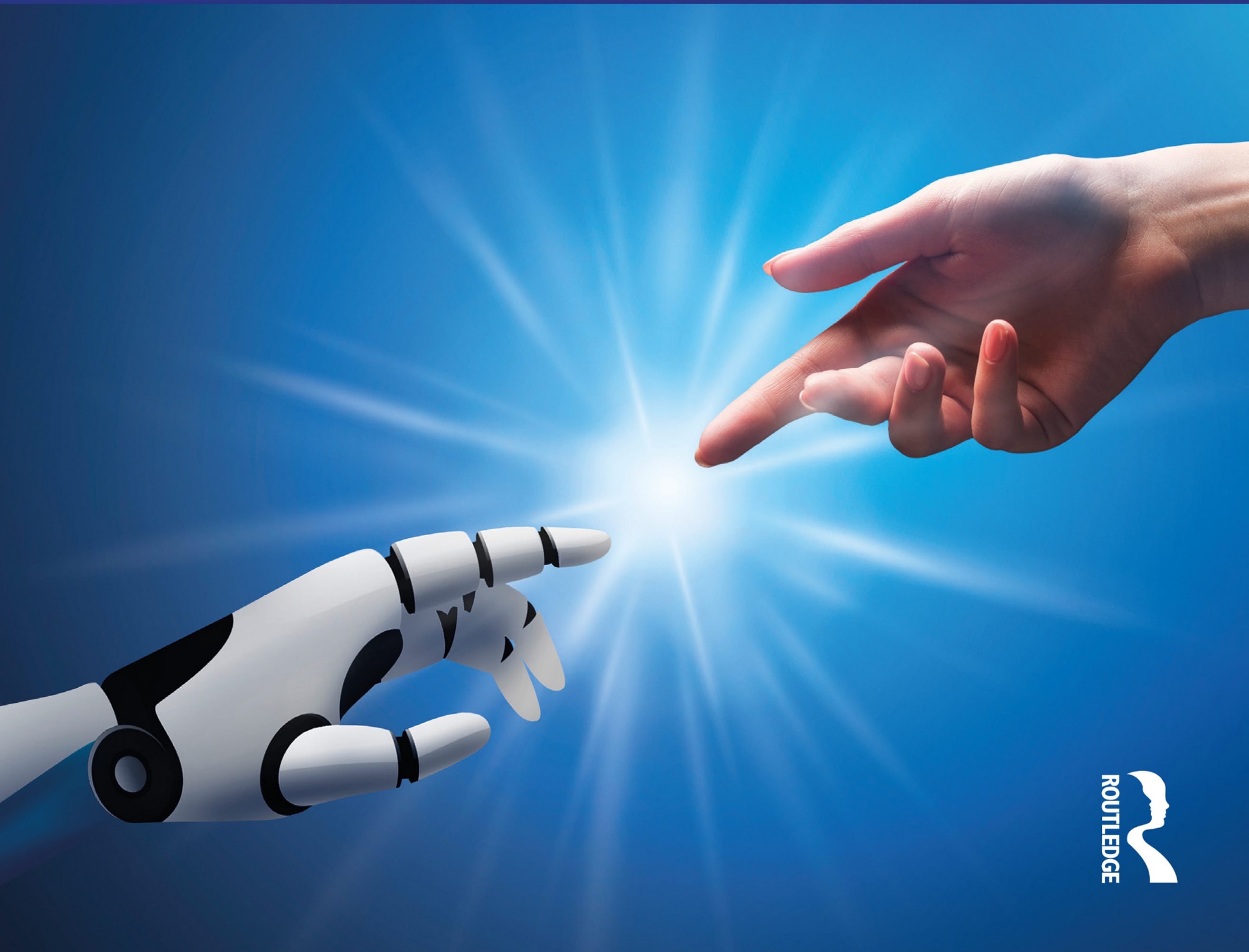
THIRD EDITION

Knowledge Management

Systems and Processes in the AI Era

Irma Becerra-Fernandez, Rajiv Sabherwal, and Richard Kumi



ROUTLEDGE

Knowledge Management

Knowledge Management: Systems and Processes in the AI Era, Third Edition, is aimed at students and managers who seek detailed insights into contemporary knowledge management (KM). It explains the concepts, theories, and technologies that provide the foundation for knowledge management; the systems and structures that constitute KM solutions; and the processes for developing, deploying, and evaluating these KM solutions. This book serves as a complete introduction to the subject of knowledge management, incorporating technical and social aspects, as well as concepts, practical examples, traditional KM approaches, and emerging topics. This third edition has been revised and expanded to include more coverage of emergent trends such as cloud computing, online communities, crowdsourcing, and artificial intelligence. Aimed at advanced undergraduate, postgraduate, and MBA students who are seeking a comprehensive perspective on knowledge management, *Knowledge Management* is also complemented by online support for lecturers including suggested solutions to the many review questions and application exercises contained within the book.

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Third Edition

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Routledge
Taylor & Francis Group
LONDON AND NEW YORK

Designed cover image: Getty © Prostock-Studio

Third edition published 2024
by Routledge
4 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
605 Third Avenue, New York, NY 10158

Routledge is an imprint of the Taylor & Francis Group, an informa business

First edition published by Routledge 2010
Second edition published by Routledge 2015

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
Names: Becerra-Fernandez, Irma, 1960- author. | Sabherwal, Rajiv, author. |
Kumi, Richard, author.
Title: Knowledge management : systems and processes in the AI era / Irma
Becerra-Fernandez, Rajiv Sabherwal and Richard Kumi.
Description: Third edition. | Abingdon, Oxon ; New York, NY : Routledge, 2024. |
Includes bibliographical references and index.
Identifiers: LCCN 2023042960 | ISBN 9781032417394 (hardback) |
ISBN 9781032428024 (paperback) | ISBN 9781003364375 (ebook)
Subjects: LCSH: Knowledge management. | Information technology.
Classification: LCC HD30.2 .B438 2024 | DDC 658.4/038--dc23/eng/20230914
LC record available at https://lccn.loc.gov/2023042960

ISBN: 978-1-032-41739-4 (hbk)
ISBN: 978-1-032-42802-4 (pbk)
ISBN: 978-1-003-36437-5 (ebk)

DOI: 10.4324/9781003364375

Typeset in Times New Roman
by Taylor & Francis Books

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Preface

Knowledge Management: Systems and Processes in the AI Era is for students and managers who seek detailed insights into contemporary knowledge management (KM). It explains the concepts, theories, and technologies that provide the foundation for KM; the systems and structures that constitute KM solutions; and the processes for developing, deploying, and evaluating these KM solutions. We hope this book will help readers acquire the relevant suite of managerial, technical, and theoretical skills for managing knowledge in the modern business environment.

The purpose of this book is to provide a thorough and informative perspective on the emergent practices in knowledge management. Information technology has been, and will continue to be, an important catalyst of this innovative field. Web-based technologies including Web 3.0, artificial intelligence, expert systems, cloud computing, analytics, and social media continue to support and transform the field of KM. However, these technologies would not be effective without the day-to-day social aspects of organizations such as "water-cooler conversations," brainstorming retreats, and communities of practice. To further complicate matters, the current business environment renders new skills obsolete in years or even months.

Knowledge management is defined in this book as *doing what is needed to get the most out of knowledge resources.* KM is an increasingly important discipline that promotes the discovery, capture, sharing, and application of the firm's knowledge. Indeed, we are witnessing a new era with advanced industrial economies being revolutionized with the advent of the knowledge age and highly skilled knowledge-based workers replacing industrial workers as the dominant labor group. Although the benefits of KM may be obvious, it may not necessarily be so obvious to know how to effectively manage this valuable resource. In this book, the discussion of KM reflects the intimacy the authors have with this topic from a theoretical as well as a practical standpoint and through their substantial and diverse experiences.

The book is divided into four parts:

Part I Principles of Knowledge Management—This section provides a more detailed discussion of the concepts of knowledge and knowledge management and describes the key constituents of KM solutions including infrastructure, processes, systems, tools, and technologies. Four types of KM processes are described and illustrated: knowledge application, knowledge capture, knowledge sharing, and knowledge discovery systems. The section also examines and provides examples of the ways in which KM impacts contemporary organizations.

Part II Knowledge Management Technologies and Systems—This section is devoted to a discussion of the underlying technologies that enable KM systems associated with the above four types of KM processes. Accordingly, four types of KM systems are discussed in this section: knowledge application systems, knowledge capture systems, knowledge sharing systems, and knowledge discovery systems. The mechanisms and technologies to support these KM systems are discussed, and case studies related to their implementation are presented.

Part III Influencers of Knowledge Management—Effective KM systems and processes depend on several factors. Hence, this section examines the factors that affect KM and identifies the specific effects of these factors. Some of the issues related to management practices and direction of knowledge management are presented in this section. Furthermore, this section evaluates KM processes and describes leadership and assessment of KM.

Part IV Emergent Trends in KM—Advances in technology are driving the innovative application of emerging technologies. This section describes how emerging technologies support and facilitate KM systems and processes. It explains how KM can benefit from emergent practices and technologies, including social networks, virtual community platforms, crowdsourcing, business intelligence, and cloud computing. Additionally, this section reviews the role of KM in the management of crises. This section and the book conclude by examining aspects that are likely to be important in the future of KM, including crowd sourcing and collective intelligence and concerns related to privacy and confidentiality.

This book may be adopted in several different ways, depending on the course and the students. It can be used as a one-semester course on KM for graduate students in management information systems by covering selected topics from Parts I, II, III, and IV. A professor teaching a course for engineering or computer science students may opt to concentrate on KM technologies and systems by covering Chapters 1, 6, 7, 8, 9, and 10, and chapters in Part IV. Alternatively, if the course is being taught to students in a master's in business administration (MBA) program, a number of case studies could be assigned to complement the discussions presented in the book, and the discussion of Chapters 6, 7, 8, and 9 could be emphasized less. Additionally, the illustrative examples and case studies from the text should be useful to MBA students.

Instructors adopting the book are encouraged to share with the authors any relevant material that could be included on the Web site to reinforce and enhance the students' experience.

Acknowledgments

We have so many people to acknowledge! First, we want to recognize our families who were so supportive during the time we spent with our heads buried in our laptops.

Writing a book, much like joining the professoriate, is a labor of love. When the first two authors set out to publish the first edition of this book, we had in mind capturing our research insights, as well as those of others, in the then nascent field of knowledge management. Our goal was to use this book to capture and help us to better share this knowledge with our students, who were mostly pursuing graduate studies, and who would then use this newly acquired knowledge to inspire their research and their work. The first edition was accompanied by a CD full of demos created with the collaboration of students working at the Florida International University (FIU) Knowledge Management Lab.

What the authors never expected is that 20 years later, the book would still find relevance among researchers and students around the world, and that excitement is what motivated the authors to write the third edition of our original book, now published by Routledge, and we welcome our new co-author Dr. Richard Kumi.

It has been a wonderful experience to have had the opportunity to meet collaborators in the field of KM from around the world, whom we may have met at global KM conferences. Over the twenty years since our first edition was published, this book has been cited thousands of times in every language imaginable. To have had the opportunity to make this kind of impact continues to make us smile. After all, our labor of love provides us the reward of reading how others have also applied this knowledge.

We further thank those organizations that provided us with the fertile ground to develop many of our ideas about KM: NASA-Kennedy Space Center, Goddard Space Flight Center, Ames Research Center, NAVY Center for Advanced Research in Artificial Intelligence, and the Institute for Human and Machine Cognition, among others. We especially thank the individuals at these organizations who made it possible for us to formalize some of the concepts and techniques presented in this book. We also thank all the authors that individually contributed to the many vignettes and case studies presented throughout.

We also thank our colleagues and administrators, who throughout our careers have supported our scholarly pursuits. Our sincere thanks are also directed to Dr. Avelino Gonzalez, who coauthored the first edition of this book. Dr. Sabherwal is also grateful for the support he has received over the years through the Edwin and Karlee Bradberry Chair. We also gratefully acknowledge the contributions of all the students who previously studied and worked at the respective institutions with the authors. Finally, we are deeply indebted to many individuals at Routledge who enabled us to publish this book, especially our editor, Andrew Harrison.

We look forward to reading how this work will continue to inspire students and researchers around the globe.

1 Introducing Knowledge Management

The scientific endeavor that culminated on July 20, 1969, with the first American walking on the Moon is considered one of the most significant accomplishments in the history of humankind. What is especially noteworthy about this undertaking is that when President John F. Kennedy issued the promise in 1961 that the United States would land a man on the Moon and return him safely to Earth before the end of that decade, most of the scientific and technological knowledge required to take this "one small step for man, one giant leap for mankind" did not exist.

The necessary science and technology knowledge had to be discovered and developed to accomplish this extraordinary task. However, many of those technological advances now have permanent presence in the landscape of our lives, from cordless tools to cellular phones. These first missions to space carried less computer power on board than what some of us typically lug around airports on our phones and portable computers. The computers on board Apollo 11, considered "state-of-the-art" in the 1960s, had four KB of RAM, no disk drive, and a total of 74 KB of auxiliary memory! From the knowledge management (KM) perspective, how did they manage the extraordinary quantities of knowledge that had to be developed to accomplish the task? The required knowledge about space travel, rocketry, aerodynamics, systems, communications, biology, and many other disciplines had to be developed and validated prior to being used in the space mission. From the knowledge creation perspective, this was an extraordinarily successful endeavor. On the other hand, a closer look reveals that attempts to elicit and capture the knowledge resulting from these efforts may have been largely unsuccessful, and some studies even suggest that NASA may have actually lost that knowledge. In fact, in the words of Sylvia Fries, who was NASA's chief historian between 1983 and 1990 and who interviewed 51 NASA engineers who had worked on the Apollo program:

> The 20th anniversary of the landing of an American on the surface of the Moon occasioned many bittersweet reflections. Sweet was the celebration of the historic event itself … Bitter, for those same enthusiasts, was the knowledge that during the twenty intervening years much of the national consensus that launched this country on its first lunar adventure had evaporated … a generation of men and women who had defined their lives to a large extent in terms of this nation's epochal departure from Earth's surface was taking its leave of the program they had built.
>
> (Fries 1992, p. vii)

In this book, we hope to impart what we know about the important field of knowledge management—what it is and how to implement it successfully with the tools provided

DOI: 10.4324/9781003364375-1

by the technological advances of our times. The book presents a balanced discussion between theory and application of knowledge management to organizations. The reader will find an overview of knowledge management theory and implementation, with a special emphasis on the technologies that underpin knowledge management and how to successfully integrate those technologies. The book includes implementation details about both knowledge management mechanisms and technologies.

In this chapter, we first discuss what knowledge management is and what the forces are that drive it. We also discuss organizational issues related to knowledge management. Specifically, we introduce knowledge management systems and their roles in the organization. Finally, we discuss how the rest of the book is organized.

What Is Knowledge Management?

Knowledge management (KM) may simply be defined as *doing what is needed to get the most out of knowledge resources.* Although KM can be applied to individuals, it has attracted the attention of organizations over the last two decades. KM is viewed as an increasingly important discipline that promotes the creation, sharing, and leveraging of the corporation's knowledge. Peter Drucker (1994, pp. 66–69), whom many consider the father of KM, best defines the need for it:

> Knowledge has become the key resource, for a nation's military strength as well as for its economic strength … is fundamentally different from the traditional key resources of the economist—land, labor, and even capital … we need systematic work on the quality of knowledge and the productivity of knowledge … the performance capacity, if not the survival, of any organization in the knowledge society will come increasingly to depend on those two factors.

Thus, it can be argued that the most vital resource of today's enterprise is the collective knowledge residing in the minds of an organization's employees, customers, and vendors. Learning how to manage organizational knowledge has many benefits, some of which are readily apparent, others not. These benefits may include leveraging core business competencies, accelerating innovation and time-to-market, empowering employees, innovating and delivering high-quality products, improving cycle times and decision-making, strengthening organizational commitment, and building sustainable competitive advantage (Davenport and Prusak 1998). In short, they make the organization better suited to compete successfully in a much more demanding environment.

Organizations are increasingly valued for their intellectual capital. An example of this fact is the widening gap between corporate balance sheets and investors' estimation of corporate worth. It is said that knowledge-intensive companies around the world are valued at three to eight times their financial capital. Consider for example Apple Inc., the highest-valued company in the world, with a market capitalization that was estimated at around US$2.98 trillion as of June 2023. Clearly, this figure represents more than Apple's net worth in buildings, computers, and other physical assets. Apple's valuation also represents an estimation of its intellectual assets. This includes structural capital in the form of copyrights, customer databases, and business-process software. Added to that is human capital in the form of the knowledge that resides in the minds of all of Apple's software developers, researchers, academic collaborators, and business managers.

In general, KM focuses on organizing and making available important knowledge, wherever and whenever it is needed. The traditional emphasis in KM has been on knowledge that is recognized and already articulated in some form. This includes knowledge about processes, procedures, intellectual property, documented best practices, forecasts, lessons learned, and solutions to recurring problems. Increasingly, KM has also focused on managing important knowledge that may reside solely in the minds of organizations' experts.

Consider, for example, the knowledge of commercial pilots. Not only they are expected to ensure the safety of passengers, but also keep their flights on time under various weather conditions. They need to discover and establish the relevance of all available information related to problems during flight, diagnose problems, identify alternative actions, and estimate the risk associated with each alternative within the available time. The number of flight hours and years of flying experience have been considered as indicators of a pilot's level of expertise. This level of knowledge has been obtained through many years of experience in flight and successful decisions. With the large number of pilots' retirements looming, how can an airline organization elicit and catalog this knowledge so that new generations may benefit?

KM is also related to the concept of **intellectual capital**, which is considered by many as the most valuable enterprise resource. An organization's intellectual capital refers to the sum of all its knowledge resources, which exist in aspects within or outside the organization (Nahapiet and Ghoshal 1998). There are three types of intellectual capital: human capital, or the knowledge, skills, and capabilities possessed by individual employees; organizational capital, or the institutionalized knowledge and codified experience residing in databases, manuals, culture, systems, structures, and processes; and social capital, or the knowledge embedded in relationships and interactions among individuals (Gogan et al. 2016). Recent research shows that utilizing intellectual capital and knowledge management capabilities would lead to innovation and firms' performance improvement (Hsu and Sabherwal 2011).

Forces Driving Knowledge Management

Contemporary organizations rely on their decisionmakers to make "mission critical" decisions based on inputs from multiple domains. The ideal decisionmaker possesses a profound understanding of specific domains that influence the decision-making process, coupled with the experience that allows her to act quickly and decisively on the information. This profile of the ideal decisionmaker usually corresponds to someone who has lengthy experience and insights gained from years of observation. This profile does not mark a significant departure from the past, but the following four trends are increasing the stakes in decision-making.

1. Increasing Domain Complexity

The complexity of the underlying knowledge domains is increasing. As a direct consequence, the complexity of the knowledge required to complete a specific business process task has increased as well. Intricacy of internal and external processes, increased competition, and the rapid advancement of technology all contribute to increasing domain complexity. For example, new product development no longer requires only brainstorming sessions by the freethinking product designers of the organization, but instead it requires the partnership of interorganizational teams representing various functional subunits—from finance to marketing to engineering. Thus, we see an increased emphasis from professional recruiters around the world seeking new job applicants who not only possess excellent educational and professional qualifications, but who also have outstanding communication and team-collaboration skills. These skills will enable them to share their knowledge for the benefit of the organization.

2. Accelerating Market Volatility

The pace of change, or volatility, within each market domain has increased rapidly in the past decade. For example, market and environmental influences can result in overnight changes in an organization. Corporate announcements of a missed financial quarterly target could send a company's capitalization, and perhaps that of a whole industry, in a downward spiral. Stock prices on Wall Street have become increasingly volatile in the past few years resulting in the phenomenon of day trading, where many nonfinancial professionals make a living from taking advantage of the steep market fluctuations.

3. Intensified Speed of Responsiveness

The time required to take action based upon subtle changes within and across domains is decreasing. The rapid advance in technology continually changes the decision-making landscape, making it imperative that decisions be made and implemented quickly, lest the window of opportunity closes. For example, in the past, the sales process incorporated ample processing time, thus allowing the stakeholders a "comfort zone" in the decision-making process. Typically, in response to a customer request, the sales representative would return to the office, discuss the opportunity with his manager, draft a proposal, and mail the proposal to the client, who would then accept or reject the offer. The time required by the process would essentially provide the stakeholders sufficient time to ponder the most adequate solution at each of the decision points. Contrast yesterday's sale process with today's, for example the process required by many online bidding marketplaces thriving on the Web. Consider the dilemma faced by a hotel manager that participates in an Internet auctioning market of hotel rooms: "Should I book a US$200 room for the bid offer of US$80 and fill the room or risk not accepting the bid hoping to get a walk-in customer that will pay the US$200?" Confronted with a decision to fill a room at a lower rate than what the hotel typically advertises poses an important decision that the hotel manager must make within minutes of a bid offer.

4. Employee Turnover

Organizations continue to face employee turnover, both voluntary (i.e., decided by the employee, for example, due to opportunities for career advancement) and involuntary (i.e., for reasons beyond the employee's control, such as health-related problems and termination of employment by the employer). Employee turnover is especially important in tough economic conditions and during crisis events, such as the 2008 to 2009 recession or the COVID-19 pandemic, when several companies laid off large numbers of employees. Such employee turnover inevitably leads to the organization losing some of the knowledge possessed by the departing individuals. Moreover, in some cases these individuals might have knowledge that would be valuable to competitors. When employees leave, it affects company resources because of the loss of productivity, cost of hiring replacement personnel, and training of new employees. This strains company resources and hinders growth. In addition to the cost of training, there is considerable time required for a new employee to be effectively productive (Skelton et al. 2020).

Artificial intelligence, machine-learning, cloud computing, and other enabling technologies play an important role in the processes of knowledge discovery, capture, sharing, and application, enabling the development of KM systems. We provide a short introduction to these technologies in each of these chapters. Because KM systems provide access to explicit corporate knowledge, it is easy to learn from previous experiences. **Experience management** is another term related to knowledge management. Basically, experience develops over time to coalesce into more general experience, which then combines into general knowledge. Experiences captured over time can be managed using technology. Chapters 12 through 14, examine how emerging technologies are used to manage experiences as well as create new knowledge.

Box 1.1 Is Knowledge Management for Everybody?

John Smith owns an independent auto repair shop in Stillwater, Oklahoma, which he established in 1985. Prior to opening his own shop, he had been repairing foreign cars as a mechanic for the local Toyota dealership. In these days of increasing complexity in automobiles, he had to learn about such new technologies as fuel injection, computer-controlled ignition, and multi-valve and turbocharged engines. This has not been easy, but he managed to do it, and at the same time created a successful business, one with an outstanding reputation. As his business grew, he had to hire mechanics to help him with the workload. At first, training them was easy since cars were simple. That has radically changed in the last ten years. He now finds himself spending more time training and correcting the work of his mechanics instead of working on cars himself, which is what he truly enjoys. To further complicate matters, his mechanics are so well-trained that the local Toyota dealership is hiring them away from him for significant salary increases. Being a small business, he cannot afford to compete with them, so he finds himself doing more and more training and correcting all the time. The turnover has now begun to affect the quality of the work he turns over to his customers, increasing complaints and damaging his hard-earned reputation. Basically, he has a knowledge problem. He has the knowledge and needs to capture it in a way that is easy to disseminate to his mechanics. He must find a way to manage this knowledge to survive. How successful he is will dictate his future survival in this business.

Issues in Knowledge Management

In practice, given the uncertainty in today's business environments and the reality of continuing layoffs, what could make employees feel compelled to participate in knowledge management initiatives? Although many attempts have been made to launch KM initiatives, including the design and implementation of KM systems, not all KM implementations have been successful. In fact, many KM systems implementations, for example of lessons learned systems (discussed in Chapter 8), have fallen short of their promise. Many KM systems implemented at organizations have failed to enable knowledge workers to share their knowledge for the benefit of the organization. Effective KM uses all the options available to motivated employees to put knowledge to work. Effective KM depends on recognizing that all these options basically need each other.

One of the primary differences between traditional information systems and KM systems is the active role that users of KM systems play on building the content of such systems. Users of traditional information systems are typically not required to actively contribute to building the content of such systems, an effort typically delegated to the MIS department or to information systems consultants. Therefore, traditional IS research has concentrated much of its efforts in understanding the factors leading users to accepting, and thereby using, IT. As we will see later in Chapter 8, users of lessons learned systems will not only utilize the system to find a lesson applicable to a problem at hand but will typically also contribute lessons to the system database. As a result, the successful implementation of KM systems requires that its users not only effectively "use" such systems as in traditional information systems but that in fact they also "contribute" to the knowledge base of such systems. Therefore, seeking to understand the factors that lead to the successful implementation of KM systems is an important area of research that is still growing.

Whereas technology has provided the impetus for managing knowledge, we now know that effective KM initiatives are not only limited to a technological solution. An adage states that effective KM is 80 percent related to organizational culture and human factors and 20 percent related to technology. This means that there is an important human component in KM. This finding addresses the fact that knowledge is first created in the people's minds. KM practices must first identify ways to encourage and stimulate the ability of employees to develop new knowledge. Second, KM methodologies and technologies must enable effective ways to elicit, represent, organize, reuse, and renew this knowledge. Third, KM should not distance itself from the knowledge owners but instead celebrate and recognize their position as experts in the organization. This, in effect, is the essence of knowledge management. More about the controversies surrounding KM will be presented in Chapters 3, 5, and 16.

Text Overview

Part I Principles of Knowledge Management

This section of the book includes the overview of knowledge management that we have presented in this chapter, including the role that IT plays in KM and the relevance of KM to modern organizations. Chapter 2 discusses the concept of knowledge in greater detail and distinguishes it from data and information, summarizes the perspectives commonly used to view knowledge, describes the ways of classifying knowledge, and identifies some key characteristics of knowledge. Chapter 3 explains in greater detail the concept of knowledge management. It also describes knowledge management foundations, which are the broad organizational aspects that support KM in the long-term and includes KM infrastructure, KM mechanisms, and KM technologies. KM foundations support KM solutions. Chapter 4 describes and illustrates KM solutions, which include two components: KM processes and KM systems. Chapter 5 describes the variety of ways in which KM can affect individuals and various aspects of organizations.

Part II Knowledge Management Technologies and Systems

This section of the book is devoted to a discussion of the underlying technologies that enable the creation of knowledge management systems. Chapter 6 introduces the reader to **knowledge application** systems, which refer to systems that utilize knowledge and summarize the most relevant intelligent technologies that underpin them, specifically rule-based expert systems and case-based reasoning. Case studies of knowledge application systems are also discussed in this chapter. In Chapter 7 we introduce the reader to **knowledge capture** systems, which refer to systems that elicit and preserve the knowledge of experts so that it can be shared with others. Issues related to how to design the knowledge capture system, including the use of intelligent technologies, are discussed. The role of RFID technologies in knowledge capture is also presented in this chapter and specific examples of knowledge capture systems are discussed. The chapter also includes a discussion on mechanisms for knowledge capture and the use of storytelling in organizations, and it concludes with a short discussion on research trends on knowledge capture systems. In Chapter 8 we describe **knowledge sharing** systems, which refer to systems that organize and distribute knowledge and comprise most of the KM systems currently in place. This chapter also discusses how the Internet, the World Wide Web, is used to facilitate communications. Search techniques used in Web-based searches are also discussed. Design considerations and special types of knowledge sharing systems are covered: lessons learned systems and expertise locator systems. Case studies of knowledge sharing systems are discussed based on the experience gained from their development. Finally, in Chapter 9 we introduce **knowledge discovery** systems, systems and technologies that create knowledge. The chapter presents a description of knowledge discovery in databases and data mining (DM), including both mechanisms and technologies to support the discovery of knowledge. The material covers design considerations and the CRISPDM process. Two very relevant topics, DM and its relationship to discovering knowledge on the Web and customer resource management (CRM), are also presented including the importance of "knowing" about your customer. Barriers to the use of knowledge discovery are also discussed and case studies of the use of knowledge discovery systems are also presented. The chapter includes a discussion on mechanisms for knowledge discovery and the use of socialization to catalyze innovation in organizations.

Part III Management of Knowledge Management

This section of the book presents some of the issues related to management practices and the future of knowledge management. Chapter 10 presents emergent KM practices including a discussion of social networks and communities of practice, how they facilitate knowledge sharing, and how they benefit from communication technologies. This chapter also incorporates a discussion of such emergent technologies as wikis, blogs, and open-source development and examines how they enable KM. Chapter 11 describes some of the factors influencing KM, including a discussion of the impact of the type of knowledge, the business strategy, and the industry environment on KM. It also describes a methodology to prioritize implementation of KM solutions based on knowledge, organizational, and industry characteristics.

Part IV Emergent Trends in Knowledge Management

Chapter 12 explains how cloud computing technologies support and enable KM systems and processes. Information technologies are critical to KM systems and processes and cloud computing makes technology easily accessible. Through cloud computing technologies, organizations can deploy cutting edge technologies that improve the methods and practices of capturing, storing, organizing, and applying knowledge. Chapter 13 describes crowdsourcing and online communities as virtual platforms for organizing and coordinating knowledge and expertise embedded in the experience, skills, and expertise of individuals and groups in an organization or a domain. Chapter 14 describes how artificial intelligence, business intelligence, and analytics are developing new ways of discovering, capturing, organizing, and applying knowledge. The capacity to capture and store large amounts of data has created new opportunities for the discovery, extraction, and combination of knowledge. Chapter 14 describes how emerging technologies are making it possible to exploit new ways of knowledge discovery and capture. Chapter 15 describes some of the challenges of capturing, sharing, and applying knowledge during a crisis. Crisis events present unique challenges to organizations, and Chapter 15 explains how KM processes can be useful in managing crisis events. Chapter 16 presents some issues in organizational leadership and the future of KM. As KM becomes widely accepted in corporate organizations, it will increasingly become critical for corporate managers to supply adequate leadership for it as well as important safeguards for ensuring the security and adequate use of this knowledge. Also in this chapter, we present a discussion on the future of KM. In the future, knowledge management systems are expected to help decisionmakers make more humane decisions and enable them to deal with “wicked,” one-of-a-kind problems. We anticipate a future where people and advanced technology will continue to work together, enabling knowledge integration across diverse domains and with considerably higher payoffs.

Summary

In this chapter, you have learned about the following knowledge management issues as they relate to the learning objectives:

1. A description of KM ranging from the system perspective to the organizational perspective.
2. A discussion of the relevance of KM in today’s dynamic environments that are augmented with increasing technological complexity.
3. Benefits and considerations about KM are presented, including an overview of the nature of the KM projects currently in progress at public and private organizations around the world.
4. Finally, IT plays an important role in KM. The enabling role of IT is discussed, but the adage of “KM is 80 percent organizational, and 20 percent about IT” still holds today.

Review

1. Describe knowledge management.
2. Discuss the forces driving knowledge management.

3 What are knowledge management systems? Enumerate the four types of KM systems.
4 Describe some of the issues facing knowledge management.

Application Exercises

1 Identify an example of a knowledge management initiative that has been undertaken in your organization. Has the initiative been successful? What are some of the issues, both technical and nontechnical, that were faced during its implementation?
2 Design a knowledge management initiative to support your business needs.
3 Describe the non-technical issues that you will face during its implementation.
4 Consider the four forces driving KM described in this chapter. Think of another example that illustrates each of these forces.

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Part I

Principles of Knowledge Management

2 The Nature of Knowledge

In the previous chapter, we provided an introduction to the basic concepts of knowledge management. This chapter takes the next step by explaining in detail what we mean by **knowledge**. It also distinguishes knowledge from **data** and from **information** and illustrates these three concepts using some examples. This chapter also summarizes some of the perspectives commonly used to view knowledge, including both subjective and objective viewpoints. Moreover, it describes some of the ways to classify knowledge and identifies some attributes that may be used to characterize different types of knowledge. It also relates knowledge to the concept of **intellectual capital** and its various dimensions. Finally, the chapter also explains the various reservoirs, or locations, in which knowledge might reside.

What Is Knowledge?

"Knowledge" is quite distinct from "data" and "information," although the three terms are sometimes used interchangeably. In this section, we define and illustrate these concepts and differentiate among them. This discussion also leads to our definition of knowledge.

Data comprise facts, observations, or perceptions (which may or may not be correct). Data represent raw numbers or assertions and may therefore be devoid of context, meaning, or intent. Let us consider three examples of what is considered to be data. We will then build upon these examples to examine the meaning of information and knowledge.

> *Example 1*: That a sales order at a restaurant included two large burgers and two medium-sized vanilla milkshakes is an example of data.
> *Example 2*: The observation that upon tossing a coin it landed heads also illustrates data.
> *Example 3*: The wind component (u and v) coordinates for a particular hurricane's trajectory, at specific instances of time, are likewise considered data.

Although data are devoid of context, meaning, or intent it can be easily captured, stored, and communicated using electronic or other media.

Information is a subset of data, only including those data that possess context, relevance, and purpose. Information typically involves the manipulation of raw data to obtain a more meaningful indication of trends or patterns in the data. Let us continue with the three aforementioned examples:

DOI: 10.4324/9781003364375-3

Example 1: For the manager of the restaurant, the numbers indicating the daily sales (in dollars, quantity, or percentage of daily sales) of burgers, vanilla milkshakes, and other products are information. The manager can use such information to make decisions regarding pricing and raw material purchases.

Example 2: Let us assume that the context of the coin toss is a betting situation where John is offering to pay anyone US$10 if the coin lands heads but take US$8 if the coin lands tails. Susan is considering whether to take up John's bet, and she benefits from knowing that the last 100 times the coin was tossed, it landed heads 40 times and tails on 60 occasions. The result of each individual toss (head or tail) is data but is not directly useful. It is therefore data but not information. By contrast, that 40 heads and 60 tails that resulted from the last 100 tosses are also data, but they can be directly used to compute probabilities of heads and tails and hence to make the decision. Therefore, they are also information for Susan.

Example 3: Based on the *u* and *v* components, hurricane software models may be used to create a forecast of the hurricane trajectory. The hurricane forecast is information.

As can be seen from these examples, whether certain facts are information or only data depends on the individual who is using those facts. The facts about the daily sales of burgers represent information for the store manager but only data for a customer. If the restaurant is one out of a chain of 250 restaurants, these facts about daily sales are also data for the CEO of the chain. Similarly, the facts about the coin toss are simply data for an individual who is not interested in betting.

Knowledge has been distinguished from data and information in two different ways. A more simplistic view considers knowledge as being at the highest level in a hierarchy with information at the middle level and data at the lowest level. According to this view, knowledge refers to information that enables action and decisions or information with direction. Hence, knowledge is intrinsically similar to information and data, although it is the richest and deepest of the three, and is consequently also the most valuable. Based on this view, data refer to bare facts void of context, for example a telephone number. Information is data in context, for example a phone book. Knowledge is information that facilitates action, for example, individuals who are the domain experts within an organization. An example of knowledge includes recognizing that a phone number belongs to a good client who needs to be called once per week to get his orders.

Although this simplistic view of knowledge may not be completely inaccurate, we feel it doesn't fully explain the characteristics of knowledge. Instead, we use a more complete perspective, according to which knowledge is intrinsically different from information. Instead of considering knowledge as a richer or more detailed set of facts, we define knowledge in an area as *justified beliefs about relationships among concepts relevant to that particular area*. This definition has support in the literature (Nonaka 1994). Let us now consider how this definition works for the above examples.

Example 1: The daily sales of burgers can be used, along with other information (e.g., information on the quantity of bread in the inventory), to compute the amount of bread to buy. The relationship between the quantity of bread that should be ordered, the quantity of bread currently in the inventory, and the daily sales of burgers (and other products that use bread) is an example of knowledge. Understanding of this relationship (which could conceivably be stated as a mathematical formula) helps to use the information (on quantity of bread in the inventory and daily sales of burgers, etc.) to compute the quantity of bread to be purchased. However, the quantity of bread to be ordered should itself be considered information and not knowledge. It is simply more valuable information.

Example 2: The information about 40 heads and 60 tails (out of 100 tosses) can be used to compute the probability of heads (0.40) and tails (0.60). The probabilities can then be used, along with information about the returns associated with heads (US$10 from Susan's perspective) and tails (–US$8, again from Susan's perspective) to compute the expected value to Susan from participating in the bet. Both probabilities and expected values are information, although more valuable information than the facts that 40 tosses produced heads and 60 produced tails. Moreover, expected value is more useful information than the probabilities; the former can directly be used to make the decision, whereas the latter requires computation of expected value.

The relationship between the **probability** of heads, the number of times the coin lands heads, and the total number of tosses (i.e., the probability of heads, or $p_H = n_H/(n_H + n_T)$, assuming that the coin can only land heads or tails) is an example of knowledge. It helps compute the probability from the data on outcomes of tosses. The similar formula for probability of tails is knowledge as well. In addition, the relationship between expected value (EV) and the probabilities (p_H, p_T) and returns (R_H, R_T) for heads and tails (i.e., $EV = p_H*R_H + p_T*R_T$) is also knowledge. Using these components of knowledge, probability of heads and tails can be computed as 0.40 and 0.60, respectively. Then, the expected value for Susan can be computed as $0.40*(+\$10) + 0.60*(-\$8) = -\$0.80$.

Example 3: The knowledge of a hurricane researcher is used to analyze the *u* and *v* wind components as well as the hurricane forecast produced by the different software models, to determine the probability that the hurricane will follow a specific trajectory.

Thus, knowledge helps produce information from data or more valuable information from less valuable information. In that sense, this information facilitates action such as the decision of whether to bet or not. Based on the new generated information of the expected value of the outcome as well as the relationship with other concepts, such as Susan's anticipation that the coin may be fair or not, knowledge enables Susan to decide whether she can expect to win at the game. This aspect of the relationship between data and information is depicted in Figure 2.1, which shows the relationship between data (which has zero or low value in making the decision), and information (which has greater value than data, although different types of information might have differing values).

The above relationships between data, information, and knowledge are illustrated using Example 2 in Figure 2.2. As may be seen from the figure, knowledge of how to count helps convert data on coin tosses (each toss producing a head or tail, with the set of 100 tosses producing 100 such observations, shown as H and T, respectively) into information (number of heads and number of tosses). This information is more useful than the raw data, but it does not directly help the decisionmaker (Susan) to decide on whether to participate in the bet. Using knowledge of how to compute probabilities, this information can be converted into more useful information—that is, the probabilities of heads and tails. Moreover, combining the information about probabilities with information about returns associated with heads and tails, it is possible to produce even more information—that is, the expected value associated with participation in the

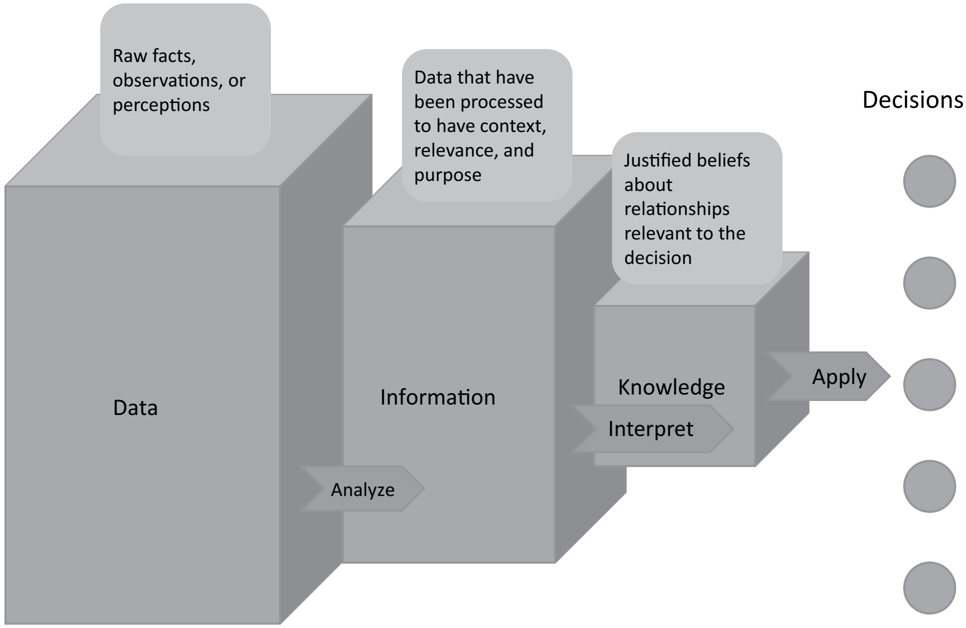

Figure 2.1 Data, Information, and Knowledge

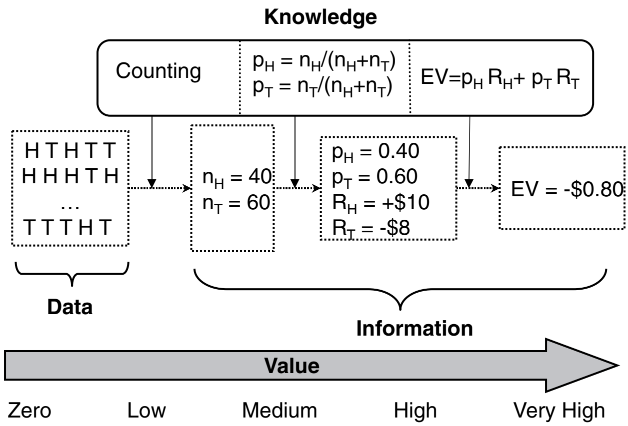

Figure 2.2 An Illustration of Data, Information, and Knowledge

bet. In making this transition, knowledge of the formula for computing expected value from probabilities and returns is utilized. Figure 2.2 illustrates how knowledge helps produce information from data (e.g., probabilities based on outcomes of tosses of 60 heads and 40 tails) or more valuable information (expected value) from less valuable information (e.g., probabilities and payoffs associated with heads and tails).

The above distinctions among data, information, and knowledge are consistent with Nonaka and Takeuchi's (1995) definition of knowledge as "a justified true belief." It is also consistent with Wiig's (1999, p.46) view of knowledge as being fundamentally different from data and information:

> Knowledge consists of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies, and know-how. It is possessed by humans, agents, or other active entities and is used to receive information and to recognize and identify; analyze, interpret, and evaluate; synthesize and decide; plan, implement, monitor, and adapt—that is, to act more or less intelligently. In other words, knowledge is used to determine what a specific situation means and how to handle it.

Figure 2.3 depicts how knowledge, data, and information relate to information systems, decisions, and events. As discussed, knowledge helps convert data into information. The knowledge could be stored in a manual or computer-based information system, which receives data as input and produces information as output. Moreover, the use of information to make the decision requires knowledge as well (e.g., in the context of the second example above, the knowledge that expected value above zero generally suggests that the decision is a good one). The decisions, as well as certain unrelated factors, lead to events, which cause generation of further data. The events, the use of information, and the information system might cause modifications in the knowledge itself. For example, in the context of example 1 on ordering raw materials based on sales, information about changes in suppliers (e.g., a merger of two suppliers) might cause changes in the perceived relationship (i.e., knowledge) between the quantity on hand, the daily sales, and the quantity to be ordered. Similarly, in example 2 on betting on the outcome of a coin toss, the individual's risk aversion, individual wealth, and so forth, might cause changes in beliefs related to whether expected value above zero justifies the decision to participate in the bet.

Alternative Views of Knowledge

Knowledge can be viewed from a subjective or objective stance. The subjective view represents knowledge using two possible perspectives: as a state of mind or as a

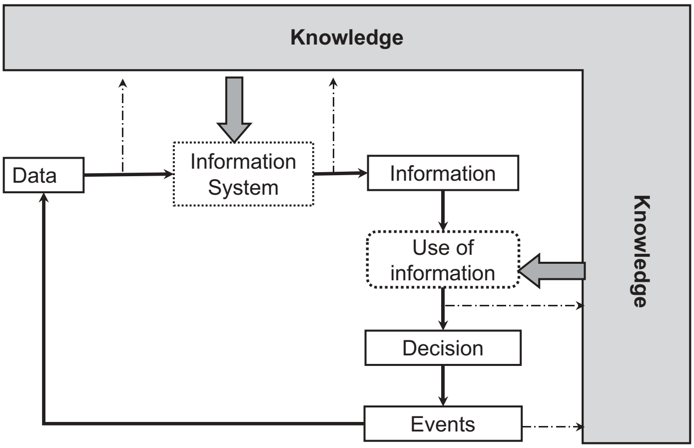

Figure 2.3 Relating Data, Information, and Knowledge to Events

practice. On the other hand, the objective view represents knowledge in three possible perspectives: as an object, as access to information, or as a capability. The perspectives on knowledge are shown in Figure 2.4.

Subjective View of Knowledge

According to the subjective view, reality is socially constructed through interactions with individuals (Schultze 1999). Knowledge is viewed as an ongoing accomplishment that continuously affects and is influenced by social practices (Boland and Tenkasi 1995). Consequently, knowledge cannot be placed at a single location, as it has no existence independent of social practices and human experiences. According to the subjective view, knowledge could be considered from two perspectives, either as a state of mind or as practice.

Knowledge as State of Mind

This perspective considers knowledge as being a state of an individual's mind. Organizational knowledge is viewed here as the beliefs of the individuals within the organization. Moreover, to the extent the various individuals have differing experiences and backgrounds, their beliefs, and hence knowledge, could differ from each other. Consequently, the focus here is on enabling individuals to enhance their personal areas of knowledge so that they can apply them to best pursue organizational goals (Alavi and Leidner 2001).

Knowledge as Practice

According to this perspective, knowledge is also considered as subjective but it is viewed as being held by a group and not as being decomposable into elements possessed by individuals. Thus, from this perspective, knowledge is "neither possessed by any one agent, nor contained in any one repository" (Schultze 1999, p. 10). Moreover, knowledge resides not in anyone's head but in practice. Knowledge is comprised of beliefs, consistent with our definition earlier, but the beliefs themselves are collective rather than individual, and therefore, are better reflected in organizational activities rather than in the minds of the organization's individuals. Viewed from this perspective, knowledge is "inherently indeterminate and continually emerging" (Tsoukas 1996, p. 22).

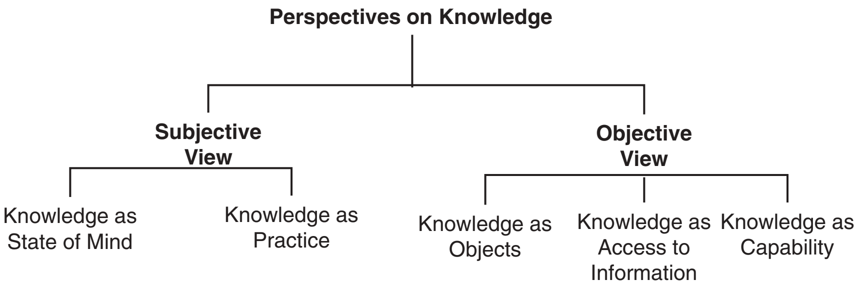

Figure 2.4 Various Perspectives on Knowledge

Objective View of Knowledge

The objective view is the diametrical opposite of the subjective stance. According to the objective view, reality is independent of human perceptions and can be structured in terms of *a priori* categories and concepts (Schultze 1999). Consequently, knowledge can be located in the form of an object or a capability that can be discovered or improved by human agents. The objective view considers knowledge from three possible perspectives.

Knowledge as Objects

This perspective considers knowledge as something that can be stored, transferred, and manipulated. Consistent with the definition of knowledge as a set of justified beliefs, these knowledge objects (i.e., beliefs) can exist in a variety of locations. Moreover, they can be of several different types, as discussed in the next section.

Knowledge as Access to Information

This perspective considers knowledge as the condition of access to information (Alavi and Leidner 2001). Thus, knowledge is viewed here as something that enables access and utilization of information. This perspective extends the above view of knowledge as objects, emphasizing the accessibility of the knowledge objects.

Knowledge as Capability

This perspective is consistent with the last two perspectives of knowledge as objects or as access to information. However, this perspective differs in that the focus here is on the way in which knowledge can be applied to influence action. This perspective places emphasis on knowledge as a strategic capability that can potentially be applied to seek a competitive advantage.

Thus, the five perspectives discussed above differ in their focus in viewing knowledge, but they are all consistent in viewing knowledge as a set of beliefs about relationships. The first perspective, knowledge as a state of mind, focuses on beliefs within human minds; while the second perspective, knowledge as a practice, focuses on beliefs implicit to actions or practice. In either case, the beliefs, and the knowledge they comprise, are considered subjective. In contrast, the last three perspectives (knowledge as objects, knowledge as access to information, and knowledge as a capability) view knowledge as objective, focusing on beliefs as objects to be stored and managed, as the condition of access to information, and as a capability that affects action. We recognize all five perspectives as important, and consider them as simply providing different ways of examining knowledge. However, in the remainder of the book, we adopt a position that is more objective than subjective. This is due to the desire to make this textbook useful for students and managers responsible for managing knowledge in their organizations; an objective view facilitates making practical recommendations about how organizations should manage knowledge, whereas a subjective view helps with understanding knowledge management but may be less valuable in recommending actions for knowledge management.

We next examine the different forms of knowledge, which are clearly consistent with the objective perspective of knowledge. However, an argument could also be made that at least some types of knowledge discussed below (e.g., tacit) are not inconsistent with a subjective view.

Different Types of Knowledge

Knowledge has been classified and characterized in several different ways. For example, knowledge has been categorized as individual, social, causal, conditional, relational, and pragmatic (Alavi and Leidner 2001) and also as embodied, encoded, and procedural (Venzin et al. 1998). In this section, we examine some of the more important classifications of knowledge. It is important to understand the nature of these various types of knowledge because different types of knowledge should be managed differently, as discussed in detail in some of the later chapters.

Procedural or Declarative Knowledge

The first distinction we examine is that between **declarative knowledge** (facts) and **procedural knowledge** (how to ride a bicycle) (Kogut and Zander 1992; Singley and Anderson 1989). Declarative knowledge (or substantive knowledge, as it is also called) focuses on beliefs about relationships among variables. For example, all other things being equal, a greater price charged for a product would cause some reduction in its number of sales. Declarative knowledge can be stated in the form of propositions, expected correlations, or formulas relating concepts represented as variables. For example, stating that the sum of the square of the sine of an angle and the square of the cosine of the same angle would equal one is an example of declarative knowledge. Similarly, identifying the specific product features a specific customer likes is also an example of declarative knowledge.

Procedural knowledge, in contrast, focuses on beliefs relating sequences of steps or actions to desired (or undesired) outcomes. An example of such procedural knowledge is the set of justified beliefs about the procedure that should be followed in a government organization in deciding on whom to award the contract for a particular area (e.g., information system development).

Declarative knowledge may be characterized as "know what," whereas procedural knowledge may be viewed as "know-how." To further understand the difference between these two types of knowledge, let us consider the example of a hypothetical automobile manufacturing firm. An instance of declarative knowledge in this context is the set of justified beliefs about the effect that the quality of each component would have on the final product. This could include the effect of quality on such features as reliability, fuel consumption, deterioration over time, and quality of the ride of a particular model. Such declarative knowledge, combined with information about the set of components needed for each model and the prices of various alternatives for each component, would help determine the specific components that should be used in each model. An example of procedural knowledge in the same context would be the set of beliefs about the process used to assemble a particular model of the car. This could include such things as the steps in the engine assembly process, which tasks can be performed in parallel, the amount of time that each step should take, the amount of waiting time between successive steps, and so on.

Tacit or Explicit Knowledge

Another important classification of knowledge views it as tacit or explicit (Nonaka 1994; Polanyi 1966). **Explicit knowledge** typically refers to knowledge that has been expressed into words and numbers. Such knowledge can be shared formally and systematically in the form of data, specifications, manuals, drawings, audio- and videotapes, computer programs, patents, and the like. For example, the basic principles for stock market analysis contained in a book or manual are considered explicit knowledge. This knowledge can be used by investors to make decisions about buying or selling stocks. It should also be noted that although explicit knowledge might resemble data or information in form, the distinction mentioned earlier in this chapter is preserved; although explicated, the principles of stock market analysis are justified beliefs about relationships rather than simple facts or observations. Also, the rules about how to process a travel reimbursement, which becomes embedded in an enterprise resource planning system, is considered explicit knowledge.

In contrast, **tacit knowledge** includes insights, intuitions, and hunches. It is difficult to express and formalize, and therefore difficult to share. Tacit knowledge is more likely to be personal and based on individual experiences and activities. For example, through years of observing a particular industry, a stock market analyst might gain knowledge that helps him make recommendations to investors in the stock market regarding the likely short-term and long-term market trends for the stocks of firms within that industry. Such knowledge would be considered tacit, unless the analyst can verbalize it in the form of a document that others can use and learn from. Tacit knowledge may also include **expertise** that is so specific that it may be too expensive to make explicit; therefore, the organization chooses to let it reside with the expert.

As discussed above, explicit and tacit forms of knowledge are quite distinct. However, it is possible to convert explicit knowledge into tacit, as occurs, for example, when an individual reads a book and learns from it, thereby converting the explicit knowledge contained in the book into tacit knowledge in the individual's mind. Similarly, tacit knowledge can sometimes be converted into explicit knowledge, as happens when an individual with considerable tacit knowledge about a topic writes a book or manual formalizing that knowledge. These possibilities are discussed in greater detail in the next chapter on knowledge management solutions.

General or Specific Knowledge

The third classification of knowledge focuses on whether the knowledge is possessed widely or narrowly (Sabherwal and Becerra-Fernandez 2005). **General knowledge** is possessed by a large number of individuals and can be transferred easily across individuals. For example, knowledge about the rules of baseball can be considered general, especially among the spectators at a baseball park. One example of general knowledge in this context is recognizing that when a baseball player takes the fourth "ball," he gets a walk; when he takes the third "strike," he is out. It is general because everyone with a basic understanding of baseball would possess this knowledge.

Unlike general knowledge, **specific knowledge**, or "idiosyncratic knowledge," is possessed by a very limited number of individuals, and is expensive to transfer (Hayek 1945; Jensen and Meckling 1996; Sabherwal and Becerra-Fernandez 2005; Sabherwal et al. 2023). Consider the distinction between a professional coach and a typical fan watching a baseball game. The coach has the knowledge needed to filter, from the chaos of the game, the information required to evaluate and help players through advice such as when to try to hit the ball, when to steal a base, and so on. For example, if Albert Pujols is at bat, a slow man is on first, his team has two outs and is behind by one run against a left-handed pitcher, Pujols should be allowed to swing away. Few fans may have this knowledge, and so it is considered specific.

Specific knowledge can be of three types: technology-specific knowledge, context-specific knowledge, and context-and-technology-specific knowledge. **Technology-specific knowledge** is deep knowledge about a specific area. It includes knowledge about the tools and techniques that may be used to address problems in that area. This kind of knowledge is often acquired as a part of some formal training and is then augmented through experience in the field. Examples include the scientific knowledge possessed by a physicist and the knowledge about computer hardware possessed by a computer engineer. Within the engineering directorate at NASA-Kennedy Space Center, the knowledge of project management techniques (such as PERT charts and critical path analysis) is technology specific, as it pertains to project management in general without being specific to NASA or Kennedy Space Center.

On the other hand, **context-specific knowledge** refers to the knowledge of particular circumstances of time and place in which work is to be performed (Hayek 1945; O'Reilly and Pondy 1979; Sabherwal and Becerra-Fernandez 2005). Contextually specific knowledge pertains to the organization and the organizational subunit within which tasks are performed. For example, the detailed knowledge a design engineer possesses about the idiosyncrasies of the particular design group in which she is working is contextually specific. Another example is a baseball catcher's knowledge of the team's pitching staff. Contextually specific knowledge cannot be acquired through formal training but instead must be obtained from within the specific context (such as membership in the same design group or baseball team). Within the engineering directorate at NASA-Kennedy Space Center, the knowledge of the mechanisms used to patent and license NASA-developed technology for public use is context-specific, because it depends primarily on the Kennedy Space Center's context with minimal effect of the particular technical discipline.

A third kind of specific knowledge, which may be called **context-and-technology-specific knowledge**, is specific in terms of both the context and the technical aspects. Context-and-technology-specific knowledge simultaneously involves both rich scientific knowledge and an understanding of the particular context (Machlup 1980; Sabherwal and Becerra-Fernandez 2005). For example, knowledge of how to decide on the stocks to acquire within an industry is context-and-technology-specific; it blends an understanding of that industry's dynamics as well as the tools used to analyze stock performance. Similarly, in the engineering directorate at NASA-Kennedy Space Center, the knowledge of how to plan and develop ground and flight support systems is context-and-technology-specific because it depends on both the design context of flight systems at Kennedy Space Center and principles of engineering.

Combining the Classifications of Knowledge

The above classifications of knowledge are independent. In other words, procedural knowledge could be either tacit or explicit and either general or specific. Similarly, declarative knowledge could be either tacit or explicit and either general or specific.

Combining the above three classifications and considering technically specific and contextually specific knowledge as distinct, 12 ($2 \times 2 \times 3$) types of knowledge can be identified as indicated and illustrated in Table 2.1.

Knowledge and Expertise

We define **expertise** to be knowledge of higher quality. It addresses the degree of knowledge. That is, one who possesses expertise is able to perform a task much better that those who do not. This is specific knowledge at its best. The word "expert" can be used to describe people possessing many different levels of skills or knowledge. A person can be an expert at a particular task irrespective of how sophisticated that area of expertise is. For example, there are expert bus drivers just as there are expert brain surgeons. Each of them excels in the performance of tasks in their respective field.

Thus, the concept of expertise must be further classified for different types of domains. The skill levels of experts from different domains should not be compared to each other. All experts require roughly the same cognitive skills. The difference

Table 2.1 Illustrations of the Different Types of Knowledge

	General	*Contextually Specific*	*Technically Specific*
Declarative			
Explicit	A book describing factors to consider when deciding whether to buy a company's stock. This may include information on price to earnings ratio and dividends.	A company document identifying the circumstances under which a consultant team's manager should consider replacing a team member who is having problems with the project.	A manual describing the factors to consider in configuring a computer so as to achieve performance specifications.
Tacit	Knowledge of the major factors to consider when deciding whether to buy a company's stock.	A human relations manager's knowledge of factors to consider in motivating an employee in a particular company.	A technician's knowledge of symptoms to look for in trying to repair a faulty television set.
Procedural			
Explicit	A book describing steps to take in deciding whether to buy a company's stock.	A company document identifying the sequence of actions a consultant team's manager should take when requesting senior management to replace a team member having problems with the project.	A manual describing how to change the operating system setting on a computer so as to achieve desired performance changes.
Tacit	Basic knowledge of the steps to take in deciding whether to buy a company's stock.	A human relations manager's knowledge of steps to take in motivating an employee in a particular company.	A technician's knowledge of the sequence of steps to perform in repairing a television set.

lies in the depth of their expertise when compared to others from their own domains. For example, a highly skilled bus driver has greater abilities than a novice driver, just as an expert brain surgeon has greater skills than a surgical intern. Prior empirical research on expertise indicates the importance of knowledge management: “It takes time to become an expert. Even the most gifted performers need a minimum of ten years of intense training before they win international competitions” (Ericsson et al. 2007, p. 18).

Expertise can be classified into three distinct categories. Expert systems have had varying degrees of success when representing expertise from each of these categories. These categories, discussed in the following subsections, are (1) associational (black box), (2) motor skills, and (3) theoretical (deep) expertise.

Associational Expertise

In most fields, it is usually desirable that experts have a detailed understanding of the underlying theory within that field. But is this absolutely necessary? What about the television repair technician considered an expert repairman but who does not understand all of the complex internal workings of a transistor or a picture tube? He can associate the observations of the performance of the device to specific causes purely based on his experience. This individual may have expert-level **associational understandings** of these devices and may be able to fix almost any problem encountered. However, if he encounters a new, previously unseen problem, he may not know how to proceed because he does not understand the inner workings of the device.

Motor Skills Expertise

Motor skill expertise is predominantly physical rather than cognitive; therefore, knowledge-based systems cannot easily emulate this type of expertise. Humans improve these skills by repeated and coached practice. While some people have greater abilities for these types of skills than others, real learning and expertise result from persistent guided practice. For example, consider the tasks of riding a bicycle, hitting a baseball, and downhill snow skiing. When you observe experts performing these activities, you notice that their reactions seem spontaneous and automatic. These reactions result from the experts’ continual and persistent and coached practice. For example, when a skilled baseball player bats, he instinctively reacts to a curveball, adjusting his swing to connect with the ball. This appropriate reaction results from encountering thousands of curveballs over many years and the coaches’ recommendations on how to hit the ball in a particular situation. A novice batter might recognize a curveball being thrown, but due to a lack of practice reacts more slowly and consequently may strike out.

These processes do not involve conscious thinking per se. The batter merely reacts instinctively and almost instantaneously to the inputs. In fact, many coaches maintain that thinking in such situations degrades performance. Of course, some cognitive activity is necessary—the batter must follow the track of the ball, recognize its motion (curve, changeup, etc.), and make a decision on what to do (swing, let it go, etc.). The issue, however, is that the result of the decision-making is manifested in very quick physical actions and not in carefully pondered statements.

Theoretical (Deep) Expertise

Finding a solution to a technical problem often requires going beyond a superficial understanding of the domain. We must apply creative ingenuity—ingenuity that is based on our theoretical knowledge of the domain. This type of knowledge allows experts to solve problems that have not been seen before and, therefore, cannot be solved via associational expertise.

Such deeper, more theoretical knowledge is acquired through formal training and hands-on problem-solving. Typically, engineers and scientists who have many years of formal training possess this type of knowledge. Box 2.1 illustrates **deep theoretical knowledge**.

Box 2.1 Deep Theoretical Knowledge Enables Competitive Advantage

During the 1980s, two firms were involved in competition for a long-term (multiple decades) and large (multibillion dollar) government contract for tactical missiles. Neither company had a significant performance advantage over the other.

A scientist at one of the firms, who was not a member of the project team, broke the stalemate. He had deep expertise in developing missiles due to over 20 years of experience in this area. He was well regarded as a technical expert, and when he called a meeting of the major participants in the project they all came. For several hours, he enchanted them with a comprehensive description of design changes that he had identified within a single week of committed effort. Making no use of any kind of notes, he guided them through the reconfiguration of the entire missile. To implement the extensive changes he suggested in hardware, wiring, and software, 400 individuals would need to work full-time for a year and a half. However, the expert's audience was convinced that the redesign would produce tremendous competitive advantage. His proposal led to a frenzy of activity and enabled his firm to win the contract. More than 20 years later, in 2004, the redesign that this individual with deep expertise had created was still producing benefits.

Source: Compiled from Leonard and Swap (2004)

Some Concluding Remarks on the Types of Knowledge

In addition to the above types of knowledge, some other classifications also deserve mention. One of these classifications views knowledge as either simple or complex. Whereas **simple knowledge** focuses on one basic area, **complex knowledge** draws upon multiple distinct areas of expertise. Another classification focuses on the role of knowledge within organizations. It divides knowledge into: **support knowledge**, which relates to organizational infrastructure and facilitates day-to-day operations; **tactical knowledge**, which pertains to the short-term positioning of the organization relative to its markets, competitors, and suppliers; and **strategic knowledge**, which pertains to the long-term positioning of the organization in terms of its corporate vision and strategies for achieving that vision.

Based in part on the above types of knowledge, a number of characteristics of knowledge can be identified. One such characteristic is explicitness of knowledge, which reflects the extent to which knowledge exists in an explicit form so that it can be stored and transferred to others. As a characteristic of knowledge, explicitness indicates that rather than simply classifying knowledge as either explicit or tacit, it may be more appropriate to view explicitness as a continuous scale. Explicit and tacit kinds of knowledge are at the two ends of the continuum, with explicit knowledge being high in explicitness and tacit knowledge being low in this regard. Any specific knowledge would then be somewhere along this continuum of explicitness.

Specific knowledge is directly related to the concept of knowledge specificity (Choudhury and Sampler 1997). A high level of knowledge specificity implies that the knowledge can be acquired and/or effectively used only by individuals possessing certain prior knowledge (Jensen and Meckling 1996). Knowledge specificity implies that the knowledge is possessed by a very limited number of individuals and is expensive to transfer (Choudhury and Sampler 1997). Taking a step further, technically specific and contextually specific knowledge lead us to break down knowledge specificity into **contextual knowledge specificity** and **technical knowledge specificity**. Of course, contextually specific knowledge and technically specific knowledge are high in contextual knowledge specificity and technical knowledge specificity, respectively (Sabherwal et al. 2023).

In addition, the distinction between simple and complex knowledge may be represented using complexity as a knowledge attribute. Similarly, the organizational role of knowledge reflects the distinction among support, tactical, and strategic knowledge.

An organization does not have only one of the above types of knowledge. Instead, in any given organization, multiple different types of knowledge exist together. In Box 2.2, we provide an example of how different types of knowledge exist together within an organization.

Box 2.2 Different Types of Knowledge at Hill and Knowlton

Founded in 1927, Hill and Knowlton is a leading international communications consultancy headquartered in New York, with 74 offices in 41 countries and an extensive associate network. It is part of WPP Group Plc, which is one of the world's largest communications services groups and provides services to local, multinational, and global clients. Among other things, the company is hired by organizations to manage their product launches, media relations, and communication during crises.

In the late 1990s, turnover rates in certain practices in public relations, such as those related to technology, increased from 15 percent to over 30 percent. The loss of talented individuals led to a leakage of important knowledge as well as information about specific projects. In 1988, in response to concerns by several key clients of the company, the Worldwide Advisory Group (a summit of the company's 200 managers) considered ways of addressing this issue of knowledge leakage. This group identified three broad types of knowledge that were important to the company. One of these was the company's internal knowledge about its own products and services. The second was external knowledge, such as economic forecasts and other related research by outside experts. The third type of knowledge related to clients including budgets, templates, and account activity.

Subsequently, Ted Graham was appointed as Hill and Knowlton's worldwide director of knowledge management. He concluded that while the company was performing well in terms of capturing the structured knowledge such as case studies, proposals, and staff bios, it was not doing so well in capturing unstructured knowledge such as knowledge embedded in speeches, e-mail messages, and other information that had not been classified in any fashion. To deal with this problematic situation, the advisory group decided to replace the current global Intranet with “hK.net,” a “Web-based virtual workspace” serving the company’s offices across the world. Based on Intraspect Software Inc.’s Salsa application and a password-protected website, hK.net was designed to enable both the employees and clients to access internal and external repositories of information and knowledge such as news about the company and the industry, client-related budget information and e-mail archives, staff biographies, presentations, spreadsheets, case studies, pictures, video clips, conference notes, research reports, and so on. Clients as well as Hill and Knowlton executives appreciated hK.net because it reduced the time spent in educating new members of project teams as well as training new employees.

Sources: Compiled from Hill and Knowlton Strategies (n.d.); Meister and Mark (2004)

Locations of Knowledge

Knowledge resides in several different locations or reservoirs, which are summarized in Figure 2.5. They include people, including individuals and groups; artifacts, including practices, technologies, and repositories; and organizational entities, including organizational units, organizations, and interorganizational networks. These locations of knowledge are discussed in the rest of this section.

Knowledge in People

A considerable component of knowledge is stored in people. This relates to the arguments some scholars make about all learning being inherently inside human minds. For example, Simon (1991, p. 125) remarks:

> All learning takes place inside individual human heads; an organization learns in only two ways: (a) by the learning of its members, or (b) by ingesting new members who have knowledge the organization didn’t previously have.

Knowledge could reside among people, either at the individual level or within a group or a collection of people (Felin and Hesterly 2007; Sabherwal et al. 2023). Some knowledge is stored in *individuals* within organizations. For instance, in professional service firms, such as consulting or law firms, considerable knowledge resides within the

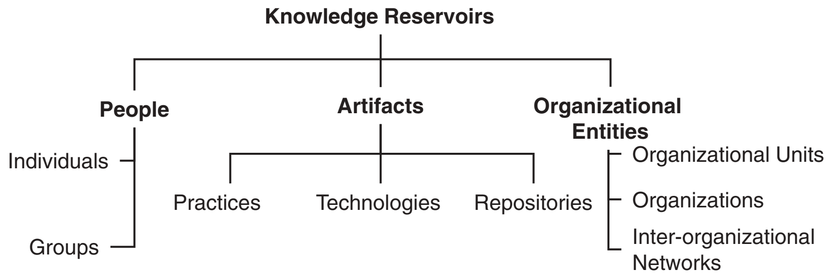

Figure 2.5 The Reservoirs of Knowledge

minds of individual members of the firm (Argote and Ingram 2000; Felin and Hesterly 2007). The knowledge stored in individuals is the reason several companies continually seek ways to retain knowledge that might be lost because of individuals retiring or otherwise leaving the organization.

In addition, considerable knowledge resides within *groups* because of the relationships among the members of the group (Felin and Hesterly 2007). When three individuals have worked together for a long time, they instinctively know each other's strengths and weaknesses, understand the other's approach, and recognize aspects that need to be communicated and those that could be taken for granted (Skyrme 2000). Consequently, groups form beliefs about what works well and what does not, and this knowledge is over and above the knowledge residing in each individual member. In other words, the collective knowledge is synergistic—greater than the sum of their individual knowledge. Communities of practice that first develop as individuals interact frequently with each other (physically or virtually) to discuss topics of mutual interest, and they illustrate such embedding of knowledge within groups.

Knowledge in Artifacts

Over time, a significant amount of knowledge is stored in organizational artifacts as well. Some knowledge is stored in *practices*, organizational routines, or sequential patterns of interaction. In this case, knowledge is embedded in procedures, rules, and norms that are developed through experience over time and guide future behavior (Levitt and March 1988). For example, fast-food franchises often store knowledge about how to produce high-quality products in routines (Argote and Ingram 2000).

Considerable knowledge is also often stored in *technologies* and systems. As discussed earlier in this chapter, in addition to storing data, information technologies and computer-based information systems can store knowledge about relationships. For example, a computerized materials requirement planning system contains considerable knowledge about relationships among demand patterns, lead times for orders, and reorder quantities.

Knowledge repositories represent a third way of storing knowledge in artifacts. Knowledge repositories could either be paper-based, such as books, papers, and other documents, or electronic. An example of a paper-based repository is a consultant's set of notes to herself about the kind of things the client might focus on more, when examining the proposals submitted by the consultant firm and its competitors. On the other hand, a website containing answers to frequently asked questions (FAQs) about a product represents an electronic knowledge repository.

Knowledge in Organizational Entities

Knowledge is also stored within organizational entities. These entities can be considered at three levels: organizational units (parts of the organization), an entire organization, and in interorganizational relationships (such as the relationship between an organization and its customers).

Within an *organizational unit*, such as a department or an office, knowledge is stored partly in the relationships among the members of the units. In other words, the organizational unit represents a formal grouping of individuals, who come together not because of common interests but rather because of organizational structuring. Over