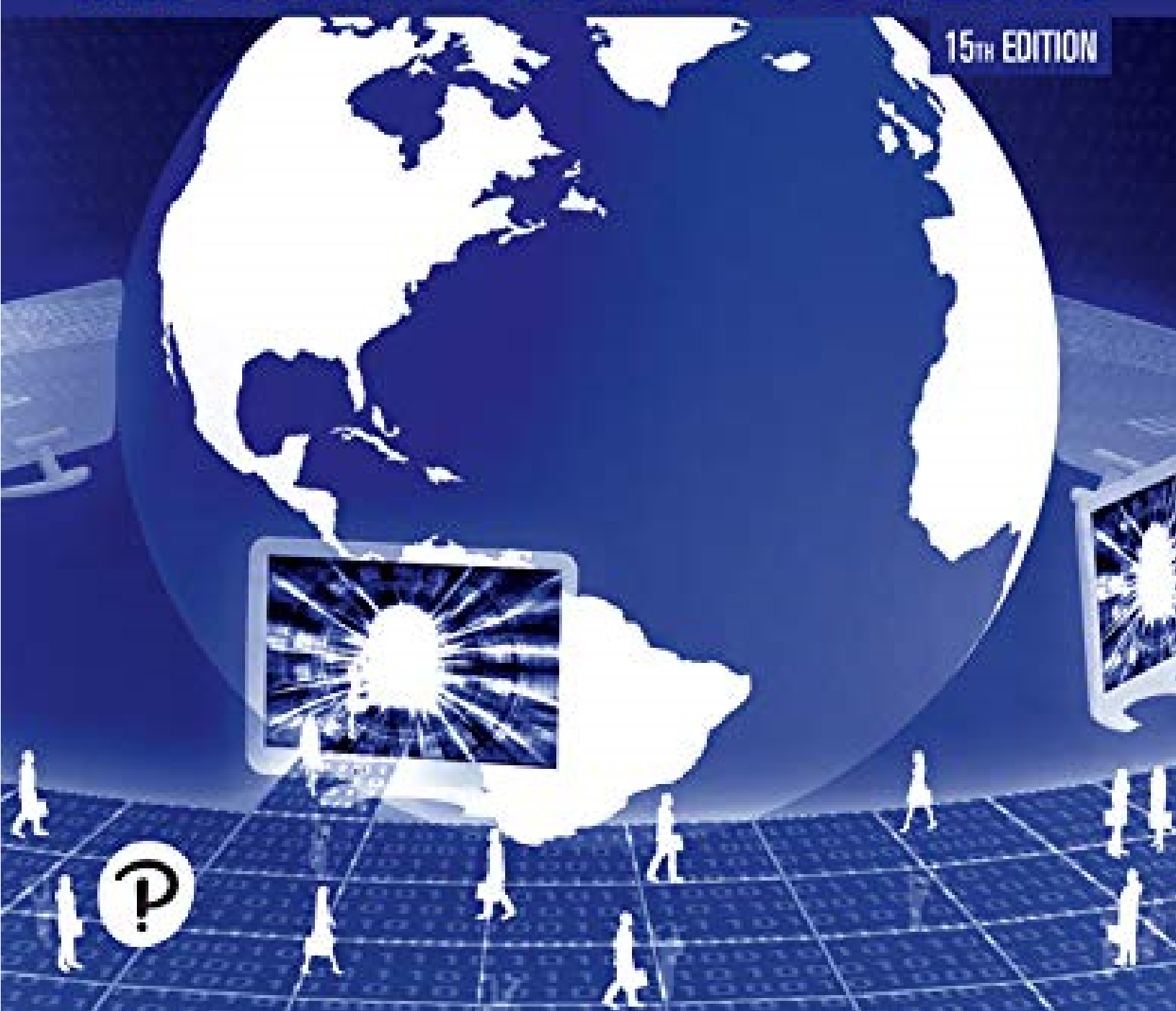
Marshall B. Romney | Paul John Steinbart | Scott L. Summers | David A. Wood

ACCOUNTING INFORMATION SYSTEMS

15TH EDITION



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Accounting Information Systems

FIFTEENTH EDITION

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Brief Contents

Preface

New to This Edition

INTRODUCING TWO NEW CO-AUTHORS

Scott L. Summers and David A. Wood, both from Brigham Young University, joined as new co-authors. Scott and David created the new section on data analytics (Part II), consisting of four chapters. The first chapter is an update of Chapter 4 that discusses relational databases not only as the basis for transaction processing systems, but also as one of the sources of Big Data and Analytics. The next three chapters (Chapters 5–7) discuss the Extract, Transfer, and Load (ETL) process and various data analytic techniques. This new content covers an extremely important topic that affects all aspects of designing, using, managing, and auditing an AIS.

ENHANCEMENTS IN THE FIFTEENTH EDITION

We made extensive revisions to the content of the material to incorporate recent developments while retaining the features that have made prior editions easy to use. Every chapter has been revised to include up-to-date examples of important concepts. Specific changes include the following:

1. Introduced several new topics in Chapter 1. The chapter discusses how an AIS can use artificial intelligence and data analytics to improve decision making, how the AIS is affected by blockchain technology, and the use of cloud computing, virtualization, and the internet of things.
2. Shortened and simplified the discussion of computer fraud and abuse techniques by eliminating many of the less frequently used techniques.
3. Simplified the discussion of control and the AIS by using the COSO Internal Control framework instead of the COSO Enterprise Risk Management framework as the structure for discussing controls.
4. Updated the discussion of information security countermeasures.
5. Updated the discussion of transaction processing and encryption to include blockchain technology.
6. Updated the discussion of privacy to include the EU's General Data Privacy Regulation (GDPR).
7. Updated the end-of-chapter discussion questions and problems, including Excel exercises that are based on articles from the *Journal of Accountancy* so that students can develop the specific skills used by practitioners. Most chapters also include a problem that consists of multiple-choice questions we have used in our exams to provide students with an additional chance to check how well they understand the chapter material.
8. Moved the topic of auditing (Chapter 11 in the fourteenth edition) to a web-only appendix because most of that material is covered in other courses.

Solving Learning and Teaching Challenges

STRUCTURED LEARNING

KEY LEARNING OBJECTIVES When you finish reading this text, you should understand the following key concepts:

- Basic activities performed in major business cycles.
- What data needs to be collected to enable managers to plan, evaluate, and control an organization's business activities.
- How to extract, transfer, and load (ETL) data from both the organization's AIS and other sources into a common repository that can be used for data analytics.
- How IT developments can improve the efficiency and effectiveness of business processes.
- How to design an AIS to provide the information needed to make key decisions in each business cycle.
- Risk of fraud and motives and techniques used to perpetrate fraud.
- COSO's models (Internal Control and ERM) for internal control and risk management as well as specific controls used to achieve these objectives.
- Control Objectives for Information and Related Technology (COBIT) framework for the effective governance and control of information systems and how IT affects the implementation of internal controls.
- AICPA's Trust Services framework for ensuring systems reliability by developing procedures to protect the confidentiality of proprietary information, maintain the privacy of personally identifying information collected from customers, assure the availability of information resources, and provide for information processing integrity.
- Fundamentals of information security.
- Fundamental concepts of database technology and data modeling and their effect on an AIS.
- Tools for documenting AIS work, such as REA diagrams, business processing diagrams, data flow diagrams, and flowcharts.
- Basic steps in the system development process to design and improve an AIS.

FEATURES TO FACILITATE LEARNING To help students understand these concepts, the text includes the following features:

1. **Each chapter begins with an integrated case that introduces key chapter concepts and topics and identifies several key issues or problems that students should be able to solve after mastering the material presented in that chapter.** The case is referenced throughout the chapter, and the chapter summary presents solutions to the problems and issues raised in the case.
2. **Focus boxes and real-world examples** to help students understand how companies use the latest IT developments to improve their AIS.
3. **Hands-on Excel exercises in many chapters** to help students hone their computer skills. Many of these exercises are based on "how-to" tutorials that appeared in recent issues of the *Journal of Accountancy*. Some of those articles discuss older versions of Excel, thereby giving students practice in developing the important life-long learning skill of adapting older instructions to updated versions of software.
4. **Numerous discussion questions and problems in every chapter** provide additional opportunities for students to demonstrate mastery of key concepts. Many problems were developed from reports in current periodicals. Other problems were selected from various professional examinations, including the CPA, CMA, CIA, and SMAC exams. One problem in every chapter consists of a set of multiple-choice questions to provide practice in answering exam-style questions. One or more problems where students are asked to match terms with their definitions to help students learn the terminology introduced in that chapter. **Each chapter also has one or more cases** that require more extensive exploration of specific topics.

5. **Quizzes** at the end of each chapter enable students to self-assess their understanding of the material. We also provide detailed explanations about the correct answer to each quiz question.
6. A number of chapters have a **comprehensive problem** in the AIS in Action section at the end of the chapter with the solution to the problem provided after quiz question solutions and explanations at the very end of the chapter.
7. **Extensive use of full-color graphics.** The text contains hundreds of figures, diagrams, flowcharts, and tables that illustrate chapter concepts, and color is used to highlight key points.
8. Definitions of key terms are repeated in the **glossary margins** in each chapter. In addition, a **comprehensive glossary** located at the back of the book makes it easy to look up the definition of the various technical terms used in the text.

CONTENT AND ORGANIZATION

Part I: Conceptual Foundations of Accounting Information Systems Part I consists of three chapters that present the underlying concepts fundamental to an understanding of AIS.

Chapter 1 introduces basic terminology and provides an overview of AIS topics. It discusses how an AIS can add value to an organization and how it can be used to help organizations implement corporate strategy. It also discusses the types of information companies need to successfully operate and introduces the basic business processes that produce that information. It concludes by describing the role of the AIS in an organization's value chain. It also introduces several new topics in the text: artificial intelligence, data analytics, blockchain, virtualization, cloud computing, and the Internet of Things.

Chapter 2 introduces transaction processing in automated systems and presents basic information about input/output, processing, and data storage concepts as well as the wide range of data that must be collected by the AIS. This information helps students understand what an AIS does; throughout the remainder of the book, we discuss advances in IT and how it affects the manner in which those functions are performed. The chapter discusses the impact of blockchain on transaction processing. Chapter 2 also introduces Enterprise Resource Planning (ERP) systems and their importance and uses in modern business.

Chapter 3 covers three of the most important tools and techniques used to understand, evaluate, design, and document information systems: business process diagrams, flowcharts, and data flow diagrams. Students will learn how to read, critique, and create systems documentation using these tools.

Part II: Data Analytics Part II consists of four chapters about relational databases, the ETL process, and various data analytics techniques.

Chapter 4 describes the principles of relational database design and how to use SQL to analyze the data. It also discusses how an organization's relational database used for transaction processing provides one important source of data for advanced data analytics.

Chapter 5 introduces the topic of data analysis and begins by stressing the importance of formulating and asking the right questions to obtain useful insights. It then explains the basic steps of extracting, transforming, and loading (ETL) data to be used for analytics. Next, it discusses how to choose appropriate analytic techniques and how to interpret and share the results. A discussion about the potential for automating analytics and a word of caution about the limits of what analytics can and cannot do concludes the chapter.

Chapter 6 delves into more detail about the different steps in the ETL process, focusing on how to transform data. It begins by describing the attributes that make data useful for analytics and then discusses techniques for structuring data, standardizing data being consolidated from multiple sources, cleaning data, and validating data.

Chapter 7 discusses the differences between descriptive, diagnostic, predictive, and prescriptive analytic techniques. It also describes how to choose the right visualization tools to aid in analysis and presents best practices for designing high-quality visualizations.

Part III: Control of Accounting Information Systems The six chapters in Part III focus on threats to the reliability of the AIS and applicable controls for addressing and mitigating the risks associated with those threats.

Chapter 8 introduces students to the different kinds of threats faced by information systems, primarily focusing on the threats of fraud and errors. The chapter describes the different types of fraud and explains how fraud is perpetrated, who perpetrates it, and why it occurs.

Chapter 9 discusses computer fraud and abuse techniques. Three major types of computer fraud are discussed: computer attacks and abuse, social engineering, and malware. The chapter explains the dozens of ways computer fraud and abuse can be perpetrated.

Chapter 10 uses the COSO Internal Control framework, to discuss the basic concepts of internal control. It introduces the expanded enterprise risk management (COSO-ERM) model and compares it with the COSO Internal Control framework. It also introduces the COBIT framework which applies those concepts to IT, thereby providing a foundation for effective governance and control of information systems.

Chapter 11 focuses on information security. It introduces the fundamental concepts of defense-in-depth and the time-based approach to security. The chapter provides a broad survey of a variety of security topics, including access controls, firewalls, encryption, and incident detection and response.

Chapter 12 discusses the many specific computer controls used in business organizations to achieve the objectives of ensuring privacy and confidentiality and discusses the implications of new regulations such as the EU's General Data Privacy Regulation (GDPR) and similar laws enacted by California and other states. The chapter also provides a detailed discussion of blockchain technology.

Chapter 13 addresses the controls necessary to achieve the objectives of accurate processing of information and ensuring that information is available to managers whenever and wherever they need it. It also discusses how virtualization and cloud technology are changing the methods used for backup and recovery.

Part IV: Accounting Information Systems Applications Part IV focuses on how a company's AIS provides critical support for its fundamental business processes. Most large and many medium-sized organizations use enterprise resource planning (ERP) systems to collect, process, and store data about their business processes as well as to provide information reports designed to enable managers and external parties to assess the organization's efficiency and effectiveness. To make it easier to understand how an ERP system functions, Part III consists of five chapters, each focusing on a particular business process.

Chapter 14 covers the revenue cycle (also referred to as the sales-to-cash business process), describing all the activities involved in taking customer orders, fulfilling those orders, and collecting cash.

Chapter 15 examines the expenditure cycle (also referred to as the purchase-to-pay business process), describing all the activities involved in ordering, receiving, and paying for merchandise, supplies, and services.

Chapter 16 reviews the production (manufacturing) cycle, with a special focus on the implications of recent cost accounting developments, such as activity-based costing, for the design of the production cycle information system.

Chapter 17 explains the human resources management/payroll cycle, focusing primarily on the activities involved in processing payroll.

Chapter 18 explores the general ledger and reporting activities in an organization, discussing topics such as XBRL, the balanced scorecard, and the switch from GAAP to IFRS.

Each of these five chapters explains the three basic functions performed by the AIS: efficient transaction processing, provision of adequate internal controls to safeguard assets (including data), and preparation of information useful for effective decision making.

Part V: The REA Data Model Part V consists of three chapters that focus on the REA data model, which provides a conceptual tool for designing and understanding the database underlying an AIS.

Chapter 19 introduces the REA data model and how it can be used to design an AIS database. The chapter focuses on modeling the revenue and expenditure cycles. It also demonstrates how the REA model can be used to develop an AIS that can not only generate traditional financial statements and reports but can also more fully meet the information needs of management.

Chapter 20 explains how to implement an REA data model in a relational database system. It also shows how to query a relational database to produce various financial statements and management reports.

Chapter 21 explains how to develop REA data models of the production, HR/payroll, and financing cycles. It also discusses a number of advanced modeling issues such as the acquisition and sale of intangible products and services and rental transactions.

Part VI: The Systems Development Process Part VI consists of three chapters that cover various aspects of the systems development process.

Chapter 22 introduces the systems development life cycle and discusses the introductory steps of this process (systems analysis, feasibility, and planning). Particular emphasis is placed on the behavioral ramifications of change.

Chapter 23 discusses an organization's many options for acquiring or developing an AIS (e.g., purchasing software, writing software, end-user-developed software, and outsourcing) and for speeding up or improving the development process (business process management, prototyping, agile methodologies, and computer-assisted software engineering).

Chapter 24 covers the remaining stages of the systems development life cycle (conceptual design, physical design, implementation, and operation and maintenance) and emphasizes the interrelationships among the phases.

SUPPLEMENTAL RESOURCES For more information and resources, visit www.pearson.com.

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EXCEL HOMEWORK PROBLEMS Accountants need to become proficient with Excel because it is a useful tool for tasks related to every business process. That is why each of the chapters in the business process section contains several homework problems designed to teach new Excel skills in a context related to one of the business processes discussed in the chapter.

As with any software, Microsoft regularly releases updates to Microsoft Office, but not everyone always immediately switches. During your career you will periodically move to a newer version of Excel. When you do, you will find that sometimes you need to make only minor changes to existing spreadsheets, but other times you may have to make more significant changes because the newer version of Excel now incorporates different features and functions.

So how do you keep abreast of changes? And how can you learn new Excel skills "on the job" to simplify tasks that you now find yourself doing repeatedly? You could pay to take a course, but that can be costly, time-consuming and not always timely. Alternatively, you can develop life-long learning skills to continuously update your knowledge. One important way to do this is to begin now to save copies of two types of articles that regularly appear in the *Journal of Accountancy*. The first is the monthly column, "Technology Q&A," which often contains answers to questions about how do you do something in a newer version of Excel that you know how to do in an older version. The second type of article is a complete tutorial about a powerful way to use one or more Excel functions to automate a recurring task. Often, this second type of article has an online spreadsheet file that you can download and use to follow along with the example and thereby teach yourself a new skill.

The *Journal of Accountancy* website maintains an archive of these articles that you can search to see if there is one that addresses a task that is new for you. Even if the article explains how to do something (such as create a pivot table) in an older version of Excel, in most cases you will find that many of the steps have not changed. For those that have, if you read the old way to do it as described in the article, you can then use Excel's built-in help feature to see how to do the same task in the newer version that you are now using.

The ability to learn how to use new versions of software on your own is an important lifelong learning skill. Indeed, recruiters are looking for evidence that a job candidate not only has acquired a body of knowledge but also knows how to research and learn new versions of existing software tools. The various Excel homework problems in this text help you learn how to do this.

From the Authors

TO THE INSTRUCTOR

This book is intended for use in a one-semester course in accounting information systems at either the undergraduate or graduate level. Introductory financial and managerial accounting courses are suggested prerequisites, and an introductory information systems course that covers a computer language or software package is helpful, but not necessary.

The book can also be used as the main text in graduate or advanced undergraduate management information systems courses.

The topics covered in this text provide information systems students with a solid understanding of transaction processing systems that they can then build on as they pursue more in-depth study of specific topics such as databases, data analytics, networks, systems analysis and design, cloud computing, virtualization, blockchain, artificial intelligence, Internet of Things, computer security, and information system controls.

TO THE STUDENT

As in previous editions, the fifteenth edition of *Accounting Information Systems* is designed to prepare you for a successful accounting career whether you enter public practice, industry, or government. All of you will be users of accounting information systems. In addition to being users, some of you will become managers. Others will become internal and external auditors, and some of you will become consultants. Regardless of your role, you will need to understand how accounting information systems work in order to effectively measure how cost-effectively they perform, to assess their reliability and that of the information produced, or to lead the redesign and implementation of new and better systems. Mastering the material presented in this text will give you the foundational knowledge you need to excel at all those tasks.

This text discusses important new IT developments, such as blockchain and data analytics, because such developments affect business processes and often cause organizations to redesign their accounting systems to take advantage of new capabilities. The focus, however, is not on IT for the sake of IT, but on how IT affects business processes and controls. Indeed, new IT developments not only bring new capabilities, but also often create new threats and affect the overall level of risk. This text will help you understand these issues so that you can properly determine how to modify accounting systems controls to effectively address those new threats and accurately assess the adequacy of controls in those redesigned systems. We also discuss the effect of recent regulatory developments, such as the EU's General Data Privacy Regulation (GDPR) and similar legislation in California and other states, on the design and operation of accounting systems.

In addition to technology- and regulatory-driven changes, companies are responding to the increasingly competitive business environment by reexamining every internal activity to reap the most value at the least cost. As a result, accountants are asked to do more than simply report the results of past activities. They must take a more proactive role in both providing and interpreting financial and nonfinancial information about the organization's

activities. Therefore, throughout this text, we discuss how accountants can improve the design and functioning of the accounting information system (AIS) so that it truly adds value to the organization by providing management with the information needed to effectively run an organization.

Acknowledgments

We wish to express our appreciation to all supplements authors for preparing the various supplements that accompany this edition. We thank Martha M. Eining of the University of Utah and Carol F. Venable of San Diego State University for preparing the comprehensive cases included on our website. We are also grateful to Iris Vessey for her contributions to the problem material. We thank Bill Heninger of Brigham Young University for allowing us to use portions of his database normalization tutorial to create the appendix to Chapter 4.

Perhaps most importantly, we are indebted to the numerous faculty members throughout the world who have adopted the earlier editions of this book and who have been generous with their suggestions for improvement. We are especially grateful to the following faculty who participated in reviewing the fifteenth edition throughout various stages of the revision process:

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We are grateful for permission received from four professional accounting organizations to use problems and unofficial solutions from their past professional examinations in this book. Thanks are extended to the American Institute of Certified Public Accountants for use of CPA Examination materials, to the Institute of Certified Management Accountants for use of CMA Examination materials, to the Institute of Internal Auditors for use of CIA Examination materials, and to the Society of Management Accountants of Canada for use of SMAC Examination materials. We also wish to thank Netsuite, Inc., for providing permission to use screenshots of their software throughout the text.

Of course, any errors in this book remain our responsibility. We welcome your comments and suggestions for further improvement.

Finally, we want to thank our wives and families for their love, support, and encouragement. We also want to thank God for giving us the ability to start and complete this book.

—Marshall B. Romney
Springville, Utah

—Paul John Steinbart
Apache Junction, Arizona

—Scott L. Summers
Provo, Utah

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Conceptual Foundations of Accounting Information Systems

PART

I

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CHAPTER

1

Accounting Information Systems: An Overview

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

1. Distinguish data from information, discuss the characteristics of useful information, and explain how to determine the value of information.
2. Explain the decisions an organization makes, the information needed to make them, and the major business processes present in most companies.
3. Explain how an accounting information system (AIS) adds value to an organization, how it affects and is affected by corporate strategy, and its role in a value chain.

INTEGRATIVE CASE S&S

After working for years as a regional manager for a retail organization, Scott Parry opened his own business with Susan Gonzalez, one of his district managers, as his partner. They formed S&S to sell appliances and consumer electronics. Scott and Susan pursued a "clicks and bricks" strategy by renting a building in a busy part of town and adding an electronic storefront.

Scott and Susan invested enough money to see them through the first six months. They will hire 15 employees within the next two weeks—three to stock the shelves, four sales representatives, six checkout clerks, and two to develop and maintain the electronic storefront.

Scott and Susan will host S&S's grand opening in five weeks. To meet that deadline, they have to address the following important issues:

1. What decisions do they need to make to be successful and profitable? For example:
   a. How should they price products to be competitive yet earn a profit?
   b. Should they extend credit, and, if so, on what terms? How can they accurately track what customers owe and pay?
   c. How should they hire, train, and supervise employees? What compensation and benefits package should they offer? How should they process payroll?
   d. How can they track cash inflows and outflows to avoid a cash squeeze?
   e. What is the appropriate product mix? What inventory quantities should they carry, given their limited showroom space?

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2. What information do Scott and Susan need to make those decisions?
   a. What information do the external entities they interact with need?
   b. What information do management and other employees need?
   c. How can they gather, store, and disseminate that information?
3. What business processes are needed, and how should they be carried out?
4. What functionality should be provided on the website?

Although Scott and Susan could use an educated guess or "gut feeling" to make these decisions, they know they can make better decisions if they obtain additional information. A well-designed AIS can solve these issues and provide the information they need to make any remaining decisions.

Introduction

We begin this chapter by explaining important terms and discussing the kinds of information organizations need and the business processes used to produce that information. We continue with an exploration of what an accounting information system (AIS) is, how an AIS adds value to an organization, how an AIS and corporate strategy affect each other, and the role of the AIS in the value chain.

A **system** is a set of detailed methods, procedures, and routines that carry out specific activities, perform a duty, achieve goals or objectives, or solve one or more problems. Most systems are composed of smaller subsystems that support the larger system. For example, a college of business is a system composed of various departments, each of which is a subsystem. Moreover, the college itself is a subsystem of the university.

Each subsystem is designed to achieve one or more organizational goals. Changes in subsystems cannot be made without considering the effect on other subsystems and on the system as a whole. **Goal conflict** occurs when a subsystem's goals are inconsistent with the goals of another subsystem or with the system as a whole. **Goal congruence** occurs when a subsystem achieves its goals while contributing to the organization's overall goal. The larger the organization and the more complicated the system, the more difficult it is to achieve goal congruence.

Data are facts that are collected, recorded, stored, and processed by an information system. Businesses need to collect several kinds of data such as the activities that take place, the resources affected by the activities, and the people who participate in the activity. For example, the business needs to collect data about a sale (date, total amount), the resource sold (good or service, quantity sold, unit price), and the people who participated (customer, salesperson).

Information is data that have been organized and processed to provide meaning and context that can improve the decision-making process. As a rule, users make better decisions as the quantity and quality of information increase. Table 1-1 presents 14 characteristics that make information useful and meaningful.

system - Detailed methods, procedures, and routines that carry out activities, perform a duty, achieve goals or objectives, or solve problems.

goal conflict - When a subsystem's goals are inconsistent with the goals of another subsystem or the system as a whole.

goal congruence - When a subsystem achieves its goals while contributing to the organization's overall goal.

data - Facts that are collected, recorded, stored, and processed by an information system.

information - Data that have been organized and processed to provide meaning and improve decision making.

TABLE 1-1 Characteristics of Useful Information

Access restricted	Able to limit access to authorized parties
Accurate	Correct; free of error; accurately represents events and activities
Available	Available to users when needed; in a format that can be easily and quickly used
Reputable	Perceived as true and credible due to highly regarded source or content
Complete	Does not omit aspects of events or activities; of enough breadth and depth
Concise	Clear, succinct; appropriate volume presented briefly but comprehensively
Consistent	Presented in same format over time
Current	Includes event and activity data up to the present date and time
Objective	Unbiased; unprejudiced; impartial
Relevant	Reduces uncertainty; improves decision making; applicable and helpful
Timely	Provided in time for decision makers to make decisions
Useable	Easy to use for different tasks; human and machine readable
Understandable	Presented in a useful and intelligible format; easily comprehended and interpreted
Verifiable	Same information produced by two independent, knowledgeable people

machine-readable - Data in a format that can be processed by a computer.

Data is most useful when it is in a **machine-readable** format that can be read and processed by a computer. This processing may involve data collection, recording, storage, updating, and data dissemination. For example, public companies are now required to code their financial statements using XBRL (eXtensible Business Reporting Language)—a programming language designed specifically to facilitate the communication of financial and other business information. Without XBRL, electronic documents are digital versions of paper reports. Humans can read the data, but computers cannot automatically process the data until a person manually enters it in the appropriate format. XBRL changes that by encoding information about what a particular data item means so that other computer programs can understand what to do with it. XBRL is discussed more fully in Chapter 16.

Using machine readable formats like XBRL improves many of the other 14 characteristics that make information useful. For example, XBRL improves:

- Reliability by reducing human error and using standard taxonomies.
- Relevance by assigning relevant meaning to data so it can be compared to similar data from other organizations.
- Accessibility by enabling the automatic importing of data into decision models and other computer systems.
- Understandability and usability by making the data readable to both humans and computers.
- Timeliness by reducing the time needed to import, produce, and distribute information.

Machine readable data also facilitates newer technologies such as artificial intelligence and data analytics, which are discussed later in the chapter.

information overload - Exceeding the amount of information a human mind can absorb and process, resulting in a decline in decision-making quality and an increase in the cost of providing information.

information technology (IT) - The computers and other electronic devices used to store, retrieve, transmit, and manipulate data.

value of information - The benefit provided by information minus the cost of producing it.

However, there are limits to the amount of information the human mind can absorb and process. **Information overload** occurs when those limits are passed, resulting in a decline in decision-making quality and an increase in the cost of providing that information. Information system designers use **information technology (IT)** to help decision makers more effectively filter and condense information. For example, Walmart has invested heavily in IT so that every day it can collect and process almost 50 petabytes of transaction data and mine more than 200 internal and external databases to produce valuable information.

The **value of information** is the benefit produced by the information minus the cost of producing it. Benefits of information include reduced uncertainty, improved decisions, and improved ability to plan and schedule activities. The costs include the time and resources spent to produce and distribute the information. Information costs and benefits can

be difficult to quantify, and it is difficult to determine the value of information before it has been produced and utilized. Nevertheless, the expected value of information should be calculated as effectively as possible so that the costs of producing the information do not exceed its benefits.

To illustrate the value of information, consider the case of 7-Eleven. When a Japanese company licensed the very successful 7-Eleven name from Southland Corporation, it invested heavily in IT. However, the U.S. stores did not. Each 7-Eleven store in Japan was given a computer that:

- Keeps track of the 3,000 items sold in each store and determines what products are moving, at what time of day, and under what weather conditions.
- Keeps track of what and when customers buy to make sure it has in stock the products most frequently purchased.
- Orders sandwiches and rice dishes from suppliers automatically. Orders are placed and filled three times a day so that stores always have fresh food. In addition, suppliers can access 7-Eleven sales data electronically so that they can forecast demand.
- Coordinates deliveries with suppliers. This reduces deliveries from 34 to 12 a day, resulting in less clerical receiving time.
- Prepares a color graphic display that indicates which store areas contribute the most to sales and profits.

Average daily sales of 7-Eleven Japan were 30% higher and its operating margins almost double those of its closest competitor. What happened to Southland and its 7-Eleven stores in the United States? Profits declined, and Southland eventually had to file for bankruptcy. 7-Eleven Japan came to the company's rescue and purchased 64% of Southland.

As shown in Figure 1-1, an **information system** is the combination of the people and the technologies in an organization that collect, record, store, and process data to produce the information needed to make informed decisions.

information system - The people and technologies in an organization that produce information.

Information Needs and Business Processes

All organizations need information in order to make effective decisions. In addition, all organizations have certain business processes in which they are continuously engaged. A **business process** is a set of related, coordinated, and structured activities and tasks that are performed by a person, a computer, or a machine, and that help accomplish a specific organizational goal.

business process - A set of related, coordinated, and structured activities and tasks, performed by a person, a computer, or a machine, that helps accomplish a specific organizational goal.

To make effective decisions, organizations must decide what decisions they need to make, what information they need to make the decisions, and how to gather and process the data needed to produce the information. This data gathering and processing is often tied to the

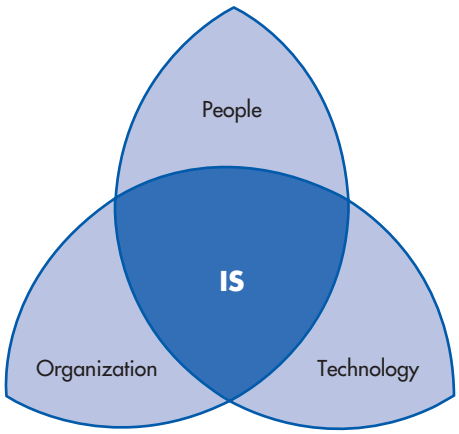

FIGURE 1-1
The Components of an Information System

basic business processes in an organization. To illustrate the process of identifying information needs and business processes, let's return to our S&S case study.

INFORMATION NEEDS

Scott and Susan decide they must understand how S&S functions before they can identify the information they need to manage S&S effectively. Then they can determine the types of data and procedures they will need to collect and produce that information. They created Table 1-2

TABLE 1-2 Overview of S&S's Business Processes, Key Decisions, and Information Needs

Business Processes	Key Decisions	Information Needs
Acquire capital	How much	Cash flow projections
	Find investors or borrow funds	Pro forma financial statements
	If borrowing, how to obtain best terms	Loan amortization schedule
Acquire building and equipment	Size of building	Capacity needs
	Amount of equipment	Building and equipment prices
	Rent or buy	Market study
	Location	Tax tables and depreciation regulations
	How to depreciate	
Hire and train employees	Experience requirements	Job descriptions
	How to assess integrity and competence of applicants	Applicant job history and skills
	How to train employees	
Acquire inventory	What models to carry	Market analyses
	Optimal level of inventory to carry	Sales and inventory turnover forecasts
	How much to purchase	Inventory status reports
	How to manage inventory (store, control, etc.)	Vendor performance
	Which vendors; best quality, prices	
Advertising and marketing	Which media	Cost analyses
	Content	Market coverage
Sell merchandise	What is optimal price for each product	Product costs; desired margins
	How to customize products for customers	Customer needs and preferences
	How to deliver products to customer	Customer delivery preferences
	Offer in-house credit; determine credit limits	Credit card costs; company policies
	Which credit cards to accept	Customer credit status
Collect payments from customers	If offering credit, what terms	Customer account status
	How to effectively handle cash receipts	Accounts receivable aging report
		Accounts receivable records
Pay employees	Amount to pay	Sales (for commissions)
	Deductions and withholdings	Time worked (hourly employees)
	Process payroll in-house or use outside service	W-4 forms
		Costs of external payroll service
Pay taxes	Payroll tax requirements	Government regulations
	Sales tax requirements	Total wage expense
		Total sales
Pay vendors	Whom to pay	Vendor invoices
	When to pay	Accounts payable records
	How much to pay	Payment terms

to summarize part of their analysis. It lists S&S's basic business processes, some key decisions that need to be made for each process, and information they need to make the decisions.

Scott and Susan realize that the list is not exhaustive, but they are satisfied that it provides a good overview of S&S. They also recognize that not all the information needs listed in the right-hand column will be produced internally by S&S. Information about payment terms for merchandise purchases, for example, will be provided by vendors. Thus, S&S must effectively integrate external data with internally generated data so that Scott and Susan can use both types of information to run S&S.

S&S will interact with many external parties, such as customers, vendors, and governmental agencies, as well as with internal parties such as management and employees. To get a better handle on the more important interactions with these parties, they prepared Figure 1-2.

BUSINESS PROCESSES

Scott decides to reorganize the business processes listed in Table 1-2 into groups of related transactions. A **transaction** is an agreement between two entities to exchange goods or services or any other event that can be measured in economic terms by an organization. Examples include selling goods to customers, buying inventory from suppliers, and paying employees. The process that begins with capturing transaction data and ends with informational output, such as the financial statements, is called **transaction processing**. Transaction processing is covered in more depth in Chapter 2.

Many business activities are pairs of events involved in a **give-get exchange**. Most organizations engage in a small number of give-get exchanges, but each type of exchange happens many times. For example, S&S will have thousands of sales to customers every year in exchange for cash. Likewise, S&S will continuously buy inventory from suppliers in exchange for cash.

These exchanges can be grouped into five major **business processes or transaction cycles**:

- The **revenue cycle**, where goods and services are sold for cash or a future promise to receive cash. This cycle is discussed in Chapter 14.

transaction - An agreement between two entities to exchange goods or services, such as selling inventory in exchange for cash; any other event that can be measured in economic terms by an organization.

transaction processing - Process of capturing transaction data, processing it, storing it for later use, and producing information output, such as a managerial report or a financial statement.

give-get exchange - Transactions that happen a great many times, such as giving up cash to get inventory from a supplier and giving employees a paycheck in exchange for their labor.

business processes or transaction cycles - The major give-get exchanges that occur frequently in most companies.

revenue cycle - Activities associated with selling goods and services in exchange for cash or a future promise to receive cash.

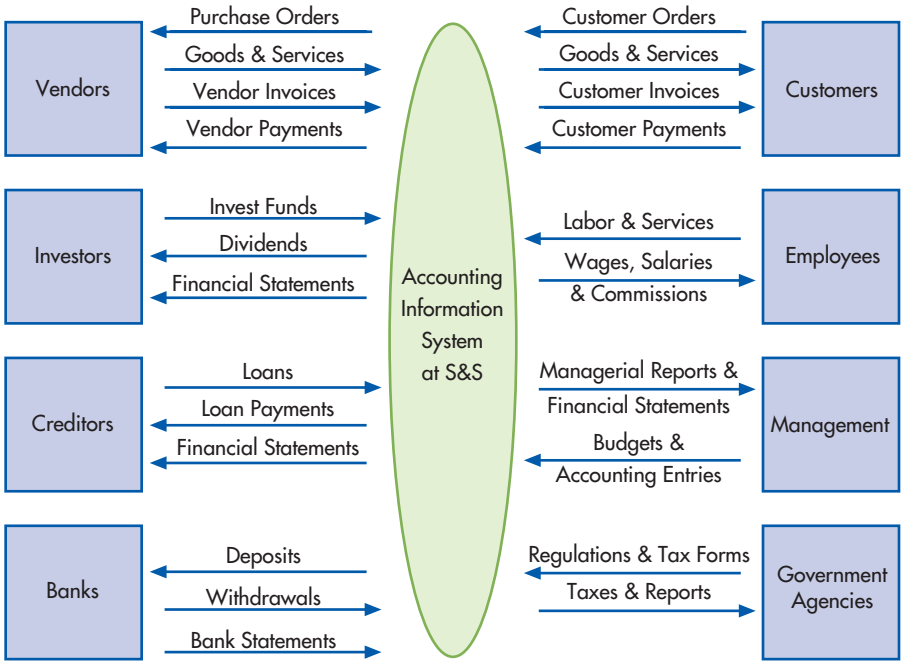

FIGURE 1-2
Interactions between S&S and External and Internal Parties

expenditure cycle - Activities associated with purchasing inventory for resale or raw materials in exchange for cash or a future promise to pay cash.

production cycle - Activities associated with using labor, raw materials, and equipment to produce finished goods. Also called conversion cycle.

human resources/payroll cycle - Activities associated with hiring, training, compensating, evaluating, promoting, and terminating employees.

financing cycle - Activities associated with raising money by selling shares in the company to investors and borrowing money as well as paying dividends and interest.

- The **expenditure cycle**, where companies purchase inventory for resale or raw materials to use in producing products in exchange for cash or a future promise to pay cash. This cycle is discussed in Chapter 15.
- The **production cycle**, or conversion cycle, where raw materials are transformed into finished goods. This cycle is discussed in Chapter 16.
- The **human resources/payroll cycle**, where employees are hired, trained, compensated, evaluated, promoted, and terminated. This cycle is discussed in Chapter 17.
- The **financing cycle**, where companies sell shares in the company to investors and borrow money, and where investors are paid dividends and interest is paid on loans.

These cycles process a few related transactions repeatedly. For example, most revenue cycle transactions are either selling goods or services to customers or collecting cash for those sales. Figure 1-3 shows the main transaction cycles and the give-get exchange inherent in each cycle.

These basic give-get exchanges are supported by a number of other business activities. For example, S&S may need to answer a number of customer inquiries and check inventory levels before it can make a sale. Likewise, it may have to check customer credit before a credit sale is made. Accounts receivable will have to be increased each time a credit sale is made and decreased each time a customer payment is received. Table 1-3 lists the major activities in each transaction cycle.

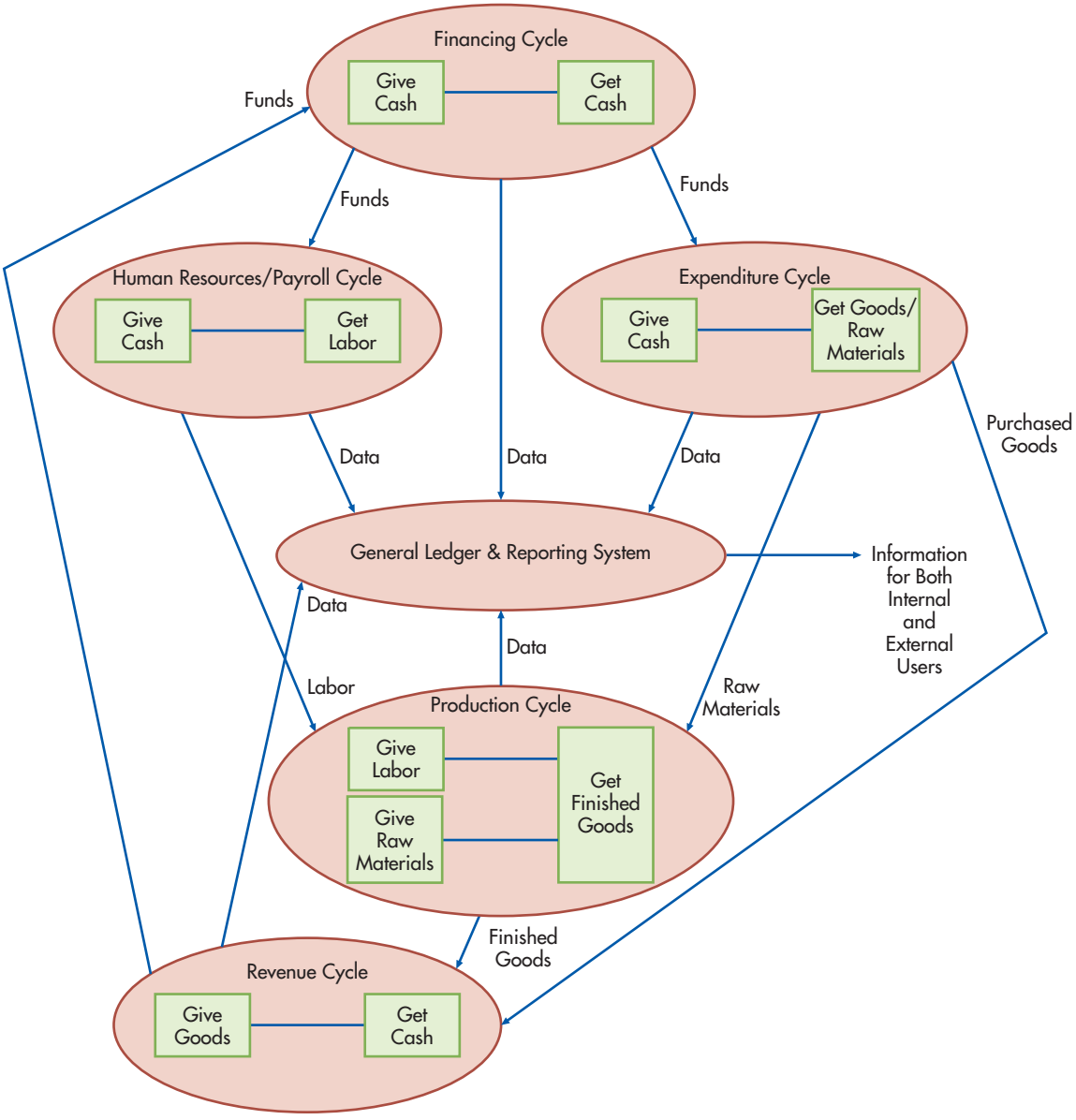

FIGURE 1-3
The AIS and Its Subsystems

Notice that the last activity listed in Table 1-3 for each transaction cycle is "Send appropriate information to the other cycles." Figure 1-3 shows how these various transaction cycles relate to one another and interface with the **general ledger and reporting system**, which is used to generate information for both management and external parties. The general ledger and reporting system is discussed in more depth in Chapter 18.

general ledger and reporting system - Information-processing operations involved in updating the general ledger and preparing reports for both management and external parties.

In many accounting software packages, the various transaction cycles are implemented as separate modules. Not every organization needs to implement every module. Retail stores like S&S, for example, do not have a production cycle and would not implement that module. Moreover, some organizations have unique requirements. Financial institutions, for example, have demand deposit and installment-loan cycles that relate to transactions involving customer accounts and loans. In addition, the nature of a given transaction cycle differs across different types of organizations. For example, the expenditure cycle of a service company,

TABLE 1-3 Common Cycle Activities

Transaction Cycle	Major Activities in the Cycle
Revenue	Receive and answer customer inquiries
	Take customer orders and enter them into the AIS
	Approve credit sales
	Check inventory availability
	Initiate back orders for goods out of stock
	Pick and pack customer orders
	Ship goods to customers or perform services
	Bill customers for goods shipped or services performed
	Update (increase) sales and accounts receivable
	Receive customer payments and deposit them in the bank
	Update (reduce) accounts receivable
	Handle sales returns, discounts, allowances, and bad debts
	Prepare management reports
	Send appropriate information to the other cycles
Expenditure	Request goods and services be purchased
	Prepare, approve, and send purchase orders to vendors
	Receive goods and services and complete a receiving report
	Store goods
	Receive vendor invoices
	Update (increase) accounts payable
	Approve vendor invoices for payment
	Pay vendors for goods and services
	Update (reduce) accounts payable
	Handle purchase returns, discounts, and allowances
	Prepare management reports
	Send appropriate information to the other cycles
Human Resources/Payroll	Recruit, hire, and train new employees
	Evaluate employee performance and promote employees
	Discharge employees
	Update payroll records
	Collect and validate time, attendance, and commission data
	Prepare and disburse payroll
	Calculate and disburse taxes and benefit payments

TABLE 1-3 Continued

Transaction Cycle	Major Activities in the Cycle
Human Resources/Payroll	Prepare employee and management reports
	Send appropriate information to the other cycles
Production	Design products
	Forecast, plan, and schedule production
	Request raw materials for production
	Manufacture products
	Store finished products
	Accumulate costs for products manufactured
	Prepare management reports
	Send appropriate information to the other cycles
Financing	Forecast cash needs
	Sell stock/securities to investors
	Borrow money from lenders
	Pay dividends to investors and interest to lenders
	Retire debt
	Prepare management reports
	Send appropriate information to the other cycles

such as a public accounting or a law firm, does not normally involve processing transactions related to the purchase, receipt, and payment for merchandise that will be resold to customers.

Each transaction cycle can include many different business processes or activities. Each business process can be relatively simple or quite complex.

After preparing Tables 1-2 and 1-3 and Figures 1-2 and 1-3, Scott and Susan believe they understand S&S well enough to begin shopping for an information system. Susan recalled a previous employer that had several separate information systems because its software was not designed to accommodate the information needs of all managers. She also vividly recalled attending one meeting where she witnessed the negative effects of having multiple systems. The head of marketing had one report on year-to-date sales by product, the production manager had a different report that contained different sales figures, and the controller's report, which was produced by the general ledger system, had yet a third version of year-to-date sales. Over an hour was wasted trying to reconcile those different reports! Susan vowed to ensure that S&S did not ever find itself in such a mess. She would make sure that any system selected would have the capability to integrate both financial and nonfinancial data about S&S's various business processes so that everyone could pull information from the same system.

Accounting Information Systems

accounting information system (AIS) - A system that collects, records, stores, and processes data to produce information for decision makers. It includes people, procedures and instructions, data, software, information technology infrastructure, and internal controls and security measures.

accounting - The systematic and comprehensive recording of an organization's financial transactions, including summarizing, analyzing, and reporting these transactions to all users.

It has often been said that accounting is the language of business. If that is the case, then an **accounting information system (AIS)** is the intelligence—the information-providing vehicle—of that language.

Accounting is the systematic and comprehensive recording of an organization's financial transactions. It also includes summarizing, analyzing, and reporting these transactions to management, owners/investors, oversight agencies, and tax collection entities. That means accounting is a data identification, collection, and storage process as well as an information development, measurement, and communication process. By definition, accounting is an information system, since an AIS collects, records, stores, and processes accounting and other data to produce information for decision makers. This is illustrated in Figure 1-4.

An AIS can be a paper-and-pencil manual system, a complex system using the latest in IT, or something in between. Regardless of the approach taken, the process is the same. The

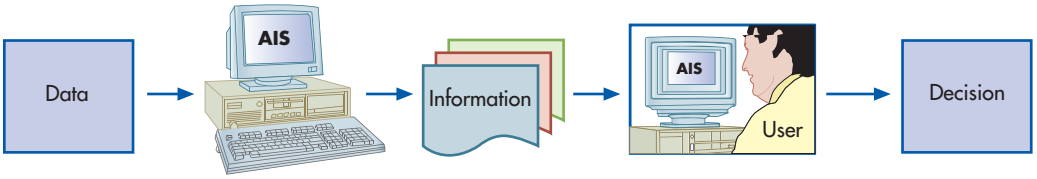

FIGURE 1-4
An AIS Processes Data to Produce Information for Decision Makers

AIS must collect, enter, process, store, and report data and information. The paper and pencil or the computer hardware and software are merely the tools used to produce the information.

This text does not distinguish an AIS from other information systems. Instead, our viewpoint is that the AIS can and should be the organization's primary information system and that it provides users with the information they need to perform their jobs.

There are six components of an AIS:

1. The *people* who use the system.
2. The *procedures and instructions* used to collect, process, and store data.
3. The *data* about the organization and its business activities.
4. The *software* used to process the data.
5. The *information technology infrastructure*, including the computers, peripheral devices, and network communications devices used in the AIS.
6. The *internal controls and security measures* that safeguard AIS data.

These six components enable an AIS to fulfill three important business functions:

1. Collect and store data about organizational activities, resources, and personnel. Organizations have a number of business processes, such as making a sale or purchasing raw materials, which are repeated frequently.
2. Transform data into information so management can plan, execute, control, and evaluate activities, resources, and personnel. Decision making is discussed in detail later in this chapter.
3. Provide adequate controls to safeguard the organization's assets and data. Control concepts are discussed in detail in Chapters 8–13.

Since accounting data comes from an AIS, AIS knowledge and skills are critical to an accountant's career success. Interacting with an AIS is one of the most important activities accountants perform. Other important AIS-related activities include designing information systems and business process improvements, as discussed in Chapters 22 to 24. Focus 1-1 explains a specialty to designate that certain CPAs (Certified Public Accountants) have an in-depth knowledge of AIS topics.

HOW AN AIS CAN ADD VALUE TO AN ORGANIZATION

A well-designed AIS can add value to an organization by:

1. ***Improving the quality and reducing the costs of products or services.*** For example, an AIS can monitor machinery so operators are notified immediately when performance falls outside acceptable quality limits. This helps maintain product quality, reduces waste, and lowers costs.
2. ***Improving efficiency.*** For example, timely information makes a just-in-time manufacturing approach possible, as it requires constant, accurate, up-to-date information about raw materials inventories and their locations.
3. ***Sharing knowledge.*** Sharing knowledge and expertise can improve operations and provide a competitive advantage. For example, CPA firms use their information systems to share best practices and to support communication between offices. Employees can search the corporate database to identify experts to provide assistance for a particular client; thus, a CPA firm's international expertise can be made available to any local client.
4. ***Improving the efficiency and effectiveness of its supply chain.*** For example, allowing customers to directly access inventory and sales order entry systems can reduce sales and marketing costs, thereby increasing customer retention rates.

FOCUS 1-1 CITP—An IT Specialty Designation for CPAs

The American Institute of Certified Public Accountants (AICPA) offers several specialty designations for CPAs. The CITP (Certified Information Technology Professional) designation reflects the AICPA's recognition of the importance of IT and its interrelationship with accounting. A CITP possesses a broad range of business, managerial, and technological knowledge, making it possible for the CITP to understand how organizations use IT to achieve their business objectives. To obtain a CITP certification, a person must demonstrate a mastery of the following topics: information system management, business intelligence, fraud, risk assessment, internal control concepts, and how to test and evaluate an information system.

There are many reasons to earn the CITP certification:

- Because only CPAs can be CITPs, this certification further differentiates you from others in the marketplace.
- It affirms your value as an IT specialist and increases your value to your employer or clients.
- It is a great "calling card" for IT people who want to be leaders in industry, public practice, government, or academia.
- It opens the doors to new technology-related roles and opportunities.
- Automatic membership in the IT Section, which allows you to meet, share best practices, network, and communicate with other CITPs. You can also receive CITP newsletters and other communications, attend CITP Webinars, receive CITP member discounts, and access exclusive CITP resources and content on the CITP website.

To qualify for the CITP designation, you must:

- Be a CPA and a member of the AICPA
- Pass the CITP exam
- In the five years preceding your application, meet the 1,000-hour experience and the 75-hour continuing professional education requirements

Based on information from http://www.aicpa.org.

5. ***Improving the internal control structure.*** An AIS with the proper internal control structure can help protect systems from fraud, errors, system failures, and disasters.
6. ***Improving decision making.*** Improved decision making is vitally important and is discussed below in more detail.

AN AIS CAN USE ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS TO IMPROVE DECISION MAKING

Decision making is a complex, multistep activity that involves identifying a problem, collecting and interpreting data, evaluating ways to solve the problem, selecting a solution methodology, and determining and implementing the solution. An AIS can help in the decision-making process by providing the information to reduce uncertainty, providing feedback about the effectiveness of prior decisions, providing information in a timely manner, and identifying situations that require management action.

Artificial intelligence and data analytics tools can be used in each of these decision-making activities to help improve decision making.

artificial intelligence (AI) - The use of computer systems to simulate human intelligence processes such as learning, reasoning, and self-improvement.

Artificial intelligence (AI) uses computer systems to simulate human intelligence processes such as learning (acquiring information and rules for using it), reasoning (interpreting data and using its rules to arrive at conclusions), and self-improvement (learning from the information and past experiences to improve its rules).

The AI field draws from many disciplines, including computer science, information engineering, linguistics, mathematics, philosophy, and psychology. Some popular AI applications include expert systems, intelligent routing of delivery vehicles, machine vision (used in self-driving cars), and speech recognition. Some popular AI cloud offerings include Amazon AI, Google AI, IBM Watson, and Microsoft Cognitive Services.

Here are a few examples of the fields where AI is used:

- **Business.** AI-driven robots now perform many highly repetitive tasks, especially in manufacturing. AI algorithms determine how to better serve customers. Website chatbots provide immediate customer service.

- **Education.** AI software automatically grades student work, assesses student performance and progress, and provides additional support as needed.
- **Finance.** Robo-based stock picking algorithms give advice on what stocks to buy and sell. Software executes most stock market trades. Personal finance applications use AI to advise their users and keep track of their finances.
- **Healthcare.** AI can make better and faster diagnoses than humans, thereby improving patient outcomes and reducing costs. For example, doctors can use IBM Watson to mine patient data, evaluate their symptoms, access external databases, communicate a diagnosis and how confident Watson is in the diagnosis, and receive and answer doctor questions.

Data analytics is the use of software and algorithms to discover, describe, interpret, communicate, and apply meaningful patterns in data to improve business performance. Data analytics tools draw from many disciplines, including computer programming, mathematics, operations research, and statistics. Companies have long analyzed their past performance. Data analytics is a more recent development and is designed to focus on the future and answer questions such as why something happened, what will happen next, and how performance can be improved. Analytics tools are most efficient when there are abundant computational resources and there is a large quantity of data from multiple internal or external databases.

data analytics - Use of software and algorithms to find and solve problems and improve business performance.

An essential part of most analytic tools is a **data dashboard** that displays important data points, metrics, and key performance indicators in the form of line or bar charts, tables, or gauges. A dashboard provides a central location for businesses to monitor performance. The dashboard is connected to internal and external data sources, analyzes the data, and displays it visually in an easy-to-understand format. Dashboards are usually customized to meet the specific needs of a business process, department, or the entire company.

data dashboard - A display of important data points, metrics, and key performance indicators in easily understood line or bar charts, tables, or gauges.

There are many different types of analytics, including predictive, prescriptive, descriptive, and cognitive. Some analytics are named after their usage such as retail, supply chain, store optimization, sales force optimization, marketing optimization, call center optimization, web, social media, speech, credit risk, and fraud analytics. Analytics are also categorized by their use and characteristics such as actionable, visual, embedded, automated, and operational analytics.

Analytics can help improve decision making in many ways. At the most basic level, analytics can identify a problem or issue for management to resolve. At an intermediate level, analytics can also collect the data needed to solve the problem, analyze it, and make recommendations to management on how to resolve it. At an advanced level, actionable insights can be integrated into the systems used to make decisions. That is, the analytics can be embedded into AIS components, such as databases, applications, and devices, and operationalized to automatically resolve problems that occur and communicate solutions to management.

The data analytics market is estimated to exceed $50 billion and is growing rapidly. Businesses use analytics to increase sales, create products and services to meet new customer needs, reduce costs, and improve decision making. Here are just a few ways data analytics are used:

- Cargill has developed an analytics platform that allows dairy farmers to use a tablet or computer to analyze large quantities of data about their cows' living conditions, diet, and milk productivity. When cows are happier and more comfortable, they produce more milk.
- Under Armour uses data from MapMyFitness to determine popular running routes and times so it knows when to advertise sneakers, energy drinks, and other products. Research shows that when an advertiser sells repeat-purchase products, ads sent at the right time to consumers will generate up to 16 times more sales than when sent at other times.
- Most web-based retailers such as Amazon use their sales database to suggest additional products and services for its customers to purchase.
- A technician at a support center uses key words from a caller, as well as a database of past problems and solutions, to quickly solve technical issues. In time, when the data and analytics are robust enough, the process will be automated; customers will visit the company's website and diagnose most problems themselves, with the most complex issues handed off to a human technician.

- An airline embeds sensors in all important airplane components, continuously monitors them, automatically schedules preventive maintenance, and provides a detailed list of what needs to be done.

Focus 1-2 explains how Walmart uses data analytics to improve their business.

FOCUS 1-2 Data Analytics at Walmart

Walmart, the world's biggest retailer, has more than 245 million customers who shop at more than 20,000 stores in 28 countries. Walmart tracks individual customers, gathering data on what customers like and what they buy. Every hour, more than 1 million customers purchase something, which generates 2.5 petabytes (a quadrillion bytes) of unstructured data. The 2.5 petabytes are roughly 167 times the books contained in America's Library of Congress.

To make use of this data, Walmart spent considerable resources to become a leader in big data analytics. In fact, Walmart's data analytics efforts started before the term *big data* became popular. Walmart's analytics systems analyze millions of products and hundreds of millions of customers using data gathered from many different internal and external data sources.

Data analytics support several Walmart goals. First, they optimize and personalize customers' shopping experiences, whether they are in a store, shopping online via a computer or a mobile device, or browsing Walmart's website. They analyze customer data and buying behaviors to better anticipate customer needs. Walmart also uses analytics to improve the store checkout experience.

Second, data analytics optimize operational efficiency, including increasing sales and profits, facilitating better and quicker decision making, improving store and employee efficiency, improving product assortment, managing the supply chain, and locating distribution centers and stores. Analytics helped Walmart (1) develop smarter stocking, pricing, merchandising, and marketing solutions in real time and (2) make its pharmacies more efficient.

Walmart analyzed sales before and after big data analytics were used to change their e-commerce strategy and found that online sales increased 10% to 15%, resulting in $1 billion in incremental revenue.

The data analytics team at Walmart Labs monitors Walmart.com and analyzes every clickable action to determine what consumers buy online and how to improve their online experience. The Lab also monitors what is trending on Twitter, local events such as sports activities and concerts that affect sales, and local weather deviations to determine how they affect buying patterns. Walmart's predictive data analytics software contains machine learning technologies that continuously improve the accuracy of analytics algorithms.

Walmart built the world's biggest private cloud to facilitate its data analytics processes. At its headquarters, Walmart also created a Data Café (Collaborative Analytics Facilities for Enterprise) to model, manipulate, and visualize data to create solutions. The Café uses Walmart's transaction data as well as data from 200 other data sources such as economic, gasoline, local events, social media, telecommunications, television, and weather data to predict outcomes and resolve issues to make Walmart stores more efficient, responsive, and profitable.

Employees are encouraged to submit their problems to Data Café experts for a solution usually produced in minutes rather than weeks and displayed on the Café's touchscreen smartboards. These real-time solutions help correct errors instantly, gain sales and marketing insights, and track customer trends and competitor strategies.

Here are two examples of Walmart's use of the Data Café. A grocery team could not figure out why sales in a product category had suddenly declined and used the Café to drill down into the data. They found that a pricing miscalculation resulted in the product being priced higher than it should have been in some stores. In a second example, Walmart data mining algorithms found that a specific cookie was popular at all Walmart stores except one. An investigation showed that a simple stocking oversight resulted in the cookies not being stocked on the store shelves. Ordering and stocking the cookies prevented the further loss of sales.

THE AIS AND BLOCKCHAIN

In 2008, Satoshi Nakamoto invented the blockchain to digitally record cryptocurrency transactions such as Bitcoin. Since then, blockchain technology has been adapted so that virtually everything of value can be recorded, and private blockchains have been developed for business use.

Just as people do not have to know exactly how the Internet or an automobile works, they do not need to know the technical details of how the blockchain works to use it. However, a basic knowledge of blockchain technology helps users make better use of the technology.

Blockchain got its name from its structure, which is individual digital records, called blocks, linked together using cryptography in a single list, called a chain. The blockchain isn't stored in a single location—it is a distributed ledger that functions as a decentralized database. Each computer in the distributed peer-to-peer network maintains a copy of the ledger to prevent a single point of failure. Since the blockchain is managed by a network that follows protocols for inter-node communication and validating new blocks, there is no need for a central authority that controls everything. The information recorded in the blockchain is made public, so everyone on the blockchain's peer-to-peer network has a copy of the blockchain and all transactions are accessible to everyone.

blockchain - Individual digital records, called blocks, linked together using cryptography in a single list, called a chain.

Here is a brief, high-level view of how the blockchain works; that is, how a transaction is added to a block and how a block is added to a chain. Blockchains are explained in more detail in Chapter 11.

1. **Initiate transaction.** Two parties, such as a buyer and a seller, decide to exchange something of value and request that a transaction be initiated. Instead of using actual buyer or seller names, a unique digital signature or identifier is used. This is analogous to using a part number for a product or a username for a person.
2. **Validate transaction.** The transaction is sent to the peer-to-peer network nodes who use algorithms to simultaneously validate transaction details, including its time, dollar amount, and participants. To achieve a consensus, a simple majority of 51% of the nodes must validate the block. The number of computers in the peer-to-peer networks can be as large as desired; the Bitcoin blockchain has millions, each with a copy of its blockchain ledger. In a public, permission-less blockchain platform like Bitcoin, every network node can record transactions and participate in the consensus process. In a private, permissioned chain, participation in the consensus process is restricted to approved nodes.
3. **Create a block.** Since each block in a chain can store up to 1 MB of data, the verified transactions are combined with hundreds or thousands of similar transactions to create a new block for the ledger. The transaction's dollar amount and the digital signatures of both parties are stored in the block.
4. **Calculate and insert a hash.** Each block is given two unique codes, or pieces, of identifying information called a hash, which distinguishes it from other blocks. Hash codes use a mathematical algorithm to turn digital information into a string of numbers and letters. One hash is that of the current block and the second is the hash of the block that precedes it in the chain. When a new block is added to the chain, it is linked to the previous block by storing a cryptographic hash generated from the contents of the previous block. The second hash ensures that the chain is never broken and that each block is recorded in a permanent and unalterable way. The second hash makes the block tamper resistant and secure; that is, it adds a high level of assurance that the prior block contents have not been changed. If the data on a block is edited in any way, that block's hash code changes, and the codes of all subsequent blocks change. This discrepancy makes it extremely difficult for information on the blockchain to be changed without notice. How a hash is created is discussed in Chapter 11.
5. **Complete transaction.** The block is added to the blockchain, and all the other computers storing the blockchain are updated automatically. This completes the transaction recording process, and the right of ownership of the item of value is passed from the seller to the buyer.

Blockchain has several significant advantages, including the following:

- **Accuracy.** Transactions are verified by many thousands of networked computers instead of error-prone humans. Even if a computer makes a computational mistake, the error would not spread to the rest of the blockchain unless at least 51% of the network's computers validated the mistake.

- **Transparency.** Blockchain data are transparent. That is, all transaction details, including participant user names, transaction amount, transaction date and time, and who entered the transaction, are open for everyone on the blockchain to see. This includes authorized regulators, auditors, etc.
- **Data consistency.** In older legacy systems, data are often located in multiple databases and finding data can be complex. The data can also be inconsistent among databases, with some of them updated and others not. With blockchain, data are stored in one location only.
- **Trust.** To ensure that blockchain networks can be trusted, computers that want to join the blockchain are tested. That is, new users are required to prove themselves before they can be a part of a blockchain network. For example, in Bitcoin's proof of work test, a system must expend significant computer power and energy to solve a complex math problem before they can add a block to the blockchain. While Bitcoin's proof of work does not make a hack impossible, the cost of organizing an attack would almost always outweigh the benefits that could be achieved from the attack.
- **No need for third parties.** The consensus process of all nodes in the network agreeing on the blockchain's content allows mutually distrustful parties to enter into transactions safely without trusted third parties.
- **Single set of books.** As both sides of a transaction are stored in a single source, that eliminates some of the need for a set of books for the buyer and for the seller. One set of books provides a trust level not present in current legacy systems.
- **Cost.** Blockchain eliminates the costs of human third-party verification and many transaction processing costs.
- **Decentralization.** By storing the blockchain on all network computers, the risks of data held centrally is eliminated. For example, if a copy of the blockchain is hacked or compromised, only that copy is affected. This reduces or eliminates the traditional requirement for file and database backups.
- **Efficiency.** Blockchain works all day, every day—and transactions can be finalized within minutes and considered secure in no more than a few hours. Contrast that with limited business hours and waiting days for transactions to clear and for money to be available.
- **Privacy.** Although many blockchains are public databases, where users can view transaction information, users are unable to access confidential data that identify those engaging in the transactions.
- **Security.** A blockchain is difficult to corrupt. There is no single point of failure; if one node goes down, there is a copy of the ledger on all the other nodes. Information is shared and continually reconciled by thousands of computers. New blocks are always added chronologically to the end of the blockchain. It is very difficult to go back and change a block's contents because each block contains its own hash and the hash of the previous block. If information is changed, the hashes for the previous and subsequent blocks also change and this disrupts the ledger's shared state. When other network computers become aware that the change has caused a problem, consensus is no longer possible. Until the problem is solved, no new blocks are added to the blockchain. In most cases, the block that caused the error is discarded and the nodes again attempt to achieve consensus. This process ensures that no single system or user can tamper with the transaction records or add invalid blocks to the blockchain.
- **Provenance.** Provenance is the history of ownership of something of value. The data collected by Blockchain shows who did what, when they did it, and the history of the item since it was entered in the blockchain. That history is transparent, verified by all network participants, and frequently reconciled.

While blockchain has many important advantages, there are significant challenges to its adoption, including political and regulatory issues. These challenges include the following:

- **Cost.** Cost is a blockchain advantage because transaction fees are less, but it is also a disadvantage because the technology needed to operate a blockchain is expensive. So are the thousands of hours expended to produce the custom software and back-end processes needed to insert blockchain technologies into current business systems. There are also the utility costs required to run the computers that process and store the blockchain.

- **Loss of privacy and confidentiality.** Since blockchain users are unable to identify those engaging in transactions, dishonest users can use blockchain networks like Bitcoin to make illegal purchases. To prevent this, some countries like the United States prohibit full anonymity by requiring online exchanges to collect customer information, verify their identity, and confirm that they are not on any list of known or suspected terrorists.
- **Susceptibility.** A 51% attack is difficult to execute due to the computational power required to gain majority control of a blockchain network. That might change as technology costs decrease and hackers are able to affordably rent computational power rather than buying it. In addition, these attacks are more difficult as the number of nodes in the blockchain network increases.

In summary, a blockchain is a public, global, cryptographically secure ledger that automatically records and verifies large volumes of digital transactions. The combination of blocks that cannot be changed, blocks linked together in a chain, and cryptography to secure everything creates a transaction recording system that can be trusted for transactions among untrusted partners.

Focus 1-3 briefly discusses some of the many blockchain applications in use today.

FOCUS 1-3 Current and Planned Uses of Blockchain

Blockchain was first used for digital currencies but has spread to many industries because it is a secure and cost-effective way to manage all types of digital transactions. Recent startups developed their business processes using newer technologies, so they are much more likely to use blockchain. As time passes, some of these blockchain-inspired startups become what some people call emerging disruptors as they begin displacing older and larger companies.

Established companies with older legacy information systems find it more challenging to use blockchain. They often discover that to achieve blockchain's advantages, they must change the way they do business.

Deloitte surveyed executives at 1,000 established companies about their blockchain experience and found 74% of respondents see compelling reasons to use it, though only 34% currently do. Some 41% expected to begin using blockchain, and almost 40% will invest at least $5 million in blockchain applications. Deloitte believes blockchain adoption is higher than their survey indicates because emerging disruptors were not included in the survey.

Here are just a few of the more prominent uses of blockchain:

- Banks only open during business hours and deposits take up to 3 days to clear. Blockchain is always open, and deposits can be seen in 10 minutes. It is estimated that blockchain could save banks $20 billion by eliminating money in-transit costs and consumers $16 billion in banking and insurance fees.
- Currently, healthcare data is stored by different institutions using different formats and standards, making it hard for doctors to understand a patient's medical history. Using blockchain technology, patient information can be signed, time-stamped, and stored securely on a distributed ledger. Doctors and patients can go to a single source to access a patient's health information, and patients have more control over their own health data. Blockchain could also help solve the problem of counterfeit drugs in the medical supply chain.
- Recording property rights occurs when a deed is delivered to the local recording office and manually entered in the county's database and public index. The process is costly, inefficient, time-consuming, error prone, and susceptible to fraud. Disputed property claims are difficult to reconcile. Blockchain can eliminate scanning documents and finding paper files in a recording office. Property owners can trust that their deed is accurate and permanent if its ownership is stored and verified on the blockchain.
- In 2016, Overstock.com was one of the first publicly traded company to use blockchain to sell and distribute company shares. Without blockchain, selling stock involves brokers, clearing houses, and custodians. The money and shares involved in the trade are frozen for up to 3 days. With blockchain peer-to-peer trading, there is no need for intermediaries, and the shares exchange hands within minutes. Companies are also developing a blockchain application for proxy voting.
- Manufacturing companies are developing applications to track the flow of materials, information, and payments as they move through their supply chains.

Source of Survey data: https://www2.deloitte.com/us/en/pages/consulting/articles/innovation-blockchain-survey.html

CLOUD COMPUTING, VIRTUALIZATION, AND THE INTERNET OF THINGS

virtualization - Running multiple systems simultaneously on one physical computer.

Recently, many organizations have embraced virtualization, cloud computing, and the Internet of things to enhance both efficiency and effectiveness. **Virtualization** takes advantage of the power and speed of modern computers to run multiple systems simultaneously on one physical computer. This cuts hardware costs because fewer computers need to be purchased. Fewer machines means lower maintenance costs. Data center costs also fall because less space needs to be rented, which also reduces utility costs.

cloud computing - Using a browser to remotely access software, data storage, hardware, and applications.

Cloud computing takes advantage of the high bandwidth of the modern global telecommunication network to enable employees to use a browser to remotely access software (software as a service), hardware (infrastructure as a service), and entire application environments (platform as a service). The arrangement is referred to as a "private," "public," or "hybrid" cloud, depending on whether the remotely accessed resources are entirely owned by the organization, a third party, or a mix of the two. Table 1-4 compares the different levels of service provided in the cloud to eating pizza. You can either make and bake a pizza in house, buy a frozen pizza and bake it, have a pizza delivered to your home, or go out to eat a pizza. As the table shows, you can do the same with computer services (the items in blue are done in house, and the items in red are done by a cloud provider).

Cloud computing can potentially generate significant cost savings. For example, instead of purchasing, installing, and maintaining separate copies of software for each end user, an organization can purchase one copy, install it on a central server, and pay for the right for a specified number of employees to simultaneously use a browser to remotely access and use that software. Public clouds eliminate the need for making major capital investments in IT, with organizations purchasing (and expensing) their use of computing resources on a pay-for-use or subscription basis. In addition to reducing costs, the centralization of computing resources with cloud computing (whether public, private, or hybrid) makes it easier to change software and hardware, thereby improving flexibility. The term **Internet of Things (IoT)** refers to the embedding of sensors in a multitude of devices (lights, heating and air conditioning, appliances, etc.) so that those devices can now connect to the Internet. The IoT has significant implications for information security.

Internet of Things (IoT) - Embedding sensors in devices so they can connect to the Internet.

THE AIS AND CORPORATE STRATEGY

Since most organizations have limited resources, it is important to identify the AIS improvements likely to yield the greatest return. Making a wise decision requires an understanding of the organization's overall business strategy. To illustrate, consider the results of a *CIO* magazine survey of 500 Chief Information Officers. Asked to identify the three most important skill sets for a CIO, more than 75% put strategic thinking and planning on their list.

Figure 1-5 shows three factors that influence the design of an AIS: developments in IT, business strategy, and organizational culture. It is also important to recognize that the design of the AIS can also influence the organization's culture by controlling the flow of information within the organization. For example, an AIS that makes information easily accessible and widely available is likely to increase pressures for more decentralization and autonomy.

TABLE 1-4 Comparing Cloud Services to Eating Pizza

Traditional (make pizza from scratch in house)	IaaS: Infrastructure as a Service (take and bake)	PaaS: Platform as a Service (pizza delivered)	SaaS: Software as a Service (dine out)
Dining table			
Soda			
Electricity and gas			
Oven			
Dough			
Toppings			