools, and techniques to achieve specific targets within specified budget and time constraints.

project portfolio management software: Software that 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.

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: Cloud maintained by an external service provider, accessed through the Internet, and available to the general public.

public key encryption: Encryption using two keys: one shared (or public) and one private.

public key infrastructure (PKI): System for creating public and private keys by 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.

pure-play: Business models based purely on the Internet.

push-based model: Supply chain driven by master production schedules based on forecasts or best guesses of demand for products; products are pushed to customers.

quality: Product or service's conformance to specifications and standards.

quantum computing: Use of principles of quantum physics to represent data and perform operations on the data, with the ability to be in many states at once and to perform many computations simultaneously.

query languages: Software tools that provide immediate online answers to requests for information that are not predefined.

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, user-friendly 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.

reach: Measurement of how many people a business can connect with and how many products it can offer those people.

records: Groups of related fields.

referential integrity: Rules to ensure that relationships between coupled database tables remain consistent.

relational database: 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 change screen resolution and image size automatically 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: 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.

ringtones: Digitized snippets of music that play on mobile phones when a user receives or places a call.

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.
- RSS:** Technology using aggregator software to pull content from websites and feed it automatically to subscribers' computers.
- SaaS (software as a service):** Services for delivering and providing access to software remotely as a web-based service.
- 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 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.
- satellites:** Machines that orbit the earth and serve as relay stations for transmitting microwave signals over very long distances.
- 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 or 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 marketing:** Use of search engines to deliver sponsored links, for which advertisers have paid, in search engine results.
- search engine optimization (SEO):** Process of changing a website's content, layout, and format to increase the site's ranking on popular search engines and to generate more site visitors.
- search engines:** Tools for locating specific sites or information on the Internet.
- secondary storage:** Relatively long-term, nonvolatile storage of data outside the CPU and primary storage.
- 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.
- semantic web:** Ways of making the web more intelligent, with machine-facilitated understanding of information so that searches can be more intuitive and effective.
- semistructured decisions:** Decisions in which only part of the problem has a clear-cut answer provided by an accepted procedure.
- semistructured knowledge:** Information in the form of less structured objects such as email, chat room exchanges, videos, graphics, brochures, or bulletin boards.
- senior management:** People occupying the topmost hierarchy, who are responsible for making long-range decisions, in an organization.
- sensitivity analysis:** Models that ask what-if questions repeatedly to determine the impact of changes in one or more factors on the outcomes.
- sensors:** Devices that collect data directly from the environment for input in a computer system.
- sentiment analysis:** Mining text comments in an email message, blog, or other social media.
- 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 the customer expects.
- 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 bots:** 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.
- smart card:** A credit-card-size plastic card that stores digital information and can be used for electronic payments in place of cash.
- smartphones:** Wireless phones with voice, messaging, scheduling, email, and Internet capabilities.
- sniffer:** A 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:** Online community for expanding users' business or social contacts 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.
- 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 programs for certain functions.
- 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.
- solid state drive (SSD):** Storage device that stores data on an array of semiconductor memory organized as a disk drive.
- spam:** Unsolicited commercial email.
- spamming:** A form of abuse in which thousands and even hundreds of thousands of unsolicited email and electronic messages are sent out, creating a nuisance for both businesses and individual users.
- 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.
- spreadsheet:** Software displaying data in a grid of columns and rows, with the capability of easily recalculating numerical data.
- spyware:** Technology that aids in gathering information about a person or organization without their knowledge.
- SQL injection attack:** Attack against a website that takes advantage of vulnerabilities in poorly coded SQL applications to introduce malicious program code into a company's systems and networks.
- stateful inspection:** Provides additional security by determining whether packets are part of an ongoing dialogue between a sender and a receiver.
- strategic information system:** Information system that changes the goals, operations, products, services, or environmental relationships of an organization to help gain a competitive advantage.
- structured decisions:** Decisions that are repetitive, 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.
- supercomputer:** Highly sophisticated and powerful computer that can perform very complex computations extremely rapidly.
- 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 (SCM)**
- systems:** Information systems that automate the flow of information between a firm and its suppliers 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 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 software:** Generalized programs that manage the computer's resources, such as the central processor, communications links, and peripheral devices.
- system testing:** Tests the functioning of the information system as a whole to determine whether 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 development life cycle (SDLC):** 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.

systems integration: Ensuring that a new infrastructure works with a firm's older systems and that the new elements of the infrastructure work with one another.

T lines: High-speed 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.

telepresence: Technology that allows a person to give the appearance of being present at a location other than his or her true physical location.

terabyte: Approximately one trillion bytes.

test plan: Plan prepared by the development team in conjunction with the users; it includes all 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.

touch screen: Device that allows users to enter limited amounts of data by touching the surface of a sensitized video display monitor with a finger or a pointer.

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.

transaction fee revenue model:

E-commerce revenue model in which 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.

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 where 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.

twisted wire: A transmission medium consisting of pairs of twisted copper wires; used to transmit analog phone conversations but can be used for data transmission.

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 by which 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 in 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.

up-selling: Marketing higher-value products or services to new or existing customers.

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 impedes communication and problem solving among end users and information systems specialists.

utilitarian principle: Principle that assumes one can put values in rank order 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 produce a product or service collectively for a market.

virtual company: A company that 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.

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.

virtual world: Computer-based simulated environment intended for its users to inhabit and interact through graphical representations called avatars.

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 programming language: Allows users to manipulate graphic or iconic elements to create programs.

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: An eavesdropping technique in which eavesdroppers drive by buildings or park outside and try to intercept wireless network traffic.

wearable computer: Small wearable computing device such as a smartwatch, smartglasses, or activity tracker.

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 browsers: 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 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.

wide area networks (WANs): Telecommunications networks that span a large geographical distance. May consist of a variety of cable, satellite, and microwave technologies.

Wi-Fi: Standards for wireless fidelity and refers to the 802.11 family of wireless networking standards.

wiki: Collaborative website where visitors can add, delete, or modify content on the site, 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 10: Most recent Microsoft client 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 in the physical environment to provide measurements of many points over large spaces.

wisdom of crowds: Belief that large numbers of people can make better decisions about a wide range of topics and products than a single person or even a small committee of experts.

word processing software: Software for electronically creating, editing, formatting, and printing documents.

workflow management: The process of streamlining business procedures so that documents can be moved easily and efficiently from one location to another.

workstation: Desktop computer with powerful graphics and mathematical capabilities and the ability to perform several complicated tasks at once.

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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