Information and Enterprise Systems in Today's Businesses

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Chapter 1: The Competitive Landscape. What the World is Like in Which You Will Operate Your Business.

CHAPTER OBJECTIVES

After studying this chapter, you should be able to

- Explain how changes in the geopolitical world have changed the nature of competition
- Explain how technology as contributed to these changes
- Explain how the economic job market has changed as a result of globalization and technological disruption
- Explain how business managers should act in the face of the global pressures
- Discuss some of the ethical challenges of this new competitive world

INTRODUCTION

In your business career in the 21st century, you will have to deal with information systems. This is now an inescapable fact of business life. Like it or not, all areas of business and organizational life have been affected by the use of information systems. Information technology in part has enabled the increasing globalization of business and disrupted old markets created new ones. The ways that functions have been performed have dramatically changed. Back office functions such as accounting, payroll and HR are done in almost all organizations today by means of computer systems. These were some of the earliest information systems that eliminated rooms of accountants and payroll clerks. Communications technologies provided by the internet have enabled the widespread outsourcing and offshoring of manufacturing and back office functions. Similarly increasing automation of manufacturing processes has eliminated many manufacturing jobs in areas such as welding and painting and in the future more will be replaced. This disruption of business functions and markets by technology is an ongoing fact of life. Business as it operates today will not be the way it operates in the future in large part because technology will change how functions are performed.

To survive in business in the 21st century, you will need to be able to effectively utilize information systems. And not only use systems but also to evaluate and select systems and supervise their implementation. Most importantly, at the higher levels of the business, even a small business, managers will need to be able to envision how information systems can be used to increase the organization's ability to compete and thereby to survive.

Additionally, the advance of technology creates additional issues for the business manager. How information is acquired, secured and handled is of increasing concern to customers. Who owns the information and who can do what with it is becoming a major area of controversy. Similarly, cybercrime and similar hacking events threaten business competitiveness and even survival. Similarly, the survival of the business in the face of adverse events is an additional key consideration. Security and ethical handling of information and business continuity planning is therefore also critical areas of knowledge for business managers.

That is what this course is designed to provide. In completing this course, students will learn the foundational elements of what is involved in managing information systems in business.

TECHNOLOGICAL DISRUPTION OF THE GLOBAL BUSINESS ENVIRONMENT

As business people in the 21st century, you will have to face an environment that the people of your parents' generation did not. After World War II, Europe, Japan and the Soviet Union were in ruins. Africa, Asia and South America were relatively undeveloped. The United States was the only functioning major economy in the world. So for a generation, the US was able to build the greatest economic power in the world. It allowed the US to provide a high standard of living for all of its citizens, so that for the first time, factory workers were able to enter the middle class, own homes and send their children to college. While this was a great thing for all Americans, it was a transient phenomenon that could not last. Beginning in the late 1970s and coming in full force in the 1980s, the forces of globalization and technological disruption shook American economic dominance. Europe and Japan had rebuilt and were now capable of global competition while the rest of the world, development had begun. The rise of automation transformed how business was done in the world. These forces returned competition to its normal higher state and while the US was still the dominant economic power in the world, it was not the only economic power in the world.

So you will encounter two key forces that you will have to consider for all of your careers: globalization and technology disruption. Both of them are enabled by information technology. As you go through this course, you will learn how to deal with them:

Globalization

Watch this video from Tom Friedman, as he explains his thesis on "The World is Flat": …….
Then review this Summary discussion of the 10 flatteners:
https://flatworldbusiness.wordpress.com/flat-education/previously/flatteners-of-the-world/

When Friedman says **the world is flat** he means that the barriers to international trade have been lowered. Don't think that this means that there is universal free trade throughout the world. There isn't. But the forces are in places to create increasing amounts of free trade and they have an increasing effect on the world's trade situation. Information technology has facilitated this flattening by enabling the flow of information through the world.

To summarize the 10 flatteners, we can think of them in 5 categories.

1) Reduction in geo-political barriers.

The fall of the Berlin Wall in 1989 symbolizes the idea that nation states have increasingly adopted the idea of free trade. The fall of the Soviet Union and its satellite countries resulted in the dramatic lowering of barriers to trade in Europe. The free trade agreements (NAFTA, TPP, ……) also have lowered barriers in the form of tariffs and restrictions to trade. These legal reforms have increased the free flow of goods and services across the globe.
Of course, not all legal barriers are down. For example, North Korea remains one of the most restrictive regimes on the planet. Other countries restrict or distort free trade by the use of currency manipulation, import restrictions, tariffs and other barriers.

2) The internet: a global platform for information exchange.

Friedman's next three flatteners: Netscape (browsers), workflow software and uploading (user created content) relate to the internet as a global platform for information exchange. As you will see in chapter 3, the internet provides a standard platform to publish and access information across the globe. The i**nternet** is a global network of networks that has enabled communications around the globe. This platform has enabled the global sourcing, information access and informating phenomena. The internet in addition to providing standards, dramatically speeds up the transfer of information. Data can be transferred around the globe in seconds as opposed to the potential weeks as was the case before.

3) Global Sourcing

Friedman's next four flatteners (outsourcing, offshoring, supply chaining and insourcing) refer to the ability to source products and services around the globe. **Outsourcing** means to acquire goods and services from the outside instead of making or performing them for yourself. **Offshoring** means to outsource outside the borders of your home country. **Supply Chaining** means to collaborate horizontally with your suppliers and customer to create value. **Insourcing** means to outsource whole functions of your business such as supply chain management, manufacturing or even human resources. With the lowering of geo-political barriers, international trade now becomes possible and/or more profitable. The internet allows the transfer and access of information in real time to trading partners.

Previously, global outsourcing would have been difficult requiring the sending of stacks of paper around the world with the loss of significant amounts of time. E.g. If you wanted to outsource the creation of component parts for a car, the parts specification document would have to be transmitted and the proposal sent back by mail. This would have consumed considerable amounts of time especially if significant clarification and revision was required. With the internet, that now can happen in seconds or even real-time.

It has also enabled global operations. We can therefore have "follow the sun" software development for example. HP has established development centers in Europe, Asia and North America. Development on a piece of software takes place during normal business hours in a geography and then at the close of business transfers to a development center just starting its day. The internet allows the programs to be stored in a common area along with records of development status so that minimal downtime is experienced in transferring responsibility for development from one center to another.

Another "follow the sun" activity is technical support. HP again has support centers to provide support for its software so that no matter when you call with a technical problem, there is a team that supports your product available. For example, HP established a Japanese language support center for its operating systems products in the United States so that when its Japanese customers experienced problems in the middle of their night, they would have a Japanese speaking technical support staff available to them.

4) Informing.

The concept of **informing** relates to the global accessibility of information and its competitive impacts. Information is now available all over the world at the same time. Prior to the internet, this was not so. In those days, for example, a used book store could stock books and charge what they needed to get for the books because there was no way to compare prices outside of having people going to a number of bookstores and check availability and prices. Since the rise of the internet and sites such as amazon.com, alibris.com, and bookfinder.com, the knowledge of what books are available where and for what price is now globally available. This has caused a dramatic drop in prices. One of the authors of this textbook had a business selling books. In 2003 when he started selling books, an art technique book called "A Painterly Approach" sold for over $90. As he was writing this text book, he checked on bookfinder.com and found that a used version of the book now sold for about $4 INCLUDING shipping. The availability of information has caused the price of that book to fall to essentially nothing. In your business career you will have to deal with this phenomenon. The price at which you sell your goods and services will be available globally.

5) Enablers

Enablers refers to what Friedman calls "steroids", technologies that make these forces more powerful. These technologies are extensions of the internet and other technologies such as Voice of Internet Protocol (VOIP), Digitization of data, mobile devices and apps, virtualization. These enablers create the ability to create digital content and share it at any time with anyone. As you will see in future chapters, new technologies involving business analytics and artificial intelligence will accelerate business changes and change your business' competitive environment.

Figure 1-1 shows how these forces are interrelated. The lowering of geo-political barriers and the creation of the internet made outsourcing feasible for the first time. The internet also make informing possible. Finally the enablers make all these relationships stronger resulting in more movement toward globalization.

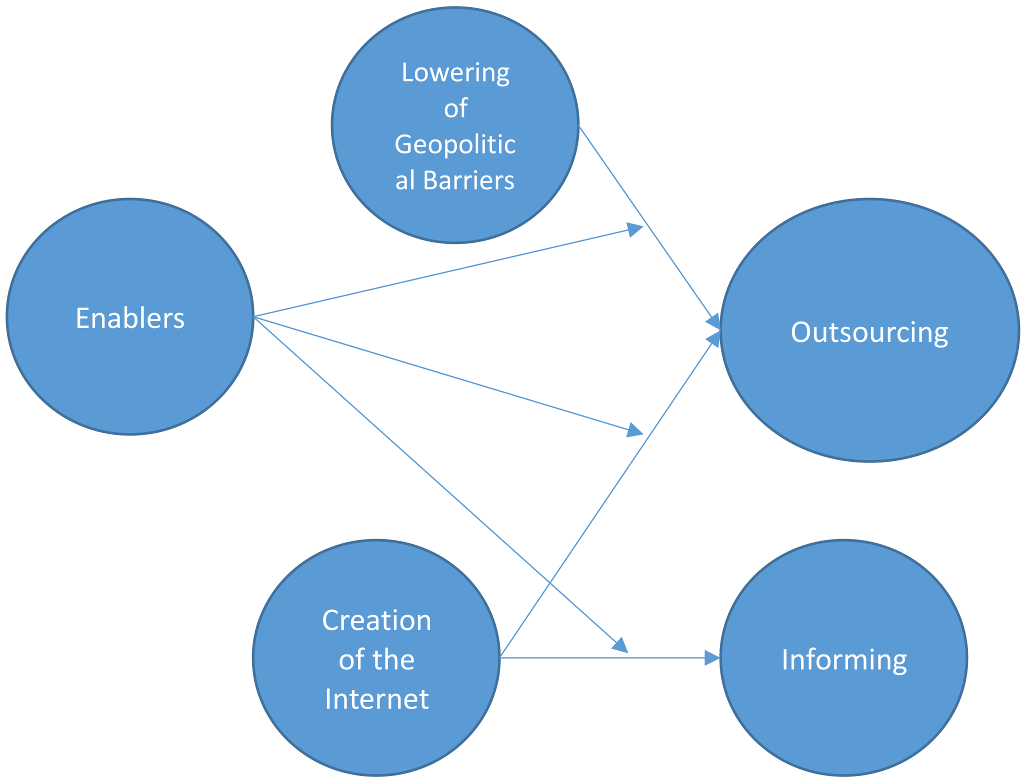

Figure 1-1: Causal Map for Globalization

Globalization has had the effect of "hollowing out" the middle class. The flattening of the world resulted in the ability to do business in many parts of the world which were previously impossible. The low standard of living in those places combined with a relatively advanced infrastructure, allowed business to be done at a much lower cost than that possible in the home country. Much of the manufacturing activity and other manpower intensive activities moved to those areas. The steel business which used to dominate much of American midwest has moved overseas. A similar migration has happened to dinnerware, shoe and electronics manufacture. This migration has resulted in a loss of thousands of manufacturing jobs in the United States.

It is commonly thought that outsourcing only results in job loss. But while there is job loss in certain areas, there are also job gains in others. One study has shown that in countries where jobs are outsourced there are job gains for college educated workers while lesser skilled workers suffer job losses. In the countries which have received the jobs, job gains occur across all levels of skill. Globalization has also had effects on wages even on jobs that are not outsourced. It has put downward pressure on wages in outsourcing countries. One study has shown that wages fall 10-15% in job categories subject to outsourcing.

Technological Advancement

The second force you will encounter is that of **technological advancement**, the introduction of technology that changes how the world works. Processes in business are becoming increasing automated and information systems are performing more and more roles that humans used to perform. This has resulted in significant economic disruption where those in relatively low skilled find those jobs becoming harder and harder to find and paying less and less.

There are several "laws" that have been described by industry leaders that pertain to technological change that will have an effect on the business environment: Moore's Law, Neilsen's Law, Metcalf's law and Bell's Law

Moore's Law

Moore's Law was formulated by Gordon Moore, former CEO of INTEL in the 1960s. He formulated the law as:

"the number of transistors in a dense integrated circuit doubles approximately every two years." Gordon Moore, Intel 1965

What this means is that raw computing power doubles ever two years. Processor ability and storage capability per $ have dramatically fallen over the last 40 years (Figure 1-2). The price/performance ratio also falls about every two years. The cost of computing and storage has fallen so far that the cost of increasing processor speed and memory capacity is essentially zero. This zero incremental cost is allowing software developers to ignore processing power and storage limitations and designing new processing systems that were unthinkable just a few years ago.

What this means to you is that innovations in technology will be coming faster and faster. The ability to change the way competition is done by means of technology will continue to increase. You will need to stay on top of these technological advances and even anticipate them so that you can stay ahead or at least even with them.

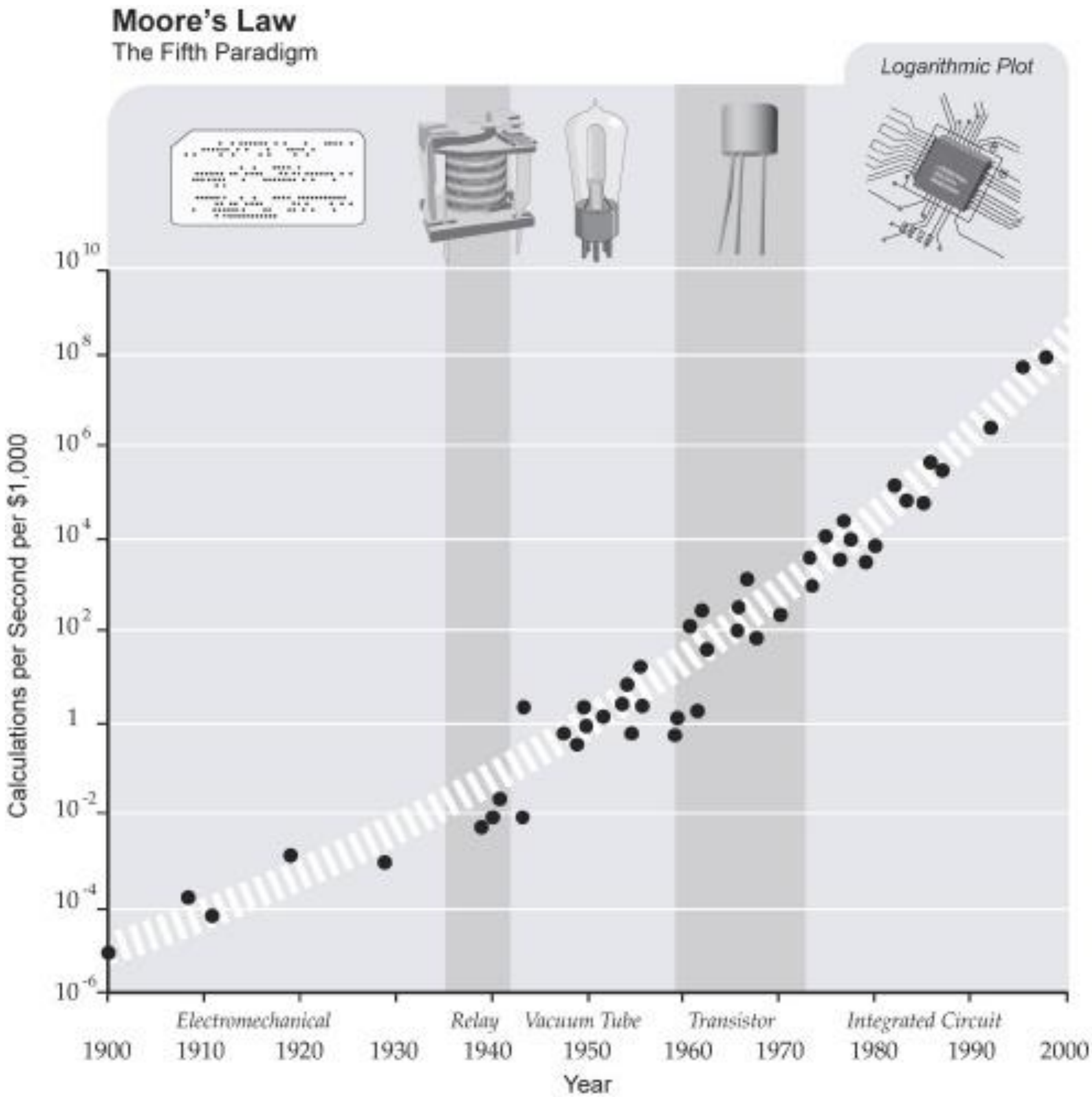

Figure 1-2: Moore's Law (http://singularity.com/charts/page67.html)

Nielsen's Law

Jacob Nielsen, who formulated **Neilsen's law** is a web usability consultant. His law stated that

" … [N]etwork connection speeds for high-end home users would increase 50% per year, or double every 21 months. As a corollary, he noted that, since this growth rate is slower than that predicted by Moore's Law of processor power, user experience would remain bandwidth-bound. "(https://en.wikipedia.org/wiki/Jakob_Nielsen_(usability_consultant))

How his law has played out in practice is shown in figure 1-3.

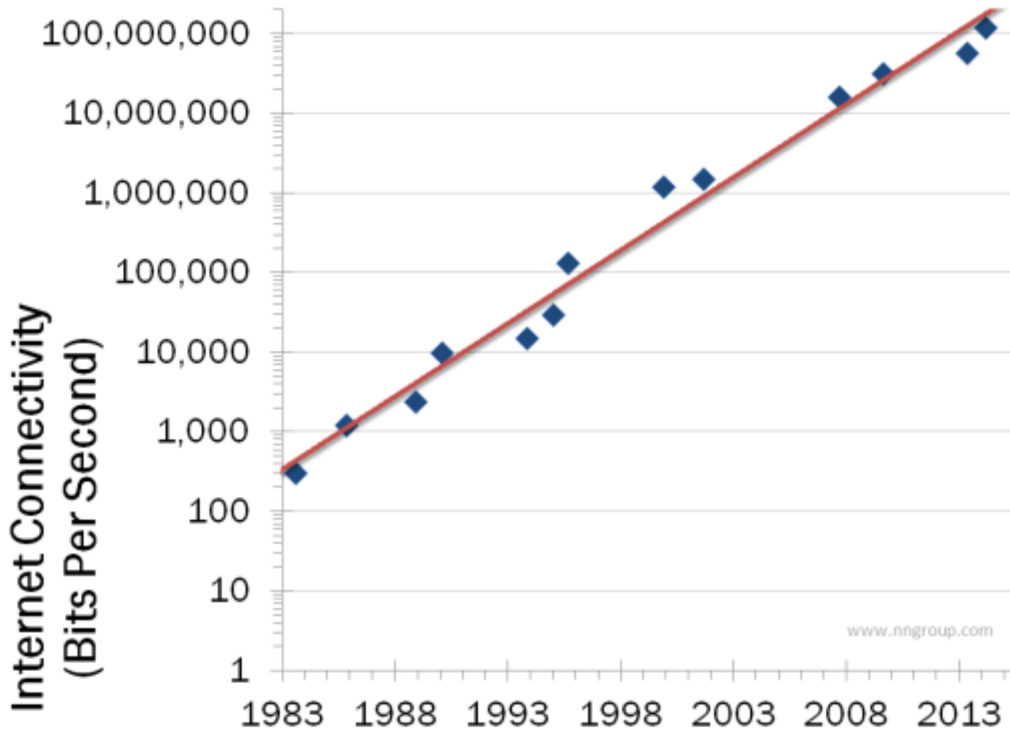

Figure 1-3: Nielsen's Law (https://www.nngroup.com/articles/law-of-bandwidth/)

Similar to Moore's Law this indicates that internet bandwidth will increasingly not be an issue for the implementation of technological capabilities. In the past, lack of connection speed was an impediment to certain applications such as embedded video. Web pages at first had no images and then only static images. Today, it is not an issue to have embedded videos in our facebook pages that play as we scroll past them.

Together Moore's Law and Nielsen's law tell us that the cost of computing and network bandwidth is dropping rapidly and make possible business capabilities that previously weren't possible. One of the authors remembers attempting to do a video presentation in the mid-1990s using the fastest Macintosh computers then available. While the video did play, the processor was not fast enough to render a smooth display on the screen with the net result that there was a lot of hesitation in the rendering which we called "the Max Headroom effect"after a science fiction from the early 90s who was a computer generated image that had a similar hesitation pattern. Streaming even in on the internal network was just not thinkable. Today thanks to Moore's Law and Nielsen's Law those are not even issues.

Bell's Law

As we discussed before together, Moore's Law and Nielsen's enable new computing capabilities. Gordon Bell, then vice-president for Engineering at Digital Equipment Corporation, stated **Bell's Law** in 1972 that about every decade a new, lower priced computer class based on advances in computing technology and networking would emerge enabling new usage and establishing a new industry. This has in general held true. The 1960s saw the introduction of mainframes; the 1970s, the minicomputer; the 1980s personal computers and networks of computers. In the 1990s, we saw the internet; the 2000s web services and the convergence of phones and computers; the 2010s is seeing the emergence of unbiquitous computing and automation (figure 1-4).

This new class of computers that emerges acts to disrupt the business associated with the previous classes. For you this means that every decade or so there will be a new computer platform with low priced computing capabilities that you will need to examine and learn how to exploit in your business.

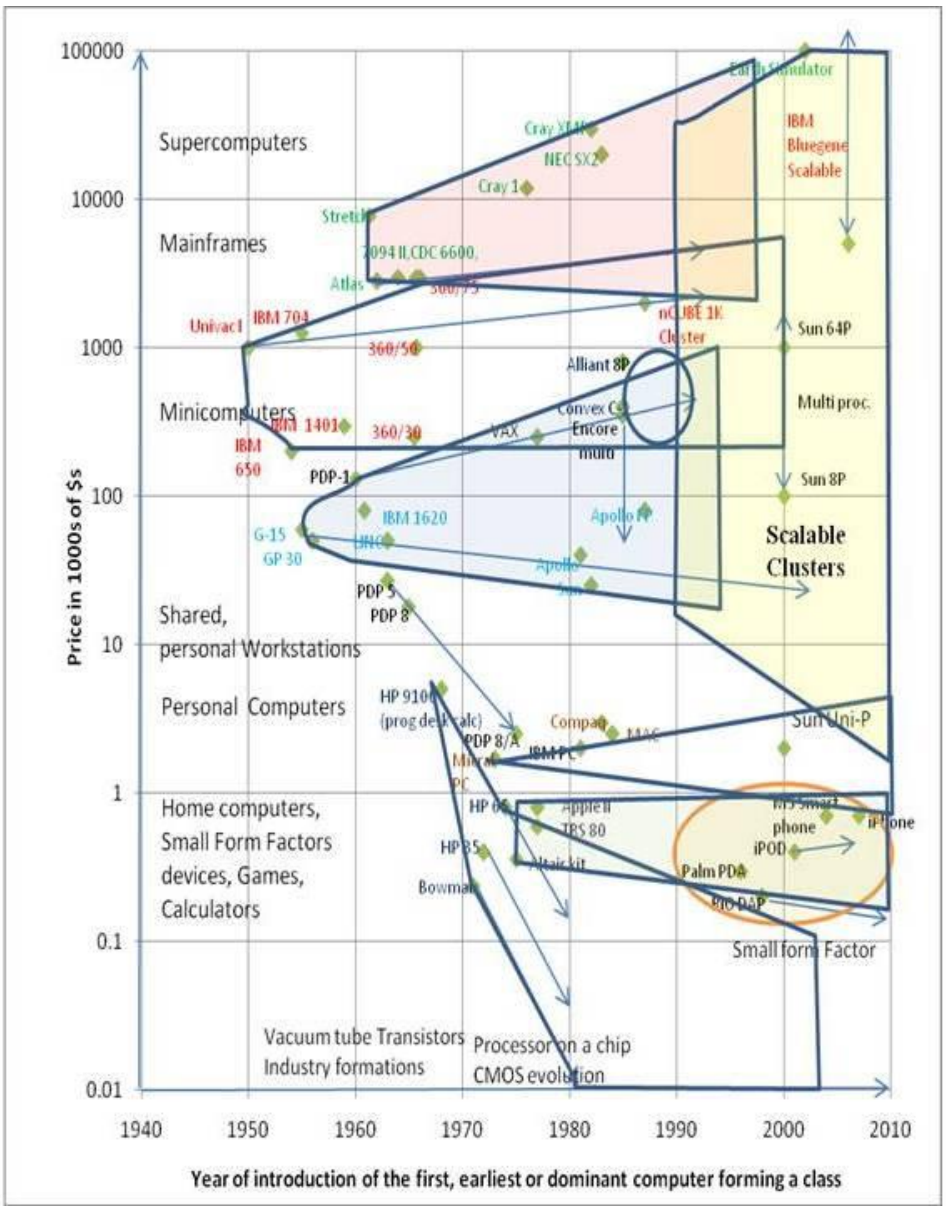

Figure 1-4: Bell's Law (http://hanworks.blogspot.com/2010/05/bells-law-of-computer-classes.html)

Metcalfe's Law

Finally, we consider **Metcalfe's law**. This is a law about the value of networks. This law was first formulated by George Gilder in 1993 and applied by Robert Metcalfe to computer networks around 1980. Metcalfe's law states that the value of a network is proportional to the square of the number (n^2) connected users of a system.

To illustrate Metcalfe's Law, consider an ecommerce site such as eBay or Amazon which matches buyers and users. The value of eBay to buyers is the fact that they have the most sellers from which to select products. For the seller, the value is that fact that it has the most buyers.

For businesses, this means when attempting to create new business that depend on networks such as eBay, there will be a required number of users that must exist to offset the cost of establishing the network. This is why it has been very difficult for any other site to displace eBay or Amazon as leading marketplace sites. They have been unable to attract enough business to offset the cost of running the business (Figure 1-5).

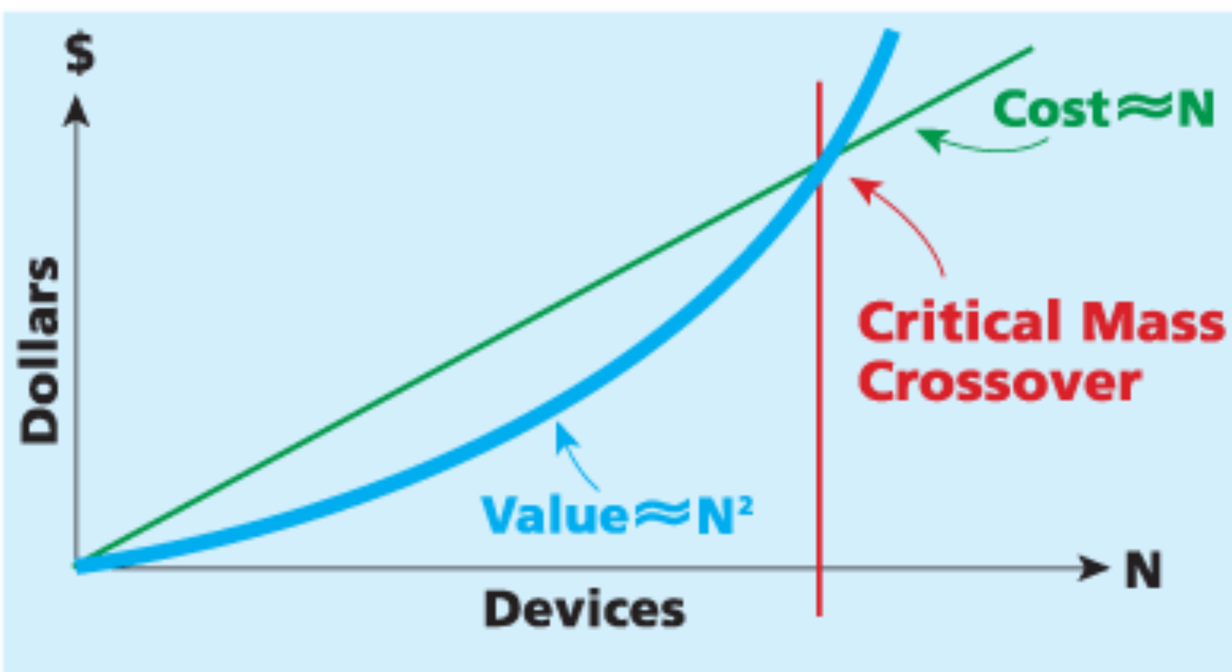

Figure 1-5: Metcalfe's Law (http://www.noahbrier.com/archives/2008/07/metcalfes_plateau/)

In summary, this section was to indicate to you that you need to understand that technology will change during your career. The cost of computing, storage and network will continue to be near zero and these capabilities will create new computing classes that will offer new capabilities to your business and your competitor's business. You will need to keep your eye on technology and what your competitors are doing with it to understand how the market is shifting and what you will need to respond to in order to stay in business.

TECHNOLOGY'S IMPACT ON THE GLOBAL ECONOMIC MARKETPLACE

The effects of technology enabled globalization and disruption are also having a profound impact on global labor markets. Outsourcing and offshoring are moving the content of work around the globe. Automation is changing how that work gets done. **Automation** refers to the process by which human work is replaced by work done by machines. When outsourcing occurs it has dramatic effects on the work force. First, those whose jobs are outsourced are of course thrown out of work. But not only are there jobs available in those categories, but the wage rate for those jobs also declines. This is partially offset by increases in the number of jobs for people who manage the outsourced relationship. For example, when a factory is moved for the USA to China, the factory jobs not only those of blue collar workers but also the foremen and managers also move. However, to manage the outsourced relationship requires people in the legal, procurement and management ranks who monitor and control the relationship to ensure that the company receives the goods and services that it contracted for.

As we saw above internet based informing technology enabled the mainstreaming of that trend. And now another trend is occurring which is also effecting the labor market. The increasing amount of automation in the workplace is causing a replacement of what was formerly done by humans with machines. Eric Brynjolfsson and Andrew McAfee have studied this effect and have noted the data shown in figure 1-6. Historically, productivity and employment have moved in synchronization. Increases in productivity were accompanied by increases in employment. However, after the year 2000, this synchronization was broken so that this synchronization no longer occurred, a phenomenon Bryjolfsson and McAfee called **decoupling**. While productivity continued to increase, employment did not. Their explanation for this phenomenon is that for the first time, machines are able on a significant level to replace the function of human beings so that the number of jobs required to perform work was actually lower.

In the past, machines extended human capabilities, making them stronger, faster, smarter. Where humans were displaced such as in accounting and payroll as discussed above, they were able to find jobs for which their skills and abilities fitted hem. However, now that has changed. Thanks to Moore's law, Nielsen's law and Bell's law, digital devices have become more and more capable. They first took the more routine tasks now they are moving into more complex white collar jobs. Just like with outsourcing, we see that those jobs will become fewer and fewer and the wages for those jobs will become less and less. And this trend will not decrease, Moore's, Nielsen's and Bell's law are still in effect. This digital labor will continue to gain capabilities and become cheaper. We will see work come back from outsourced relationships but the jobs that outsourcing eliminated will be done by machines. As machines gain more capability, we will see more and more jobs even those farther up the complexity scale be performed by machines.

The implications of this for you are very clear. As Marc Andreessen, founder of Netscape and now a technology venture capitalist said, "The spread of computers and the Internet will put jobs in two categories: People who tell computers what to do, and people who are told by computers what to do." (http://www.nytimes.com/2012/12/12/opinion/global/jobs-productivity-and-the-great-decoupling.html?_r=0) And only one of these will be well paid.

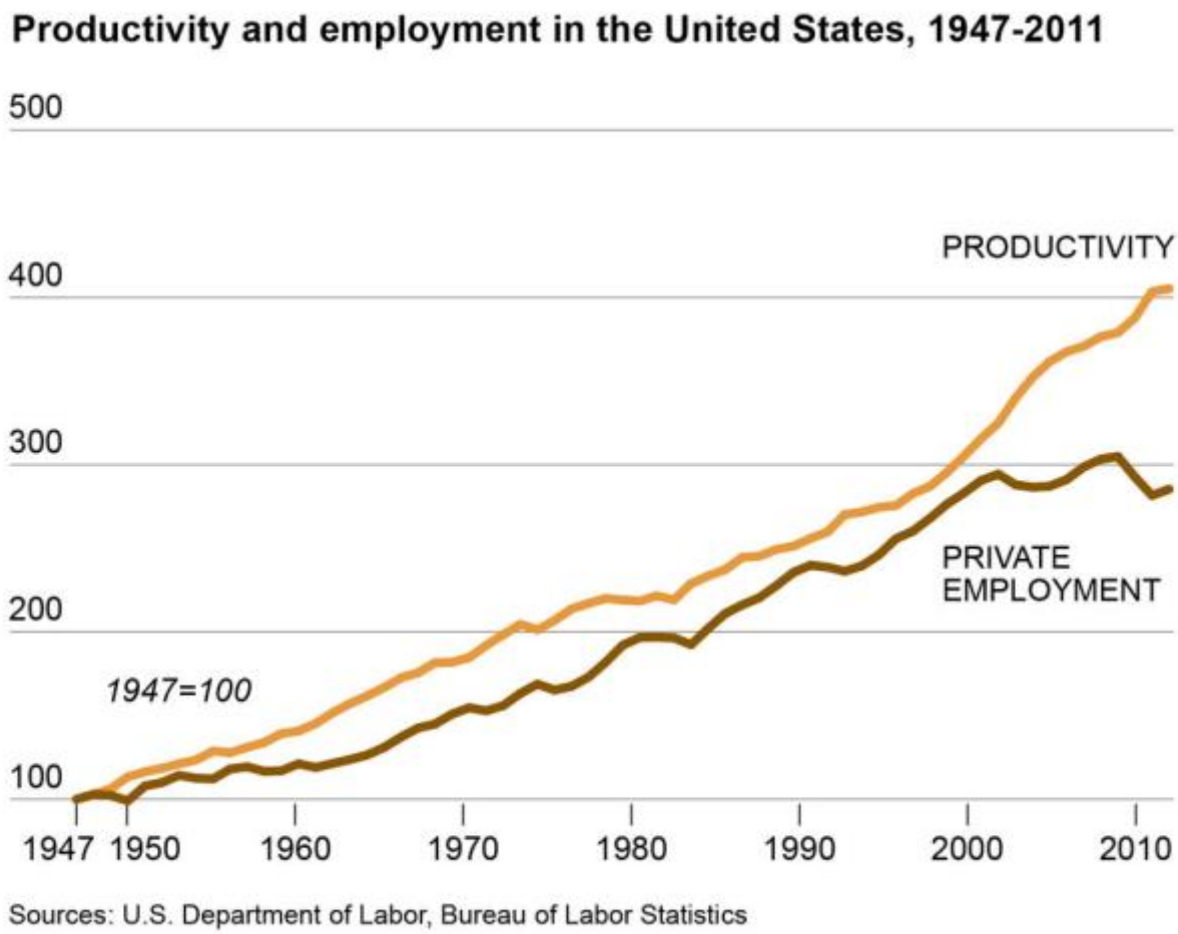

Figure 1-6: The Great Decoupling (http://www.nytimes.com/2012/12/12/opinion/global/jobs-productivity-and-the-great-decoupling.html?_r=0)

The implications for you are clear. The forces of globalization and technology disruption will not be going away. Moore's, Nielsen's and Bell's laws tell us that technology will gain more and more capability for less and less cost. These new technologies will become enablers for further globalization as Friedman tells us. These new technologies will also become the source of more labor force disruption. To manage your own personal job security, it will be important for you to be aware of these trends and be alert to technological change so that you can manage your career. You will probably have to reinvent yourself multiple times in your career and constantly learn new skills and technologies.

THE NEW ETHICAL CONCERNS

Globalization and the rise of the internet raise significant ethical issues for the 21st century business person. **Ethics** seeks to answer the question of "what is the right thing to do? In ethical analysis we attempt to establish ethical rules. These are rules that we follow in our interactions with people and in our actions that affect other people. What rules to establish is a very complex question that has been debated for millennia. In this book, we will try to identify the questions and some responses to those questions.

To begin, there are two basic approaches to ethics. First, there is the **deontological** approach. This approach proposes absolute rules which are followed whether they lead to good or bad consequences. The question is does the rule make logical sense. In other words is the rule based on reason rather than emotion. The second approach is **utilitarianism**. The object of the rules is maximizing happiness or what the economists call **utility**. The question here is does action satisfies a person's needs and values. Another way to look at utilitarianism is how does the action affect all those who will be impacted? How will it impact their utility? Utilitarianism has some profound issues. It is difficult to understand all he consequences of an act. Utilitarianism doesn't recognize any rights, there are no absolute prohibitions if the concept of utility is met.

Others are for example**, natural rights** theories. In this view, individuals have certain basic rights such as a right to life, liberty and property. Ethical rules here seek to not violate these natural rights possessed by others. They are referred to as natural because they are said to be inherent to each person. Rights to life, liberty and property would imply rules against murder, kidnapping, theft, robbery and coercion. This position was held by the founders of the United States for example who sought for a country which would be characterized by free exchange and voluntary interaction.

As you might have guessed, there are no easy answers to ethical questions. In many cases, trade-offs are involved. Trading off one value against another. Some distinctions need to be made however. First, we don't refer to things as right or wrong but rather whether they are **ethically obligatory** or prohibited. Second, there is a distinction between **harm and wrong**. Some ethical actions have bad results. Or something can be wrong but have no harm come from it. E.g. hacking into a computer system but not changing anything just having a look around might not cause harm, but it could be said to violate someone's property rights by trespassing on their property. There is also a difference between **law** and ethics. Laws generally are ethical rules or behavioral conventions enforced by the government whereas ethics are usually private decisions as to what is ethically obligated or prohibited.

The tremendous changes lead us to some very serious ethical questions that we will only raise here, leaving the answers to later chapters. For example, globalization has led to large scale job displacement. Is a company ethically obligated to maintain jobs in a location even if it leaves the company in a weaker competitive position that threatens its viability? Technology disruption causes some companies to lose competitive advantage and thus go out of the market causing thousands to lose their job. Is there an ethical obligation to preserve those jobs or to prohibit that technology that aided the competitors to drive that company from the market? Were the managers of that failed company ethically obligated to keep abreast of technology so as to avoid business failure? In the internet world, what are you ethical obligations toward the customer's data? Is it ethically permitted to sell that information to others or use it to make marketing decisions? Is hacking a competitor's information systems ethically permitted? Because I can download music or a book from the internet is it ethically permitted for me to do that? All of these questions arise as a result of new technology and business capability that you will have to determine in your business careers.

ABOUT THIS COURSE

In this course, you will gain some of the background and skills necessary to cope in the increasingly competitive landscape. As you go through the course, you will learn about what information systems and techonology are and how to use them for competitive advantage. How they integrate with your business processes and how to acquire and manage them. You'll also become familiar with two critical technologies: Enterprise Requirements Planning (ERP) systems and Business Intelligence Systems which are critical for business success in the 21st century. In more detail, you will cover the following topics.

1) The Competitive Landscape. What is the world like in which you will operate your business.

In this chapter you will understand that the world is flat and that there a few natural barriers to global competition anymore. You business must be be able to complete on a global basis. You will understand that as information systems evolve they disrupt competitive capabilities and you will need to anticipate and adapt to new technologies or accept the fact that you will be at a competitive disadvantage or your business will be liable to be eliminated from the marketplace. Involved in this competitive world, you will also have ethical challenges that arise from information systems that you must consider. You'll see how failure to consider the changing nature of technology caused the failure of the Encyclopedia Britannica.

2) The Nature of Business Information Systems

In chapter 2, you'll learn that a Business Information System (BIS) is more than computers. It involves people, processes and information as well. You'll learn the types of information systems, where they have come from and where they are going.

3) Competing with Information Systems

In chapter 3, you'll learn a way to think about your business and the market that it is in using Porter's strategy model. The way that you market is structured competitively will drive how you choose to compete which will in turn drive how you will use information systems. Information systems can be used by your company to affect the competitive structure of the market. In the POGO airlines case, you'll analyze a market, choose a competitive strategy and then select appropriate information systems to support that strategy.

4) Infrastructure elements

In Chapter 4, you'll learn about the "plumbing" of information systems. The hardware, software and networks that make information systems possible. You'll also learn how the changing nature of infrastructure can enable or disable competitive advantage. We will also look at the importance of risk management and taking steps to ensure that your infrastructure stays intact in the face of various threats to it. In the Medical Supply Company Case, you will learn how failure to keep up with technological trends can cause failure of a business.

5) BIS Acquisition and Implementation.

In chapter 5, you'll learn how to decide which information technology to select and how to implement it within your organization. You'll learn the various ways in which information systems can be acquired and the considerations that you will need to make as you move to implement them within your organization. We also look at the ethics of outsourcing to acquire IS capabilities.

6) Business Process

In chapter 6, you'll learn about business processes. Business processes are a key component of information systems. They are what makes technology "work" within a business. You'll get an overview of evaluating, benchmarking, and improving processes. You'll learn about Business Process Modeling Notation (BPMN) and using MS Visio to create these diagrams.

7) Enterprise Systems

In chapters 7-10, you'll learn about enterprise systems using the example of SAP. You'll learn what they are, how important they are as transaction processing systems and how they enable your business to do purchasing, manufacturing, and order fulfillment. You'll learn to operate the SAP systems to complete these processes in a typical manufacturing company.

8) eCommerce and Social Media

Any company in the 21st century that does not use eCommerce and Social Media, puts themselves at a competitive disadvantage. In Chapter 11, we how eCommerce works and how social media affects your business. We also look at the ethical and legal components of these areas.

9) Business Analytics

Any company in the 21st century should be using business analytics to help them make decisions. In chapter 12, we look at the various analytic technologies and show how they are used to assist in making decisions. We will also look at the ethical and legal aspects of information use.

CHAPTER SUMMARY

The competitive environment in which you will be working is one which is at once challenging and changing. Over the past 25 years, because of technological advances and geo-political changes, commerce has transformed into a global marketplace and your business will encounter competition from around the world. In addition, technological change will continue. These changes will accelerate the globalization of commerce and in addition, will change the way the market works for your goods and services. Finally, automation will be increasing performing jobs that people used to do.

As a business person, you will need to be aware of technological change in your markets and business. You will need to harness technology to remain competitive and gain competitive advantage over your rivals. You will also need to be aware of technological changes to retain your job and career prospects. You will want to be on the side of those people who prosper in an increasingly automated world.

This course will help you do all of those things. You will gain an insight into what it takes to be competitive in your marketplace and what technology exists now that you can use to support your business.

KEY TERMS

Automation 11	Bell's Law 9	Decoupling 11
Deontological Approach to Ethics 13	Enablers 4	Ethics 13
Geo-Political Barriers 3	Globalization 2	Harm 13
Informing 4	Insourcing 3	Internet 3
Law 14	Metcalf's Law 10	Moore's Law 6

Natural Rights 13	Nielsen's Law 7	Obligation (ethical) 13
Offshoring 3	Outsourcing 3	Supply-Chaining 3
Technological Advancement 6	The World is Flat 2	Utilitarianism 13
Utility (Ethical) 13	Wrong (ethical) 13	

REVIEW QUESTIONS

1. How did information technology enable globalization?
2. What are the two forces causing disruption of the business environment?
3. How did the lowering of geopolitical barriers and the rise of the internet make outsourcing easier and more cost effective?
4. How do the enablers increase globalization?
5. What are the consequences of globalization for business?
6. How does technological disruption affect competitive strengths?
7. What do Moore's Law and Neilsen's law have to do with Bell's law?
8. How does Metcalfe's law affect competition?
9. What effects does automation have on the job market?
10. What are the two basic approaches to ethics?
11. What is the difference between harm and wrong?
12. What is the difference between law and ethics?

CASE STUDY:

Read the Encyclopedia Britannica Case (Evans and Wurster, Blown to Bits, pp. 1-7) and answer the following questions.

Questions

1. What were the Britannica company's strengths at the start of the story?
2. What technology destroyed Britannica's business?
3. Why did that technology disrupt Britannica?
4. What problems did the managers of the Britannica company have in dealing with the threat?
5. What should the managers of Britannica done to avoid this disaster?
6. Do some research on the web. Since the end of this story what happened to Encarta and to Britannica?

Chapter 2 – Business Information Systems: Fostering Competitiveness in Today's Business Environments

CHAPTER OBJECTIVES

By the end of this chapter, you should be able to:

- Describe the characteristics of open systems and explain why business organizations and business information systems are viewed as open system
- Describe the segments of business environments
- Explain how information differs from data and identify the factors that contribute to information quality.
- Identify and briefly describe the major components of business information systems.
- Describe the goals and benefits of business information systems.
- Describe business information systems' risks and challenges.
- Identify and briefly describe the major components of enterprise systems.
- Describe how enterprise systems have evolved.
- Describe the goals and benefits of enterprise systems.
- Identify enterprise systems' risks and challenges.
- Describe how business information systems and enterprise systems continue to evolve.

INTRODUCTION

In Chapter 1, you learned that today's information systems exist in a highly turbulent business and technological environment. The business information systems in place today are a response to the hyper-competitive business environment that is being shaped by globalization and Friedman's other "flatteners". They are also a response to Moore's Law which has resulted in a computing landscape characterized by increasingly computing capabilities and lower costs for many forms data communications and computing equipment, including storage technologies.

Technological advancements have also spawned disruptive innovations such as mobility, cloud computing, Big Data, and the Internet of Things (IoT). Businesses put themselves at risk by ignoring these new technologies and organizations are rapidly including them in their business computing plans. Some organizations, including Apple, use IT to disrupt the market environments in which they compete.

An important lesson from Chapter 1 is that businesses do not exist in a vacuum and cannot ignore environmental forces that are creating turbulence. Businesses are not closed systems, they are open systems that have exchanges with their environment. When changes occur in the environment, businesses must respond and adapt; if they do not, they run the risks of obsolescence and extinction. Business history is littered with the skeletons of one-time Fortune 500 companies who failed to respond and adapt to environmental changes.

Like business enterprises, information systems can be described as open systems that receive inputs from the environment in which they exist and produce outputs needed by the environment. They too need to respond to changes in their environment in order to continue to add business value. Information technologies and systems become obsolete when they are unable to keep with the changes in the environment.

So, this chapter begins with a brief look at systems theory, a framework that encompasses both business enterprises and business information systems (BIS). It then addresses business information system components (hardware, software, data, people, procedures) and provides a brief summary of the evolution of information systems in businesses. Some the major business information system goals and benefits are summarized along with some of the major challenges and risks.

Chapter 2 also introduces enterprise systems and briefly explains their distinctions from other business information systems. Enterprise systems components are introduced along with the benefits that businesses aspire to realize by implementing enterprise systems. Enterprise systems risks and challenges are also explored.

The chapter concludes by considering the ongoing evolution of enterprise systems and BIS. Our brief glimpse of the future includes more turbulence as markets, businesses, and information and communication technologies continue to be reshaped by business responses to disruptive technologies and technological adaptations to new business strategies and models.

Chapter 2's focus on systems and external environments provides a bridge to the concepts addressed in Chapter 3. In Chapter 3, you will see that businesses exist for business purposes. Businesses invest in information systems to support business processes associated with the value chain activities that are most closely related to the organization's competitive strategy. Essentially, information systems help a business compete within its industry by being aligned with competitive strategy, value chain activities and business processes.

SYSTEMS THEORY

Business enterprises are often described as systems. A **system** is a set of interrelated elements that work together to achieve a common purpose or goal. Traditional functional areas within a business organization, such as marketing, finance, and operations, are examples of system elements that work together for the purpose of serving the business's customers. In some organizations, these functional areas large enough in size to be considered *subsystems* that included their own set of interacting elements.

All systems function within some sort of environment, which, like the system, is a collection of elements. Environmental elements surround the system and interact with it. Systems are normally delimited by a *boundary* that separates them from their environment. Elements within the boundary are part of the system while elements outside the boundary are part of the environment.

Systems are often classified as open or closed. A *closed system* is self-contained and does not interact or make exchanges with its environment across its boundary. An **open system** interacts and makes exchanges with elements in its environment. Business organizations are examples of open systems.

Figure 2-1 summarizes the key features of open systems. Key features include:

- The system exists in an environment which includes all external forces capable of affecting some part of the system or the system as a whole.
- The system receives inputs from the external environment.
- The system includes a transformation (throughput) process which converts inputs to outputs.
- The system produces outputs which are exported to the environment.
- The system includes one or more feedback mechanisms for ensuring that it continues to serve a useful purpose within the environment.
- The overall goal of the system is to survive and grow.

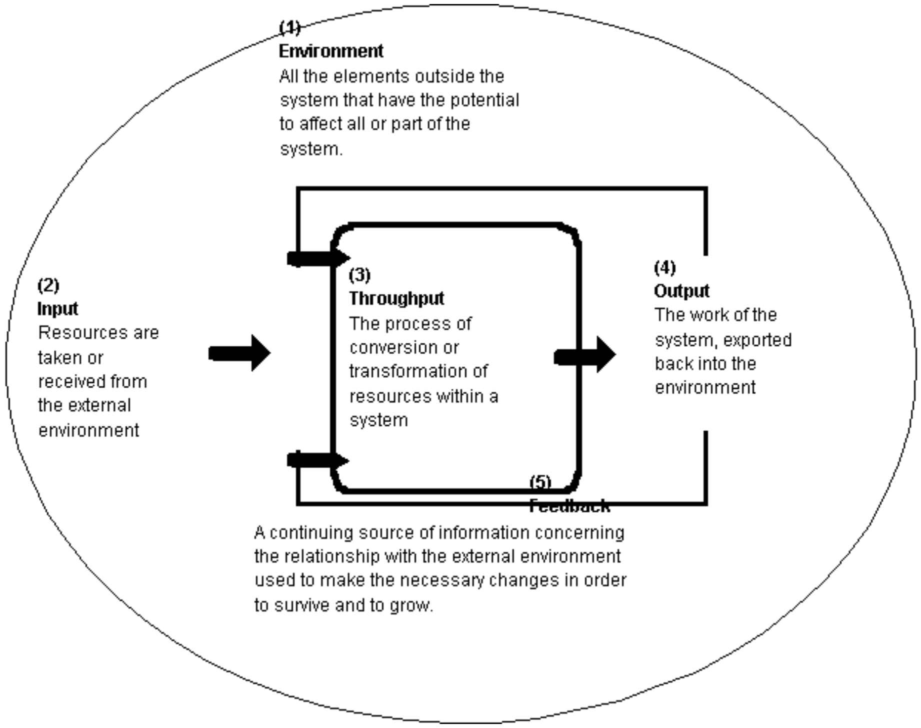

Figure 2-1: Key Features of an Open System

As illustrated in Figure 2-1, an open system, such as a business, is intimately related to its environment. It is dependent on the environment for the resources used in its transformation process, such as raw materials and energy used by a business to manufacture products. An open system also depends on the environment to consume its transformation process outputs; businesses sell their products or services to customers and this exchange of goods/services for cash provides the money needed to pay for the resources (raw materials, energy, etc.) it needs to stay in business.

If environmental disruptions prevent the system from receiving needed resources, the system's transformation process will be adversely affected and its ability to produce and export outputs will be constrained. So, a disruption to the input stream can affect the system as a whole.

Similarly, if there is a disruption to the organization's ability to produce or export outputs or if the environment loses its taste for the organization's outputs, the organization may not be able to secure the inputs it needs from the environment to keep going.

Because of its intimate relationship with the environment, the system needs feedback mechanisms to provide it with information about its interactions with the environment and whether it is fulfilling its role within the environment. Feedback from the environment is essential for identifying how the system can be modified to enable it to grow and survive. The information flows from the environment enable the system to identify, adapt and respond to environmental changes that have the potential to threaten its survival.

Business Environments

In strategic management literature, the external environment of a business is frequently describes as consisting of three interacting segments: the business's *operating environment*, its *industry environment* and its *remote environment*. These are illustrated in Figure 2-2.

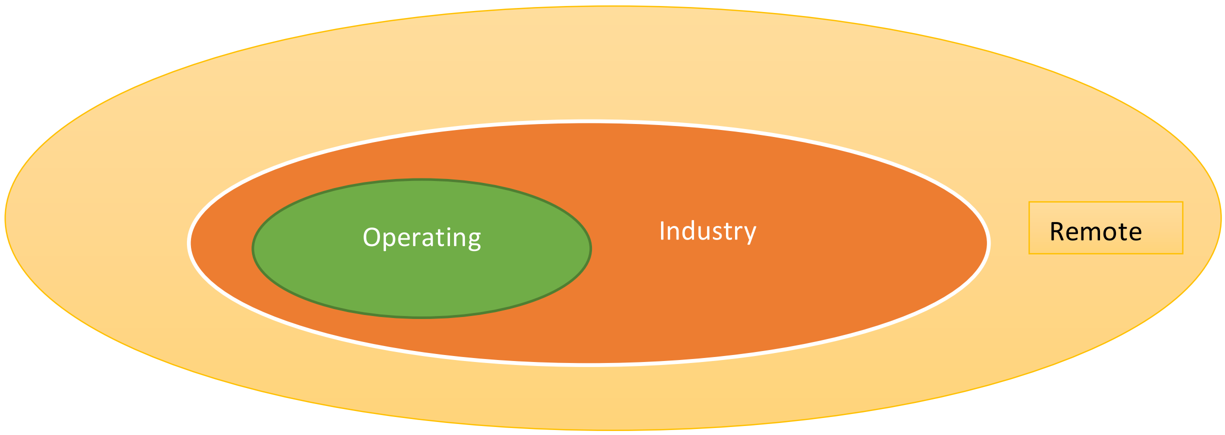

Figure 2-2: Interacting Segments of Business Environments

A business's **operating environment** consists of the environmental elements and forces that are most closely related to its specific competitive situation. This typically includes customers, suppliers, competitors, business partners, and the availability of appropriately skilled human resources.

A business's **industry environment** includes environmental factors and forces that shape the industry in which the organization competes. These include entry barriers, supplier power, buyer power, substitute availability, and rivalry among competitors within the industry. These will be explored more fully in Chapter 3.

A business's **remote environment** consists of environmental elements, forces, and conditions that are beyond the organization's direct control. These include government regulations, global economic conditions, climate change, and socio-economic and geo-political factors.

So, as open systems, businesses have a wide-range of environmental factors that affect their ability to be competitive. The operating environment includes elements (such as customers and suppliers) with whom they engage in essential transactions and exchanges. The industry environment includes forces that determine competitiveness and competitive options industry-wide and the remote environment includes factors that affect a wide swath of industries.

In order to survive and grow as an open system, a business needs to be able to monitor, respond, and adapt to changes in its business environment. Monitoring and responding to changes in its operating environment is crucial, but it cannot overlook competitive forces that are transforming its industry environment or social, economic, ecological, and geo-political factors that have global impacts.

Information systems provide the information flows required to monitor environmental changes and play a key role in a business's ability to adapt and respond. So, now we will turn our attention to information systems, first as systems, and subsequently to the roles that they play within business systems.

Information Systems

An **information system (IS)** is a system that provides people with information related to an organization's processes or operations. An IS supports the activities of employees, managers, owners, business partners and other key people in the organization's environment by providing information in a timely manner to inform decision making.

Today, almost all information systems used to support an organization's processes are computer-based, but this has not always been the case. Prior to computerization, information systems were paper-based. Data consisted of stacks of paper documents that had to manually sifted to extract information and produce summary reports. In those times, larger organization's included numerous clerical "paper-pusher" and bookkeeping jobs. So, it is not accurate to say that information systems did not exist before computers. Organization's had information systems, but they were paper-based.

The names of the paper documents used to support business processes prior to computerization are still used today even though today's documents are electronic rather than paper in form. For example, we still describe the document flow within the procurement process as including purchase requisitions, purchase orders, shipping documents, receiving documents, invoices, and vendor payments despite the fact that none of these documents are printed on paper.

As you will learn a little later in the chapter, computer-based business information systems include computer and networking hardware, software, data, and procedures. But like the information systems of old, their main purpose is to provide people with information about business processes and operations so that they can make informed business decisions. People (users) are the lynchpins of successful information systems and this is not likely to change in the foreseeable future.

INFORMATION

Data and Information

Many people use the terms data and information interchangeably. To technology professionals, however, there is a distinct and important difference. **Data** refer to facts. (Note that data is the plural form of datum; many people treat data as a singular noun.) When data is filtered so that they take on both meaning and value to a person, they become **information**. Information, rather than data, is what people use to make decisions. Figure 2-3 illustrates some of the differences between data and information, but let's look at a few additional examples to clarify this distinction.

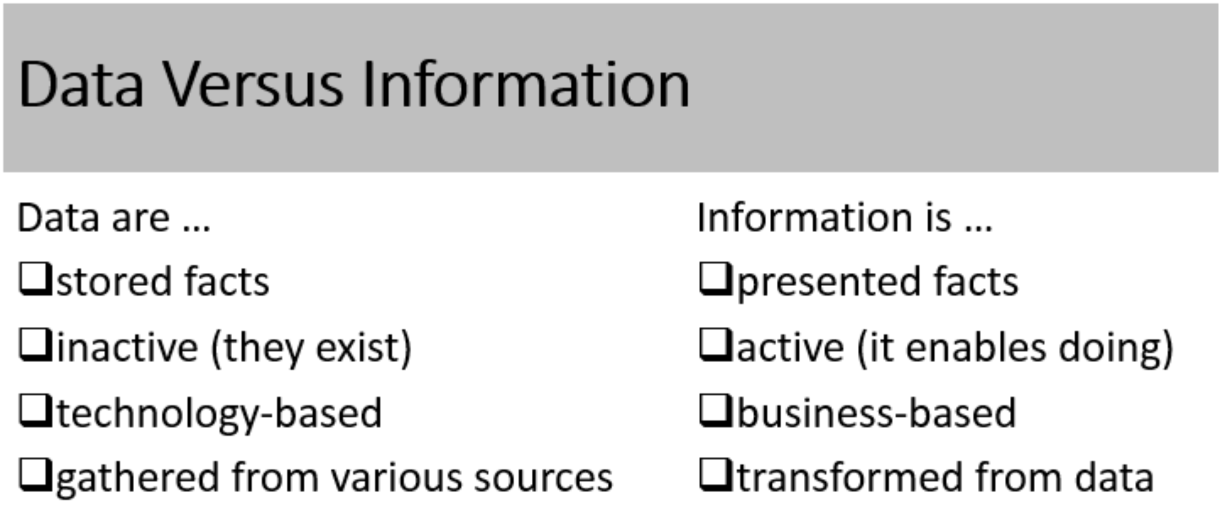

Figure 2-3: Data Versus Information

Virtually any fact is an example of data. For instance, the names and cell phone numbers of all students at Georgia Southern University and the details regarding flights departing and arriving daily at Atlanta's Hartsfield International Airport are each examples of data. When a person uses an app such as Kayak to identify all possible flights from Atlanta to San Francisco, (s)he is interested in extracting information from the large bank of airline data that is available. (S)he wants to know, for instance, the price and availability of specific seats on specific dates for specific times between two specific cities. Being able to find the right types of information quickly enables travelers to make informed choices. The choices they make becomes data (facts) in the data bank used by decision makers at airlines regarding how many flights to schedule between specific cities, their departure times, and how large each plane should be. So, choices (decisions) based on information from a data pool becomes part of the data pool for future decision making. This relationship is depicted in Figure 2-4.

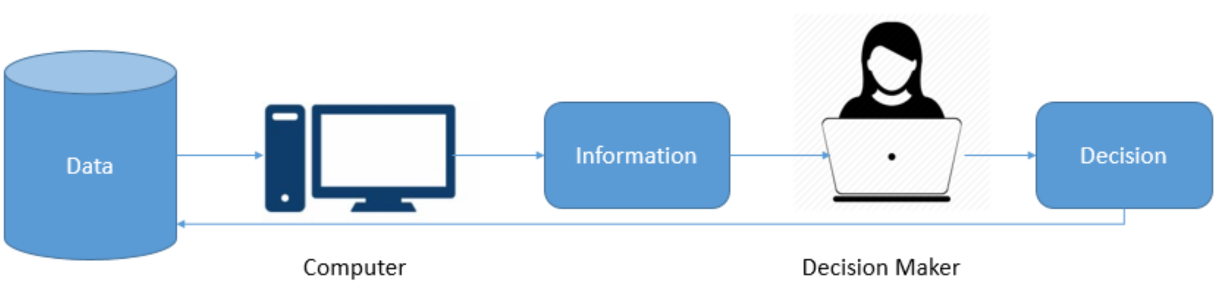

Figure 2-4: Processing Data into Information for Informed Decision-Making

Because business operations and decision-making processes depend on information, information is perceived as a key business resource. Along with tangible assets -- such as buildings, equipment, personnel, and financial resources – data, information, and knowledge have substantial value to businesses and should (like other vital resources) be properly managed. Information and the information systems that produce it, are seen by most business organizations as desirable investments that can be used strategically to provide a competitive edge, rather than as a necessary expense that must be controlled.

Information Quality

To be valuable to decision makers, information should have as many of the following properties as possible: availability, comprehensibility, relevance, usefulness, timeliness, reliability, accuracy, and consistency. Figure 2-5 provides a brief definition of each of these properties.

Desirable Properties of Information

Property	Description
• Availability	• Is accessible to those who need it
• Comprehensibility	• Is understandable
• Relevance	• Has bearing on business performance
• Usefulness	• Is in a form that can be used
• Timeliness	• Is available at the right time
• Reliability	• Is trustworthy
• Accuracy	• Is correct
• Consistency	• Is not self-contradictory

Figure 2-5: Properties that Determine Information Quality

The manner in which information is presented to decision makers can affect the degree to which it is perceived as being comprehensible and useful. For example, most decision makers are able to quickly comprehend trends in data when it is presented visually as a chart instead of in tabular form (see Figure 2-6).

Year	Actual Sales (Millions)	Predicted Sales (Millions)
2012	4	7
2013	18	13
2014	22	19
2015	15	25
2016	37	31
2017	43	36
2018	--	42

Figure 2-6a: Tabular Data

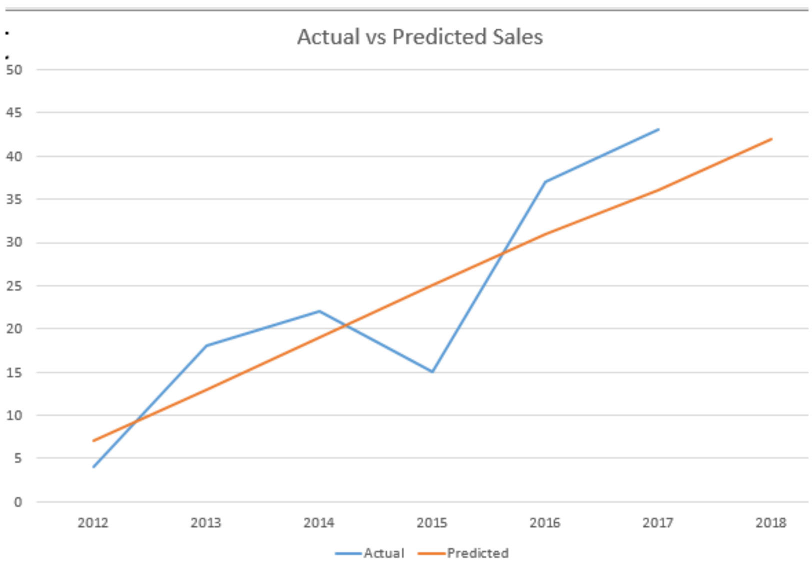

Figure 2-6b: Data Presented as a Chart

In order to maximize the impact of data and information on decision makers, it should be presented in a manner that:

- Eliminates the presence of unnecessary information that could detract attention from the key information that is presented.
- Uses size, placement, color, animation, and other attention-grabbing elements to feature the most critical information.

In Chapter 12, you will learn that these information presentation guidelines are incorporated in business dashboards and data visualization tools.

BUSINESS INFORMATION SYSTEMS

Based on our previous definitions of systems and information systems, a **business information system** (BIS) may be defined as a set of interrelated components that work together to support business processes, operational activities, and decision making. Like systems, they include conversion/transformation of data inputs into valuable information outputs. The information produced by business information systems is used to support forecasting, planning, coordination, control, decision-making, business processes, and operational activities. Data inputs and information outputs are typically stored by business information systems for future use.

Business Information Systems Components

Six basic components of BIS can be identified: people, hardware, software, data, telecommunications, and procedures. These are illustrated in Figure 2-7. People include the users and developers of the BIS as well as the IT managers and technical support staff that operate and maintain the system. Hardware includes computers and other computing equipment such as monitors, and printers found in the BIS. Software includes computer programs that enable users to take advantage of BIS capabilities. Telecommunications includes networks and the hardware and software that support them. Data includes the data that the business has access to such as databases and social media data feeds. Procedures provide the guidance and instructions needed by BIS users to take full advantage of the data transformation/conversion capabilities provided by the interaction of the other BIS components.

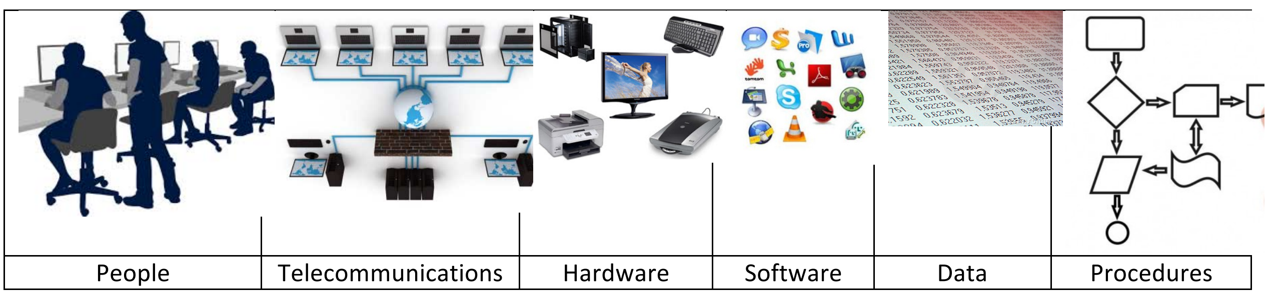

Figure 2-7: Business Information System Components

All business information systems can be viewed as consisting of these six components, but the people component is typically considered to be the most important determinant of BIS success. BIS users include decision-makers who utilize BIS information outputs to run the business and BIS developers, IT managers, and the technical support staff are tasked with ensuring that the other BIS components work together to ensure that users have the outputs that they need operate the business and position it for growth and survival.

Business Information Systems Evolution

Business information systems emerged as important contributors to business operations during the middle of the 20th century alongside the development of computers and computer-related technologies. To better understand what people mean when they refer to business information systems, we need to turn the calendar back several decades to the early 1950s.

In June 1951, a milestone in the history of modern computing was reached when the U.S. Bureau of Census purchased a computer called Univac I. This machine was the first electronic computer manufactured by a business machine company (Remington Rand) specifically for business purposes. Prior to that time, computers were primarily found only in laboratories where they were used for scientific and defense work.

In the 1950s, the predominant business applications were payroll, billing, and other types of routine clerical and accounting operations. Because these applications were relatively easy to structure using the limited number and typically hard-to-use programming languages available at that time, they were the prime targets for computerization. Using computers to automate these functions were relatively easy to cost justify to business managers. For example, if a computer could do the work of 100 bookkeepers who each earned a $10,000 salary, the business could save $1,000,000 a year by installing the computer system.

The first computers used in businesses were difficult to operate, failure-prone, and by today's standards—crawled along at a snail's pace. By the mid-1960s, however, the atmosphere was starting to change. Advances in disk storage technologies made it possible for decision makers to get data faster and to access it in different ways. Programming languages improved dramatically, making it much easier to develop and code new applications. The refinement of operating systems—the programs that manage and control the operations of computer equipment—enabled computers to be operated with much less manual intervention. In general, employees began to accept computers and to rely on their outputs. By the late 1960s, business information systems were entrenched in larger organizations.

Major developments in the 1970s included microcomputers, interactive display devices, user-friendly software, improvements in database technology, and declining prices on computing equipment. These and other forces combined to pave the way for systems tailored to provide specialized support for particular business functions or departments. Functional area information systems--for example, an accounting information system (AIS) or a human resources management system (HRMS)—are designed to support a specific functional area by increasing its internal efficiency and effectiveness. In addition to accounting and HR, common functional information systems include those for finance, marketing, and operations.

Declining prices enabled many business units to squeeze special-purpose business information systems into their budgets. "Islands of automation" were fostered in many organizations as business units invested in systems that met their particular needs, but could not communicate or interact with the systems in other business units. For example, a manufacturer might have an "accounting information system" and a "manufacturing information system" that supported the accounting and manufacturing functions very well, but could not share data.

Decision support systems emerged in the 1970s and 1980s to provide decision-makers with easy-to-use computing and communications capabilities to meet their individual computing needs. Computing and communications technologies also proliferated business offices. The office automation technologies commonly observed in business offices by the mid-1980s included word processing, desktop publishing, electronic mail, and facsimile. Local area networks (LANs) also took root during the 1980s which enabled file sharing, printer sharing, e-mail and other electronic communication among network users.

By the end of the 1980s, information technologies began to take on a new role in many business organizations—that of strategic weapon. Strategic management experts observed that information technology could affect competition in several ways, including:

- IT can change industry structures and alter the rules of competition.
- IT can provide new ways to outperform rivals and create new opportunities for competitive advantage.
- IT can spawn new businesses, some from within a company's existing operations.

The realization that business information systems can significantly affect interorganizational competition paved the way for the BIS developments that occurred in the 1990s.

By the start of the 1990s, computers and business information systems woven into the fabric of business organizations. BIS and information technologies enabled many organizations to reduce or eliminate their middle-management layers by providing unfiltered communication between workers and top-level managers. LANs served as fundamental building blocks in networks and infrastructure that served the organization as a whole, not just particular parts. The Internet was opened for commercial use in the early 1990s and by 1995, advances in hypertext and browser technologies led to the explosion of the World Wide Web. Business rapidly embraced the Internet as a sales and marketing channel and adopt Web servers, commerce servers, and e-commerce tools to build out their website and drive online sales.

The Internet and Web spawned new business models and the first fully online businesses during the 1990s. Amazon.com disrupted the book selling industry with its only online sales channel that enabled it to compete head-to-head with traditional bookstores without have to invest in brick-and-mortar stores. Google unveiled its business model based on online advertising revenue. Of course there are many other business success stories that resulted from the evolution Internet-oriented business information systems during the 1990s.

The robust network and information and communication technology infrastructures constructed during the 1990s also kindled business interest in making their functional information systems interoperable or replacing them with enterprise systems such as enterprise resource planning (ERP) systems. The last several years of the 1990s also included extensive investment in software, hardware, telecommunications, and database systems to replace aging computing technologies that were expected to fail when at 12:00 AM on January

1, 2000. The predicted wide-spread Y2K computer-failures didn't amount to much, but there were numerous IT support staff members worldwide who didn't get much sleep that night.

Software-oriented architectures (SOA) became popular in the early 2000s alongside the maturation of client-server computing and distributed processing systems. These were the precursors of cloud-computing architectures by helping business realize that the Internet and other wide-area-networks (WANs) that BIS components would be distributed across locations and did not have be co-located on premises. Some businesses began to consume some or all of their BIS hardware, software, data storage, and communications technologies from application service providers and third-party data centers. There was no longer a need to have huge on site server farms to support business operations. Businesses were also coming to the realization that technology could be used to support more flexible work arrangements including enabling employees to work from home.

In the 2010s, businesses witnessed the proliferation of tablets, smart phones, and other mobile handheld computing devices. Mobility has been enabled by the maturation of cloud computing options including software-as-a-service (SaaS), platform-as-a-service (PaaS), and infrastructure as a service (IaaS). In the mid-2010s, businesses entered the post-PC era with more software and applications being written for mobile devices than for desktop, laptop, and other traditional computing platforms. More than 6 billion cell phones were in use by the mid-2010s and more than a third were smartphones, handheld computing and communications devices. Businesses also entered the Big Data era characterized by the doubling of the volume of data worldwide every 16 months. Big Data processing platforms such as Hadoop Clusters and SAP HANA are being rapidly adopted by business organizations so that they can take advantage of quickly evolving data visualization and business analytics tools.

The Internet of Things (IoT) is taking shape and promises to interconnect billions of new devices by 2020. IoT will contribute to drive the volume, velocity, and variety of Big Data that businesses will have available to mine for new opportunities. connections. In manufacturing facilities, efficiency and productivity gains will be driven by industrial robots using machine-to-machine (M2M) communications to coordinate interrelated operations.

So, from their clunky start in the 1950s when business information systems included only a few applications on difficult-to-use computers, business information systems have evolved to a state where they proliferate every facet of business. BIS are indispensable parts of today's organization and play a key role in just about everything that a business does. Despite being challenged to assimilate disruptive technologies such as Big Data and the Internet of Things, business information systems continue to evolve and will be increasingly important determinants of business success in the years ahead.

BIS Goals and Benefits

Because they are systems, the overall goal of business information systems is to help the business survive and grow. However, BIS have the potential to benefit businesses in other ways.

Some of the commonly identified benefits of business information systems are summarized in Figure 2-8.

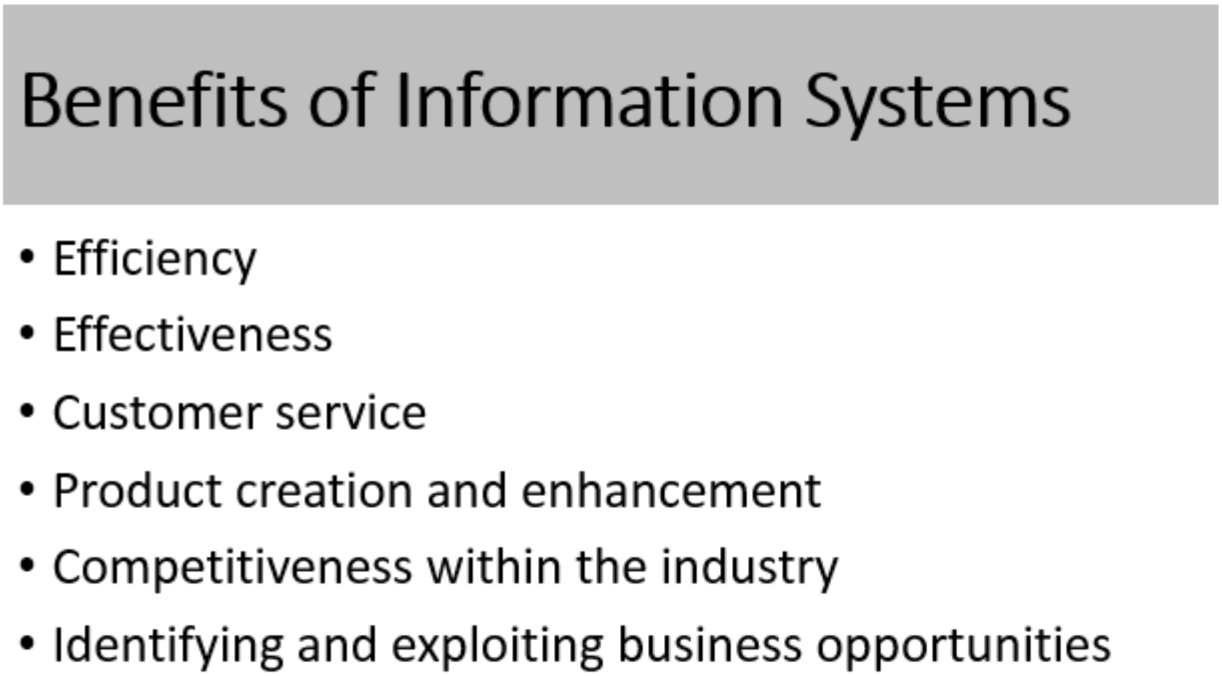

Figure 2-8: Benefits of Information Systems

Efficiency

Operational efficiency gains are realized when routine tasks and business process activities are done better, faster, or cheaper. ERP systems and other transaction processing systems have contributed to significant increases in operational efficiency in multiple business processes and office automation technologies have greatly increased the productivity of office workers. As you make your way through this book, you will encounter other examples of operational efficiency gains that are too numerous to recount here.

Effectiveness

Whereas efficiency is often described as "doing things right", effectiveness is described as "doing the right things". As you read earlier in this chapter, the information outputs of business information systems are designed to help decision-makers make informed, and better, decisions. So, if a BIS contributes to helping managers make better decisions or helps salespeople close sales with customers, it is helping employees, and the business as a whole, to be more effective.

Customer Service

Improving customer experience with the business's products and service is common business goals. Not surprisingly, BIS can play a critical role in improving customer service and how customers experience the organization's products and services. A variety of self-service systems have been developed to enable busy, on-the-go, customers to satisfy their own needs. These include automatic teller machines (ATMs), airline check-in kiosks at airports, self-check-out lanes in grocery stores, pay-at-the pump systems at gas stations, remote deposit capture systems at banks, and mobile payment systems. One can argue that such systems also increase operational efficiency, but it is important to not lose sight of the fact that they were primarily designed to increase customer satisfaction.

Today, customer relationship management (CRM) systems and social media are increasingly used to identify ways opportunities to keep customers happy and to improve customer service. Many customers feel valued when businesses reach to them to let them know about a product or service they might be interested in. Such contacts make customers feel like the business is paying personal attention to them and this makes them more likely to continue to do business with the organization.

Product Creation and Enhancement

In many industries—notably banking, insurance, financial services, and travel—information is a major force in creating the products being sold. For instance, it is typically the effective use of information that distinguishes a good investment portfolio from a bad one, or that separates a well-designed travel itinerary from one with long airport layovers.

Products that can be differentiated largely on the basis of the information inherent within them are sometimes called *information-intensive products*. In industries characterized by information-intensive products, old products can be improved and new products can be created with information technologies.

Information-intensive products are also shattering traditional boundaries between industries. Many banks and credit unions, for example, have started offering insurance products in additional to their traditional banking services. In an increasing number of banks and credit union, a home buyer can get a mortgage loan and also purchase home insurance and a car buyer can get an auto loan and car insurance at the same time. It is no longer necessary for these customers to get a loan at a bank and insurance from an insurance company. And, of course, given today's communication technologies, it may not be necessary for customers to set foot in either or bank or insurance agent's office to get the loan and insurance that they need.

The development, manufacturing, and distribution of non-information-intensive products has also improved in response to advances in information technology. The evolution of robotics, artificial intelligence, machine learning, enterprise resource planning (ERP) systems and other information technologies has enabled organizations to implement mass customization systems, flexible manufacturing systems (FMS), and computer-integrated manufacturing (CIM) applications. Supply chains are faster, better, and more responsive to changing customer preferences from advances in radio-frequency IDs (RFIDs), bar code scanners, and warehouse management technologies. You will encounter a wide range of other IT-enabled improvements to non-information-intensive products as you read this book.

Greater Competitiveness

Using information technologies to create new products or services has enabled some businesses to alter the basis of competition within their industries. Many businesses mine customer purchase histories to determine the mix or products to put on the shelves of local stores. Family Dollar, for example, analyzes local sales data to determine which products are most popular at each location. This has enabled them to use an “every day low price” strategy that is similar to that is used by Walmart to stock products that customers want to buy at very low prices. By locating in smaller stores in neighborhoods rather than in bigger stores in shopping centers, Family Dollar appeals to customers who can most of the same products they want to buy for the same prices they would pay at Walmart, without having to go to the big box retailer.

As was noted earlier in the chapter, Amazon altered the basis of competition among book sellers by launching its online only sales channel. It was quickly able to offer more titles to online book shoppers than they could find in even the biggest bricks-and-mortar book store, without having to build, stock, and operate its own stores. The information technologies that contributed to Amazon’s success in the book business were subsequently used in its evolution in becoming the force that it is today as an online retailer (e-tailer) at which customers can order just about any product that they want. Amazon’s success as an e-tailer has forced other retailers, including, Walmart, Sears, and K-Mart) to beef up their online sales channels. Amazon has also leveraged its IT investments to offer digital content in addition to physical products. Amazon Prime competes with Netflix, Hulu, and other digital content providers and this provides Amazon with additional revenue streams that are beyond the reach of other online retailers.

Uber and Lyft have altered the basis of competition in the taxi and limousine services industry and Airbnb has altered competition in short-term rentals markets. By disrupting traditional competition within their industries and quickly gaining traction with customers, these companies illustrate how greater competition can result from information systems.

Identifying and Exploiting Business Opportunities

Adapting quickly to change, taking advantage of shorter product life cycles, and exploiting niche markets can be keys to success in today’s chaotic business environments. Appropriately configured information systems are ideal tools for spotting subtle changes or trends in market data and helping businesses rapidly respond to changes in the business environment.

Today, many businesses are investing in Big Data processing platforms, such as Hadoop clusters and SAP HANA, and Big Data analytics tools because of their ability to combine data sources--that were previously impossible or very difficult to merge—and to unearth patterns in business data that have previously gone unnoticed. While not every previously undiscovered pattern has business value, some do, and businesses that are quick to recognize the value and respond to the new insights have the opportunity to capitalize on what they learn.

JJ Food Service, one of the largest independent food delivery companies in the U.K, is a Big Data success story. The company provides a wide range sorts of food products — fresh, frozen and packaged — as well as related products, including cleaning supplies to its 60,000+ customers. JJ's catalog includes more than 4,500 products. Despite being in business for more than 25 years, JJ felt it did not really know what was happening in its market and embarked on a Big Data project. They created a system that analyzes past purchases and automatically pre-fills customer shopping carts with items when they call or log in the JJ Food Service website. Customers have been amazed to find that nearly 80 percent of the items they intend to order are already in the shopping cart when they call or log in. And, JJ Food Service has been amazed to find that they can accurately predict what products customers will purchase in their next order. The system enables customers to place orders more quickly and has increased their satisfaction levels. The company is planning to use the system to optimize their warehouse stock by using customer order content forecasts to determine what customers are most likely to buy in the near future. By using Big Data to identify opportunities to better serve its customers, JJ Food Service has also identified ways to increase operational efficiencies.

BIS Challenges & Risks

In order to realize BIS benefits, like those described in the previous section, businesses must contend with challenges and risks posed by information systems. Some of the major challenges and risks are summarized in Figure 2-9.

BIS Challenges & Risks

- BIS success relies on a wide variety of knowledge areas
- BIS technologies can evolve at a fast and unpredictable pace
- BIS terms can be imprecise and/or controversial
- BIS and business alignment can be difficult to maintain
- Lack of rapport between BIS users and technical staff
- Returns from BIS investment can be uncertain
- BIS security is difficult to achieve and maintain
- IT talent can be difficult to attract and retain
- Knowing where to draw the line between personalization and privacy

Figure 2-9: BIS Challenges and Risks

BIS Success Requires Leveraging a Wide Variety of Knowledge Areas

Functional areas of business that rely heavily on information systems include accounting, finance, marketing, human resources, and manufacturing. An organization's BIS may support several or all of these areas. To be successful, the BIS must be designed to handle the problems and opportunities that are unique to each of the functional areas that it supports, so subject matter expertise of functional area users and decision-makers must be part of BIS design, implementation, and maintenance equation. Technical expertise is also needed to ensure that BIS hardware, software, telecommunications, and data components are appropriately configured to support BIS users and the business as a whole.

BIS Technologies are Evolving at an Extremely Fast and Unpredictable Pace

Information and communication technologies are evolving so rapidly that most businesses continually face the risk of falling behind the technology curve. During the 20th century, businesses could often be safe as a "late adopter" of new technology; they could sit back and wait for "early adopters" to work out all the kinks before implementing the new technologies in their organizations. Today, allowing competitors to get out in front with new technologies can be fatal. Being a late adopter can translate into "being out of business".

As you read in Chapter 1, Moore's Law, Neilsen's Law, Bell's Law and Metcalf's Law are alive and well. The emergence of disruptive technologies is the new normal. Not every new technology is valuable to every organization and it is virtually impossible for every organization to be proficient in all new technologies. However, it is important for businesses to monitor technological developments, assess their potential consequences for the organization, and to quickly assimilate new technologies than can improve efficiency, effectiveness, and competitiveness.

BIS Terms can be Imprecise and Controversial

Because information technologies are evolving at such a rapid pace, many BIS terms have definitions that are ambiguous or rapidly evolving. How big does data have to be to be Big Data? What makes a smart phone smart? How are predictive analytics different from data analytics? How will 5th generation cellular systems differ from 4th generation cellular systems? What will be included in the Internet of Things (IoT) and what will not? While there are no precise or definitive answers to any of these questions, these are the types of questions that businesses should continue to ask about new technologies.

BIS and Business Alignment can be Difficult to Maintain

Ideally, BIS components support business processes and help businesses compete within their industries. Technology developments, mergers and acquisitions, and other major changes in the business environment result in BIS and business misalignment. This creates pressure to improve the alignment between the business and its information systems and in some instances, radical changes are needed to enable the business to have the systems it needs to grow and survive within its environment. BIS and business alignment is a perennial issue is many large businesses largely because of the turbulent nature of global business environments.

Lack of Rapport Between BIS Users and Technical Staff

The people component of a BIS includes users and developers of the BIS as well as the IT managers and technical support staff that operate and maintain the system. Users often have business backgrounds and limited technical savvy, while IT managers, technical support staff, and developers often have technical backgrounds and limited business knowledge. These differences can make it difficult for business users to communicate with IT staff members and vice-versa. Each group may perceive the other as speaking a language it does not understand. Business user want the BIS to work, and when it is not, they do not want a technical explanation about what is wrong. The IT technical staff similarly may have limited tolerance for "business stuff". Bridging the communication gap between the business and technical sides of the organizations is an ongoing challenge in many businesses that is unlikely to be resolved anytime soon.

Investing in IT is Still Somewhat of a Mystery

Like other capital investments, there should be a return on investment (ROI) for the investments a business makes in IT. In a nutshell, a business realizes a positive ROI when it receives more than a dollar for each dollar that it invests and a negative ROI when the investment returns less than a dollar for each dollar spent.

ROI for IT investments is often difficult to measure. ROI investments can produce both direct and indirect benefits and they often have both tangible and intangible benefits and costs. For some information technologies, benefits only begin to outweigh costs several years in the future. For these IT investments, the ROI is not realized immediately but becomes significant with the passage of time. Some IT investment benefits never make it into productivity improvements or cost savings that show up in ROI financial calculations. For example, it may be impossible to put a dollar value on improved business processes that keep a company competitive within its industry.

In some instances, a positive ROI is not needed to justify an IT investment. For example, if the IT investment brings the business into compliance with government regulations, the investment is likely to be considered worthwhile even it costs more than its financial returns to the business.

Research suggests that on average, large corporations realize an ROI in the range of .30 to .60 for the investments they make in IT. This means that for every dollar they invest, the get back somewhere between $1.30 and $1.60. Small businesses that invest in IT do even better, their average ROI is 3.0 ($3 for every dollar invested).

No Amount of BIS Security is Ever Enough

Security breaches are arguably the most serious BIS risks and challenges faced by today's businesses. Data and BIS hardware components can be compromised by security breaches and breaches often have financial consequences resulting from disruptions in business operations. In addition, the public image of the business may be tarnished if their systems are successfully hacked. As BIS infrastructures become more network-centric, additional potential points of attack are opened which put businesses even more at risk.

Ensuring BIS security is an ongoing business challenge. Attacks and attackers are becoming more sophisticated and appear more determined than ever to break into systems. In response, businesses are investing heavily in security defenses, even though the ROI from these investments is uncertain. Businesses are scrambling to beef up their in-house cybersecurity expertise and are partnering with third-party cybersecurity organizations for assistance in monitoring and improving their defenses and ensuring business continuity.

Many public corporations have added cybersecurity expertise to their boards of directors and some corporate governance experts predict that most public corporations will have such board-level expertise within five years. Internally, Chief Security Office (CSO) is one of the new c-level titles within executive ranks. However, many CSOs are having a hard time recruiting cybersecurity expertise. Currently, there are five job openings for every qualified cybersecurity expert and average annual salaries surpass $100,000.

"Hot" IT Talent is in High Demand and Short Supply

Ensuring adequate IT staffing is another ongoing challenge. Business competition for highly qualified and experienced IT personnel is fierce and it is quite easy for talented personnel to move from one company to another for a fatter paycheck and greater challenge or responsibility. And, it can be extremely difficult to backfill the position when a talented IT professional leaves for another organization.

Data scientists and cybersecurity experts are among the "hottest" talents in today's IT job market. Other IT talent, such as experienced ERP expertise, are perennially hot. Such expertise is expensive and difficult to hold on to. So, attracting and retaining necessary IT talent is a business challenge that will persist for a long time to come.

Balancing Personalization and Privacy

BIS systems have been capable of mining customer data and monitoring the online activities of customers for some time. They are also capable of monitoring employees as they work on their computers; even an employee's individual key strokes can be monitored and logged. Such capabilities are causing businesses to question how much data should be captured about customers and employees without invading personal privacy.

Businesses often claim that amassing and mining vast amounts of data about their customers enables them to better serve individual customers via personalized attention and advertising. Some customers, however view such data collection as stalking and are annoyed when a visit to a website translates into personalized ads for the business's products or services on their Facebook page, often just a few hours later.

Big Data and data analytics opens the door for businesses to provide even greater personal attention to their customers. While businesses may rationalize their data collection and data mining activities as a means for making it easier and more convenient for customers to do business with them, they should not forget that they are pushing the boundaries of personal privacy. Balancing convenience and personal privacy will continue to be a challenging juggling act within businesses.

So, BIS provide numerous benefits to today's businesses and because they are the central nervous system of the organization, their potential for contributing to the growth and sustainability of businesses is likely to increase. However, there are numerous challenges that accompany the infusion of technology in all aspects of business. The ability of individual organizations to address these challenges will determine which business will reap the most benefits from their business information systems.

ENTERPRISE INFORMATION SYSTEMS

An **enterprise information system (EIS)** is a business information system that improves an organization's business processes through integration. Businesses often implement EIS to address information fragmentation caused by having multiple functional area information systems that emerged in the 1970s and 1980s to serve the computing and information needs of particular business functions such as accounting, manufacturing, or human resources. In contrast, an EIS is capable of supporting all parts of and organization. An EIS is also capable of providing information needed by decision makers at all levels of the management hierarchy.

EIS Components

In order to enable an organization to integrate and coordinate its business processes, an EIS must be have robust technical platform is needed. EIS infrastructure may be housed in one or more on-premises or cloud-based data centers. An EIS also includes *enterprise software* such as enterprise resources planning (ERP), customer relationship management (CRM), and supply chain management (SCM) software.

A central *enterprise information database* serves as the data repository for an enterprise system. The database must be capable of handling the large volumes of data needed to service all parts of the organization. Data and information in the EIS database can be shared across functional areas and by decision makers at all management levels. A standard data structure is provided by the EIS database and this can be invaluable in eliminating information fragmentation caused by multiple "legacy" functional area information systems.

Like any BIS, people are a key component of an EIS. EIS are designed to help their users perform their jobs and to provide business decision makers with the data and information that they need. Figure 2-10 illustrates the key components of enterprise information systems.

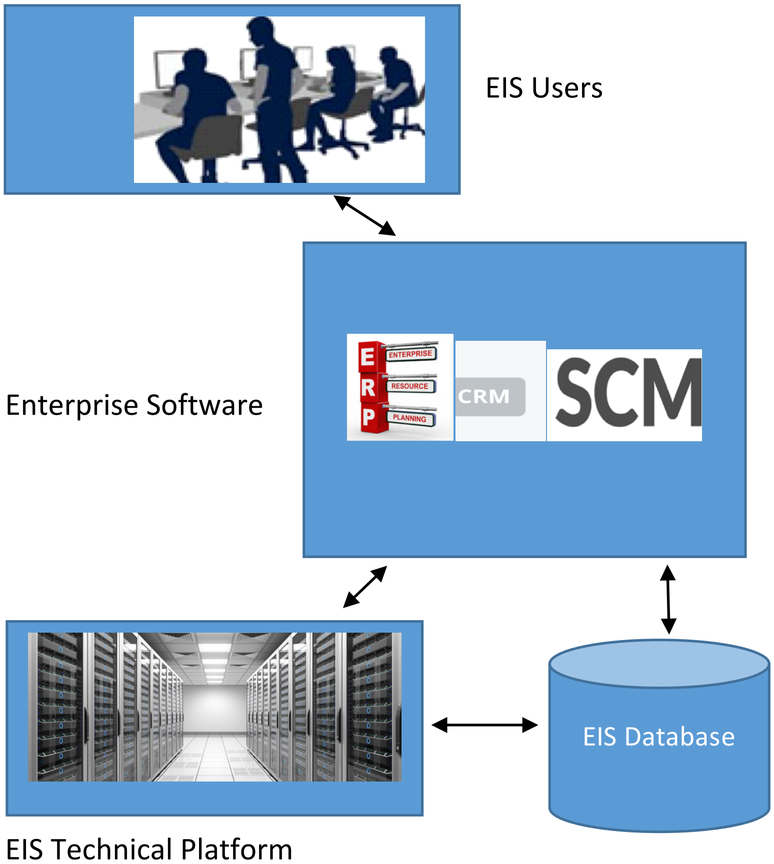

Figure 2-10: Enterprise Information Systems Components

EIS Evolution

Enterprise information systems were spawned in response to the “islands of automation” were emerged many organizations in the 1970s and 1980s as business units invested in systems that met their particular needs, but could not communicate or interact with those of other business units. To support the various functional area information systems and other applications, many organizations accumulated sizable IT staffs and began to incur significant expense associated with maintaining and extending their business applications. While this was taking places, businesses were realizing the challenge they faced in linking their functional BIS and other applications into a cohesive interoperable system.

Some organizations have attempted to address this challenge by embarking on large programming projects to link their various systems to one another. Such projects often involved the creation of **middleware** – software that "glues together" separate already existing programs that may be very complex. Some organizations have created a central “middleware framework" to enable integration of systems and applications across an enterprise. This middleware framework enables application integration to simplify and automate business without having to make sweeping changes to the existing applications or data.

Other organizations have chosen to adopt enterprise software to provide integrated support for functional areas of business and to migrate away from legacy functional area information systems. The first enterprise systems began to emerge in the 1980s. These were on premises systems which often required powerful computer and database management capabilities.

In the 1990s, the rate of enterprise information systems adoption increased dramatically. The maturation of enterprise software contributed to its increased popularity, but so did the emergence of consultancies capable of guiding enterprise systems adoption and implementation projects for their clients. All the “Big Six” accounting firms created enterprise systems consulting divisions and many other consultancies acquired enterprise systems expertise to help client organizations make the move to enterprise systems. In the late 1990s, EIS adoption was fueled by Y2K fears and many businesses chose to replace rather than try to reprogram legacy applications.

In the 2000s, cloud computing versions of enterprise systems were introduced. These gave businesses the option of running enterprise software in-house, or getting access to it from a SaaS (software as a service) provider. Cloud versions of enterprise software brought enterprise software price points down to ranges that small and medium-size enterprises (SMEs) could afford. This resulted in widespread adoption of enterprise systems by SMEs during the 2000s. Enterprise software vendors also released products for small businesses at attractive price points, and this began the proliferation of enterprise systems among smaller organizations. And, open source enterprise software emerged as an alternative to the products available from enterprise software vendors.

The 2010’s have witnessed the shaping of enterprise software for mobile devices (tablets and smart phones) and the integration of analytics capabilities with enterprise software products. Because enterprise systems generate large volumes of data, data analytics and data visualization tools have become very important to organizations who have adopted enterprise systems.

Industry pundits predict that EIS will be primarily cloud-based rather than on-premises in the years ahead. Some expect that many organizations will run their businesses entirely in the cloud and will have very little, if any, on premises EIS hardware, software, and data components.

EIS Goals and Benefits

Enterprise information systems share many of the previously discussed goals for business information systems. An EIS provides a robust technology platform that enables an organization to integrate and coordinate its business processes. This means that an EIS can contribute to improved operating efficiency and productivity, each of which can have direct effects on a business’s bottom line. And, because an EIS can be used to amalgamate existing applications, a business may realize cost savings by adopting an EIS.

EIS enabled business process integration can also contribute to improved customer service by reducing service cycle times and increasing transparency in customer order fulfillment processes. Reductions in product development cycles may also be realized.

By providing a central system that enables data and information to be shared across functional areas and levels of the management hierarchy, an EIS can also contribute to informed decision-making and improved effectiveness. And, because enterprise software vendors incorporate best practices into how their products support business processes, an EIS can help an organization be more competitive within its industry.

Research that has asked organizations why they adopted enterprise suggests that these are indeed the benefits they expect from enterprise systems. According to businesses that have adopted EIS, drivers of the adoption decision include:

- Replace legacy systems
- Simplify and standardize systems
- Gain strategic advantage
- Improve interactions with customers and/or suppliers
- Keep up with competitors
- Restructure the organization

The opportunity to use enterprise systems to restructure the business organization around business processes has resulted in the emergence of process-centered organizational structures which many experts view as the organization forms that are best-suited to today's Information Age business environments.

EIS Challenges and Risks

Because of their central role in business computing platforms, previously discussed BIS challenges are often amplified by the introduction of an EIS. EISs also bring several additional challenges and risks. These are described below.

EIS Implementation Projects Can Be Lengthy and Expensive

It is not uncommon for EIS implementation or upgrade projects to take two or more years and millions of dollars to complete. Some organizations, including Coca-Cola, have invested billions of dollars in their enterprise systems since the mid-1990s. Because of the time and expense associated with EISs, EIS investment decisions should be based on appropriate due diligence and solid business cases. Despite the sizable investment that may be required, EIS have the potential to have a significant ROI, especially over the long haul. But since it may take a while to roll out the EIS, organizations should not expect to quickly recoup EIS implementation costs. The payoffs may not be realized for several years after the start of the project.

Ongoing maintenance costs for an EIS can also be significant post-implementation. Opportunities to fine-tune the EIS configuration can usually be found alongside the continual costs associated with EIS care and feeding, such as vendor maintenance contracts and help desk expenses. While getting the EIS installed is often very costly, an organization may face ongoing challenges maintaining the system once it is in place.

Change Management

Rolling out an EIS and retiring legacy systems is typically accompanied by major changes in how work has traditionally been done. Employees who have been comfortable using functional area information systems and legacy applications often have a long and sometimes steep learning curve while adjusting to the EIS. The EIS typically changes the way in which they perform their job duties and new tasks may have to be mastered. Organizations should expect stress and frustration among employees when the EIS system goes live and should have appropriate change management strategies in place, including ongoing training programs, to help employees adjust to the new integrated computing platform.

Organizations that implement EISs in order to force organizational restructuring around business processes must plan on having very robust change management strategies and tactics to facilitate adjustment to the new system. In these instances, traditional reporting relationships and work teams get shaken up which requires employees to adjust to working with new people in addition to learning how to use the EIS.

Managing Relationships with EIS Vendors and Consultants

Like other information technologies, EIS vendors continue to evolve their products and provide upgrades in response to customer needs. Like many software products, enterprise software is often upgraded incrementally in versions and it often up to the customer to determine when the new version will be installed on their current system. Because new versions of enterprise software typically include new capabilities, EIS software vendors often push their customers to install the new version soon after its release. Their customers, however, often balk at moving to a new version very rapidly, particularly when doing so is likely to cause some confusion among users. When vendor push is met by customer resistance, vendor-customer relationships can get testy. Since customers rely on vendors for EIS technical support, their push-back on vendors is often measured, but this does not mean that they are happy with the relationship.

Organizations that implement EISs also have ongoing relationships with consultants from one or more consulting firms. In larger organizations, consultants are persistently on site providing the project management and other EIS expertise needed on projects required for the ongoing care and feeding of the EIS. While organizations with EISs wish they could reduce their reliance on EIS consultants, the reality is that they would have a difficult time developing and retaining the expertise they need in house. Hence, like it or not, consultants are part of the typical EIS landscape within today’s larger businesses.

So, the challenges and risks associated with enterprise information systems echo those for other business information systems. Like other BISs, EISs continue to evolve, often at a rapid pace and in an unpredictable manner. EISs bring staffing challenges and experienced EIS talent can be difficult to retain. Despite supporting integrated business processes, EISs can usually be further aligned with business strategy and needs. And since it provides a central technical architecture that extends throughout the organization, the need to keep the EIS secure is ever present.

BIS AND EIS TRENDS

The future of business information systems and enterprise information systems are being shaped by many of the same technological forces including the Internet of Things (IoT), Big Data, data analytics, social media, and collaboration technologies. It is also being shaped by forces in the business environment including the globalization of business and increasingly competitiveness within industries. To best understand the changes that are underway, it is important to recall that BISs and EISs, like the businesses they are in, are open systems which are designed to survive and grow within their environments.

The IoT exemplifies the ongoing convergence of computing and communication infrastructures. As more and more devices communicate with one another over data communication networks, the volume of Big Data will continue to grow at faster and faster rates. Both BISs and EISs will be pressed to add Big Data processing and analysis capabilities, especially predictive analytics and data visualization. Alongside traditional business data, these systems will also be required to process and analyze social media data, especially customer data since this is likely to help businesses personalize advertising and improve customer service. Collaboration technologies are already blending with social media to provide rich communication environments that enable innovation, idea sharing, and business process improvement.

From their very limited and clunky beginnings in the middle of the Twentieth Century, business information systems are now inseparably infused in all aspects of business. The marriage of business and technology will continue to thrive and will evolve in interesting ways, many of which are impossible to foresee.

CHAPTER SUMMARY

Business organizations, business information systems (BIS), and enterprise information systems (EIS) are examples of open systems. Systems are composed of inter-related elements involved with transforming inputs into outputs that have value within the environments in which they operate. Open systems have exchanges that cross boundaries with their environments. For example, business organizations receive inputs such as raw materials and energy from suppliers in the external environment in order to produce outputs (goods and services) which are purchased by consumers in the external environment. Similarly, a BIS is an open system that transforms inputs (data) into information (outputs) that is used by decision makers to make informed choices.

A BIS includes six major components: hardware (computing equipment), software (programs), data (business databases), telecommunications infrastructure (networks), procedures (guides for how to use the software to process and analyze data), and people (BIS users). As consumers and users of BIS outputs, people are the most important component of a BIS and the determinants of how the other components are configured.

Before the computerization of business, business information systems were paper-based. The computer-based business information systems that emerged in the 1950s were limited in scope and difficult to use. Advances in computing, storage, and networking technologies and falling prices facilitated the creation functional area information systems and the proliferation of other BIS applications were commonly found in businesses by the end of the 1980s. Business began to use their information systems as strategic weapons during the 1990s and quickly adapted to the explosive growth of the Internet that began in the middle of the decade. In the 2000s, businesses began to supplement their on-premises computing infrastructures with cloud-based services and in the 2010s, businesses entered the post-PC era centered on mobile devices (smart phones and tablets) running cloud-based apps.

BISs are attractive to businesses because of their ability to improve operational efficiency, effective decision-making, customer service, the ability to identify business opportunities, and to help organizations be more competitive within their industries. A BIS can also be used to enhance existing products or to create new ones. BISs also bring challenges and risks such as the risk of the falling behind the technology curve because of rapid and unpredictable changes in computing technology and the challenge of attracting, developing, and retaining necessary IT talent. Other challenges include maintaining BIS security and BIS alignment with business needs and knowing where to draw the line between personalized attention and privacy.

Enterprise information systems (EIS) began to emerge in the 1980s in response to fragmented data and information within functional area information systems that were not designed to communicate with one another or interoperate. EIS became common in large businesses during the 1990s and became increasing popular with SMEs during the 2000s as the result of more affordable cloud-based product offerings. By the mid-2010s, EISs were entrenched as central computing platforms in most large- and medium-sized businesses.

The major components of an EIS include EIS users, a robust technical platform (typically housed in on-premises or cloud-based data centers), enterprise software (such as ERP, CRM, and SCM), and a central data repository that enables data to be shared across functional areas and management levels. The major goal/benefit of an EIS is the provision of support for integrated business processes. In doing this, an EIS enables cost-savings, productivity increases, and improvements in efficiency, effectiveness, customer service, and competitiveness. However, because EISs typically require sizable up-front investments and significant ongoing maintenance expenses, EIS adoption decisions should only be made after appropriate due diligence and the development of compelling business cases that demonstrate ROI.

The future of BISs and EISs is being shaped by the emergence of the Internet of Things (IoT), the evolution of Big Data processing and analysis platforms, and mobility and cloud-computing. Their future is also being shaped by social media and collaboration technologies.

KEY TERMS

Business information system (BIS) 10	Data 6	Enterprise information system (EIS) 21
Information 6	Information system (IS) 6	Industry environment 5
Middleware 22	Open system 3	Operating environment 5
Remote environment 5	System 3	

REVIEW QUESTIONS

1. What is a system? Identify and briefly describe the major characteristics of a system.
2. What is an open system? Identify and briefly describe the key features of open systems.
3. Why may business enterprises be described as open systems?
4. Identify and briefly describe the three interacting segments of a business's external environment.
5. What is an information system?
6. How does information differ from data? Provide examples of each.
7. Identity and briefly describe the properties that contribute to information quality.
8. What is a business information system?
9. Identify and briefly describe the components of business information systems.
10. Briefly summarize the evolution of business information systems from the 1950s through the 1980s.
11. Briefly summarize how business information systems have evolved since 1990.
12. Identify and briefly describe BIS goals and benefits.
13. Identify and briefly describe BIS challenges and risks.
14. What is an enterprise information system (EIS)?
15. Identify and briefly describe the components of enterprise information systems.
16. Briefly describe the evolution of enterprise information systems.
17. Identify and briefly describe EIS goals and benefits.
18. Identify and briefly describe EIS challenges and risks.
19. Identify and briefly describe several BIS and EIS trends.

CASE STUDY

To be Determined

Chapter 3: Using Information Systems to Gain and Maintain Competitive Advantage

CHAPTER OBJECTIVES

After studying this chapter, you should be able to

- Discuss the nature of competitive advantage
- Discuss how to achieve competitive advantage
- Explain how the structure of the industry in which you compete changes how you need to compete
- Explain how the structure of the industry and how you choose to compete affect how your deliver value to your customers
- Discuss how the work system you design affects your firm's achievement of your competitive strategy
- Explain how you choose to compete affects how you will use information systems in your business
- Explain how information systems can provide competitive advantage to your business
- Explain how information systems can change the industry's competitive structure

INTRODUCTION

As we saw in chapter 1, competition is a fact of life for 21st century business people. You must be able to anticipate and adapt to changing market situations. In chapter 2, you saw the different types of information systems in use within organizations. In this chapter, we're going to investigate how we can use these information systems to achieve competitive advantage for your organization.

Competitive advantage is something important for all organizations, even nonprofits. A commercial business of course exists to make a profit for its owners. So, in these businesses a company needs to attract customers willing to purchase its goods or services at a profit-making price. As customers are relatively rare, they need to compete for those customers. A nonprofit, which does not need to make a profit, still needs to attract donors to enable them to carry on their charitable purposes. As donors are relatively rare, they need to compete to attract donations. An organization then needs to be able to develop a competitive advantage compared to its rivals to survive and thrive in our global hypercompetitive world.

One of the ways you can achieve competitive advantage is by strategic use of information systems. As we'll see in this chapter, Information Systems properly applied can be used to take advantage of market characteristics so that you offer something that your rivals do not. IS can also be used to alter the characteristics of a market so that you can achieve an advantage over your rivals.

To properly apply IS for competitive advantage, you need to understand your market. You will need to analyze the competitive situation in a market into which we compete or in which we wish to compete and then select a competitive strategy that will fit that market. Then determine how to create value for the customer in that market and how information systems can help you compete.

The essence of competitive advantage is being able to create more value for customers that your competitors can do. This chapter, then, is about creating value with information systems.

WHAT IS COMPETITIVE ADVANTAGE?

Competitive Advantage may be defined as

> *Being able to offer a product or service in such a way that the customer values that offering more than those of your rivals.*

Competitive advantage therefore comes from being able to do something that your competitors can't. This can be such things as providing a product they can't or a product with features that they cannot. Alternatively, there may be a service wrapped around a generic product that is not offered by your competitors. For example, when Apple introduced the first commercial offering of a PC with a windows, icon, mouse, and pointer (WIMP) interface, that was at that time something that IBM could not match. It provided them with a competitive advantage. When Ford developed the production line, it enabled him to mass produce cars that a much lower cost than his competitors thus providing him a competitive advantage.

An important part of this definition is the concept that the customer must **value** your offering. Value may be defined as what a customer is willing to pay for the product or service. Therefore, we can see that if you have competitive advantage, a customer is willing to pay you more for your product or service than your competitor's offerings.

Competitive advantage is not forever. Eventually competitors will learn to imitate your offering which will eliminate your advantage. At this point, what was your competitive advantage is now a requirement to be competitive. Without it, you can't be competitive in the marketplace. For example, in the 1970s banks starting rolling out ATMs. Prior to that time, you had to go to the bank when it was open and deal with a teller to do deposits or withdrawals. Then, in the mid-1970s, banks started implementing ATMs which gave those implementing them an advantage with customers as they could now offer 24x7 access to basic services. Once almost all banks had ATMs, customer expected that banks had ATMs and it was no longer a source of competitive advantage but not having ATMs would be a competitive disadvantage.

This is especially true of IT innovations like ATMs. If you can purchase hardware or software so can your competitors. What makes IT a source of competitive advantage is what you do with it. Simply having it in your organization does not add value to your customers, you need to apply that IT to increase value to your customers by making your product different and more valuable to them. In fact, this is the only sustainable source of competitive advantage: your organization's ability to see the trend of technology and take advantage of it. If your organization has this capability, you will be able to continuously innovate and as your previous innovation is imitated, introduce a new one that will maintain your competitive advantage.

CREATING AND SUSTAINING COMPETITIVE ADVANTAGE

Michael Porter in 1980 introduced his proposal for analyzing industries and competitors so that you could successfully compete in your industry. His model suggests that if you understand the competitive structure of the industry in which you compete this will provide direction for you to determine what you need to do to compete. This competitive strategy will in turn help you determine how you will provide value the customer. You can then use the competitive strategy and your value creation strategy to determine how to create work systems using information technology to deliver that value. In this section, we walk through each of those steps to create value using information technology for your customers.

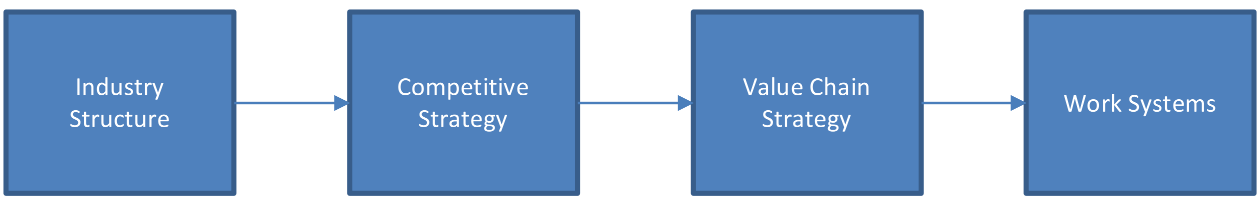

Figure 3-1: IS Strategy Progression.

Understanding Industry Structure

To successfully compete in and industry, you need to know the competitive structure of the industry. Porter has provided us the **five forces model** in order describe the competitive forces in the industry. Given an analysis of these five forces, you can understand the long-term profitability of the industry. This in term will allow you to make decisions on whether to enter or stay in an industry and what you must do to successfully compete.

Porter indicates that the five competitive forces are: **Rivalry, Threat of New Entrants, Threat of Substitution, Buying Power of the Customer and the Buying Power of the Supplier.** These forces are illustrated in figure 3-2.

The two axes in the figure define two different types of forces in the model. The vertical axis defines **competitive forces**. That is what is it that will change the nature of competition in the industry. The horizontal axis defines **supply chain forces**. How the balance of power amongst the buyers and suppliers within an industry affect competitive capability.

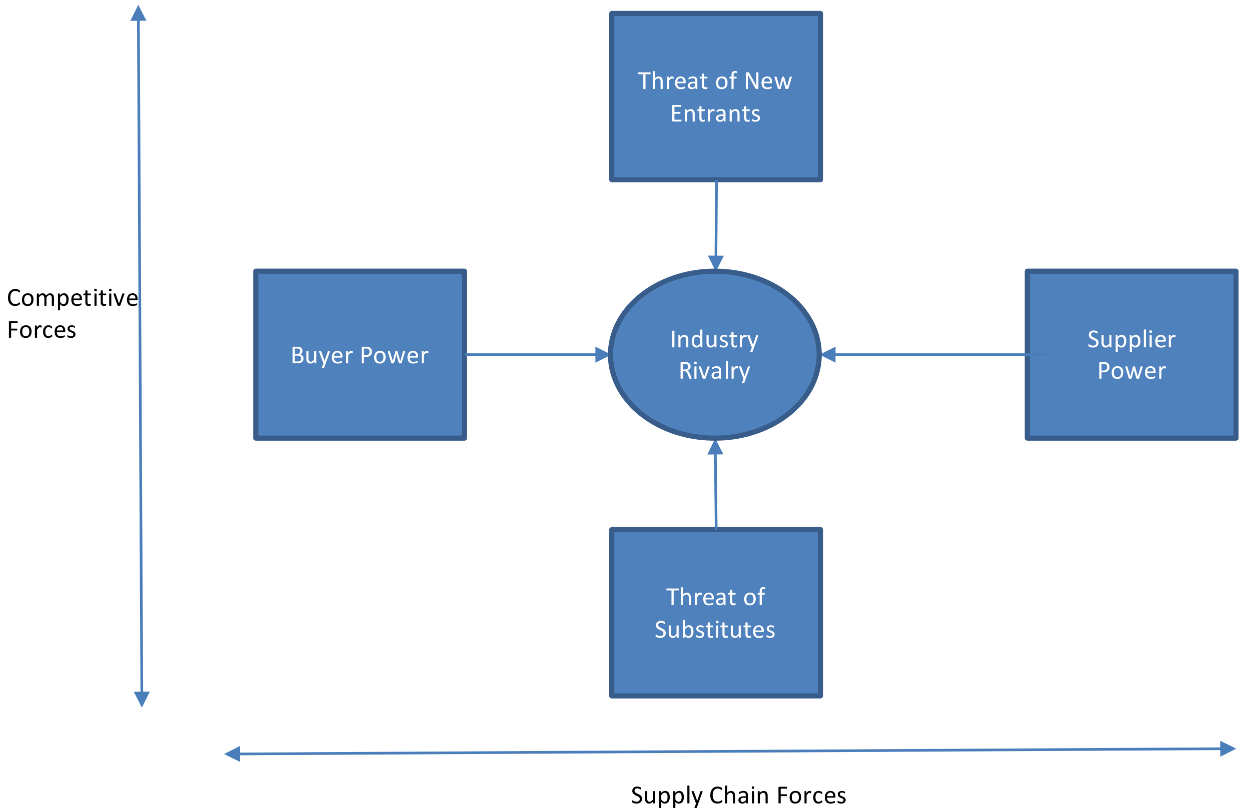

Figure 3-2: Porter’s Five Forces

Competitive Forces

We begin with a discussion of the competitive forces: Rivalry, Threat of Substitutes and Threat of new entrants. These forces assess the level of competition exists between the companies within an industry, the possibility of new companies entering the industry and the possibility of customers moving to different products or services.

Rivalry and Substitution. **Rivals** are those companies who offer the same product or service. **Substitutes** are those companies offering a product or service which is different than the rivals but by which one can accomplish the same goal or function. To distinguish between rivals and substitutes, we first must begin by understanding who is on the industry and who is not. We must carefully define the industry to understand which companies are rivals and which are substitutes. For example, if we were to define the industry as air travel, then companies which offered transportation by means of flight such as the scheduled airlines, charter services, jet time share etc. would be rivals. Substitutes in this case would be companies that offered such services as ground transportation, water transportation, and such things as virtual meetings. However, if we were to define the industry as charter air travel then only companies offering charters would be rivals and all the others would be substitute products.

The force of **rivalry** describes how fierce the competition is between companies within the industry. Industries which have little differentiation between products, compete primarily on price, and compete for the same customers will tend to have a higher rivalry than those who do not. For example, grocery stores in the United States offer the same products to the same customers and compete primarily on price thus they have high rivalry. This is partially offset by **loyalty**, the bond that a consumer has for a brand. Distance between the rivals in terms of their target customers also has an effect. Two grocery store chains competing however one in the United States, the other in Europe would have low rivalry as their customer bases do not overlap.

The **threat of substitution** assesses how likely a customer is to not purchase from one of the companies in the market but instead use one of the substitute products to accomplish their goals. The level of this threat is assessed by examining the cost of switching to the substitute product and the loyalty that a customer has to the products in the industry. **Switching costs** are the costs that a customer incurs in moving from one product to another. For example, if you want to break a cell phone contract with one cell phone service provides and move to a different company, you must pay a monetary penalty. This is one form of switching cost. Another type of switching cost would be the level of effort that a customer must make to switch to a different product. To move from air travel to bus travel, while it costs less, the customer must pay switching costs in the form of time as it takes longer to travel by bus and discomfort as riding in a bus for several days is less comfortable than travel by air. It thus would require more from a customer to travel by bus than by air. Similarly, if a customer wanted to move from using Microsoft Word to a competing word processing package, they would incur the cost of learning the new package, the initial inefficiency in using the new package and the cost of potential incompatibilities in file formats between the new package and Word. If the switching costs for a customer to move to a substitute product are high and the loyalty that a customer has to products in the industry are high, then the threat of substitution is low. On the other hand, if the switching costs are low and the level of loyalty is low, then the threat of substitution is high.

The **threat of new entrants** refers to the question of how easy is it for a new competitor to enter the industry? This force is assessed by examining the **barriers to entry** into the industry. An entry barrier is a feature or service that a customer has come to expect from competitors in this industry. For example, as referenced above in the banking industry, ATMs are now expected by customers and so any company seeking to compete in the banking industry must have access to a network of ATMs. Because it costs money and requires expertise, this becomes a barrier to entry for new firms. Similarly, to enter the automobile industry, you must have efficient factories and volume to support producing cars at a competitive price. This requires significant money to build the factory and significant expertise to design and market cars that will command the suitable level of volume to offset the costs of bringing them to market. These are significant barriers to entry. Where barriers to entry are high, the threat of new entrants is low. Where the barriers to entry are low, the threat of new entrants is high.

Supply Chain Forces

The **supply chain forces** refer to those forces that affect the firm's ability to set prices in the market place based on relationships with suppliers and customers. The affect the firm's ability to respond to competitive pressures. A supply chain refers to the linkage between buyers and suppliers from the original raw material supplier to the ultimate end customer. An example supply chain is shown in figure 3-3. **Suppliers** provide raw materials, those components to be made into a sellable product to **manufacturers** who create the sellable product.

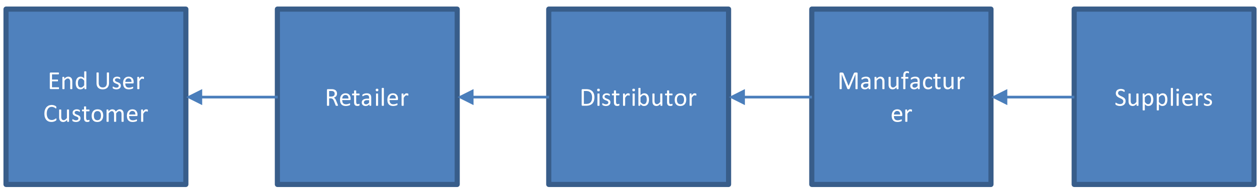

Figure 3-3: Example Supply Chain.

The manufacturers in turn package large lots of finished products and sell them to **distributors** who in turn make smaller lots and sell them to **retailers** who sell them to the **end users**.

Buyers and Suppliers. It is important to understand the different between buyers and suppliers. **Buyers** pay for goods and services you produce. **Suppliers** provide raw materials and components that you use to provide the finished goods. While conceptually simple, this can be difficult to determine in practice. Consider a staffing service which works with companies to locate personnel to fill vacancies in their organizations and with people to locate suitable employment for them. If the company works with people to locate positions for them and is paid by them for the positions, then the buyers are the people and the suppliers are the firms with the positions. Conversely, if the company seeks to find candidates for the firm's positions and is paid by the company then, the firms are the buyers and the candidates are the suppliers.

They key question in the supply chain forces is who sets the price of the exchange? Does your firm or the buyer or supplier have the upper hand in the negotiation? The **Bargaining Power of Buyers,** the ability of the buyer to set the price, is high if the buyer has many options to purchase the product beside you and switching costs and loyalty to you are low which gives them the upper hand. Similarly, the **Bargaining Power of the Supplier**, the ability of the supplier to set the price, is low if you have many options to purchase the product besides them and switching costs and loyalty to them are low. In the grocery store industry, for example, the buyer for the grocery store is the end customer. The supplier is the food manufacturer or farmer. The bargaining power of the buyer is high because there are many different outlets to purchase the same product. If the buyer does not get the price he wants to buy a can of green beans then, then he can go to a different grocery store. Similarly, the bargaining power of the supplier is high here as customer often have brand preferences. For many years Campbell's Soup has commanded a premium as there was a marked brand preference among consumers for their soup. On the other hand, Walmart with its tremendous volume had high bargaining power with its suppliers since its volume could make or break the fortunes of any supplier. Therefore, if the buyer or supplier can set the price in the exchange, their power is high. If the converse is true, then their power is low.

Porter's five forces with their indicators and examples are summarized in table 3-1.

Force	Indicators	Example of High force	Example of Low Force
Rivalry	Level of differentiation, Brand loyalty, Type of competition Common Customers	Grocery stores in the same country, Mass market no name clothing	Grocery stores in different countries, Designer clothing
Threat of Substitution	Switching Costs, Loyalty to products in this industry	Cell phone service with contracts to individuals	Airlines vs. Bus Service
Threat of New Entrants	Barriers to Entry	Automobile industry, banks – high capital and technology requirements	Personnel service, low capital requirements
Bargaining Power of the Buyers	Who has the most power to set the price?	Walmart as a buyer of goods	Customers in relation to Walmart
Bargaining Power of the Supplier	Who has the most power to set the price?	Microsoft as a supplier of MS Office	Professional sports team

Table 3-1: Examples of the Five Forces

Once a five forces analysis is completed, a firm can decide about the long-term profitability of the industry. If the forces are high, then the profitability of the industry will tend to be low. Conversely, if the forces are low then there is a possibility for sustained profitability. If the competitive forces are high but the supply chain forces are low, then there are opportunities to maintain profitability by adjusting prices to customers or suppliers.

An Example Analysis

As an example, consider an analysis of the automobile industry (Table 3-2).

Force	Level of the Force
Rivalry	High – there are many competitors in the marketplace competing at all levels of luxury in all geographic areas. Partially offset by brand loyalty

Threat of Substitution	Low – While there are substitute products such as motorcycles and trucks and services such as Uber. Only a personally owned automobile offers to combination of cost and flexibility.
Threat of New Entrants	Low – High barriers to entry in the form of capital requirements, expertise requirements and dealer network requirements
Bargaining Power of the Buyer	High – due to the high rivalry, there is a significant risk that they customer will go where they can get the best price
Bargaining Power of the Supplier	Low – the volumes purchased by the car company give them significant power in the transaction

Table 3-2: Analysis of the Automobile Industry

You may disagree with these analyses and come to different evaluations based on your experience and perceptions. In real-life, these analyses would be based on significant detailed economic and market based analyses. For the moment, assume that this is the result of such a detailed analysis. We see that the competitive forces are low except for a high rivalry. Similarly, the supply chain forces are split. We do not expect new entrants coming into this market, nor do we expect customers defecting to substitutes. So, the main force here is how to deal with rivalry with other car manufacturers in the market. On the supply chain side, we see that while we are at risk from buyer power, we can offset this with our power with suppliers. This indicates that given an appropriate competitive strategy vis a vis our rivals we have an opportunity for profitability in this industry.

Selecting a Competitive Strategy

Once we have analyzed the industry competitive structure and determine where the opportunities for profitability lie, we can consider how to respond to those opportunities by selecting an appropriate competitive strategy. Porter's strategy model helps us out here by suggesting four different approaches to competition. These strategies are illustrated in table 3-3.

		Cost Leadership	Differentiation
Competitive Scope	Industry-wide	Lowest Cost across the entire industry	Offering superior product or service across the entire industry

	Niche	Lowest cost in an industry niche	Offering superior product or service in an industry nice.

Table 3-3: Porter's Competitive Strategies

There are two dimensions to each strategy. First is cost leadership or differentiation. **Cost leadership** means to have the lowest cost of production. Note that this does not mean lowest price. Having the lowest cost of production certainly allows your firm to have the lowest price, but it also could mean that you will use this cost leadership to have higher margins. **Differentiation** means that rather than competing on cost, we will attempt to provide our product or service in such a way that our competitors cannot. Typically, differentiation is based on product superiority or service superiority.

Some examples from the retail industry illustrate this principle (Table 3-4).

	Cost Leadership	Differentiation
Industry-wide	Walmart	Macy's
Niche	Payless shoes	Whole Foods

Table 3-4: Examples of retailers with Different Strategies

Walmart is the quintessential cost leadership competitor. They are known to ruthlessly squeeze suppliers to get the lowest price. They seek to lower the cost of store operations as low as they can possible go. Macy's on the other hand, offers differentiation based on service. Their sales associates seek to work with you to get you exactly what you need. You can have a Macy's personal shopper if desired. In the Niche area, Payless Shoe Source seeks to provide you shoes as the lowest price. They do not attempt to cover the entire retail industry but rather only the area of budget based shoes. Whole Foods differentiates themselves by offering the best healthy food. Their prices are significantly higher than Walmart's but they compete by providing what they consider as a better option for food.

Example of the Automobile industry

Which competitive strategy is selected based on indications from the industry structure analysis. For example, in the automobile industry example discussed above, we find that we had to concern ourselves with the rivalry with other automobile manufacturers with a price controlling customer but some flexibility with suppliers. We might choose to deal with the industry rivalry by differentiating ourselves providing a significantly different product from what others are providing. This is the approach taken by Tesla. They offer an upscale electric car at a premium price. This is a significantly different product from what is offered by other manufacturers. It provides a significantly superior experience from other electric car offerings and includes the latest in automotive technology. Alternatively, you could select to have cost leadership. In this case, you do everything possible to produce cars at the lowest possible price. You would have the most automated factories and squeeze your suppliers to provide product at the lowest price to you. Your features would not be remarkable, but you could compete with anyone's price.

In the Tesla example, the also chose to compete in a niche: luxury electric vehicles, a very small segment of the automotive marketplace where the other manufacturers were not found. Our other example, could be industry wide or you could choose to focus on a niche providing low cost vehicles for a specific niche such as students or first time car buyers.

Impacts on Information Systems

The competitive strategy that you select will influence how you will choose to use information systems. If you chose to be a cost leader, then your information systems will focus on driving cost down in your organization. Walmart for example, uses information systems in just this way. They seek to use IS to optimize store electricity use, inventory management and labor expenditures, all in the effort to lower cost.

Differentiation competitors will seek to use IS to improve the customer experience. They will use it like Tesla, incorporated into their products to provide new product features. For example, car controlled parallel parking or back up controls, collision avoidance and self-driving features. Using technology in this way increases the value of their product by providing new exciting features that customers will want. Alternatively, they can use IS to improve the relationship with customers. By using customer relationship management systems, they can use their experience with customer to guide their interaction with customers to provide them information and offers that they would like and only those so that they provide additional value to customers by providing focused information that the customers would want and desire.

Work Systems

The competitive strategy that you select provides guidance for you on how to establish your organization's work systems. A **work system** is "a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific products/services for specific internal and/or external customers." (http://www.stevenalter.com/work-system-basics-2/). A work system is similar in concept to the idea of a business process but includes many more elements to provide a more complete picture of how an activity is structured.

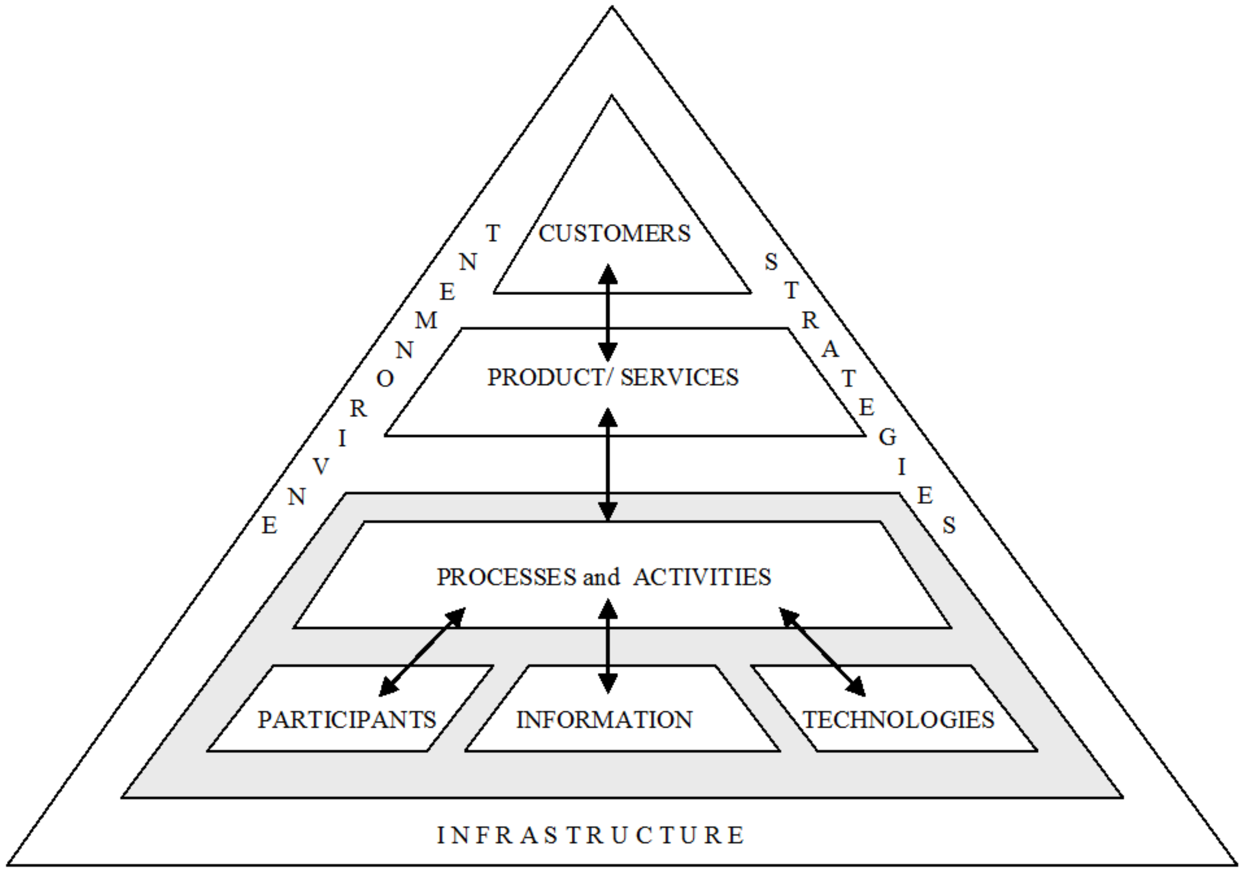

Figure 3-3: The work system framework ([http://www.stevenalter.com/wp-content/uploads/2012/05/work-system-framework.gif)](http://www.stevenalter.com/wp-content/uploads/2012/05/work-system-framework.gif)

The basic components of a work system are as follows:

1. **Processes and activities** include everything that happens within the work system. These can be anything from formally structured processes to dynamic processes to ad hoc determined methods. The method used to deliver the products or services is based on the skills, experience, and judgment of the work system participants.
2. **Participants** are actors who perform the work in the work system. Participants may be people or they could be technology. In some work systems, the work is done by people almost exclusively. In other work systems, the activities are processed almost exclusively by automation.
3. **Information** includes codified and non-codified information that is used, created, captured, transmitted, stored, retrieved, manipulated, updated, displayed, and/or deleted by processes and activities. Typical informational entities include orders, invoices, warranties, schedules, income statements, reservations, medical histories, resumes, job descriptions, and job offers. Information within a work system includes information that is processed by computers and other information that is never computerized, such as the content of conversations, verbal commitments, and

other unrecorded information/ knowledge that work system participants use as they perform processes and activities within the work system.

4. **Technologies** are tools (such as cell phones, projectors, and automobiles) and methodologies (recipes, methods, etc.) used during the processes and activities by the participants. Technologies used here are distinct from technologies acting as a participant. In this case technologies require instruction by an actor to be used in the work system. In the case of technology as a participant, technology acts independently of other participant control to perform its part of the processes and activities.
5. **Product/services** are the outputs of the work system which are given to the customers. They can be both products and services such as information, physical entities, social products such as agreements, intangibles such as entertainment or peace of mind, and/or actions.
6. **Customers** are recipients of a work system's product/ services for purposes other than performing work activities within the work system. External customers are work system customers who are the enterprise's customers, whereas internal customers are work system customers who are employed by the enterprise, such as customers of a payroll work system.
7. **Environment** includes the relevant organizational, cultural, competitive, technical, regulatory, and demographic environment within which the work system operates, and that affects the work system's effectiveness and efficiency. Organizational aspects of the environment include stakeholders, policies and procedures, and organizational history and politics, all of which are relevant to the operational efficiency and effectiveness of many work systems. Factors in a work system's environment may have direct or indirect impacts on its performance results, aspiration levels, goals, and requirements for change.
8. **Infrastructure** includes relevant human, informational, and technical resources that are used by the work system but are managed outside of it and are shared with other work systems.
9. **Strategies** that are relevant to a work system include enterprise strategy, department strategy, and work system strategy. In general, strategies at the three levels should be in alignment, and work system strategies should support department and enterprise strategies. (all these exerpted from http://www.stevenalter.com/work-system-basics-2/ 1-5 are rewritten)

Depending on the competitive strategy chosen for the business, the organization of the work system will vary. For cost leadership type strategies, the organization will seek to operate the work system and produce the products as the lowest possible cost. For those attempting to differentiate, they will seek to add value in their work systems to the customer. An example of this is figure 3-4.

Processes	**Greeting to Customer**	**Shopping Assistance**	**Product Knowledge provided**	**Checkout**

Cost Leadership	People greeter at front door that says “hello”	On request a store employee will indicate where something is located.	Customer is assumed to know what they want	Self-checkout and self bagging
High Value	Met at the door. “Hello Ms. Murphy, are you interested in looking at dresses again today?”	Takes the customer to the products in which they interested	Sales person is a product consultant providing expertise on the different products and helps customer decide.	Sales person processes the sale and packages the items for the customer.
Participants	**Characteristics**	**IT participants**	**Salary and Benefit**	**Role of Customers**
Cost Leadership	Use technology where possible. Trained to stock shelves and product location	Self-checkout system. Automatic inventory system.	Minimum benefits. Paid on straight wages.	Customers are significant participants in the work system
High Value	Use humans where possible. Trained in product knowledge, customer service and selling	Checkout system used by the sales person. Inventory system.	Paid on salary plus commission.	Customer involvement in the process is minimized.
Information	**About Customer**	**About Products**	**Inventory Managment**	
Cost Leadership	Not needed	Customer Provides or available to the customer through apps.	Automated system that tracks and orders automatically	
High Value	Customer relationship system used	Provided by sales person. A product information database is available	Sales person orders product based on knowledge of customers.	

Infrastructure	Nature	Ambiance		
Cost Leadership	Low cost, high durability fixtures. Easy to find goods	Efficiency, thriftiness		
High Value	Expensive fixtures designed to need support of staff	Conveys image of high quality, luxury		

Figure 3-4: Differences in how work systems might be implemented based on competitive strategies

In this example, we see how two business might approach a retail situation differently based on their competitive strategies. The cost leadership model assumes a “self-service” model toward the customer. The customer is expected to be a significant participant in the work system, they find the products on the shelves, supply their own product knowledge and perform their own self-checkout. Store employees are used to maintain the shelves and provide directional assistance. The high value model on the other has customer to be recipients of information and products and the store employee is to operate on a much higher level. They provide product information and consultation for the customers attempting to steer them toward the most profitable products. The wages and benefits of the cost leadership model employees are correspondingly lower than those of the high value employees who are paid on commission.

In addition to having the customer be a significant participant in the process, the cost leadership store utilizes technology to reduce cost. They utilize automated inventory management and self-checkout processes to reduce cost. The high value company utilizes information systems to provide information to sales people about the customers so that they can provide service to them. The checkout process is executed for the convenience of the sales people. It is not visible to the customer.

INFORMATION SYSTEMS IN ACHIEVING COMPETITIVE ADVANTAGE.

Once you understand the industry competitive structure and determine your competitive strategy, you construct your work systems to achieve competitive advantage for that strategy. As you can see, how IT is used in the work system is different based on how you choose to compete. Under a cost leadership strategy, IT is used primarily to lower cost. In a differentiation strategy, IT is used to add value to the customer. Information Technology can play different roles in an organization.

We need however to make a further distinction about information systems. Not all information systems are the same in terms of creating value. Some are **impact** systems. That is, they enable a firm to strongly create value for customers. In the cost leadership example, above, we saw that a self-checkout system was used to cut cost out of the process of performing the sales transaction. In the High Value scenario, information systems provided information to the sales person so they could enrich the customer experience. Both contributed directly to achievement of the company's strategy. The other classification is **institutional** systems. They are the systems you must have to operate your business but don't add value to a customer. Examples might be payroll, HR and accounting systems. These systems are critical to the operation of the firm, but do not create value in the eyes of a customer. These two types of systems are treated very differently in terms of creating advantage.

Information technology can also assist you in creating competitive advantage by creating or improving products, enabling or improving business processes or changing the structure of the industry.

Creating or improving products

First, you can create value for customers by enhancing your products with information technology or using information technology to create new products. The example of ATMs that we discussed at the beginning of this chapter is an early example of creating a new product. As we discussed, ATMs eliminated the need to come to the bank with a paper check or withdrawal slip during business hours. Customers could access their accounts 24/7 from the ATM machine. Initially this created competitive advantage but after almost all banks adopted ATMs customers expected banks to have ATMs and therefore it became a requirement or a barrier to entry for that industry.

Similarly, today, the advent of driverless technology is affecting several industries. In the car industry, many of the companies such as Tesla are working to implement driverless technology in their vehicles. In fact, Tesla advertises that the hardware for driverless technology is already in all of their cars (https://www.tesla.com/autopilot). The legistlative process to allow driverless vehicles has been lagging (http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action) but when it catches up the first manufacturer will have a competitive advantage. The authors of this textbook look forward to having driverless vehicles so that in their old age, they can retain their independence!

Driverless technology is also affecting the taxi cab industry. Uber, the taxi service company has been investigating driverless cars. While they are still fighting regulatory issues (http://www.forbes.com/sites/alanohnsman/2016/12/21/ubers-san-francisco-driverless-car-tests-end-as-dmv-revokes-vehicle-registrations/#f4a8fb17afa5), driverless Uber vehicles are coming very close to being a reality as of this writing. Driverless vehicles will solve several issues for Uber such as driver vetting and safety as well as availability and performance issues thus improving the service as well. Driverless cars will therefore create a competitive advantage for

Uber in the market as it will put more control over the delivery of the product in the hands of the company as well as reducing variable costs.

Enabling processes

Information technology can give you the capability to do things that you previously were unable to do. An early example was that of email enabling business process re-engineering. Prior to email, working across locations was difficult and slow. Email allowed companies to integrate locations electronically thus allowing information to flow much more quickly enabling changes in organization structures and allow consolidation of functions thus allowing savings from reduced headcount and improving process times. This capability was further enhanced by other internet technologies to improve communications capabilities.

These communications technologies also enable such capabilities as **"follow the sun"** development and support. For example, HP positions native Japanese speaking tech support people in the US and Europe to support their Japanese speaking clients when it is not business hours in Japan. By using global communications technologies, HP support techs can support Japanese server customers on third shift in Japan with first shift people in the US. As the time changes, the technology shifts calls to HP support from Japan to the US and Europe to provide support to their clients.

As we discussed in chapter 1, global communications technologies also enabled a global move to outsourcing. Like that of the business process re-engineering example, communications technologies allowed the rapid almost instantaneous communications capabilities between the US and outsourcing locations. Thus, allowing regular communications to be maintained. Also bulky files such as cad drawings and data files could be easily transferred thus creating the capability to operate this capability as designed.

For cost leadership competitors, using information technology can lower the cost of their operations. ERP systems can allow businesses to operate with lower levels of inventory than previously held. Communications capabilities and inter-organizational systems along with supply chain visibility applications enable just-in-time or zero inventory approaches to manufacturing to be implemented. Automated self-checkout functions reduce the cost of the front-end operations at retailers thus lowering the cost of the check-out function. Lately, Amazon has implemented automated warehouses using many robots to replace workers in picking, packing and shipping operations lowering costs while improving productivity (https://www.bloomberg.com/news/articles/2016-06-29/how-amazon-triggered-a-robot-arms-race). They have also been experimenting with automated drones to perform deliveries. Its projected that if it succeeds, it could cut the cost of the delivery by about half (http://www.nytimes.com/2016/08/11/technology/think-amazons-drone-delivery-idea-is-a-gimmick-think-again.html?_r=0). As with driverless technology, drone technology faces regulatory hurdles in the US but it is already being implemented in countries with less restrictions.

Changing the structure of the marketplace

Finally, using information technology can change the industry structure of the marketplace by altering the five forces discussed in the beginning of this chapter. First, technology can induce **Customer Lock-in**, the inability of customers to change vendors because of unacceptable costs involved in switching. A common example is the contract termination fee charged by cell phone vendors when terminating a contract. You sign up with a cell phone vendor for a two year contract and if they terminate before two years, they pay a set fee say, $150 that decreases for each month to retain the contract. Information technology can also create this feature. For example, American Airlines created the first frequent flier program in the airline industry. As is now familiar. customers earn "miles" for each mile they fly on American which could be exchanged for free or reduced cost air travel. Customers are thus "locked in" because if they fly on a different airline, they weren't earning miles for their American account. This was later expanded to include dollars charged on an "Aadvantage" credit cards, rental cars, hotel stays and mileage with affiliated airlines. Customer lock-in raises switching costs for customers and thus reduces buyer power and the threat of substitutions by increasing the costs to select products other than the vendors. It also increases loyalty by making customers want to use or purchase the company's products to gain the reward points.

Information technology can also be used to create barriers to entry. It creates these barriers by the use of disruptive technology. **Disruptive technology** is any technology that changes the industry competitive structure. When initially introduced, they may not meet all the needs of the customers as defined by existing technology but fulfills a need that is not met by existing technology. The fact that the new technology fulfills this need drives the adoption of this technology and through its acceptance, the missing functionality is added later. It is disruptive because it displaces existing technologies in the marketplace. When Apple introduced the WIMP (Windows-Icon-Mouse-Pointer) interface, it displaced the text based interfaces previously within the PC industry. After it was adopted and perfected in Windows, it became the standard interface for PCs.

Once a disruptive technology becomes dominant in the industry, subsequent changes to the technology are known as **sustaining technologies**. These technologies may fill in the gaps missing in the technology or may extend the technology to new applications or industries.
The pattern of the adoption of new technologies has been extensively studied and reported on. The **Innovation Adoption Lifecycle** was first proposed by Bohlen, Beal and Rogers in 1957 (figure 3-4). In this model, technologies are proposed to pass through several phases in the process of their adoption into an industry. . When first introduced, a very small group of **Innovators**, those who work with technology for technology's sake and seek to work with any new technology regardless of practicality. The **Early Adopters** are those who see an application of the technology for their organizations and working through the deficiencies within the technology, adopt it into their organizations seeking to obtain competitive advantage. Once the early adopters have demonstrated the potential of this technology and worked out the bugs, the **Majority** of companies adopt the technology. At this point by the end of the Late Majority phase, customers of those technologies have begun to assume that all companies in the

industry will have this technology and the technology becomes necessary to be a serious player in the industry. After that time, the **Laggards** adopt the technology when they are forced by the market to adopt it or exit the industry.

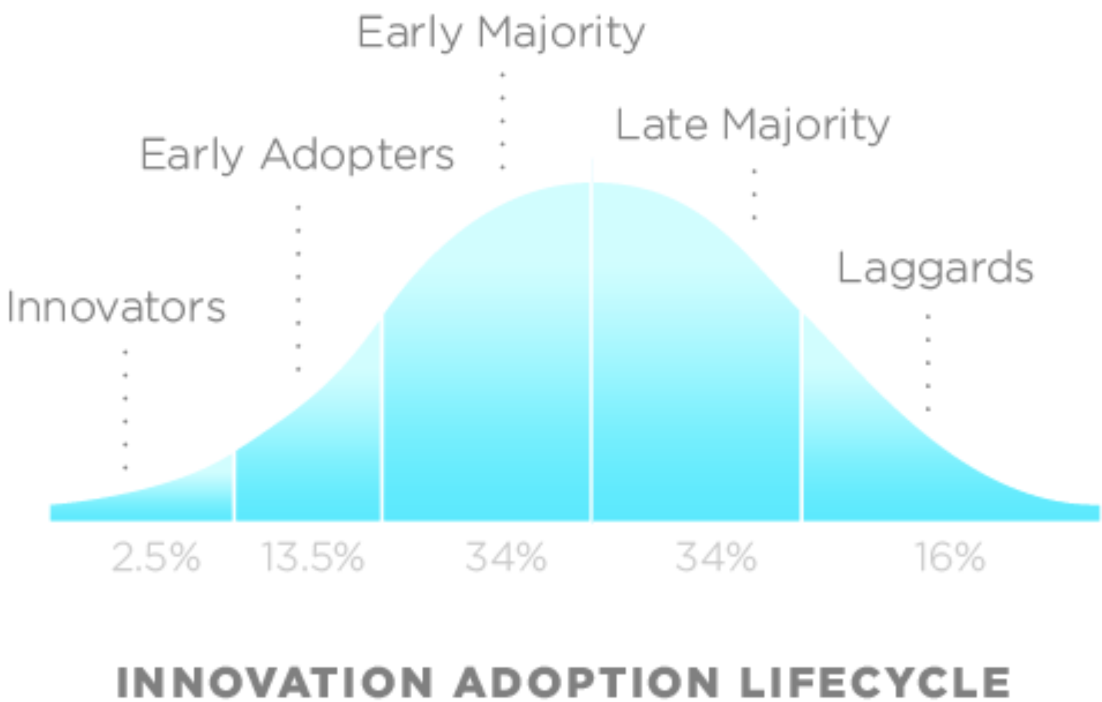

Figure 3-5: Innovation/Technology Adoption life cycle.

When the technology reaches the late majority phase, the technology has ceased to provide competitive advantage and becomes a necessary part of doing business. It then becomes a barrier to entry for potential entrants into the industry.

Information technology cannot provide sustainable competitive in and of itself. Since any technology can be purchased by anyone else, as we say with the Innovation Adoption Lifecycle, it can be adopted by anyone and once it has been adopted it ceases to provide competitive advantage and becomes instead a barrier to entry. The key to maintaining an IT based competitive advantage is the organization's ability to continue to innovate using IT. They need to be able to identify, acquire and implement technologies in their organization in such a way as to provide a competitive advantage. But they must not stop there! They must continue to investigate technologies and observe what their competitors are doing and then act to ensure that they stay ahead of their competitors.

CHAPTER SUMMARY

Achieving competitive advantage is a matter of determining how to provide value to customer in way that your competitors cannot. This chapter has discussed the nature of competitive advantage, the strategic planning process of how to achieve it and how information technology can support your strategy.

Achieving competitive advantage through the strategic planning process was described in a process derived from Porter's Strategy Model. First we analysis the competitive structure in the industry by assessing the competitive and supply chain forces in the industry using Porter's Five Forces analysis. Then based on our understanding of the industry, we select a competitive strategy for how to complete primarily either on a cost leadership or differentiation basis. Once this strategy is selected, we can then design the work systems in our company to reflect those strategies. Information technology isused to support those strategies in our work systems.

Information technology can be used as impact systems, to directly support our attempts to achieve competitive or they can be institutional systems providing needed functions that don't directly impact our competitive position. IT can impact competitive advantage by creating or improving products, enabling processes or by impact the competitive structure of the industry.

KEY TERMS

Barriers to Entry 5	Buyers 6	Bargaining Power of the Buyer 6
Bargaining Power of the Supplier 7	Competitive Advantage 3	Competitive Forces 3
Cost Leadership 9	Customers 12	Customer lock-in 17
Differentiation 9	Disruptive Technology 17	Distributors 6
Early Adopters 17	Environment 12	Five Forces Model 34
"Follow the Sun" 16	Impact Systems 15	Information 11
Infrastructure 12	Innovation Adoption Life Cycle 17	Innovators 17
Institutional Systems 15	Laggard Adopters 18	Loyalty 5
Majority Adopters 17	Manufacturers 6	Participants 11
Porter's Strategy Model 4	Processes and Activities 11	Products and Services 12
	Retailers 6	
Rivalry 5	Rivals 4	Substitutes 4
Suppliers 6	Supply Chain Forces 6	Sustaining Technologies 17
Strategies 12	Switching Costs 5	Technologies 12
Threat of New Entrants 5	Threat of Substitution 5	Work System 10

REVIEW QUESTIONS

1. What is competitive advantage?
2. What is value?
3. Will an IT based competitive advantage last forever?
4. What are the four steps given for determining how IT will be incorporated into your business?
5. What information does competitive structure information provide us?
6. What is the difference between the cost leadership and differentiation competitive strategies?
7. What is a work system?
8. How does the competitive strategy affect the way the work systems are structured?
9. What are the three ways information technology can help you achieve competitive advantage?
10. How can information technology change the industry competitive structure?

CASE STUDY: POGO CASE

In this case, you will practice doing a five forces analysis and using it to establish a competitive strategy and then determining how IT will play a role in achieving the competitive strategies.

Read the links given to you below about the POGO Air Taxi Service.

Your deliverable is a professional formatted report such as a consultant organization would present to management for their consideration.

http://justinmartin1.com/2005/03/will-air-taxis-fly/

http://www.discovery.org/a/2935

http://www.linearair.com/news/bid/306107/Top-4-Air-Taxis-for-Business-Travelers

Questions

1) What is the market that POGO competes in?
2) Describe the market in terms of size, competitors and substitutes.
3) Perform a five forces analysis on the market. Describe for each of the five forces whether the force is high or low and describe why you think so.
4) Based on your analysis would you want to enter this industry? Why?
5) Based on your analysis, select one of Porter's competitive strategies in which to position POGO. Discuss why you selected that position and how at a high level you would implement it.
6) Discuss how IS could be used to implement your strategy and how it would affect the five forces. Discuss what kind of IS you would use and its objective. Reflect on the effect on the margin equation.

Chapter 4 – BIS Infrastructure and Competitive Capability

CHAPTER OBJECTIVES

After reading this chapter, you should be able to:

- Explain how Enterprise Architecture (EA) helps organizations align business strategy with BIS infrastructure.
- Briefly describe each of the components of EA.
- Identify and describe the components of BIS architecture.
- Identify and describe the components of BIS infrastructure.
- Identify and describe BIS infrastructure components' trends.
- Describe the role of cloud computing in BIS infrastructures.
- Describe why BIS infrastructure security is important.
- Describe Defense in Depth and why security controls are layered to protect BIS infrastructure.
- Explain why BIS infrastructures can enable or inhibit business strategy.

INTRODUCTION

In the previous chapters, you have learned the importance of aligning a BIS with the business processes that support value chain activities that enable a business to achieve its strategic objectives. You have also learned that business strategy is driven by competitive forces within the business environment.

This chapter begin expands upon these alignment concepts by focusing on how/why business information system (BIS) architectures and infrastructures should be aligned with business strategy. It explores the distinctions between BIS architectures and infrastructures and examines each of the major components of BIS infrastructure: hardware, software, data, and networking components. This chapter also discusses some of the major trends that may be observed in each infrastructure component in order to help you better understand where disruptive technologies are likely to emerge.

For an increasing number of organizations, cloud computing is an important part of BIS architecture. In this chapter, we will briefly explain why this has happened and explore several of the cloud computing services that have attracted business subscribers.

Because BIS infrastructure enables an organization to achieve its strategic objectives, it is important to ensure that the infrastructure is secure and protected from forces that could disrupt business operations. You will learn that most organizations implement BIS infrastructure security controls in layers in order to protect the infrastructure's hardware, networks, software, and data components and to ensure business continuity.

BUSINESS STRATEGY, ENTERPRISE ARCHITECTURE, and BIS INFRASTRUCURE

It is frequently important for business managers and IT practitioners who want to align BIS infrastructure and business strategy to view their organizations from a holistic perspective. Enterprise architecture (EA) involves the application of architecture principles and practices in order to guide organizations through the business, data and information, business process, and technology changes needed to execute their business strategies. EA maintains a strategic perspective to guide enterprise analysis, design, planning, and implementation and the end game of aligning BIS infrastructure with strategy.

Businesses can use EA to align technology with strategy in just one organization unit or within the entire organization. EA can also be applied to a collection of organizations that share common goals and collaborate to provide specific products or services to customers, such as a supply chain. The term "enterprise" in EA covers a wide variety of organizations, regardless of their size or geographic dispersion. "Architecture" in EA refers to the elements and properties of the organization's system and its relationships and evolution within its environment.

A key purpose of EA is greater business and IT alignment. EA is also used to provide better integration among functions within organizations through strategy formulation and execution. Sustainable survival and growth within the organization's environment is also a goal of EA's holistic view of enterprises.

Common outcomes of the application of EA principles and practices include:

- innovations in the organization's structure or processes,
- innovations in the use of information technologies or systems
- the standardization and/or integration of business processes, and
- improvements in the quality and timeliness of the organization's data and information.

ENTERPRISE ARCHITECTURE COMPONENTS

EA has traditionally been depicted as consisting of four components (domains): Business architecture, data/information architecture, application architecture, and technology architecture. However, a fifth component/domain, security architecture, is also included in some descriptions of enterprise architecture. The first four components (domains) are frequently illustrated as a pyramid similar to that observed in Figure 4-1, and the security architecture is often superimposed on the other four EA components (domains) since is it includes mechanisms to protect each of the other components. This is illustrated in Figure 4-2.

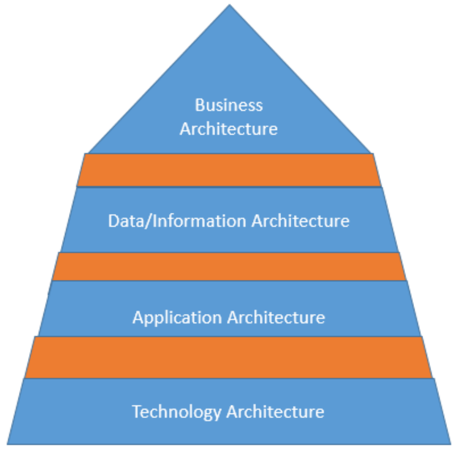

Figure 4-1: Enterprise Architecture Components
Courtesy: Thomas Case

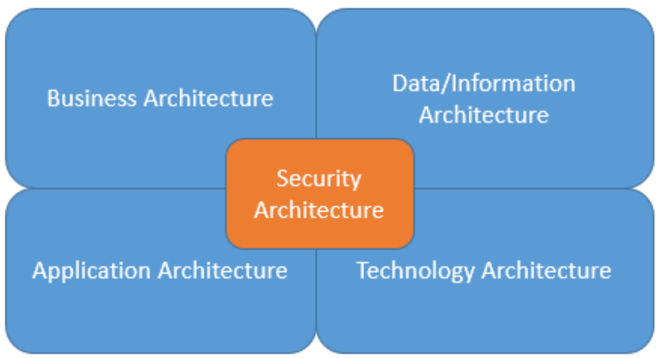

Figure 4-2: Security and EA Architecture
Courtesy: Thomas Case

Business Architecture

The business architecture domain of EA architecture The key characteristic of the business architecture represents the various components of the organization's structure and how they interact. Business architecture focuses on defining and analyzing what the business does, how it does it, how it is organized, and how it creates or realizes value. Keys to being able to develop a complete picture of an organization's business architecture include the organization's:

- mission/vision
- organizational structure
- critical success factors (CSFs)

An organization's mission/vision identifies the business's role within its environment and its evolution intentions. The organizational structure identifies how work and reporting relationships are distributed within the organization. Critical success factors (CSFs) identify those things that the organization system must do (well) to survive within the environment.

Other key elements that are examined when formulating business architecture within EA include:

- business process design and models (diagrams)
- business requirements defined for applications
- business rules configured in enterprise information systems software and application programs.

Data/Information Architecture

The data/information domain of EA should be driven by the organization's business architecture and its business needs. Some descriptions of EA separate the data/information architecture domain into two sub-domains: data architecture and information architecture. Data architecture consists of the standards, policies, models, or rules that govern the data that the organization collects, how it is collected and stored, and how it is arranged, integrated, and put to use by the organization. Data architecture describes the major types and sources of the organization's data, the organization's physical and logical data assets, and the resources used by the organization to manage data. An organization's information architecture describes how the organization's data is structured, collected, stored, maintained, and shared from a technical (IT) perspective and a business perspective. It includes blueprints for physically and semantically integrating the organization's data assets via enterprise data models and data flows. Essentially, information architecture is the domain of EA that enables business strategy to be achieved through defining the sources of the organization's business information assets and how these assets are structured, classified, and associated in a manner that prescribes the required application architecture and technical architecture capabilities.

Data quality requirements (discussed in Chapter 2) are important aspects of data/information architecture. Master data management for the organization's enterprise information systems is another important aspect of data/information architecture; metadata management for enterprise data models and data warehouses mapped to this EA domain. Corporate performance management enabled by the organization's use of data analytics, business intelligence and enterprise reporting tools also maps to this EA domain. Many of these data concepts, analysis tools and capabilities are described later in the textbook.

Application Architecture

The application architecture of EA should support the organization's data and information needs. This EA domain focuses on the programs, applications, and tools used by the organization to process its data into information needed to make strategically relevant choices. It also considers how the applications are integrated and data processing is coordinated to ensure that decision makers have the data and information needed to support business processes and to move the enterprise toward the achievement of business objectives. Software services from cloud providers, EIS software from enterprise systems software vendors, and commercial off-the-shelf software used by the organization are aspects of the application architecture. Custom applications written in-house, or acquired through outsourcing from contract programmers, that serve specialized data processing or information (reporting) requirements are other aspects of the EA's application architecture domain. Functional area information systems, whether integrated via enterprise architecture integration (EAI) or not, and legacy systems are also parts of application architecture.

Technology Architecture

The technical domain of EA includes the collection of computers, networks, storage technologies, operating systems (platforms), and database management systems (DBMS) needed to support the application architecture and to run the programs, applications, and solutions used by the organization to transform business data into information needed to achieve strategic objectives. It includes middleware that enables business applications to interoperate and exchange data and the telecommunication equipment, such as routers, switches, and modems, that enables the organization to form wide area network (WAN) connections among geographically dispersed operating locations. Client devices (desktop systems, laptops, tablets, smart phones, etc.) and the servers that provide services to client devices (application servers, database servers, e-mail servers, web servers, etc.) are also parts of the organization's technology architecture.

We will discuss several of the major aspects of the technology architecture in more detail in the BIS Infrastructure section of this chapter. That section will also provide the opportunity to further examine key aspects of the application architecture and data/information architectures.

Security Architecture

Today's organizations understand that business risk is inherently tied to the security of its data, applications, and data processing technologies. Information security is recognized as a crucial strategic business issue and enterprise security architecture seeks to align business strategy and goals with the protection of the organization's most critical business data.

An organization's security architecture strives to provide information assurance by protecting the organization's data technologies, applications, platforms (operating systems), and networks. Doing this helps to ensure the integrity of the business processes and the information generated by business processes and consumed by decision-makers to ensure progress toward strategic goals.

Enterprise security architecture focuses on ensuring information confidentiality, integrity, and availability throughout the organization in a manner that aligns with business objectives. The objective of enterprise security architecture is to provide the conceptual design of security infrastructure, security mechanisms, and security policies and procedures and to link the components of security infrastructure to one another to create unified and cohesive protection of the organization's data.

We will take a closer look at the technologies and control mechanisms used to secure information systems in this chapter's BIS Security section.

IMPORTANCE OF STRATEGY, ARCHITECTURE, AND INFRASTRUCTURE ALIGNMENT

Enterprise architecture seeks to position organizations to achieve their strategic objectives by enabling business executives to step back and look at their business, data/information, application, technical, and security architectures from a holistic perspective. EA makes it easier to perceive where EA components are adequately aligned and to identify how EA components can be better aligned to assist the organization in achieving its strategic objectives. EA essentially asks executives to address the following questions:

- Is our organizational structure appropriate for our business strategy?
- Are our business processes appropriately aligned with our business strategy?
- Do we have the data and information needed to achieve our strategic objectives?
- Do we have the programs and applications needed to process our data for the production of strategically relevant information?
- Do we have the data management technologies, operating systems, and networks needed to support our strategic data processing needs?
- Does our security architecture provide sufficient protection of the technical infrastructure, applications, and data we need to achieve our business goals?

Addressing these questions enables executives to see where gaps exist in the overall enterprise architecture and to identify where additional investments in IT and security mechanisms are needed.

Business strategy is front and center in EA. When business strategy changes, EA provides a means for identifying how organizational structures, business processes, data and information, applications, technical infrastructures, and security controls need to change to align with the new strategy. When EA components are appropriately aligned, the organization system is better positioned to execute its strategy within its environment. When EA components are inadequately aligned, the organization's performance and ability to reach strategic goals is likely to be constrained.

BIS INFRASTRUCTURE

As we focus our attention on BIS infrastructure, it important to note that we are primarily taking a more in depth look at what constitutes the Technology Architecture component of Enterprise Architecture. However, looking at BIS infrastructure also helps us better understand how Data/Information Architecture, Application Architecture, and Security Architecture are physically implemented by organizations. BIS infrastructure maps to the hardware, software, and telecommunications components of an information systems that were introduced in Chapter 2. These are depicted in Figure 4-3; BIS infrastructure also maps to the technologies used in information systems to manage data.

Figure 4-3: The Major Components of a Business Information System
Courtesy: Thomas Case
People: Stock photo ID: 669226159
Telecom: Stock illustration ID: 123574441
Hardware: Stock photo ID: 289532849
Software: Stock photo ID: 530505601
Data: Stock photo ID: 258191603
Procedures: Stock illustration ID: 515150665

Hardware Components

Hardware in BIS infrastructures includes the physical components of computer systems which have traditionally been categorized as input technologies, processing technologies, storage technologies, and output technologies. Input technologies are used to capture or enter data into the computer system. Processing technologies, such as central processing units (CPUs) carry out data processing instructions provided by programs. Storage technologies provide a means for storing data and programs outside the computer system and output technologies convert processing results into human-readable form.

Input technologies are used to enter data or instructions from outside a computer system into a computer. A keyboard and mouse are common input technologies for desktop systems while a trackpad often substitutes for a mouse on a laptop computer. Virtual keyboards are common input technologies on tablets and smartphones and since most mobile devices have touchscreens, many accept input from styluses and fingers. Voice input is also widely supported on mobile devices and increasingly on laptop and desktop systems. Everyday examples of end user input technologies are illustrated in Figure 4-4.

Figure 4-4: User input Technologies
Shutterstock Image ID:232684963

Scanning technologies are also commonly used to input data into BIS systems. For example, bar code scanners have been common in retail point-of-sale (POS) systems for decades and scanning technologies are also widely deployed to enable codes on the screens of mobile devices to directly entered into BIS systems. Document scanners enable documents to be directly input into document management systems. And, the remote deposit systems that have been implemented by many banks and credit unions enable smart phone cameras to be used to enter pictures of checks (other traditional business documents) to be entered into their banking systems.

Chip card readers are rapidly replacing card swipe readers as the primary means for entering debit and credit card payment data into POS systems. Several input technologies used in POS systems are illustrated in Figure 4-5. Smart card and badge readers are also being used to log employee entry and movements in business facilities.

Figure 4-5: Examples of POS Input Technologies
Image ID:195200477

While we often don't think of the technologies mentioned in the previous two paragraphs as BIS input technologies, these are exactly what they are. Making sure that BIS systems are leveraging input technologies that enable efficiency and effectiveness are an important management concern.

Processing technologies include central processing units (CPUs), random access memory (RAM), cache memory, and the circuits (buses) that interconnect them. These are the technologies that determine a computer's speed, power, and processing capabilities.

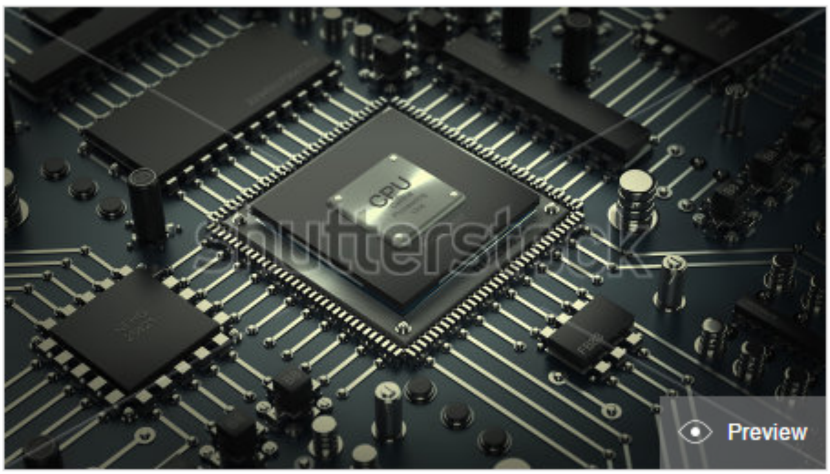

Figure 4-6: A Central Processing Unit (CPU) on a Computer Motherboard
Image ID: 332111630

Processing hardware includes the devices that compute, compare, and execute program instructions. The **central processing unit (CPU)** is the primary processing device in personal computers, laptops, tablets, smart phones, and servers. Every CPU is basically a collection of circuits. Electronic pulses enter the CPU from an input device over circuits. Within the CPU, these pulses are sent under program control through circuits to create new pulses. Eventually, as set of pulses exits the CPU over circuits that takes it to an output or storage device. The input, processing, and output of pulses over CPU circuits is called the *machine cycle*.

The central processing unit is made up of two key components: the *control unit* and the *arithmetic-logic unit (ALU)*. During the processing of a program, these two components work in harmony with primary memory.

The main function of the control unit is to coordinate the activities of the CPU and other parts of the computer system when program instructions are executed. It directs the flow of data between input and output devices and primary memory, and between primary memory and the ALU. The control unit is often called the "executive" component in the computer because it causes all the other components to carry out their assigned tasks. The control unit is responsible for decoding program instructions, getting other components set up to execute their tasks, and signaling the other components when it is time to perform their functions. This is analogous to the tasks of an orchestra conductor who must read the music and ensure that the musicians play their parts at the right moments.

The main functions of the ALU are to carry out a program's mathematical (addition, subtraction, multiplication, and division) and logical operations (comparing two data values to determine if they are equal, if one is greater than another, etc.). It is the computer component that does the rapid number crunching.

The control unit and ALU contain special storage locations, called *registers*, that act as high-speed staging areas. Program instructions are loaded into registers in the control unit, where they are decoded. Data is loaded into registers in the ALU, where the arithmetic and logical operations needed to transform data into information are performed.

The circuits that connect the CPU to primary memory and to input, output, and storage devices are called *buses*. Bits (binary digits, 0's and 1's) that represent data and program instructions move among computer system components through the buses. A CPU's *frontside bus* is the bus that moves program instructions and data from primary memory to the CPU for processing.

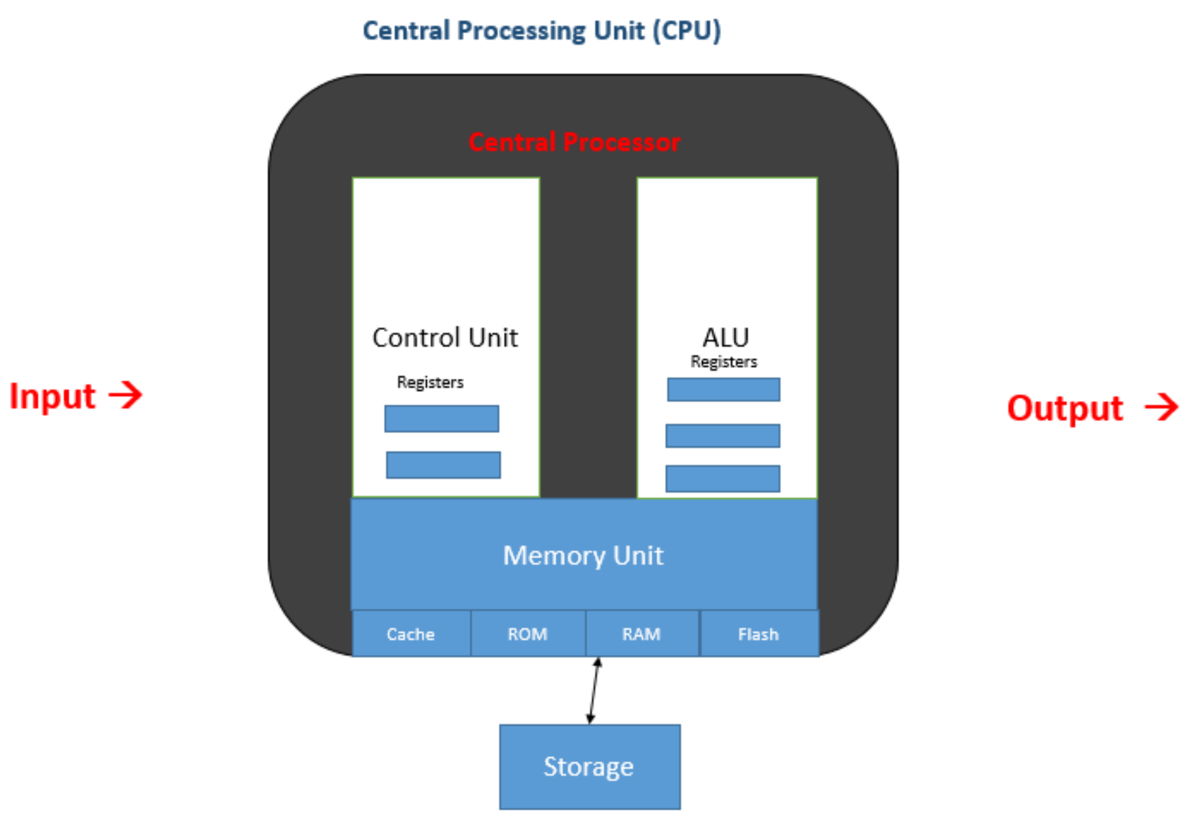

Figure 4-7: CPU Components
Courtesy: Thomas Case

The CPUs in most high-end computers (desktops, laptops, and servers) include a memory management unit or memory controller. The memory controller manages the flow of data going two and from the computer's main memory; it also enables the CPU to access data and instructions stored in ROM (read only memory), cache, and flash memory. The *memory unit* is the CPU's storage unit of the CPU. All instructions and data that need to be processed are stored here before they are retrieved by the Control Unit and sent to the ALU.

The *memory unit* is more popularly known as RAM or Random Access Memory; it is sometimes called main memory, internal storage or primary storage. The speed, processing power, and capability of a computer are largely determined by the capacity of the RAM.

The major functions of the memory unit include:

- Storing all the data and instructions that are needed for processing.
- Storing transitional and final results of processing.
- Storing processing results that will be sent to output devices.
- Routing all CPU inputs and outputs through RAM.

Determinants of Computer Performance

The primary factors that determine how fast a computer can process data and instructions are:

- The amount of RAM memory
- The generation and speed (the system clock) of the CPU
- The size of the registers in the CPU
- Bus width and speed
- The amount of cache memory

The amount of RAM in the computer can have a profound effect on its power. With more RAM, the computer can run bigger, more powerful programs, and those programs can access larger data files. More RAM also helps the computer run faster. While a computer does not have to load an entire program into memory to run it, the greater the amount of the program that fits into memory, the faster the program will run. Primary memory in today's computers is typically measured in *gigabytes* (billions of bytes of data), but primary memory in today's high-end computers may hold a *terabyte* (a trillion bytes of data) or more.

CPUs have progressed through multiple generations. Consistent with Moore's Law, which is discussed in Chapter 1, each new CPU generation has resulted in a doubling of processing capability. The current generation of CPU's manufactured by Intel is the I7 microprocessor, but you can count on this being replaced in the near future with a newer generation CPU. When investing in desktop, laptops, and servers, it is best to consider purchasing computers equipped with the latest generation of CPUs, even though considerable savings may be realized by choosing machines with last generation CPUs.

CPUs include a built-in *system clock* that synchronizes its operations. It is analogous to using a metronome to synchronize the work of an orchestra. During each clock tick, a single task can be carried out; for exam, a single piece of data could be moved from primary memory to a register in the ALU. The clock speed of today's CPUs is measured in *gigahertz (GHz)* or billions of cycles per second. Clock speed has a tremendous impact on CPU performance. A CPU operating at 2 GHz can process data nearly twice as fast as the same one operating at 1 GHz.

The size of the CPU's registers, sometimes called the *word size*, indicates the amount of data with which the computer can work at any given time. The bigger the word size, the more quickly the computer can process a set of data. Occasionally, you will encounter references to "32-bit processors," or "64-bit processors," or even "64-bit computers." This refers to the size of the registers in the processor. When all other factors are kept equal, a CPU with 64-bit registers can process data twice as fast as one with 32-bit registers.

As noted previously, buses are circuits that connect computer components to on another. Essentially, a bus is a group of parallel wires and the number of wires in the bus affects the speed at which data can travel between computer components. Because each wire in the bus can transfer 1 bit of data at a time, a 32-bit bus can transfer 4 bytes of data at a time while a 64-bit bus can transfer 8 bytes of data at a time. So, with a wider bus, the computer can move more data in the same amount of time or the same amount of data in less time.

Moving data between RAM and the CPU's registers is one of the most time-consuming operations a CPU must perform. Cache (pronounced cash) memory speeds up processing by holding the most recently used data and instructions in extremely fast (relative to RAM) memory. When a program is running and the CPU needs to read data or program instructions, the CPU checks first to see whether the data is in cache memory. If the data is not there, the CPU reads the data from RAM into its registers, but it also loads a copy of the data into cache memory. The next time the CPU needs that same data, it finds it in the cache memory and saves the time needed to load the data from RAM. So, having ample cache memory is a means to speed up CPU processing.

Storage technologies. The primary storage technology of a personal computer, laptop, or server is its hard drive. However, it is common to supplement the storage capacity of the hard drive with external hard drives and flash drives. Many computer users also use virtual storage locations such as Google Drive and Microsoft's One Drive to gain additional storage capacity. Employees in many organizations also use data servers to access data stored on storage technologies in storage area networks (SANs) and/or data centers located on premises of in the cloud. Examples of storage technologies are illustrated in Figures 4-8, 4-9, and 4-10.

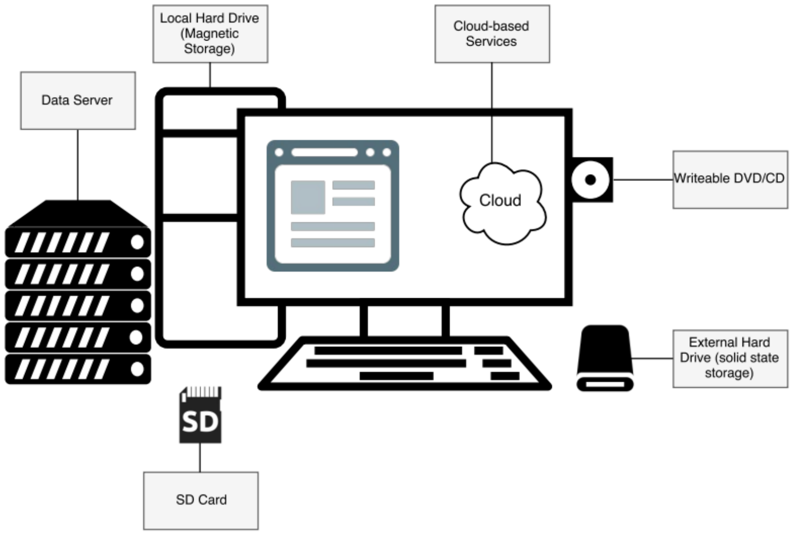

Figure 4-8: Examples of Storage Technologies
Courtesy: Ryan Wilcauskas

Figure 4-9: SAN Data Servers and Storage Devices
Image ID:132317954

Figure 4-10: Hard Drives in a Data Center
Image ID:152537678

The capacity of today's hard drives and portable flash drives that some users plug into USB ports on their computers is measured in gigabytes or terabytes. The capacities of SANs and data centers is typically measured in terabytes or *petabytes* (quadrillions of bytes).

Output technologies. Computer users send data processing outputs to a variety of output devices including monitors, printers, plotters, speakers, headphones, and projectors. Several common output devices are illustrated in Figure 4-11.

Figure 4-11: Examples of Output Technologies.
Courtesy: Thomas Case
Plotter: Stock vector ID: 255985054

Today's monitors are typically flat-screen devices that use LCD (liquid crystal display) or LED (light emitting diode) technologies to illuminate the screen. Like-televisions, monitors vary in size (physical dimensions) and viewing range. Touch-screen monitors are increasingly common in laptops, tablets, smart phones, and some PCs; this enables the monitor to be both an output and input device. Some desktop systems incorporate the monitor and computer motherboard in a single all-in-one device in contrast to traditional set ups where the monitor and CPU unit are separate components.

Laser and ink-jet printers dominate the business computing landscape. These may connect directly to PCs and laptops via USB ports or are accessible via an organization's wired and/or wireless networks. Printing technologies are often combined with facsimile (fax) and scanning technologies in multifunction devices in residential and small office settings. This enables the printer to also be used for communications and scanned input.

Plotters such as that depicted in Figure 4-12 are widely used to generate construction blue-prints, signage, and other large documents.

Figure 4-12: Example of a Commercial-Grade Plotter
Image ID:326995625

Specialized output devices for physically challenged individuals include speech generators and braille embossers. GPS automotive navigation systems are other examples of a specialized output technologies. 3-D printers (additive manufacturing devices), such as the one illustrated in Figure 4-13, can also be classified as output technologies.

Figure 4-13: A 3D Printer
Image ID:180739187

Hardware Trends

The hardware in BIS infrastructures continues to evolve. This evolution is driven in part by Moore's Law and the importance of computers in all aspects of business. There is healthy competition among the manufacturers of computer hardware and has resulted in increasingly capable input, processing, storage, and output devices at affordable prices.

In this section, some of the trends for each category of computer hardware are summarized. Business managers should not lose sight of these evolutionary trends when making IT hardware investment decisions.

Input Technology Trends: Computer users are increasingly using their fingers to make selections and provide input on the screens of smartphones, tablets, and laptops. In the past, such screens served only as output devices, but over time, they emerged into input/output devices. In self-service kiosks, touchscreen input and scanning technologies are the only input options that are available. In point-of-sale (POS) applications, the touchscreen application enables the shopper to either a finger or stylus to make on-screen selections, but require that a stylus be used to provide signatures. Over time, POS systems will increasingly allow shoppers to sign with their finger.

Scanning technologies will continue to be used to streamline business processes and to minimize the need for keyboard or keypad input. This will be especially apparent in the evolution of mobile payment systems and in self-service kiosks. Boarding pass codes will increasingly be used at gates for airlines and trains. Systems that accept pictures from smart phone cameras, such as the remote deposit systems being rolled out by banks and credit unions will become more common.

Voice activated input is increasing. Many iPhone users have embraced Siri, the iOS voice input service. Microsoft's Cortona, provides Slate and laptop users to shortcut touchscreen and keyboard entry via voice commands.

Processing Technology Trends: With smartphones outselling laptops and PCs, it is clear that businesses have entered the "post-PC era". Some businesses are minimizing PC purchases in favor of laptops, tablets, and smartphones. Docking stations for laptops enable users to access the organization's high-speed wired network when they are in the office. When PCs are purchased, they are often all-in-one systems that combine the monitor and motherboard in a single-unit rather than as separate components.

Dual- and quad-core processors are typically included in the PCs, laptops, and servers purchased by businesses. Most of these have 64-bit architectures with 64-bit registers in the

CPU and 64-bit buses. 128-bit architectures are increasingly found in high-end servers. Faster clock speeds accompany each new processor generation and the time between processor generations continues to conform to Moore's Law.

Specialized processing technologies have emerged for Big Data processing. These in Hadoop clusters and SAP HANA, both of which will be described in further detail later in the textbook.

Storage Technology Trends: For business managers, one of the most important trends in storage technologies has been the significant decrease in cost per gigabyte of storage. Since the early 1990s, the cost per gigabyte of storage has decreased by about 35% annually. As of 2012, a gigabyte of storage was $.02 (two cents). So are businesses move forward in time, storage costs are essentially negligible.

As the cost of storing business data approaches 0, and increasing volume and variety is being captured and stored. Increasing, online cloud-storage is being chosen instead of on-premises data storage. Third-party cloud-based data centers provide a vehicle for scalable storage of vast amounts of data at a reasonable cost, so these are increasingly a part of an organization's data storage infrastructure.

Solid state drives (SSD) are supplanting hard disk drives (HDD) in portable devices and are increasingly found in data center storage technologies. SSD typically provides much faster I/O (input and output) than HDD higher and thus contributes to overall computer performance. Higher storage capacities are being observed for both HDD and SSD in clients and servers.

Output Technology Trends: Increases in the variety and size of LCD and LED displays are being observed. Billboard size displays, such as that illustrated in Figure 4-14, are increasingly common. And, LCD displays have replaced a wide range of print signage including menu boards in fast food restaurants. See Figure 4-15.

Figure 4-14: A LED Billboard
Image ID:216636946

Figure 4-15: LCD Menus in a Fast Food Restaurant.
Stock photo ID: 298459574

High-end projection and telepresence systems, such as that in Figure 4-16, are increasingly used to support teleconferencing. So, display screens increasingly consume IT output technology investments.

Figure 4-17: Videoconferencing Technology
Image ID:172089131

Plotters capable of producing billboard size output are increasingly found among commercial signage providers. Laser and inkjet printers continue to dominate personal printers, but the prevalence of network printers and digital copiers capable of receiving print jobs from network-attached clients are increasingly being shared among office workers.

Speech-generated output, such as that commonly used in telephone auto attendant systems are expected to be increasingly used in other applications. And the audio output of personal devices will continue to improve as we increasingly use personal devices for audio, video, and multimedia streaming. Radio (wave) output is also becoming more common, especially for machine-to-machine (M2M) communication within the Internet of Things (IoT).

Additive manufacturing (3D printing) technologies are evolving rapidly and their output speed is slowing increasing. Advances in materials science will continue to drive the evolution of these specialized output technologies.

Software Components

As noted in the previous discussion of application architecture and technology architecture, multiple categories of software are included in BIS infrastructures. Three major categories of software included in application and technology architectures are system software, application software, and middleware.

System software consists of programs that allow application software to run on computer hardware. Because system software forms the interface between applications and computer hardware and enable them to run smoothly and efficiently, system software is sometimes referred to as computer "platforms".

Application software includes user-oriented programs, solutions, and tools needed by BIS users to perform their jobs. Middleware is software that enables different applications to interoperate, share data, and coordinate processing tasks; because its role is to integrate applications, middleware is sometimes called systems integration software. Figure 4-18 summarizes the conceptual relationships among these three categories of software and computer hardware.

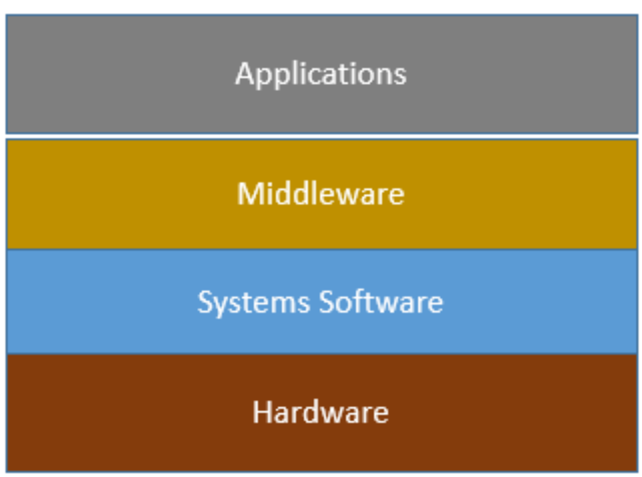

Figure 4-18: Major Categories of Software in BIS Infrastructure

There are numerous sub-categories of both system software and application software. Several of these are discussed in the following sections.

System Software

As illustrated in Figure 4-18, **system software** is the interface between user applications and computer hardware. It may also be described as software that provides services to other software. There are two major categories of system software: operating systems and utility programs.

Operating systems enable hardware components, especially CPU processing components, to work together by performing tasks such as transferring data from primary memory to storage devices and sending the results of processing to display devices or printers. The operating system essentially creates a hardware abstraction layer, a "platform", to run application software and other system software.

The core part of an operating system is called the *kernel*. The kernel defines an application program interface (API) for application programs and serves as an interface to *device drivers* that provide the basic functionality to control and operate the hardware that is built-in or connects to the computer. A computer's basic input/output system (BIOS), firmware, and printer drivers are examples of device drivers.

Operating systems also include a *user interface (UI)* that enables a user to interact with the computer. Since this is the part of the operating system (OS) that the user interacts with, the UI is sometimes considered application software instead of system software. Graphical user interfaces (GUIs) have been the norm for operating systems since the 1980s, but users can still use a "command line" interface (CLI) to interact with many operating systems.

Examples of operating systems are found on PCs and laptops, mobile devices, and servers are summarized in Figure 4-19. Every computer, regardless of type or size, requires an operating system.

PCs and Laptops	Smartphones/Tablets	Servers
Windows	Symbian	Windows Server
Mac OS	iOS	Linux
Linux	Android	UNIX

Figure 4-19: Examples of Operating Systems for Client Computers, Mobile Devices, and Servers
Courtesy: Thomas Case

Utility programs are designed to analyze, configure, optimize, and maintain computer systems. Common examples include virus protection programs, disk analyzers, disk defragmenters. Other examples of system software utilities are summarized in Figure 4-20.

Utility Program	Description
Anti-virus	Scan for computer viruses
Backup software	Makes copies of information on storage devices
Cryptographic utilities	Encrypt and decrypt files and streams
Data compression	Compress/compact files and streams
Disk checkers	Scan hard drives for physical and logical errors
Disk cleaners	Remove files not needed for computer operation
File manager	Copy, move, delete, rename files and folders
Memory tester	Check for memory failures
Network utilities	Analyze connectivity, configure settings, check data transfer
Registry cleaners	Clean and optimize Windows Registry
System monitors	Monitor computer systems resources and performance

Figure 4-20: Examples of Utility Programs
Courtesy: Thomas Case

Tools used by systems administrators in data centers are sometimes classified as systems software. Systems development tools such as program debuggers, compilers, interpreters and linkers may also be classified as system software.

Application Software

Software that allows users to do things like create documents, play games, surf the Web, or listen to music are examples of application software. Enterprise software (ERP, CRM, SCM, etc.) are other examples of application software. Application software for mobile devices are called *apps*.

No attempt will be made in this book to discuss the full range of application software used on today's computers. Instead, we will focus on the major categories of application software that business managers should be most aware of.

Commercial Off-The-Shelf (COTS) Software

Much of the application software used is today's businesses are purchased application software packages. COTS software is ready-made application software that is available for sale to the general public. Microsoft Office is an example of a COTS software package designed for businesses. COTS products can be used “out of the box”, however, many organizations configure COTS products to better integrate them with other organizational systems.

Custom Software

Custom software is software that is specially developed to meet the needs of a specific organization or user. This is what makes it different from mass market software such as COTS software. Because the software is created for a single organization (customer), it can accommodate the customer’s expectations and preferences.

Large organizations may use custom software to fill gaps in existing software or to provide functionality not found in COTS software. Some companies, however, use custom software instead of COTS applications for critical functions such as HR or inventory management.

With custom software, the customer “owns” the software after it is written, including the source code. The organization (customer) is likely to get an efficient system that more closely meets business needs than would be possible with COTS software. The time it takes to develop the application (development time) often determines the cost of custom software. Because ongoing maintenance costs for custom software can be significant, custom software solutions may be infeasible for smaller organizations.

If an organization has programmers on staff, custom software can be developed in house. However, it is common for custom software development to be outsourced to contract programming firms, some of which may be offshore.

Horizontal Market Software

Application that is useful in a wide range of industries is known as *horizontal market software*. Examples of horizontal market software are word processing and spreadsheet applications, web browsers, and general-purpose bookkeeping software such as Quickbooks. Because it helps workers do their jobs in a wide range of industries, horizontal market software is sometimes called “productivity software”. Because it is designed to be used across industries, horizontal market software generally does not include customer- or market-specific customizations.

Vertical Market Software

In contrast to horizontal market software, *vertical market software* is developed and customized to meet the needs of businesses within specific industries. For example, major enterprise resources planning (ERP) vendors, including SAP, have developed vertical market versions of ERP systems. These are pre-configured versions of the ERP system designed to meet the specialized business processes and information processing requirements of organizations within that industry. Examples of the industries for which SAP has developed vertical market software are included in Figure 4-21.

Aerospace & Defense	Life Sciences
Automotive	Logistics Service Prod.
Banking	Media
Chemicals	Mining
Consumer Products	Oil & Gas
Defense & Security	Pharmaceuticals
Healthcare	Postal Services
Higher Education	Professional Services
Industrial Machinery	Railways
Insurance	Telecommunications

Figure 4-21: Industries for which SAP has developed Industry-specific solutions.
Courtesy: Thomas Case

Open Source Software

COTS, horizontal market software, and vertical market software is *licensed* application software, this means that it comes with a *software license*, a printed or electronic legal instrument that governs the use or distribution of the software. In the United States, the source code of the software is copyright protected (protected by federal copyright laws). Typically, a software license grants the end-user (licensee) to use one (or a limited number) of copies of the software in ways that do not violate the software owner's rights under copyright law.

An application's source code is a part of the software that most users never see. It is program code that can be manipulated by programmers to change how the program (application) works. Programmers who have access to source code can improve that program by fixing parts that don't work correctly or by adding new features.

With a software license, users are allowed to use the software but are not allowed to make changes to the software's source code. The software developer/vendor retains ownership of the source code and is the only entity with legal rights to make changes to the source code. As a result, licensed software is sometimes called "proprietary" or "closed source" software. Adobe Photoshop and Microsoft Office are examples of proprietary software.

In contrast, the source code of *open source software* can be inspected, modified by anyone. Because the source code of open source software is publically available, modifications and improvements can be shared among users. The development and maintenance of the software is a "community" endeavor, rather than the closely-guarded activity that is typical for proprietary software.

Open source software licenses give users permission to use the software as they wish. However, when the application is modified and shared with others, the source code must also be shared without requiring a licensing fee.   Open source software licenses are designed to promote collaboration by permitting programmers to make modifications to source code as long as they let others do the same when they share their work.

Open source software collaboration has produced a wide range of application and system software used in today's businesses. Some examples of open source software found in BIS infrastructures are summarized in Figure 4-22.

Figure 4-22: Examples of widely used open source software in BIS.
Courtesy: Thomas Case
PHP: Stock photo ID: 173389205
WP: Stock photo ID: 698366239
Firefox: Stock photo ID: 295215620
Java: Stock photo ID: 173790836
Apache: Stock photo ID: 733343695
MySQL: Stock photo ID: 387379522

Mobile Apps

Mobile apps, such as those illustrated in Figure 4-23, are software applications designed to run on mobile devices such as tablet computers and smart phones. Thousands of mobile apps have been developed that have the potential to help business users perform jobs and businesses are increasingly deploying mobile versions of applications that traditionally have only been available on PCs and laptops. Mobile interfaces to enterprise information systems (CRM. ERP, SCM, SRM) etc. are common, especially for cloud-based versions of these systems. Enterprise software vendors have rolled out mobile apps stores to enable their customers and partners to deploy their products on mobile devices.

SAP has been building mobile apps for its customers since 2010 and continues to expand the range of apps available in its apps store to introduce new capabilities and services for larger numbers of mobile users. More than 800 SAP mobile apps are available to in the SAP Mobile Place app stores to help SAP customers support sales, service, HR, productivity, and business analytics.

At SAP, enterprise mobile apps aren't just tools sold to customers. As of 2017, more than 80,000 SAP employees used in-house enterprise apps to help them accomplish a wide range of work-related activities including filing expense reports and sending product details to customers during sales calls.

Figure 4-23: Examples of Mobile Apps
Image ID:175661117

There are many businesses, including small businesses, that are still in the early stages of adopting mobile apps. Before adopting mobile apps for its workers, partners and or customers, the business needs to determine what it wants to achieve with the apps. It should have solid targets or plans such as lowering costs, adding GPS features, or aiding business analytics.

Best-of-Breed vs. Integrated Software

Some organizations choose to use a best-of-breed approach to build the application software component of its BIS architecture. Simply put, a best-of-breed application software product is the best product of its type. Organizations that pursue a best-of-breed approach often must purchase software from multiple vendors in order to obtain the best-of-breed software for each application area. For example, an organization may purchase an accounting package from one vendor, an CRM system for a second vendor, and a human resources package from a third vendor.

While this approach to deploying a software architecture has its merits, it also has potential downsides. With multiple vendors, there are likely to be multiple licensing agreements and the potential for excessive software licensing costs. Multiple help desks may have to be available to assist users in using the different packages. It may also be challenging to share data among the applications and provide support for end-to-end business processes; like functional area information systems, complicated and expensive middleware or an EAI (enterprise application integration) solution may be needed to integrate the best-of-breed applications to support cross-functional business processes.

Enterprise resources planning (ERP) systems vendors offer numerous enterprise applications and claim that their integrated systems are superior solutions to a collection of best-of-breed applications. However, it is rare for every module in an ERP system to be best-of-breed.

A comparison of the benefits of drawbacks to both best-of-breed and integrated systems in BIS infrastructures is provided in Figure 4-24.

	Best-Of-Breed (B.O.B)	Integrated
Benefits	• Products with the most features, most functions and best possible type for each department • Specialized vendors • Flexibility of substitutions • Easily replace one software component for another • Maintenance on one module does not impact another • Latest technology • Improve process in individual departments	• Integrated and consistent process • No multiple vendor "finger pointing" • Consistent data-model • Easily estimate overall costs • Faster implementation • Lower training, implementation and maintenance costs • Single data entry point • Support business process methodology • Only have to know one system and one user interface • Lower total cost of ownership
Drawbacks	• Multiple systems, databases and vendors • Complex end user training • Greater network complexity • "Finger pointing" among vendors when troubleshooting • Data integrity issues, duplicate date entry and redundant data storage • Expensive data warehousing • IT function must support multiple systems • Won't support business process methodology • Different interfaces or presentation layers	• Technological dead end if the vendor is not using current technology • Out-dated or ineffective databases and programs • Lack functionality of B.O.B • Tied to one vendor • Less flexibility when adding features

Figure 4-24: The benefits and drawbacks of best-of-breed and integrated systems. Courtesy: Ryan Wilcauskas

On Premise vs. Cloud Software Deployment

An important BIS infrastructure question for most organizations is whether software will be deployed on-premises, in the cloud, or as a combination of on-premises and in the cloud. There are advantages and disadvantages for both on premises and cloud deployment (see Figure 4-25), so addressing this issue can be challenging.

	Cloud	On-Premise
Business Model	Small but growing business with the flexibility and ability to grow easily without having to invest heavily in network infrastructure	Larger or established businesses that can afford the infrastructure costs or want to capitalize the investment
Capital vs Expense Cost	Subscription method of the cloud can minimize cash flow	All initial hardware and software costs are capital expenses
Remote Access	Generally by internet including any mobile device	Local access or remote using terminal services
IT Requirements	No extensive IT resources required	Require solid IT resource with expertise in server and software updating
Utility Costs	Per unit of computing power, the cloud costs less	Servers can draw large amounts of power plus require air conditioning
Software Investment	Software provided by license usually includes update and support	Company owns the software, in some cases yearly maintenance fees are charged
Infrastructure investment	Generally just an internet connection as the infrastructure is already in place	Need to setup server, backups, recovery processes and connectivity
Deployment Timeframe	Usually shorter due to infrastructure and installation already being in place	Depending on requirements, deployment can take much longer on-premise
Security and Privacy	Cloud means your data is on another server	Your data is kept in house on your own servers
Backup and Recovery	Usually implemented (including redundancy) as part of the infrastructure	Additional costs and discipline to maintain backups

Figure 4-25: Some of the key differences between on-premises and cloud software deployment. Courtesy: Ryan WilcausKas

The central question that must be addressed when considering on-premises vs. cloud deployment is where the software will be housed. With on-premises, physical servers and applications are all stored on-site; with cloud-based software deployment, the software solutions are housed in cloud infrastructure at a different company's data center. So, an essential difference is whether server management responsibility remains with the business itself or is outsourced to a cloud provider. Since maintenance, system upgrades, cooling equipment and power delivery are all shouldered by the company where the servers themselves are housed, there are multiple consequences associated with decisions about on-premises vs. cloud-based software deployment.

Software Trends

Cloud software deployment continues to increase as more and more businesses choose to take advantage of the benefits of storing data and applications in off-premises environments. As of 2015, more than 70 percent of U.S. companies had invested in cloud solutions and industry pundits predict that the percentage will continue to climb in the years ahead. Some industry experts describe on-premises software deployment as "old school" and predict that few organizations will choose to continue on-premises only BIS software infrastructure in the years ahead.

Since the desire to support mobility is one of the drivers of business interest in cloud solutions, mobile applications are increasing in importance as BIS infrastructure components. The vast major of the new software applications released each year are mobile apps and this shows that businesses are now in the “post-PC” era.

Business consumption of custom software applications, especially one-off software applications, has been declining for some time and will continue to decline in the years ahead. Advancing capabilities of commercial off-the-shelf (COTS) software, especially in vertical-market applications, has reduced business interest and need for custom solutions. In many organizations, individuals who hold “programmer” titles devote most their time to evaluating COTS software products rather than writing new program code.

There will continue to be a place for open source software in BIS infrastructures. For example, Apache HTTP Server, the world’s most popular Web server software, is entrenched in many organization’s e-commerce systems, and the Linux operating system is widely used on data center servers. You will encounter other instances of business use of open source software throughout this book.

Both application and system software developers and vendors continue to be focused on improving user interfaces and making it easier and more enjoyable for users to navigate and interact with the software. The software’s *user interface (UI)* enables the user to interact with the software, typically via input devices. Essentially, the UI provides users with the means to interact with the software on the computer system. Generally speaking, a goal of user interface design is to facilitate user interaction with the software through intuitive screen layouts. Today, most software applications support a *graphical user interfaces (GUI)*, such as that illustrated in Figure 4-6.

Figure 4-26: Smart phone GUI
Stock vector ID: 138776624

Many software engineers have moved to a *user experience (UX)* orientation which is focused on providing the software's content and layout in a way that enhances the attractiveness of the software to users and promotes a positive emotional reaction when the software is used. Goals of UX include improving the perceived ease of use, usability, and pleasure experienced by users when they interact with the software. If these goals are achieved, user satisfaction is increased along with their desire to use the software in the future (their loyalty to the software product).

In sum, UX goes beyond traditional UI design and its guiding principles will continue to shape user interfaces and software layout and content for both system software and application software. Some software vendors, including SAP, have launched major initiatives to overhaul user interfaces and product experiences. SAP's Fiori UX is being marketed as "the new face of SAP". Fiori is designed to optimize ease of use and usability to simplify user interactions with SAP solutions, including the SAP Business Suite powered SAP HANA. Like other UX initiatives, the goal of SAP Fiori UX to provide a simple, responsive and personal user experience.

Data Management Components

The data management components of BIS infrastructures consist primarily of storage technologies, database management systems (DBMS), data centers, data warehouses, and Big Data processing platforms. Several storage technologies were introduced previously in this chapter's Storage Technologies section. In this section, we will consider BIS infrastructure components that are used to serve the needs of business units and/or the entire organization.

A **network attached storage (NAS)** system can be described as a specialized data storage server manufactured as an appliance that can be attached to a network to support multiple users. NAS appliances contain one or more storage drives and they are typically used as file servers by providing access to stored files via network file sharing protocols.

Network-attached storage eliminates the need for other servers in the network to be responsible for file serving. Compared to using general-purpose servers for file serving, NAS provides faster data access, simplified configuration, and easier administration. Because the storage devices are directly connected to a file server in a NAS appliance, other computers have file-level access to what is stored. An example of a network attached storage device with four hard drives is illustrated in Figure 4-27.

Figure 4-27: A network attached storage (NAS) appliance.

Image ID:119043001

A **storage area network (SAN)** is a network which provides access to data storage. A SAN typically has its own network of storage devices that SANs are accessible to servers rather than client devices. There can be a variety of storage devices in a SAN including disk arrays, tape libraries, and optical disk jukeboxes. With a SAN, the different storage devices appear to server operating systems as locally attached devices. Figure 4-28 provides a conceptual depiction of a storage area network.

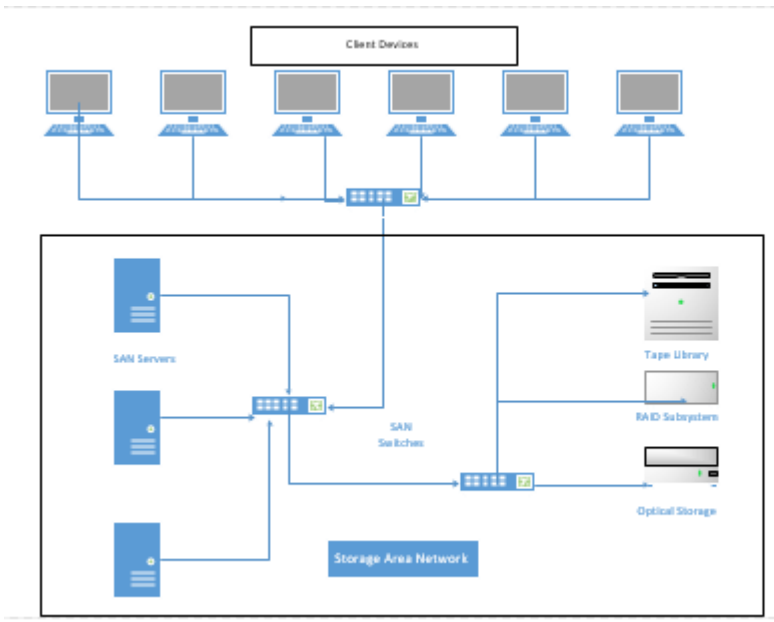

Figure 4-28: Storage Area Network (SAN)
Courtesy: Thomas Case

The cost and complexity of SANs dropped in the early 2000s and this has resulted in widespread SAN adoption across organizations of all sizes including small to medium-sized businesses. SAN help organizations increase their storage capacity utilization while enabling BIS users to access data stored on different storage media.

SANs enable the location of storage devices to be independent of user location. For example, employees for a business that has offices in multiple locations could all have access to data stored in a single SAN. It is also possible to distribute a SAN's storage devices among multiple locations; this might be purposely done to ensure business continuity by backing up data stored on a disk array in one location to a disk array in a second location.

A **data center** is essentially a large group of networked computer servers used to provide storage, processing, or distribution of large amounts of data for one or more organizations. A conceptual depiction of a data center is provided in Figure 4-29. An organization may choose to install a private on-premises data center to serve its data storage and processing needs;

alternatively, it may choose to subscribe to data storage capacity and processing capabilities in a third-party data center.

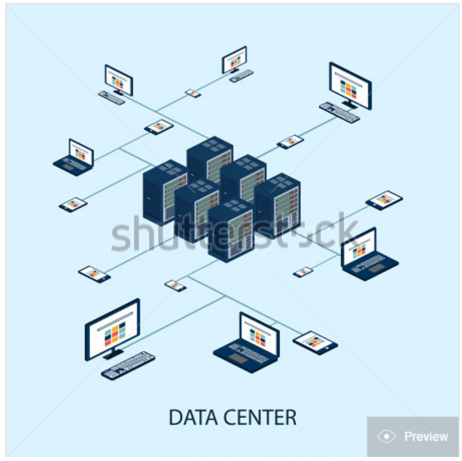

Figure 4-29: Conceptual depiction of a data center.
Image ID:378119617

Data centers vary in size. A data center may occupy one room of a building, one or more floors, or an entire building. The data center's server and storage equipment is often mounted in rack cabinets, which are usually placed rows that form corridors (aisles) – see Figure 4-30. In general, data centers also include redundant or backup power supplies, redundant connections to the Internet, environmental control systems (e.g., air conditioning, fire suppression) and security devices. Large data centers that are industrial scale operations often have redundant environmental control systems and consume as much electricity each day as a small town

Figure 4-30: Data center cabinets and aisles.
Image ID:156554486

A **data warehouse (DW)** is a central repository of integrated data from different sources that is used for data analysis and reporting. Data warehouses are key components of the business intelligence systems in many organizations because they include integrated, time-variant (historical) and nonvolatile collections of data that is used to support management decision-making processes. Data warehouses can be physically implemented in a SAN or data center. Several key data center concepts are illustrated in Figure 4-31.

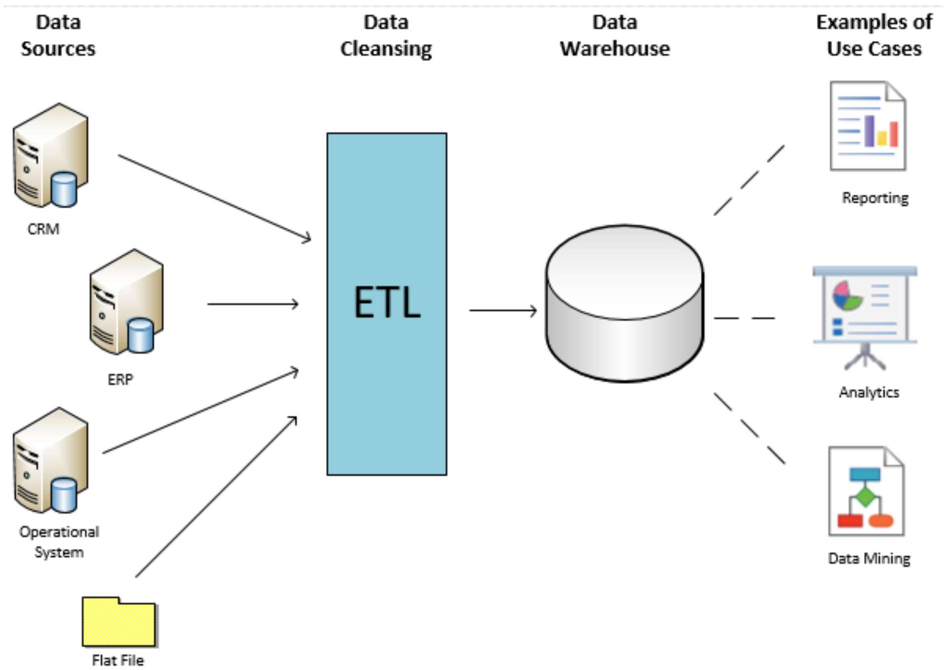

Figure 4-31: Data warehouse concepts
Courtesy: Ryan Wilcauskas

As shown in Figure 4-31, data from databases for multiple operational systems, including enterprise systems such as ERP and CRM, are extracted for inclusion in the data warehouse. Flat files, such as data and information in spreadsheets, may also be incorporated in a data warehouse.

Data from the disparate sources is extracted, transformed and loaded into the data warehouse; this is known as the ETL (extract, transform, load) process. Data cleansing is an important part of the ETL process. *Data cleansing*, which is also called *data scrubbing*, involves identifying, correcting, or removing corrupt or inaccurate records from a source file or database. This involves identifying incomplete, incorrect, inaccurate or irrelevant parts of the data and then replacing, modifying, or deleting the "dirty" data.

Once the data from each source is cleansed, it is combined with clean data from the other sources and loaded into the data warehouse. *Infocubes*, such as the one illustrated in Figure 4-32, can be created from data warehouse data and used for data mining, to create reports, and other types of data analysis.

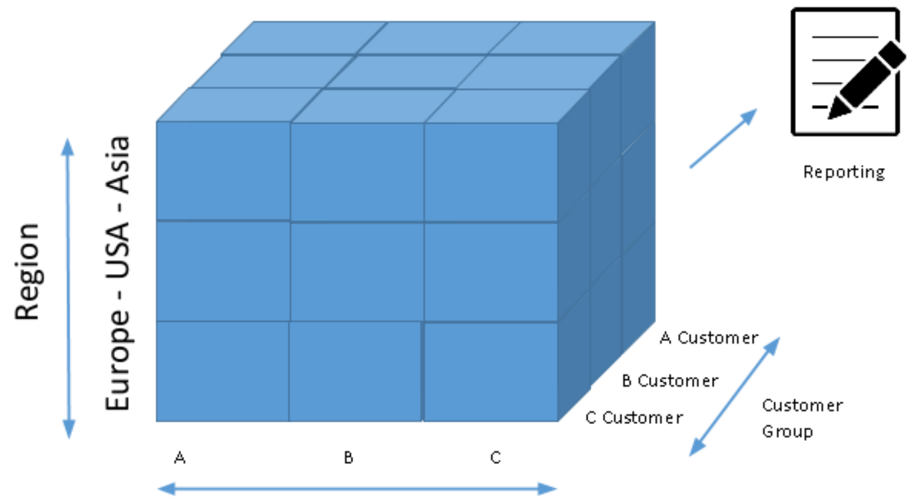

Figure 4-32: An example of an infocube
Courtesy: Ryan Wilcauskas

A **database management system (DBMS)** is software that manages data stored in a database, typically a relational database. Relational databases are described in Chapter 12. DBMS software is installed on servers and/or clients to enable users to add, modify, and retrieve data stored on storage devices.

As illustrated in Figure 4-33, a DBMS enables users to edit, query, and create reports from data in a database. Editing a database includes adding new data to the database as well as modifying or deleting existing data. Querying a database involves extracting subsets of data from the database that address specific questions. Most of the DBMSs used today, support *Structured Query Language (SQL)* as a standard tool for creating and running database queries. DBMSs also include reporting capabilities that enable user to create reports from database data that is used to provide information needed for decision-making.

Database administrators can use a DBMS to control access to data in the database and to ensure that users are only able to view data they are authorized to see and to perform editing operations that they are authorized for perform. Some users may be granted "read only" access to specific subsets of data in the database and are not allowed to "update" the database by deleting or modifying data or adding new data. Considerable granularity of data access and use can be imposed at the user level, so a DBMS can play an important role in data security.

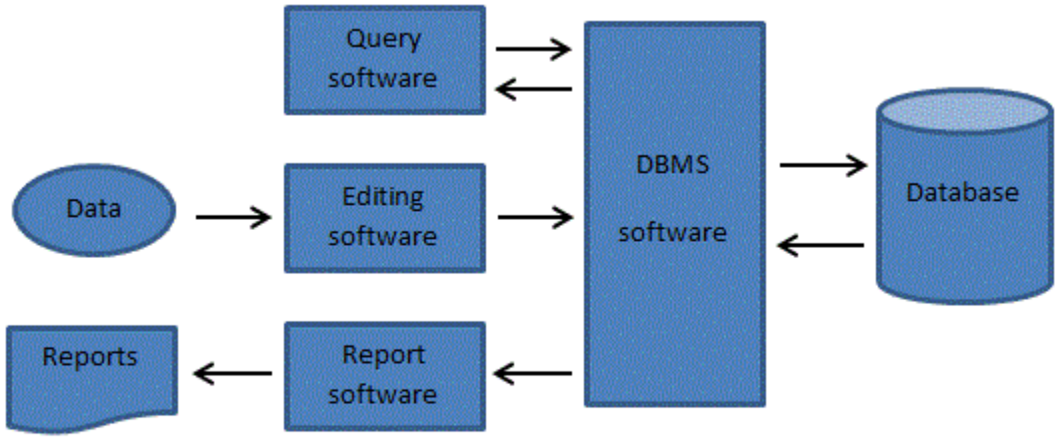

Figure 4-33: Conceptual diagram of a database management system (DBMS)
Courtesy: Thomas Case

Some of the most widely used DBMS software found in today's BIS infrastructures are illustrated in Figure 4-34. Oracle and IBM's DB2 are commonly found in enterprise systems infrastructure. MySQL, mongoDB, and PostgreSQL are popular open source DBMS. Microsoft Access, which is included in Office365, is best known as a personal database, but it is also used in smaller businesses.

Oracle	Sybase	Informix
IBM DB2	Teradata	SQL Server
MySQL	Mongo DB	Microsoft Access

Figure 4-34: DBMS that are widely used in BIS infrastructures.
Courtesy: Thomas Case

Big Data processing platforms have become important parts of BIS infrastructures in many organizations. As illustrated in Figure 4-35, Big Data processing essentially involves combining data from unstructured data sources, such as social media data, with data from structured sources, such as the data that organizations have traditionally stored in relational databases and data warehouses.

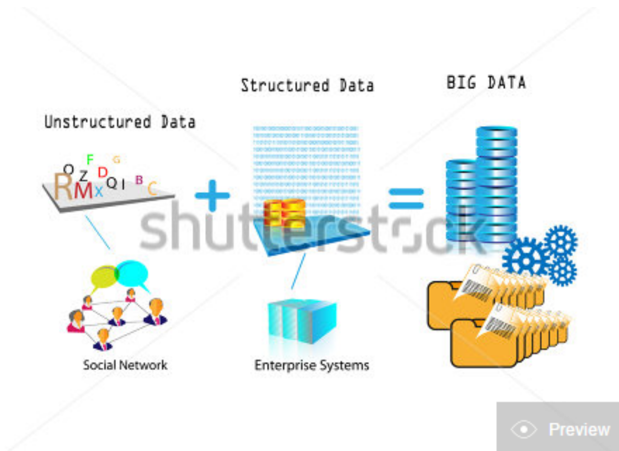

Figure 4-35: Big Data data sources.
Image ID:240878383

Two of the most important Big Data processing platforms are Hadoop clusters and SAP HANA.

Hadoop clusters are typically implemented on servers and storage technologies in data centers. Although they perform complex processing tasks, they are relatively inexpensive to implement. Hadoop clusters are typically implemented on Linux machines which enables Hadoop's software components to work directly with the underlying hardware.

As illustrated in Figure 4-36, there are three major categories of machine roles in Hadoop cluster deployment: head nodes, compute nodes, and client machines.

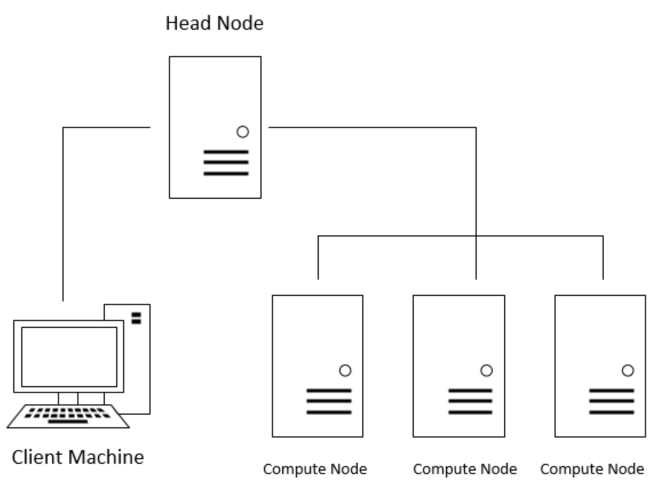

Figure 4-36: Machine roles in Hadoop clusters.
Courtesy: Ryan Wilcauskas

Head Nodes are often called Master Nodes because they oversee two critical functions: storing lots of data and running parallel computations on all the data. There are two major Head Node functions: the Name Node function, and the Job Tracker function. The Name Node functions oversees and coordinates the data storage function and use a special file system called the Hadoop Distributed File System (HDFS) to enable storage of both structured and unstructured data. The Job Tracker function oversees and coordinates the parallel processing of data using MapReduce.

MapReduce is a programming model for processing (and generating) large data sets using a parallel, distributed algorithm on a computer cluster. It is what enables diverse data sources (both structured and unstructured) to be processed simultaneously on the same cluster of computers. MapReduce enables the cluster to become a Big Data processing platform.

Compute Nodes make up the vast majority of machines in a Hadoop cluster. They are often called Slave Nodes because do all the dirty work of storing the data and running the computations. Each Compute Node runs both a Data Node and Task Tracker program that communicates with and receive instructions from their head (master) nodes. The Task Tracker program receives processing instructions from the Job Tracker function and Data Node program receives instructions about the data to be stored for processing from the Name Node function.

The role of the Client machine is to load data into the cluster, submit Map Reduce jobs describing how that data should be processed, and then retrieve or view the results of the data processing job when its finished.

Smaller Hadoop clusters typically include fewer than 50 machines. In smaller clusters, a single server may be used to do both the Job Tracker and Name Node functions. In medium and large clusters (consisting of hundreds or thousands of machines), the Job Tracker function is typically performed on one Head Node server while the Name Node function is performed on a second Head Node server.

Another Big Data process platform that has gained traction is SAP HANA. **SAP HANA** is a column-oriented, in-memory relational database management system developed by SAP. It can be physically implemented as data center appliance or cluster.

Traditionally, businesses have used row-oriented relational databases to store data and, as noted previously, SQL to retrieve and transform data into information. When SQL is used to query a database, the DBMS has to go row by row in database tables to retrieve the appropriate data; this can take time if the database tables have millions of rows. When data is stored in columns rather than rows, the DBMS can more precisely access the data it needs to answer a query because it is not necessary to scan and discard unwanted data in table rows. As a result, in a column-oriented database, query performance can be significantly faster, especially when the database is very large.

The primary function of a SAP HANA appliance or cluster is database server – storing and retrieving data requested by applications. It also includes application server and ETL capabilities.

Because it is able to bring very large data sets into main memory, data processing is very fast. Some organizations are using SAP HANA to combine the contents of data warehouses and operational databases in-memory at the same time; this enables them to perform realtime-analytics that compares current to historical performance in realtime. SAP HANA is also being used to perform predictive analytics, text analytics, and streaming analytics (including social media stream).

Strong arguments can be made for including *data analytics and visualization tools* as important parts of the data management components of BIS infrastructures, especially in the Big Data era. Data analytics and visualization are discussed more fully in Chapter 12.

Data Management Trends

We have entered the Big Data era and the three major defining dimensions of Big Data are volume, variety, and velocity. *Volume* refers to the amount of data available for processing; it is doubling approximately every 18 months which means that 18 months from now, there will be twice as much data available for processing as there is today. Variety refers the number of types of data available for processing. There are many types of structured, semi-structured, and unstructured data and that have been "datafied"—put in a form that can be processed on Hadoop clusters, SAP HANA and other Big Data processing platforms that will increasingly be found in BIS infrastructures in the years ahead. Velocity refers to the speed of data processing. As discussed in the Processing Technologies section, Moore's Law is still at work and continues to produce more and more powerful processors capable of keeping pace with explosive increases in data.

As data storage costs continue to decline, organizations of all sizes can afford to capture and store more data. This means that SANs and data centers will continue as important parts of the data management components of BIS infrastructures. There is mounting evidence, however, that these components will most commonly be located in cloud-based third-party data centers rather than on premises.

The ETL (extract, transform, load) process responsible for cleansing data prior to adding it to a data warehouse, is a holdover from the "small data" era. In the small data era that preceded the Big Data era, data was viewed as a scarce rather than bountiful quantity that needed be squeaky-clean before using it to inform decision making. Hence, "scrubbing" data prior to adding it to a data warehouse made sense. With Big Data, we have learned that "more trumps messy"; we are able to identify actionable patterns even when we omit scrubbing. This has caused some industry pundits to speculate that data warehouses be less important in BIS infrastructures in the future.

Telecommunications Components

Computer networks include the circuits and communications equipment that interconnect BIS hardware components within and across business locations. Local area networks (LAN) and/or backbone networks (BN) interconnect clients, servers, and storage technologies at a business location and wide area networks (WAN) connect different business locations to one another. Some of the most important telecommunication technologies included in LANs and WANs are illustrated in Figure 4-37.

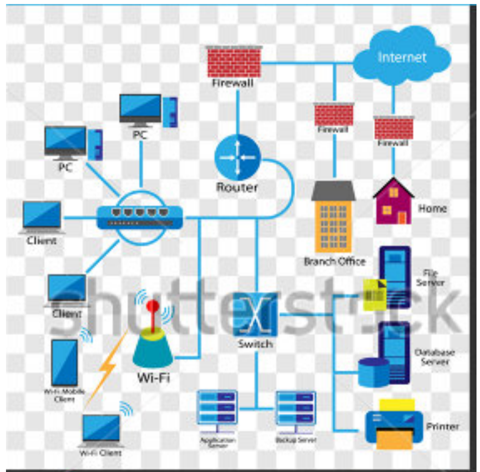

Figure 4-37: Key telecommunication technologies in LANs and WANs
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Two categories of local area networks (LANs) are common at individual business locations: wired and wireless (see Figure 4-38). In wired LANs, the circuits that connect clients, servers, and network printers to switches, are cables. Because **Ethernet** is the most widely used wired LAN architecture, Ethernet cables provide the circuits over which data is transmitted. Clients, servers, and network printers equipped with Ethernet *network interface card (NICs)* include transceivers (transmitters/receivers) capable of transmitting and receiving signals on the Ethernet cables. Ethernet's communication protocol, CSMA/CD (carrier sense multiple access with collision detection) governs when attached devices transmit signals.

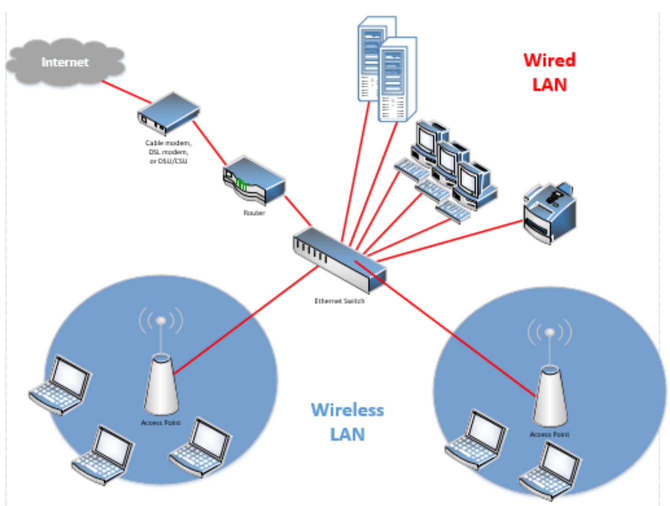

Figure 4-38: Wired and wireless LANs
Courtesy: Ryan Wilcauskas

The evolution of Ethernet standards and protocols is governed by the Institute of Electrical and Electronics Engineers (IEEE); IEEE 802.3 is the umbrella standard for Ethernet. Ethernet standards currently support transmission speeds from 10 Mbps (10 million bits per second) to 100 Gbits (100 billion bits per second) and a 400 Gbps standard is expected to be released by IEEE in 2017. Twisted-pair cabling is most common for speeds from 10 Mbps to 1 Gpbs, and fiber optic cabling is most common for 10 Gbps to 100 Gbps Ethernet.

WiFi is the most common wireless LAN in BIS infrastructures. Client devices in WiFi LANs connect to the network via *access points (APs)*. WiFi network interface cards (NICs) include transceivers that use radio waves (frequencies in the radio band of the frequency spectrum) to send and receive signals to access points. Because APs connect to switches in wired LANs via Ethernet cable, one of their jobs is to convert radio waves to electrical signals and vice-versa. In WiFi LANs, CSMA/CA (carrier sense multiple access with collision avoidance) is the communication protocol that governs how client devices take turns transmitting data through the AP.

802.11 is the umbrella IEEE standard for WiFi. Because WiFi continues to evolve, it is important for business managers to invest in WiFi components that comply with the most current standard. Today, the current standard is IEEE 802.11ac, but 802.11ad is on the horizon and will soon be the prevailing standard. As WiFi evolves, connection speeds increase. However, despite such improvements, business managers should not assume that wireless connections are going to replace wired connections. Higher connection and transmission speeds have always been available in wired LANs than in wireless LANs, and this will continue to be true in the foreseeable future.

In addition to circuits, NICs, switches, and access points, **routers** are important components of LANs. Routers enable LAN-attached devices to send and receive data from devices in other networks. When a client device transmits data to a device in another network, the data first goes to the router. The router determines the best (often the quickest) path for the data to travel to the destination network and retransmits the data on the appropriate outgoing circuit. In a sense, routers are gateways to and from other networks, including the Internet.

You may have a *wireless router* as part of a WiFi network in your home or apartment. A wireless router combines the capabilities of an access point (AP), router, and Ethernet switch in a single device. Most wireless routers include several Ethernet ports that can be used to directly connect client devices or printers to the network. So essentially, a wireless router is a router that also includes AP and switch capabilities.

At a particular business location, a **backbone network** enables data and information exchange between LANs or subnetworks. A backbone network can tie together similar or diverse networks in the same building or in different buildings in a campus environment. Backbone networks can also be created to interconnect facilities or campuses that are geographically distant from one another.

Figure 4-39 illustrates a simple backbone network that interconnects two LANs. In Figure 4-39, each of the LAN switches connects to a backbone switch—the switch in the middle of the diagram. The two LANs depicted in the figure could be in the same building or in different buildings on the same business campus.

As a general rule, a backbone network should support higher transmission speeds than the LANs or subnetworks that it interconnects. For example, if the two LANs in Figure 4-39 were 100 Mbps Ethernet LANs, the backbone network speed should be 1 Gbps or higher. In addition, while not an absolute requirement, in practice, each LAN switch in Figure 4-39 would connect to the backbone switch via fiber optic cable instead of Ethernet cable.

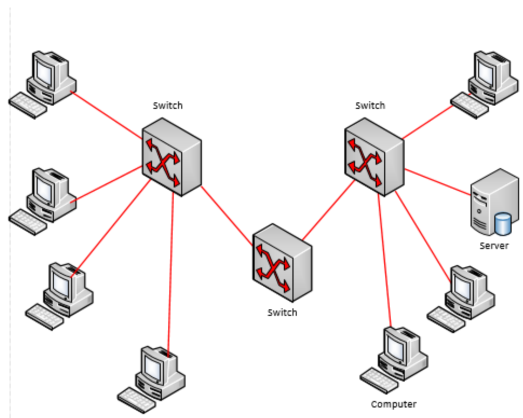

Figure 4-39: An example of a backbone network at a single business location.
Courtesy: Ryan Wilcauskas

A **wide area network (WAN)** is a telecommunications network that extends over a wide geographical distance. A WAN enables businesses to interconnect LANs at multiple locations such as those at headquarters and branch offices. Connections to cloud services may also be included in a business's WAN. WANs enable employees at the different locations to access centrally (or distributed) located computing resources including applications and services. Gateway routers at the different locations provide enable users to use the WAN. WANs are typically depicted as clouds because there are numerous ways to provide interconnections among geographically dispersed locations including dedicated circuits, packet switching services, and VPN services.

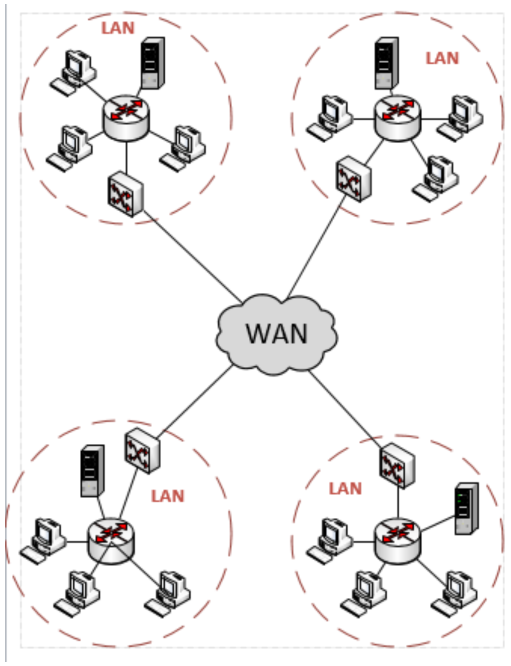

Figure 4-40: Key components of a wide area network.
Courtesy: Ryan Wilcauskas

Dedicated-circuit WANs are established with leased communication circuits. The circuits are leased from *carriers* (such as telephone companies or Internet service providers) and enable businesses to create private networks that are available to the business's users 24/7. Figure 4-41 summarizes some of the popular leased circuits that businesses use to create dedicated-circuit WANs and their cost per circuit per month.

Circuit Type	Name	Connection Speed	Monthly Cost
Telephone wire	T-1	1.5 Mbps	\$200 - \$1200
	T-3	44 Mbps	\$3000 - \$12,000
Fiber optic cable	OC-3	155 Mbps	\$10,000 - \$30,000
	OC-12	622 Mbps	\$100,000 - \$300,000
	OC-48	2.5 Gbps	\$300,000 - \$500,000

Figure 4-41: Frequently leased circuits in dedicated circuit WANs.
Courtesy: Thomas Case

Packet-switched services provide an alternative to dedicated-circuits for interconnecting dispersed business locations. Packet-switched services providers lease circuits, such as those in Figure 4-41, and resell their bandwidth to subscribers. Figure 4-42 provides a simplified depiction of a packet-switched network.

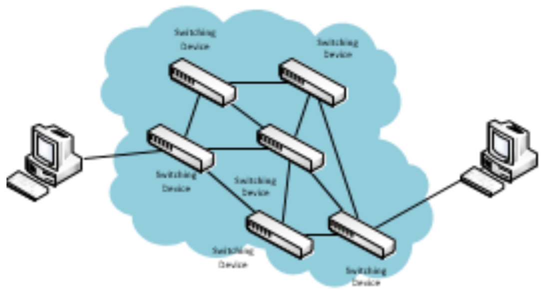

Figure 4-42: A packet-switched network.
Courtesy: Ryan Wilcauskas

A packet-switched service subscriber pays a relatively low monthly fee to access the provider's network and then pays an amount that is based on the total volume of data it transmits over the network. Generally speaking, business can save 30% or more per month by interconnecting its different locations via packet-switched services instead of dedicated-circuits.

Carrier Ethernet and *multiprotocol label switching (MPLS)*are two of the most popular types of packet-switched services. Carrier Ethernet services can be a good choice when the LAN's at a business's different locations are Ethernet LAN's (which is frequently the case). Typical connection speeds for carrier Ethernet services are 1 Gbps, 10 Gbps, and 40 Gbps. However, some providers support speeds up to 100 Gbps. In many locations, business subscribers can acquire a 1 Gbps connection to carrier Ethernet services for $100 a month (per location).

MPLS is a widely used protocol for speeding up and providing high quality transmission services. Each data packet that enters a provider's MPLS network gets tagged (labeled) and the label determines the path that the data packet will take through the network. Different paths and service levels can be created for different types of data. For example, one path/service level could be created for voice traffic, a second path/service level could be created for video traffic, and a third path/service level could be provided for data traffic such as e-mail. MPLS's popularity is based on its ability to ensure that each type of data transmitted by the business will reach its destination as quickly as possible.

Because both dedicated-circuit networks and packet-switched services can be configured to avoid transmitting data over public Internet circuits, these are attractive to security-conscious organizations. Another popular way to create WANs, however, uses rather than avoids, Internet circuits. *Virtual private network (VPN) services* provide the equivalent of a private packet-switched network over the public Internet by creating virtual "tunnels" between business locations. Typically, the data that is passed over a VPN tunnel is encrypted.

VPN tunnels can be created between geographically dispersed business offices. They may also be used to create connections between a business and its suppliers, customers, or business partners. VPNs are frequently used to enable telecommuters, traveling salespersons, and other employees to get access to the resources in a business's network from remote locations.

Wireless WAN technologies include cellular data networks such as 4G LTE, public WiFi networks, and satellite networks. Wired WAN network connections, such as those in dedicate-circuit networks and packet-switched services, are the preferred data transmission medium for most businesses. However, the popularity of wireless WAN technologies is increasing, especial those based on the 4G LTE standard.

Small businesses frequently choose business versions of broadband connections that Internet service providers (ISPs) offer to consumers. Business-oriented variants of *DSL (digital subscriber line)* were widely used during the 1990s and 2000s, but businesses have been shifting toward higher-speed *cable modem* business services in many markets and to *fiber-to-the-home (FTTH)* business service options where this is available. As 1 Gbps carrier Ethernet continues to increase as a relatively inexpensive connection option in local markets, small businesses are expected to migrate away from broadband services.

Telecommunications Trends

LAN and backbone network speeds continue to climb. The evolution of Ethernet and WiFi technologies standards has resulted in consistent increases in network speeds, and this will continue in the years ahead. Over time, wired Ethernet networks will migrate from 100 Mbps to 1 Gbps and then to 10 Gbps. Multi-gigabit per second WiFi speeds are also on the near horizon.

Ethernet twisted-pair cable will continue to be found in wired LANs. Fiber optic LANs will become more widespread, and fiber optic cable will be increasingly used in backbone networks.

Power-over-Ethernet (PoE) switches will increasingly be used to provide both power and communication capabilities to access points, surveillance cameras, badge readers, and sensor devices. Some PC manufacturers have developed motherboards and all-in-one PCs that receive their power from Ethernet cables attached to PoE switches.

WAN speeds are also expected to increase despite the pricey monthly fees for fiber optic dedicated circuits. Carrier Ethernet prices continue to decline in most markets which is motivating many MPLS subscribers to switch to carrier Ethernet. MPLS services availability, however, continues to increase and it is likely to remain an important packet-switched service alternative for many years.

The Internet of Things (IoT) has the potential to radically reshape telecommunications over the next decade. IoT's addition of 10s or 100s of billions of network attached devices to today's network will pressure all types of telecommunications networks to increase their bandwidth and data traffic shaping capabilities.

BIS AND CLOUD COMPUTING

For almost all large and medium size enterprises, the "cloud" has become a virtual extension of on-premises BIS infrastructure. Cloud computing has enabled some organizations to dramatically reduce or eliminated their on-premises BIS infrastructure and are essentially running their businesses "in the cloud." As we discussed previously, there are multiple factors that make cloud computing an attractive option for businesses. Several of these are summarized in Figure 4-25.

Adding cloud computing to an organization's BIS infrastructure involves outsourcing part or all of the BIS infrastructure to firms that specialize in managing that infrastructure. The three most common types of clouding computing providers that have attracted business subscribers are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

Software as a Service (SaaS) is a centrally-hosted software licensing and delivery model in which application software is licensed on a subscription basis and users typically access the software via a web browser. The SaaS provider is responsible for maintaining all of the hardware, telecommunications, and system software infrastructure needed to run the application software. A business that subscribes to SaaS services is a "tenant" who shares the application with other SaaS tenants, however, it is typically the case that the application software can be customized to meet each tenant's specific needs. When the application is upgraded, each tenant gains instant access to all the new features and capabilities of the upgrade. Salesforce.com is an example of widely used CRM (Customer Relationship Management) system that is delivered via the SaaS model. Citrix GoToMeeting is another widely used SaaS cloud service

Platform as a Service (PaaS) is a type of cloud computing services that providers an infrastructure platform (hardware, telecommunications, system software) on which subscribers can develop, run, and manage applications. In this outsourcing model, the subscriber "owns" the applications that it creates and the data/information processed by the application, but the PaaS provider owns the hardware, operating system, DBMS, etc. on which the subscriber's application runs. PaaS often provides subscribers with a faster and/or less expensive way to develop and deploy custom applications. Amazon's AWS Elastic Beanstalk, Apprenda, Force.com, and Google App Engine are example of PaaS cloud services.

Infrastructure as a Service (IaaS) is a cloud computing service model in which computer infrastructure is delivered on an outsourced basis to support business operations. Typically, IaaS cloud services provides hardware, storage, servers, network components, and data center space needed to support business. Because of this IaaS is sometimes called *Hardware as a Service (HaaS),* however, in some instances, IaaS may also include the provision of software. An IaaS provider provides is responsible for housing, operating and maintaining the equipment it provides for its subscribers. Subscribers may pay on a per-use basis or on a recurring basis similar to how they pay for utilities.

The model shifts the burden of buying, managing, and maintaining BIS hardware infrastructure (including hardware, servers, storage, and networking) to the IaaS provider. Subscribers remain responsible for the operating systems, DBMSs, and application software that runs on the IaaS provider's infrastructure. Amazon Web Services (AWS), Microsoft Azure, Google Compute Engine (GCE), and Joyent are example of IaaS cloud services.

In sum, SaaS applications are designed for end-users and are delivered over the web. PaaS provides tools and services that make coding and deploying custom applications quick and efficient. And, IaaS is the hardware and software – servers, storage, networks, operating systems – needed to deploy applications. With all these cloud services available and affordably priced, it is not surprising that the vast majority of businesses have supplemented or replaced on-premises BIS infrastructure with cloud services. Today's businesses face tough decisions about what BIS infrastructure (if any) to keep on-premises and what to move/use in the cloud, and many IT pundits predict that most organizations will move most or all of their BIS infrastructures to the cloud.

BIS SECURITY

One of the major issues that an organization faces when deciding to add cloud services to its BIS infrastructure is the security of its data. Each organization has to evaluate the risk of its data and applications being compromised when making choices about cloud services and providers.

Security has always been a business concern and its importance has grown as BIS infrastructures have evolved. The emergence of enterprise networks that include LANs, backbone networks, and WANs, has created new vulnerabilities and opportunities for security breaches. As businesses embrace IoT (the Internet of Things), additional vulnerabilities will be introduced to BIS infrastructures.

Newsworthy cybersecurity breaches seem to be perpetually in the news. Reported losses from cybersecurity breaches approach half a trillion dollars (USD) annually; a number that exceeds the GDP of more than 150 countries in the world. Law enforcement officials think that the non-reported losses may be twice as high as reported losses.

By 2016, the Board of Directors of most publically-traded corporations included at least cybersecurity expert. In a few years, investors are likely to look askance at any corporate board without cybersecurity expertise.

Finding and keeping qualified cybersecurity expertise is challenging and expensive. Currently, there are approximately five job openings available for each IT staffer with security credentials with an average salary more than $115,000.

LAYERED SECURITY AND INFORMATION ASSURANCE

Today, security controls are implemented in layers to help ensure protection for all BIS infrastructure components: hardware, software, data management, and telecommunication components. This approach to BIS infrastructure security is often called Defense in Depth. **Defense in Depth** is best described as an information assurance (IA) approach in which multiple layers of security controls are placed throughout BIS infrastructure. The rationale that underlies Defense in depth is that the overall security of BIS infrastructure is increased as the result of having layered security mechanisms. If an attack causes security mechanisms to at one layer to fail, mechanisms at other layers may still provide the security needed to protect the BIS. Figure 4-43 illustrates the five major layers of the Defense in Depth model. Figure 4-44 provides examples of security mechanisms found at each layer.

Data is the deepest layer of the Defense in Depth model. As can be observed in news stories about major hacks, data, especially customer data (names, credit card numbers, billing addresses, phone numbers, e-mail addresses, etc.) is typically the target of the attack. Employee or client data sources that include Social Security Numbers are also frequently targeted since such information can be used for identity theft.

Applications are found at the second deepest layer. Because application software is used to process data, if attackers can compromise applications and change program code, they may be able alter, access, or steal data that they are otherwise unable to get to because of security controls in place at the data level. Why secure coding practices exist, there are far too few programmers who know or consistently follow them. In many BIS infrastructures, security controls are needed because the programs used by the organization are inherently insecure.

The host layer is where operating systems and system software is located, the platforms used to run application programs to process data. Attackers that succeed in reaching this layer could disrupt business operations by altering how applications run or by making it impossible for the organization to run its applications.

Operating systems enable applications to run on network and hardware infrastructure. This is why the network layer is located outside the host layer. To get to operating systems and system software, attackers must first gain access to the network on which the operating system(s) run.

The perimeter layer is the “shallowest” layer of the Defense in Depth model. It represents the perimeter of the BIS infrastructure and the first layer of security defenses that attackers must penetrate before they can get to the organization’s network, operating systems, applications, and data.

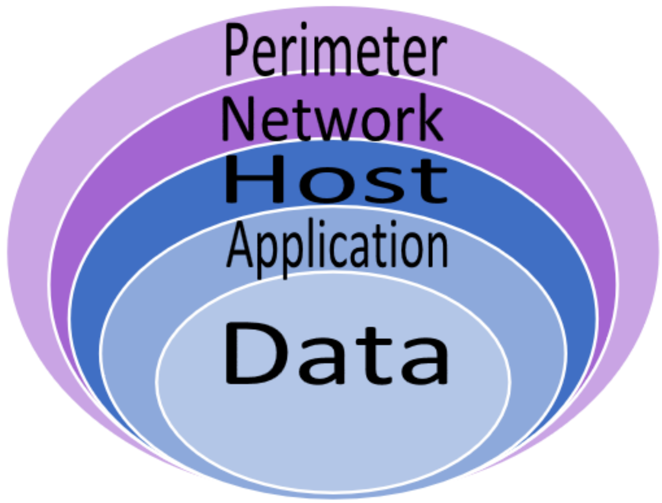

Figure 4-43: Defense in Depth Layers
Courtesy: Ryan Wilcauskas

As illustrated in Figure 4-44, the Defense in Depth model is sometimes depicted as including a sixth layer, a physical security layer. This in included to account for the common practice of restricting access to server rooms, communication closets, and data centers where BIS hardware and telecommunications equipment is housed. Many organizations use badge readers and/or biometric verification/authentication systems (retina, fingerprint, hand or facial geometry, or voice recognition scans) and/or passcode lock systems to ensure that only authorized employees can gain entry to areas with critical BIS infrastructure is located.

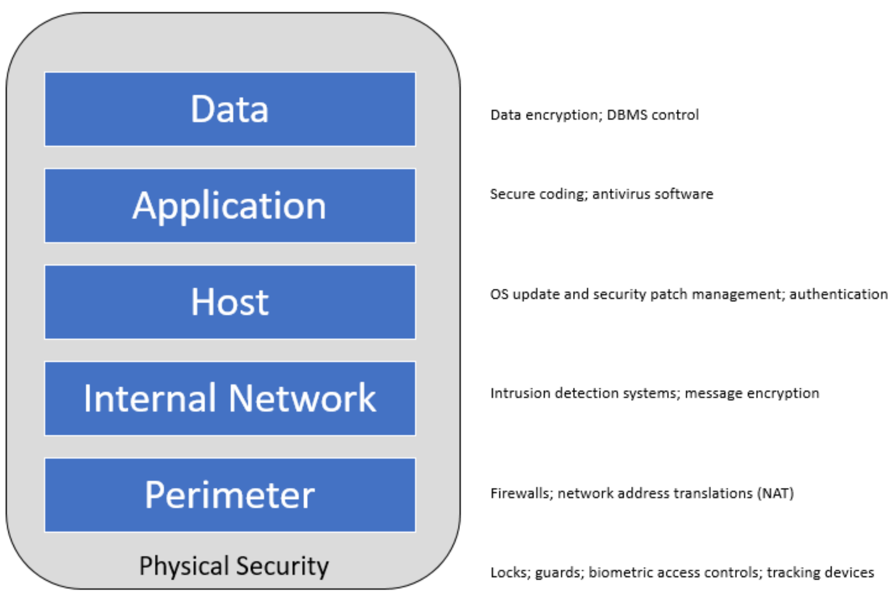

Figure 4-44: Examples of security controls at each Defense in Depth Layer
Courtesy: Ryan Wilcauskas

There are many security threats to BIS architecture including malware infections (computer viruses, worms, spyware, ransomware), external hackers, denial of service attacks, rogue employees, equipment failure or theft, and disasters (natural or manmade – e.g. terrorist attack). The potential list of threats is too long for an introductory MIS text such as this one. The list of security controls that could be implemented to protect BIS infrastructure is also beyond the scope of this book.

Many organizations use a *risk assessment* approach to consider the likelihood of potential threats actually disrupting business operations, the severity of the disruption, and the adequacy of existing security controls that are in place to guard against business disruptions. *COBIT (Control Objectives for Information and related Technology)* is a widely used example of a risk assessment framework that is used by IT auditors to assess risks and to identify security improvements for BIS infrastructures.

Business managers must be constantly vigilant when it comes to information assurance (IA) and BIS security. They should never let themselves become complacent enough to think that their organization's BIS is sufficiently secure. Security questions should be voiced and answered for each proposed expansion of enterprise networks and for each new technology that is added to the BIS infrastructure.

BIS INFRASTRUCTURE AND BUSINESS STRATEGY

In the first section of this chapter, the importance of aligning enterprise architecture with business strategy was discussed. Now that you have a clearer understanding of BIS components and how they are used to implement enterprise architecture, it is important to revisit the issue of alignment, in this case, the alignment between BIS infrastructure and business strategy.

The confluence of disruptive technologies including cloud computing, mobility, social media, and Big Data is causing managers to focus on BIS infrastructure. Increasingly, executives are looking to BIS infrastructure to drive competitive advantage and contribute to revenue and profit optimization (business performance). And, managers in non-IT functional area are increasingly involved in making BIS infrastructure decisions, especially those concerning client devices, cloud computing and security.

BIS infrastructure is sometimes compared to the foundation of a building—you may not see it (especially if much of it is physically located in cloud data centers), but you know it is critically important. When it is solid, it contributes to the soundness and sturdiness of the building, but when it is weak or shatters, the building may collapse.

BIS infrastructure security contributes significantly to the overall security of the organization. And, an appropriately constructed BIS infrastructure enables the organization to adapt to and assimilate, and constructively use disruptive technologies and increases the organization's ability to withstand threats to business continuity.

There are several questions that business managers should be asking when considering the degree to which BIS infrastructure contributes to competitive advantage:

- How is our organization using BIS infrastructure to achieve competitive differentiation in the marketplace?
- How well is our BIS infrastructure equipped to handle new workloads associated with mobility, social media, and data analytics?
- To what extent are our BIS infrastructure investment decisions driven by business requirements?
- How well can our existing BIS infrastructure respond to disaster recovery scenarios?
- What are our plans for incorporating cloud computing into our BIS infrastructure?

The previous sections of this chapter indicate the importance of viewing BIS infrastructures as consisting of many components. It is not one thing; it is many things. This means that business managers should consider how all the components of BIS infrastructure can be optimized to optimize business value and serve as a strategic vehicle to improve overall business performance and results.

Some experts argue that an organization should overinvest in BIS infrastructure to ensure that the infrastructure is robust enough to enable the organization to be strategically agile. Underinvesting in BIS infrastructure, they argue, may make it very difficult or impossible to strategically shift in response to major changes in the business environment. And not being able to respond may threaten the organization's ability to survive. In short, strategy-enabling BIS infrastructure can be re-used to support multiple business initiatives, while strategy-constraining infrastructure can threaten business survival.

Investing in BIS infrastructure may viewed as being similar to buying an option. When used successfully, infrastructure contributes to competitive advantage by speeding time to market, otherwise the infrastructure investment can be an unnecessary cost. When business executives understand what BIS capabilities are needed to achieve strategic objectives, they are better positioned to ensure that BIS infrastructure investments will support the organization's strategic objectives and business initiatives. Ideally, investments made today will support tomorrow's business strategies.

The relationship among the concepts discussed in this section (environment, business strategy, enterprise architecture, BIS infrastructure, performance) is illustrated in Figure 4-45.

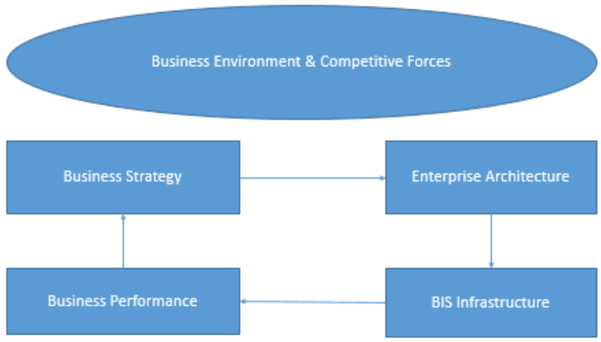

Figure 4-45: How BIS infrastructure is related to business strategy.
Courtesy: Thomas Case

CHAPTER SUMMARY

Large organizations, and many small and medium size enterprises (SMEs), utilize Enterprise Architecture's strategic perspective to align business strategy and BIS infrastructure. Enterprise architecture (EA) involves the application of architecture principles and practices to guide organizations through the business, data and information, business process, and technology changes needed to execute their business strategies. EA has traditionally included four components (domains): business architecture, data/information architecture, application architecture, and technology architecture. However, security architecture is often included as a fifth component/domain. EA is used to identify BIS infrastructure components that are crucial for the achievement of strategic objectives and thereby guides BIS infrastructure investment decisions.

BIS infrastructure maps most directly to the Technology Architecture component of EA, but it is also related to EA's data/information, application, and security architecture components. More specifically, BIS infrastructure corresponds to the hardware, software, data, and telecommunications components of BIS.

BIS hardware components include input, processing, and storage technologies. Input technologies are used to capture or enter data into the computer system. Processing technologies, including central processing units (CPUs) carry out data processing instructions provided by programs. Storage technologies provide a means for storing data and programs outside the computer system and output technologies convert processing results into human-readable form.

Multiple categories of software are included in BIS infrastructures. Three of the most important categories are system software, application software, and middleware. System software consists of programs that allow application software to run on computer hardware. Application software includes user-oriented programs, solutions, and tools needed by BIS users to perform their jobs. Middleware enables different applications to interoperate, share data, and coordinate processing tasks.

BIS infrastructure’s data management components consist primarily of storage technologies, database management systems (DBMS), data centers, data warehouses, and Big Data processing platforms. BIS infrastructure also includes telecommunications components that interconnect BIS hardware components within and across business locations. Local area networks (LAN) and/or backbone networks (BN) interconnect clients, servers, and storage technologies within a business location and wide area networks (WAN) connect different business locations to one another.

For most large and medium size businesses, the “cloud” is a virtual extension of on-premises BIS infrastructure. Adding cloud computing to an organization’s BIS infrastructure involves outsourcing part or all of the BIS infrastructure to firms that specialize in managing that infrastructure.

To help ensure protection for all BIS infrastructure components, security controls are typically implemented using a Defense in Depth model. Defense in Depth is essentially an information assurance (IA) approach in which multiple layers of security controls are deployed throughout BIS infrastructure to protect the organization’s hardware, software, telecommunications, and data assets.

Today’s business managers look to BIS infrastructure to drive competitive advantage and contribute to revenue and profit optimization (business performance). They realize that underinvesting in BIS infrastructure can impede the achievement of business objectives. Many believe that overinvesting in BIS infrastructure is acceptable if it results in a robust BIS infrastructure that enables the organization to be strategically agile.

KEY TERMS

REVIEW QUESTIONS

1. What is Enterprise Architecture (EA)?
2. How does EA contribute to the alignment of business strategy and BIS infrastructure?
3. Briefly describe each of the following EA components: business architecture, data/information architecture, application architecture, technology architecture, security architecture.
4. Briefly describe each of the following BIS hardware components: input, processing, storage, output.
5. Identify and briefly describe several examples of input technologies. Also describe several input technology trends.
6. Identify and briefly describe several examples of processing technologies. Also describe several processing technology trends.
7. Identify and briefly describe the functions carried out by each of the following central processing unit (CPU) components: arithmetic/logic unit (ALU), control unit, buses, memory unit.
8. Identify and briefly describe the factors that determine how fast a computer can process data and instructions.
9. Identify and briefly describe several examples of storage technologies. Also describe several storage technology trends.
10. Identify and briefly describe several examples of output technologies. Also describe several output technology trends.
11. What is system software? Identify and briefly describe two major categories of system software?
12. What are operating systems? Why are operating systems called “platforms”?
13. Identify and briefly describe each of the following components of operating systems: kernel, device drivers, user interface.
14. Identify examples of each of the following categories of operating systems: PCs and laptops, smart phone/tablet, server.

15. What are utility programs? Identify at least five examples of utility programs and briefly describe what each does.
16. What is application software? Identify several examples of application software.
17. Briefly describe each of the following categories of application software: Commercial-off-the-shelf (COTS), custom, horizontal market, vertical market, open source, mobile apps. Provide examples of software included in each category.
18. What is a software license? How do open source software licenses differ from traditional software licenses?
19. Identify examples of open source software that are widely used by businesses.
20. How does the best-of-breed approach to application software acquisition differ from an integrated systems approach?
21. Compare the advantages and disadvantages of best-of-breed software and integrated systems.
22. Identify and briefly describe several differences between on premises and cloud software deployment.
23. Briefly describe how user experience (UX) differs from user interface (UI).
24. What are the primary data management components of BIS infrastructures?
25. Briefly describe each of the following data management components: network attached storage (NAS), storage area networks (SAN), data centers, data warehouses (DW).
26. What is the extract-transform-load (ETL) process?
27. What does data cleansing involve?
28. What are infocubes and how are they used?
29. What is a database management system (DBMS)? What functions does an DBMS enable users and database administrators to perform?
30. Identify several examples of DBMS that are widely used by businesses?
31. What does Big Data processing involve?
32. What are Hadoop clusters? What is MapReduce?
33. Briefly describe the major functions performed by head nodes and compute nodes in Hadoop clusters.
34. What is SAP HANA? Why has it gained traction as a Big Data processing platform?
35. Briefly explain why a column-oriented database can outperform a row-oriented database?
36. Briefly explain the differences among local area networks (LAN), backbone networks (BN) and wide area networks (WAN).
37. What are the differences between Ethernet and WiFi?
38. Briefly explain the role of each of the following networking components: network interface cards (NICs), access points (AP), routers.
39. Briefly describe the characteristics of dedicated-circuit WANs. Identify examples of the leased circuits use to build dedicated-circuit WANs.
40. Briefly describe the characteristics of packet-switched services. Why are packet-switched services attractive to businesses?

41. Briefly describe the differences between the following WAN services: carrier Ethernet, multiprotocol label switching (MPLS), virtual private networks (VPN).
42. How does power-over-Ethernet (PoE) differ from traditional Ethernet?
43. What does adding cloud computing to BIS infrastructure involve?
44. Briefly describe the characteristics of each of the following cloud computing services: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a service (IaaS). Provide examples of each.
45. Why should business managers be concerned about BIS security?
46. What is Defense in Depth?
47. Identify examples of security controls used at each of the following layers of the Defense in Depth model: physical, perimeter, internal network, host/platform, application, data.
48. What is COBIT?
49. Briefly explain how BIS infrastructure can enable or inhibit the achievement of strategic objectives.
50. Why do some experts recommend overinvesting in BIS infrastructure?

INDIVIDUAL/GROUP ASSIGNMENT: The Medical Supply Company Case*

(*Modification of HBS Case: Hospital Supply Corp)

To Be Added

Chapter 5: BIS Acquisition and Implementation

CHAPTER OBJECTIVES

After studying this chapter, you should be able to

- Discuss the various forms that can be used to acquire business information systems
- Discuss both the waterfall and agile system development methodologies
- Discuss various implementation approaches
- Discuss an outsourcing methodology

INTRODUCTION

In chapter 3, we saw how the business strategy drives which information systems we should be using to support our business strategy. In this chapter, we look at how to implement those information systems. In other words, we answer the question, we know what we want to do, how do we make it happen?

In this chapter, we discuss the proper methods to be used to bring about the new work systems that we wish to engage within our organizations. We will look at how to decide whether to attempt to create the work system ourselves or outsource the function to others. We'll look at the situations in which it is appropriate to outsource or whether we will develop the capability ourselves. In general, when the work system we are examining is part of our core competence or key to our strategy advantage, it is not in our interest to outsource that function. However, when that function is not critical to our business or when we need to have the capability but don't have time to develop it ourselves, outsourcing may make sense. We will then look at a methodology for performing the outsourcing activity.

If we have determined to operate the work system ourselves, we will then look at ways of acquiring the needed information technology whether by constructing it ourselves or by purchasing it from others and the modifying it. We'll discuss various methods of acquisition and when which methods are warranted. In doing so, we'll discuss two system development methodologies: the waterfall approach or the agile approach. We will also discuss project management and how to successfully achieve project implementation.

We'll look at the drivers of successful implementation of information systems. We'll discuss the key factors to success information system implementation and then discuss how to approach implementation and change management.

At the end of chapter 3, we had arrived at the place where we had understood our competitive strategy and outlined a Work System by which we wanted to implement that strategy in our organization. In this chapter, we look at how to manage the process to design and implement that Work System in our organization. Figure 5-1 shows how we go about this process. First we have to design the Work System, then we have to acquire and/or develop the technology and then finally we need to implement the work system in our organization so that it starts to function. This entire activity can be considered a project, so we will need to manage the entire project to ensure that it concludes successfully.

Within this project note that we will be developing all the various pieces of the work system. Not only the information technology but also the work activities and processes, and training the participants of the work system to operate it. All of this is done with the goal of producing the products and services that are needed by the organization.

In this chapter, we will be following a running example. XYZ Corp. is a manufacturer of widgets. They have determined to compete by differentiating themselves in terms of the ease of configuration and ordering of widgets. The vision for this work system is to have an online ordering process for the customers by which established customers can configure and order their widgets and have them delivered on their schedule.

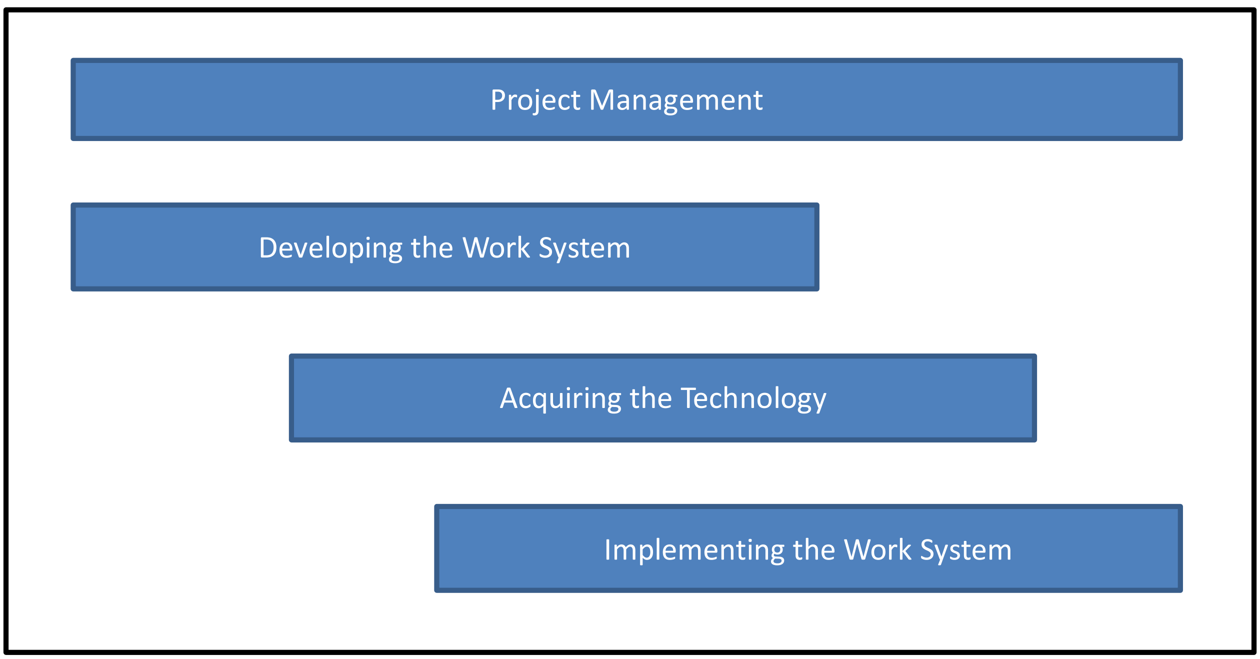

Figure 5-1: The Process of Implementing a Work System

PROJECT MANAGEMENT

To ensure that the work system is designed and implemented as efficiently as possible, XYZ will have to use a project management methodology.

Project Management International (PMI, pmi.org), the international organization of project managers has produced a Project Management Body of Knowledge (PMBOK). In the PMBOK, a **project** is a "temporary endeavor undertaken to create unique product, service or results". (PMBOK Guide, 5th Edition, p. 417). From this definition, we know that projects have a definite beginning and an end. They have limited resources in terms of time, money and people and material within which they must operate. They are also to produce a definite outcome in terms of a product or service provided. **Project management** is the "application of knowledge, skills, tools and techniques to meet project requirements" (Ibid). Project management is carried out through the application of project management processes. (ibid)

The object of using a formal project management process is to maximize the potential for a successful project. While success can mean different things to different stakeholders, we will use the definition of **project success** as occurring when a project delivers a product or service that provides the desired business benefit. In the case of XYZ, it may be that success is measured as a certain percentage of established customers using the new system and reduction in customer churn of a certain percentage and reduction in cost of sales of a certain percent. If after the new work system is implemented, these benefits are achieved then we can declare the project a success.

The Formal Project Management Process

These processes, shown in figure 5-2 are:

Initiate

In the **initiate phase**, projects are defined and authorization to begin the process is obtained. The initial scope is defined and financial resources are committed. A project manager is assigned. At this point, the **project boundaries**, the point in time at which the project is started or finished, are also defined. This information is captured in the **project charter**. The purpose of this phase is to align the expectations of **stakeholders**, those who will participate in or have a stake in the project, with the project's purpose, scope and objectives. (ibid, p. 424) Typically, the smallest amount of project time and budget is spent in this phase.

XYZ would complete this step as soon as they are ready to begin working on implementing this project. They would develop a project charter which would indicate that the project is to revise the order management process to allow established customers to select and customize the widgets they wish to purchase, receive a firm quote and then place an order in the system. The system will then send the order to manufacturing where the widgets will be built and then shipped to the customer at their requested delivery time. A project manager would be assigned and an initial budget for the planning phase would be created and approved at this time.

During this phase, the business case for the system is prepared. The **business case** provides the justification for devoting resources to the project. Projects are justified based on the type of project that they are. **Compliance projects** are "must do" projects. They must be done because some external entity has imposed the requirement on them. For example, if the government imposes a new mandate for reporting specific information or if a hurricane has destroyed a data center, a system to report the information or a new data center must be constructed. The basic consideration for these types of projects is how can they be done with the least amount of resources. **Operational projects** are those which improve existing business operations. In these projects, we want to get the maximum return for the resources expended. These projects are typically evaluated on **cost/benefit analysis** (CBA). In CBA, we want to know what the return will be for the resources invested. Typically, we have a specific required return such as **Payback** period, how long will it take to get back the money invested or appropriate **return on investment**. **Strategic projects** are those undertaken to implement a corporate strategy or to create new capability. For example, XYZ's initiative for an online ordering and customized product system is a strategic project because it creates a new capability for customer to configure and order their own parts. These projects are evaluated based on their ability to contribute to the execution of company strategy.

XYZ might have several possible projects that it could executed. However, it only has a limited amount of resources. To decide which projects it should do and which should be delayed until there are more resources, XYZ uses a **multi-criteria scoring model**. This type of model balances different selection criteria against the characteristics of the project to provide a way to compare projects against each other.

Once the defined project is approved, work moves to the planning stage.

Plan

In the **planning phase**, the total scope of the project, its objectives and plan to accomplish those objectives is developed. Through an iterative process working with the stakeholders, project plans are developed, timelines established, budgets created, risks identified, resource levels determined and communications plans established.

At XYZ, in the planning phase, the project manager working with the customer would complete the plans for executing the project and delivering the new order management system. Since this type of work system is new at XYZ and it is not clear what the final solution will be, XYZ decides to implement the project in phases: design, development, testing and implementation. After each phase, the plan for the next phase will be developed. Initially the plan for the design phase is completed. The work is outlined, the budget prepared, required resources identified, a risk assessment and communication plan is developed. These are approved by XYZ management. This type of plan is called a **stage gate** evaluation process because there is a gate at the end of each phase that must be passed before work on the next phase can begin.

Execute

In the **execute phase**, we complete the work defined in the project management plan. Work is coordinated, stakeholder expectations are managed, communications are issued. As part of this process the plan may be updated based on occurrences in the project: resource availability changes, activities running over or under time, changes in cost of resources, risk or opportunity events occurring. (ibid, p. 444) This phase usually consumes the largest amount of time and budget in the project.

In this phase, XYZ would execute the plans that were made in the planning phase. If for example, the investigation of various technologies takes longer than expected, the schedule and budget will need to be revised to take this into consideration. The design phase would be completed and the plan for the development phase created. This plan would be reviewed and approved and the stage gate would be passed. At the completion of the development phase, the plan for testing and implementation would be created and approved. When this stage gate is passed, the project moves to production.

Monitor and Control

Monitor and Control project work is composed of tracking, reviewing and reporting the progress of the project. Additionally, changes to the project plan are identified and initiated. Here data is collected on the status of project activities, overall project performance is reviewed and corrective action taken.

At XYZ, this phase runs at the same time as the execution phase. Actual work progress is recorded and project status is monitored. Status reporting is made to the stakeholders. If the project runs over because the investigation of technology is taking longer than expected, the expectations of the stakeholders as to project completion are adjusted.

Closure

In the **closure** phase, the project deliverables are completed and turned over to the project owners and all the contractual obligations of the project are completed. The project is then formally designated as complete.

At XYZ, when the work system has been completed and turned over to the users or in the case of the design phase, the design documents are completed with a proposal for the next phase, this project is determined to be complete.

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Figure 5-2: Project Management Process interaction

Benefits of a Formal Project Management Process

The key benefit of using a formal project management system is ensure that the work system is developed and implemented for least cost and achieves the benefits desired to the organization. Additionally, we ensure that we only execute **feasible projects**, those projects which can reasonably be thought to deliver the product or service for the budget and schedule desired.

Using a formal project management process reduces risk of failure by ensuring that the project has sufficient management support. For larger projects and especially cross-functional or cross-organizational projects, management support for providing resources and vocal organizational support is critical. One of the key factors in failure of such projects is lack of management support. A formal process also makes sure that the requirements for the system are correct by exposing the defined requirements to the stakeholders for approval. It also helps ensure organizational support for implementation of the system by managing stakeholder expectations. Through regular planned communications, stakeholders are kept in the loop, issues are surfaced to be addressed so that the stakeholders are not surprised by the work system when delivered.

DEVELOPING THE WORK SYSTEM

If you recall from Chapter 3, we consider that the unit of work for our activities is that of the Work System. The works system consists of 9 elements. To review, a work system is designed to product products and services for customers and to operate within a particular environment, within an infrastructure and under particular strategies. In developing a work system, we design the processes and activities to be operated by specific participants with specific technology and information to produce those products and services. The activities that we engage in to develop the work system are to 1) develop the processes and activities; 2) Acquire the technology artifacts and then implement the work system. In this chapter, we focus on how we acquire the technology. In Chapter 6, we talk about the processes and activities of the work system.

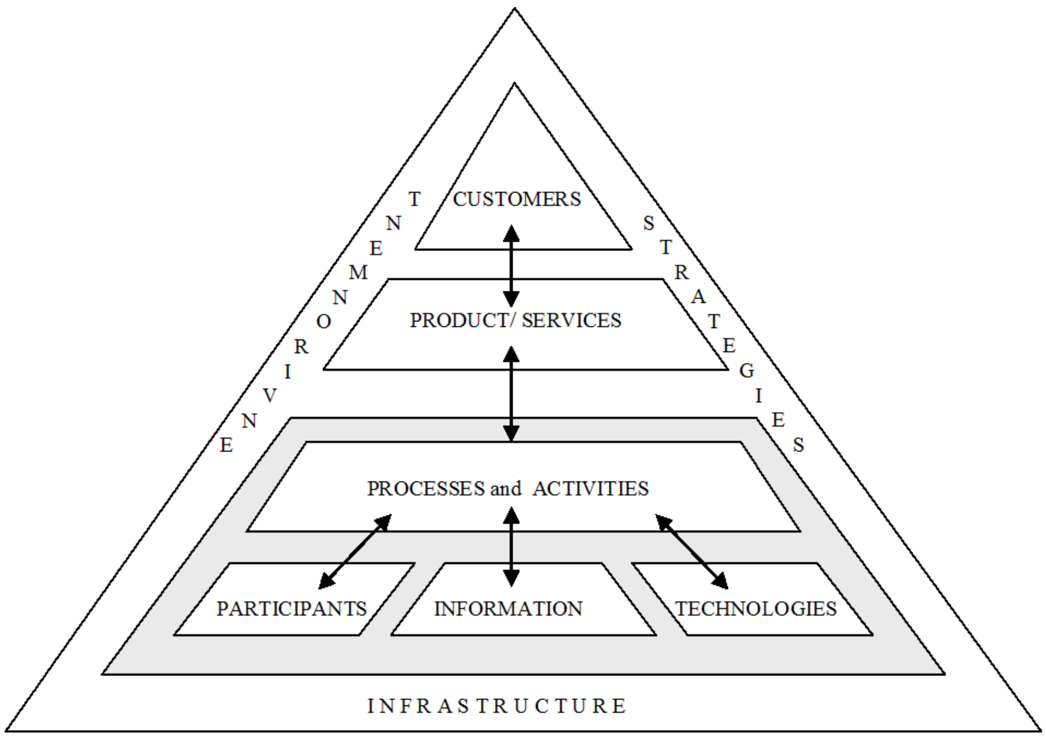


Figure 5-3: The Work System

ACQUIRING THE TECHNOLOGY

To acquire the hardware and software needed, XYZ follows a process known as the **Software Development Life Cycle (SDLC)**. The SDLC (figure 5-4x) is a process that is followed to develop or acquire systems. There are many ways to package these tasks. Here we will use this six-phase process:

1) System Definition
2) Requirements analysis
3) Design
4) Construction
5) Testing
6) Implementation

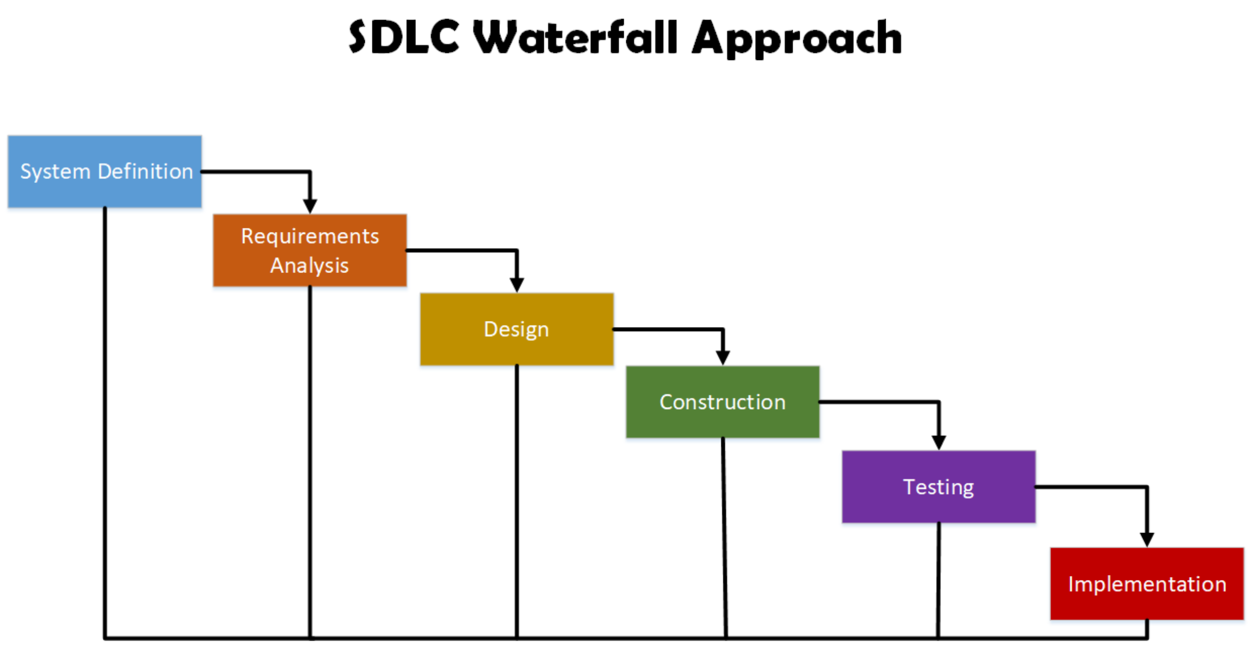


Figure 5-4: Systems Development Lifecycle

System Definition

The process begins with **System Definition**. In this phase, we seek to define the parameters of the system. In this process, we define what is to be in the system and out of the system and the parameters of time and cost associated with the system. In doing so we create what is called a **scope document**. This document provides a basic definition of the system: its objective, deliverables, technical parameters, and limits and exclusions. This document is typically very short only about a page, but it provides enough information to understand what the system is supposed to do and how it relates to the rest of the organization.

Once the system is designed we assess the feasibility of the system. There are four different types of feasibility: cost, schedule, technical and organization. **Cost feasibility** askes the question "can we afford to build this system?". Typically, we consider how much the system will cost and compare it to the anticipated benefits of the system. Issues with cost feasibility are that the organization might not have the money to be able to build the system. Other issues might be that the system will not return sufficient benefits for the cost involved. **Schedule feasibility** asks the question "do we have the time to build the system?" We may not be able to complete the system in time to meet some market deadline or resources required for the system might not be available during the time it will take to complete the system. **Technical**

feasibility asks "can we build this system? Do we have the skill and infrastructure to be able to build it?" Those might not be available or the existing infrastructure might not be able to support the new system. Finally, we consider **organizational feasibility**. This form of feasibility asks the question, "Is the organization ready to use a system such as this?" The organization may not be structured appropriately for it, personnel might not have the skills to use it properly, the organization might not see the need for the system. Answers of "no" to each of these questions does not mean that the system cannot be developed, but it does indicate that there are areas that need to be addressed if the system is to be developed successfully and meet the objectives for which it is designed.

At XYZ, the project manager meets with the **project sponsor**, the manager or executive who is the driver for this project. The sponsor provides the resources and is the executive support for the sponsor. In this case, the VP for Order Fulfillment. The PM gains the vision for the project from the sponsor and the sponsor's idea for a budget and timeframe. Then the PM meets with the IS department to assess the feasibility of the project and develops the scope document. Once the project is determined to be feasible and the scope document approved. The project begins to gather requirements for the system

Requirements Analysis

Once the system has been defined, we determine the functional requirements of the system. These requirements may be acquired from many methods. They may come from interviewing the users and managers who will be using the system. Another process is a **Joint Application Development** (JAD) activity. This is a structured process in which several users gather under the direction of a facilitator to discuss the requirements of the system. Other sources of requirements include existing information systems with which the new system is to interface or Business Process modelling activities which indicate how the processes and activities of the work system are to operate.

When the requirements are gathered, they are documented in various models. The models described how the system is the function, the objects which exist in the system and how it is to behave. When using the **Unified Modeling language**, the things the system is to do are recorded in Functional Models: use case diagrams and activity diagrams. A **use case diagram** shows at a very high level how the users interact with the system as to accomplish various functions. An **activity diagram** shows how each use case is accomplished. A **class diagram** shows the various entities within the system, their attributes and what they can do or have done to them. **Interaction diagrams** show how the various classes work together to accomplish a use case. **Behavioral State Machine** Diagrams show the various conditions or states that an object can go through in the system. These models together provide the functional specifications for the system.

At XYZ, the project manager recruits a requirement gathering team from the IS department. This team then interviews the various people who will be users of this system. Then the PM convenes a JAD session at which the prospective users discussed the requirements. These requirements are then recorded. The requirements team then develops the various UML models that will describe the requirements of the system. These models are reviewed with the users to ensure that the team understands how the various users are to interact with the system and how the system will perform the various functions that are expected of it. They find that they misunderstood some of the requirements and therefore have to go back and correct an refine various of the functionality. After a number of iterations, the users agree that they have captured the requirements of the system and approve the moving forward to develop fo the system.

Determining How to Acquire the Information System

Once the requirements are understood and agreed to, the next step is to determine the right method by which to acquire the actual work system. There are number of approaches that can be adopted by the organization. These different options are:

1) Purchase off the Shelf and implement "Vanilla"
2) Purchase off the Shelf and Modify
3) Custom development
    a. Done completely In-house
    b. Done in-house with help
4) Outsourcing the entire work system

Figure 5-5 shows the different possibilities in a graphic. First information is collected about the feasibility of the various options. Then a decision is made as to the proper approach for this project. Each of the various possibilities are described briefly below.

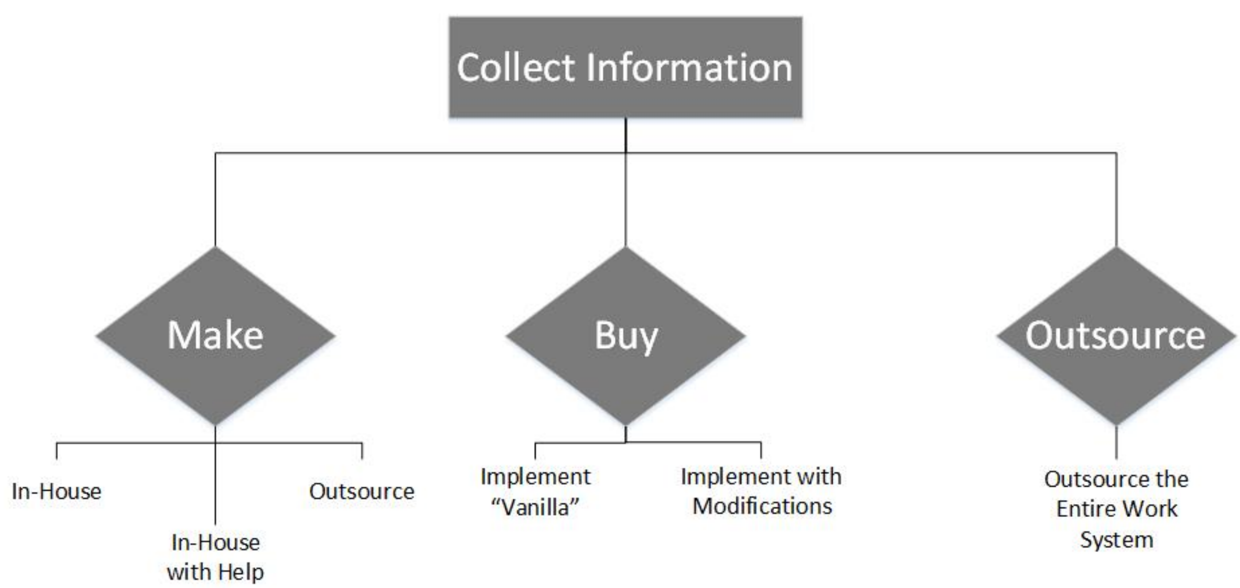


Figure 5-5: The Sourcing Decision Making Process

Purchase off the Shelf and implement "Vanilla"

Often applications can be purchased **off the shelf**. This means that the application is purchased from a software vendor. To be used "**vanilla**" means to use the software without modifications in the organization. This requires that the software match the organization's processes and activities in the various work systems in which it would be employed. Most of the time, the software is not an exact match and in this option, the company's processes are modified to conform to how the software is designed.

Purchase off the Shelf and Modify

In this option, software is purchased off the shelf and then modified to fit the needs to the organization. Many pieces of software have parameters that can be adjusted to conform the software to different ways of operating. This is called **configuration**. These parameters adjust the function of the software to execute in the way that the organization prefers.

If configuration of the software is insufficient to meet the needs of the organization, because the organization processes are unique or are beyond the capabilities of the configured system to adjust, the software can be customized. In **customization**, the software itself is modified. The program code is changed or new program code is written to provide new or changed functionality to the system. Many companies implementing ERP systems contract with consulting firms that specialize in that system to acquire skills for configuration and customization of the software.

Custom Development

A **custom development** approach is used when packages are either not available or do not sufficiently match the needs of the organization so that either the organization would have to change radically or modifying the software would not be cost effective. In that case, the software will need to be written from scratch.

There are three different approaches to custom development. First, the organization may develop the system by themselves. This approach requires the organization to have sufficient funds and technical skills to construct a system to perform the function required. If it has the funding but has insufficient technical skills, it may contract with firms to acquire those skills.

Outsourcing

Finally, it may decide to approach custom development by **outsourcing** the function. In this case, the design and development is performed by an external company under contract. This can either be an outsourced development or by outsourcing the entire function in which the entire work system is outsourced.

Determining the Correct Approach

To determine which is the appropriate approach, we need to answer several questions:

1) Are there existing packages and if so how well do they fit our requirements?
    a. Do we have the skills necessary to implement one of these packages?
    b. Do we have the skills necessary to modify one?
2) Do we have the skills necessary to build one for ourselves?
    a. Technical development skills
    b. Project management skills
3) Do we have the technical infrastructure necessary to run a package or do the development?
    a. What upgrades or enhancements will be required?
4) What help is available out there to assist us in selecting, modifying, implementing or developing the system?

Below we will describe a process by which you can get the information that you need to determine which of these is appropriate for your organization.

Determination Process

Step 1: Gather information

The first step in the process is to gather information about the options that are available to the organization. We gather information about packages that exist, the consulting help that is available for implementing them, and options available for outsourcing. Additionally, we examine our own internal capabilities.

To gather this information, we consult with experts. Consulting organizations such as Deloitte, KPMG and Accenture can assist in this area. **Consulting agencies** work with their clients to select and implement software packages among other services. They have broad experience across multiple different software packages and client companies. This broad experience allows them to know the strengths and weaknesses of packages and how well they fit in different organizations. They can therefore provide good information on what packages exist, their capabilities and what types of organizations benefit best from them.

We can also consult with **research firms** such as Gartner Group (www.gartner.com), Forrester (https://go.forrester.com/) Hfs Research (https://www.hfsresearch.com/) and IDC Research (https://www.idc.com/). Research firms not only provide consulting advice but also perform research and offer positions on the future of technology. In addition to working with companies with whom they advise, they meet with software package developers and survey the industry.

They provide consulting assistance as well as white papers on the current state and future direction of the industry.

From the consultants and research firms we can gain a certain perspective. We should also do our own research. We should read the **trade magazines** such as CIO (https://www.cio.com/), ComputerWorld (https://www.computerworld.com/), and Wired (https://www.wired.com/) as well as **Business related magazines** such as Harvard Business Review (https://hbr.org/), and Forbes (https://www.forbes.com/). Trade magazine journals devote their time to understanding the technology, its people and trend and to put it into non-technical language. Business related magazines but technology into a business-related context. We should also contact our network within the industry to see what they are doing with technology. Visits to other companies are also important to see in person what they are doing. Doing our own research allows us to verify what the consultants tell us.

We also need to assess our own capabilities. Do we have the technical and project management skills in-house to build our own system? Can we manage an outsourced development relationship? What skills would need to be acquired from outside to be successful? Is our technical infrastructure sufficient to be able to operate one of the packaged systems or will upgrades to it be required?

At the end of this step, we should have a realistic perspective on what is available in the industry and out capabilities. We can then make a reasonable decision based on data as to whether to build our own or purchase a package and if so, what will need to be done to make it work in our environment.
At XYZ, the PM and the project team meet with Garner Group and Forrester to discuss what is the state of the art in configured order management systems such as what they desire to do. They learned that given their existing ERP system, there were packages from OM Corp and Configurable Widget Co. However, these packages had never been interfaced with their ERP system and did not run on their existing infrastructure. They met a partner from Deloitte who gave them similar information. The also reviewed their internal capabilities. They have extensive experience customizing their existing ERP system and since they already run the ERP system there would be no infrastructure issues.

Step 2: Target the Services

In this step, we make the decision as to how to acquire the software. Using the information we gathered in step 1, we analyze it and make the decision. The goal is to determine the optimal way to acquire the software at least risk and lowest cost.

The first decision is "**make vs. buy**". In this decision, it is necessary to consider three major issues. Since it is almost always less expensive and less risky to purchase a package, are there packages available that will do almost all the functionality. For this case, you want to ensure that over 75% of the needed functionality can be provided by the package. If this is the case then you probably should purchase the package.

In looking at a purchase you then must consider if you have the technical skills to modify and/or implement the package and if you have the technical infrastructure to operate the package. If you do not, this will add to the cost of implementing the package. For some packages, it might cost 7 times the cost of the package in implementation costs.

If a software package is not available for your application, you will need to consider developing it in-house. In this case, you need to consider if you have sufficient technical and project management skills with which to develop such a package. If you do not, you will need to consider potentially outsourcing some or all the development based on the skills that you are missing.

In considering outsourcing, it is important to understand that sometimes outsourcing is not appropriate. In general outsourcing is not appropriate if the application is part of your core competency. A **core competency** is something that you can do or provide that customers value more highly than the offerings of your customers. It is the key to your competitive ability. You should not outsource this application. Figure 5-6 provides a matrix to assist in making the outsourcing decision around core competencies.

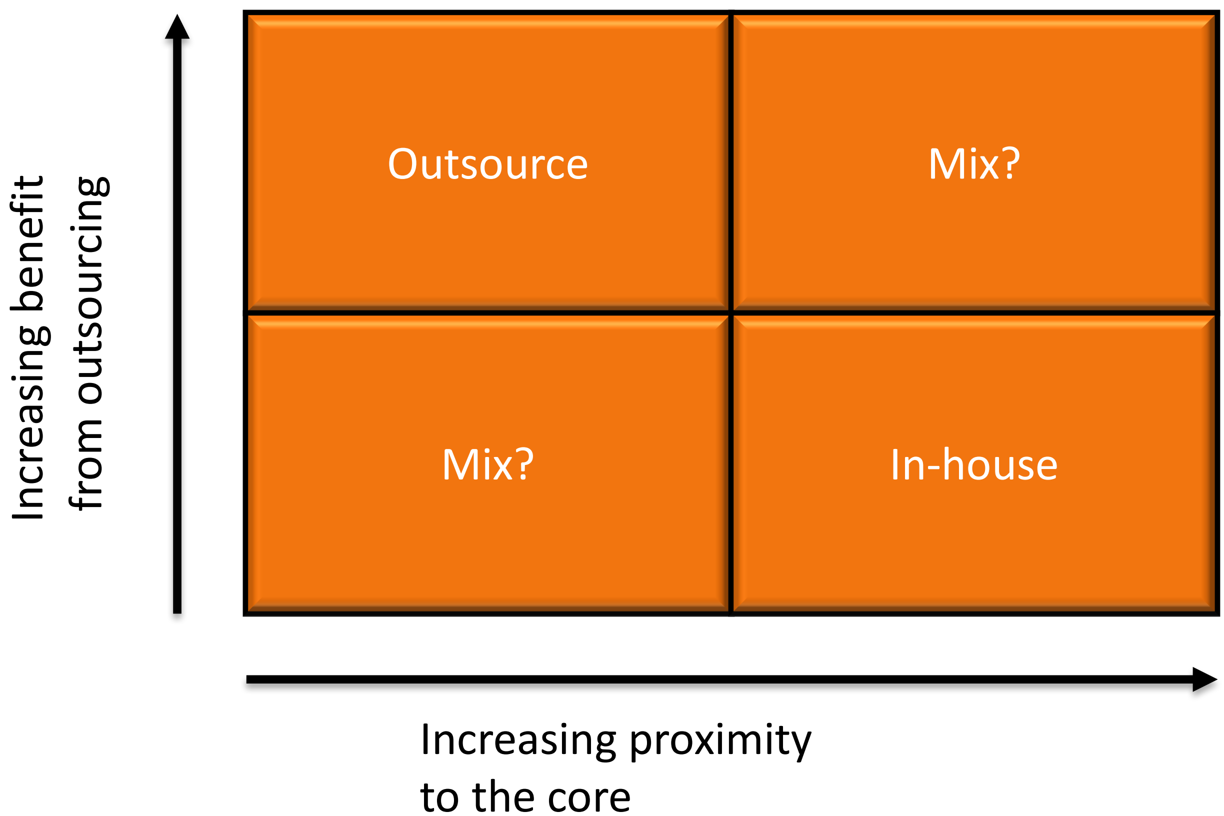


Figure 5-6: Outsourcing Decision Matrix

If the system to be outsourced provides significant value to the business and is near to the core and outsourcing it won't do must for you, in general you want to keep this in-house. If it does not provide significant value, and you can get a lot of benefit from outsourcing, then in general you want to outsource the system. In the other two situations, you need to consider other factors in making the decision such as your in-house capability and the availability of support for in-house development.

If the decision is made to outsource the develop, then the design, construction, and testing phases are performed by the vendor. We will now move forward with the work that is done if the decision is to develop the software in-house.

At XYZ, the team saw that since the packages that they reviewed did not run on their existing computing infrastructure that this was not the optimal decision for them. The IS group had sufficient bandwidth and experience to develop this functionality based on their existing ERP system. The financial implications were also about equal given the cost of the packages and new hardware compared against the cost of developing the systems in-house. Also, they viewed this as a future core competency as they hoped to gain a competitive advantage from this system. Therefore, they decided to develop the system in-house.

In-House Development

If the decision is made to develop the software in-house there are several approaches that can be taken. In these the design, construction and testing are performed by staff within your organization. They may be augmented by contracted personnel that are hired to supplement or provide the capabilities available in your in-house staff.

Traditional Waterfall Approach

The traditional approach is known as the **S**, so-called because the work products of each phase are completed and then flow into the next phase like water flowing over a waterfall. Three phases are completed here: design, construction and testing.

Design

During design, the models developed in requirements analysis are converted into specifications used by programmers for coding. These specifications include designs for the **user interface**. The specifications provide direction for how the user will interact with the system. They will include specifications for screen layouts, and report layouts. The **data management design** provides specification for construction of the databases to be used in the system. The **physical architecture** describes the hardware and operating system that the system will operate on. Decisions will be made as to cloud computing, client-server or host based architectures. The **class and method design** are used to specify how the program code will be done. Decisions will be made as to the programming language, database management system and interface protocols.

Construction

Also called implementation, In this phase, the system is actually built. The designs are transformed in the finished system. The code is written in the programming language defined during the design phase, the database designed and hardware platform acquired and implemented. Additionally, during this phase, conversion programs, programs used to convert data from systems being replaced are constructed and routines for manually loading data are developed.

Testing

Overlapping with construction, the testing phase ensures that the system functions as specified and designed. As program modules as completed, they are subjected to a unit test. In **unit testing** the individual modules are tested individually to ensure that they function as designed before they are integrated into their subsystems. Following unit test, the individual modules are integrated into subsystems and then into the complete system. In the **system testing**, the subsystems, the entire system and conversion programs are tested to ensure that the subsystem and entire system function correctly and data is converted or loaded correctly. **Test cases and test scripts** are constructed to provide complete testing. Test cases describe what will be tested, while the test script specifies how the test is to be performed. **Load or stress testing** is conducted to ensure that the system provides the response times required and can handle expected and near future transaction loads. Finally, **acceptance testing** is performed to allow the users to work with the system with actual production data to ensure that the system meets user expectations.

During testing, when the tests yield results different from what was expected, a bug report is generated. **Bugs** are defects in the function of an information system. The programming team corrects the bugs and then the tests are return. For acceptance testing, at the end of the test, the user signs off for the system to be implemented.

Agile Development Methods

Agile development methods differ from the traditional waterfall approach in that they seek to ensure project success by continuous interaction with the project owner so that changing requirements are captured as soon as possible and customer satisfaction is maximized. Unlike the waterfall approach, the work to be done is not determined up front, rather it is determined as the project goes along. The focus is therefore on agility rather than project management efficiency. Agile methods often feature incremental, interative and evolutionary development. Instead of one big software release, we have many smaller releases. They focus on being adaptive to changes rather than predictive of results. They maximize the opportunity to deliver value rather than adhering to a plan.

Agile Scrum Methodology

Scrum is a lightweight agile project management framework for incremental product development using one or more cross-functional, self-organizing teams of 4-9 people. Scrum is especially valuable for chaotic, not well defined products. It also assumes that the team is co-located and will continue to exist beyond the scope of one project. In contrast to the waterfall methodology, it values individuals and interactions vs processes and tools; working software over comprehensive documentation; customer collaboration vs contract negotiation; responding to change vs. following a plan.

The essential agile process is show in figure 5-X. In Scrum methodology, the features of a product are collected in a **product backlog** which is a list of potential features, bug-fixes, functions or uses that the system can have in it. These are prioritized by a **product owner**. The product owner has the vision behind the product development and is the final arbiter of requirements (what goes on the product backlog) and is focused on what is to be done rather than how. The product owner is also responsible for the return on investment of the product.

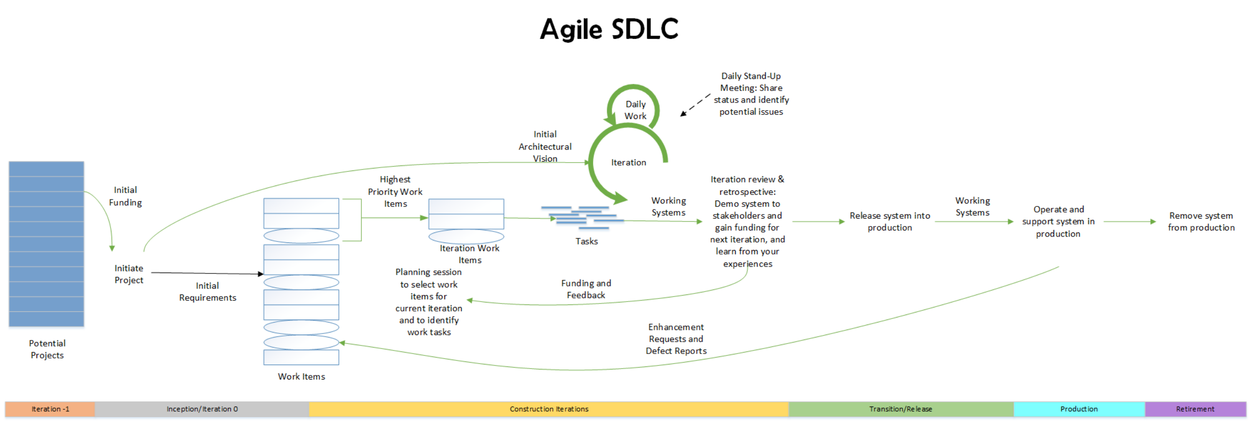


Figure 5-7: Agile process diagram.

The functionality of the product is delivered in a series of sprints. A **sprint** is short (less than one month) develop period in which the object is to deliver a working testable product increment. Within each sprint, the functions of design, construct and test are performed. The **scrum development team**, a **cross-functional** (includes all the various functions needed to develop software, requirement gathering, design, coding testing), self-organizing team, working with the product owner, selects a set of product backlog items that can be done within a sprint period to produce a working product. Once this **sprint backlog** is created, no more functionality is added to the sprint. The team then creates a series of tasks that must be completed to deliver this functionality. When the sprint is completed, an **iteration review and retrospective** is done. Stakeholders review the delivered functionality and make additional suggestions, corrections and additional functionality that is added to the product backlog. Team also examines their process in which they review what went well and what did not work so well. They revise their process for the next sprint. Then, the product owner reprioritizes the product backlog and a new sprint is started.

The team is facilitated by a **ScrumMaster**. This person is not a manager but rather a facilitator who works to ensure that the team has what it needs to succeed. The ScrumMaster removes obstacles, gets resources, protects the team from outside interference, facilitates the process, and trains new people. The ScrumMaster has no official power but rather works to ensure the team success.

Figure 5-8: Iteration. The concept of life cycle of product development. Diagram of life cycle of product development in flat style. Vector illustration Eps10 file

Scrum provides an early and sustainable rate of valuable feature delivery. Allows early feedback so we can discover errors in specification quickly and deliver the right product.

XYZ uses a Scrum development process. To develop the new system, the requirements are added to the product backlog as new features to the ERP system. The product owner is given instructions to prioritize this development, so the next several sprints are planned to be dedicated to development of the new order management system. The existing requirements are converted into user stories corresponding to each use case. The product owner and team meet and determine the use cases to be implemented in the next sprint. During the spring, the use cases go through a design process and are broken into tasks. The team addresses these tasks in their daily standup meeting discusses their progress. At the end of the sprint, they review the finished product with the product owner and users. There are a number of things they did not get correct, so these go into the backlog for the next sprint. Then the Product owner and the team discuss what will be included in the next sprint. They select the issues from the last sprint along with some new use cases. This become the content of the next sprint. This process goes forward until all the functionality for the new configurable order management system is completed. The last sprint includes a series of system test in which they ensure that the system will work properly under the expected number of transaction from their customers.

Lean and Kanban Software Development

Another form of agile development is Lean software development. **Lean Software Development** is based on the principles of the Lean Enterprise movement, and the practices of such methodologies as the Toyota Production System. The emphasis in Lean Software Development is on reduction of waste and and optimizing efficiency. Lean Software Development therefore seeks to maximize delivery of Value to the customer by optimizing the efficiency of the "**Value Stream**," the mechanisms that deliver that Value is of critical importance. The main principles of Lean methodology include:

- Eliminating Waste
- Amplifying Learning
- Deciding as Late as Possible
- Delivering as Fast as Possible
- Empowering the Team
- Building Integrity In
- Seeing the Whole

Waste is eliminated through such practices as selecting only the truly valuable features for a system, prioritizing those selected, and delivering them in small batches. To eliminate waste, emphasis is placed on efficient use of the use of team resources, ensure that everyone is productive as much of the time as possible. Lean seeks to eliminate dependencies and bottlenecks.

Lean teams make it a point to set aside time to take lessons learned about how to improve their work process. Decision-making authority and ability is pushed down in the hierarchy to individuals and small teams. Teams have significant control over their work flow. Lean believes that those closest to the work have the most knowledge about how the process is and should be performed.

Doing work "just-in-time" is the major philosophical ideal. Work is not begun until it is "pulled" via customer request. Lean Development emphasizes the speed and efficiency of development workflow, and relies on rapid and reliable feedback between programmers and customers. Lean also strongly recommends that automated unit tests be written at the same time the code is written.

Kanban

The concept of Kanban is based on the idea of a “signal”. In lean product manufacturing a kanban card or space signals to the production team that something is to be done. It is also used to manage the amount of work-in-process in the manufacturing flow.

In software development, **Kanban** is used to visualize what work is to be done. A **Kanban Board** is a board in which all the tasks necessary to be done are show along with their status. It signals what is in what status is a piece of work and what work is next to be done. By controlling the amount of work that can be entered into the Kanban board, the amount of work-in-process is controlled. As work is completed, new work is added to the Kanban board.

Outsourcing

If the decision is made to outsource the work, the design, construction and part of the test phases are performed by a contracted vendor. The acceptance test is performed by the outsourcing company.

Outsourcing is the delegation of work (IT or otherwise) from one party to another for a certain time for a certain fee at a specified level of service. We use outsourcing often in our lives. When we get our hair cut, we are outsourcing the cutting of hair to the barber or stylist. A business example would the Georgia Aquarium which outsourced operations such as parking, the cafeteria and the gift shop to other companies.

Outsourcing has therefore always been around. For example, the government routinely outsources many functions to contractors. However, outsourcing in the private sector began around 1962 when Ross Perot started the EDS company. They began selling computer time on borrowed and rented machines to companies. Outsourcing however really grew with the advent of health programs in the 1960s in which insurance companies like Blue Cross/Blue Shield outsourced their claims processing to EDS. Outsourcing received widespread prominence in the 1980s when Unilever outsourced it IS operations. After 2000, **offshoring**, outsourcing across national boundaries became prominent.

There are several types of outsourced relationships that can deliver you the IS that you need. One is the outsourcing of the complete IS operation. In this arrangement, your IS assets and people transfer to the outsourcer. The outsourcer then operates them providing it to you as a service. Another form is outsourced development. In this form, the outsourcer takes specifications from you, e.g. such as the documentation from your analysis activities described above and builds the system for your and then turns it over to you when complete. This could be combined in which your IS operations are outsourced and in the process they implement new systems for you.

What is important to understand about outsourcing is that the way that you do it is very important. Failure to do it the correct way can result in huge problems. For example, Sainsbury outsource their IS operations in 2000, by 2004 the deal have been renegotiated twice and they finally had to write of $473 in IT assets and in 2005 terminated the contract and brought the IS operations back in house. Similarly, in 2004, Dupont discovered over $150 million in over charges in their contract. So, the process by which you create the outsourcing relationship and how you manage it is critical to your successful relationship. This is not a “set it and forget it” arrangement it must be managed. Proper management can make a 40% different in cost savings.

Once the decision is made to outsource the development or modification of the software, additional work is done in the architect phase. This additional work begins with **Strategize**. In the strategize block, we plan the outsourcing engagement. We decide how we want to work with the vendor; how we will engage the contractor and how we will operate the contract. The staffing levels required to manage the contract and how decisions related to outsourcing will be made. Finally, we will do a feasibility analysis including make/buy, cost/benefit, risk and impact assessment. Here XYZ would perform all of these activities in order determine whether to proceed.

The final block in the architect phase is design. In this phase we create the configuration of the outsourcing relationship. We will define what will be outsourced, where services will be provided, the length of the contract, the relationship with the contractor, how we will be paid for it, how performance will be measured and how the contract will be managed. At this point, the company is now ready to go to market and engage with a vendor.

We will cover the next phases in less detail. In the **Engage** Phase, we select a contactor and negotiate the contract. The outsourcing relationship described in the design block of the architect phase is turned into a **Request for Proposal** (RFP). The RFP is released to the list of possible vendors that were identified in the investigate block of the architect phase. The RFP should be structured so that the decision makers have sufficient information to make an informed decision. Then the contract is negotiated. There should be no negotiation about terms, the terms were established in the design portion of the architect phase. At this point the outsourcing company has the most strength to get what they want.

The next phase, Operation, is where the contractor is executing their contract. The monitoring practices established during the design phase are put in place and regular status meetings occur regarding the status of the project. The contractor will perform the design, construction and testing phases except for acceptance testing. When they signal that test is complete, the software is delivered.

Outsourcing is not a process free of cost. You should expect to spend about 0.4% to 2.5% of the contract value in contracting (architect to engage phases). The proportion is larger for larger contracts. Operating costs run about 3-8% of contract value. If you choose to offshore, these costs run 12-15% of contract value. The goal during the length of the engagement is to spend less per dollar outsourced.

Once the contracted vendor delivers the software, the contracting company performs the acceptance test and when complete accepts the system as ready for implementation.

IMPLEMENTING THE INFORMATION SYSTEM

Implementation is phase of the acquisition where the acquired software, in which a package whether implemented vanilla or modified, the in-house developed software or contract delivered software is placed into production within the target work system. Once the acceptance test is complete and the software is accepted, the users are trained in the new system, then the old system data is converted, the manual data is entered into the system, the work system processes and the new system are entered into production.

There are several ways that the new work system can be implemented into the work system. First, the system can be implemented at once into all the areas affected by the new system. In this type of implementation, call "**plunge**" or "**Big Bang**" implementation, the old systems are shut off and the new systems are used. While effective for very small implementations where the amount of the organization affected is small, when applied to large parts of the organizations and especially where is spans organizational boundaries, this type of implementation exposes the organization to great risk. If the new work system fails for some reason, the affected area of the company is effectively out of action until the new system is fixed or the old system is reinstalled. For this reason, companies attempting larger implementations will have a "back out" strategy developed to return the operation to old system expeditiously or select one of the other styles of implementation.

In a **pilot** implementation, only one small piece of the organization is selected to gain the entire new work system. This could be a single department. This allows the system to be implemented in its entirety so we see how well it operates and how well it integrates with other systems. It also allows, in the event of issues with the new work system, for only a small part of the company to be effect while the bugs are being worked out. The system is then implemented in another department and a similar process is followed. This process continues until all areas targeted to use the system receive the system. A **phased** implementation, is like a pilot except that only a piece of the new system is implemented across the entire organization. This would a single subsystem of the entire system. Once the issues associated with that subsystem are resolved, another subsystem is implemented in the company. This process continues until the entire system is implemented. With a **parallel** implementation, the old system is operated simultaneously with the new system. Once the new system is held to be operation and ready to be on its own, the old system is disabled. This method of implementation, while avoiding the issue of what to do if the new system fails, is very expensive. Both systems must be kept running and often additional personnel must be brought on board to assist with the operation of one or both systems and with reconciling the two systems to each other.

At XYZ, the system developed through several sprints is readied for implementation. First, it goes through an acceptance test. The requirements team has developed a set of functional tests to ensure that the system functions as specified. A group of users and cooperative customers is trained on the new system and then executes these procedures with the new system. They identify issues and areas that could be improved. These changes go into the product backlog, some to be corrected in the next spring, others as enhancements for later. Eventually, the acceptance test is passed and is approved for implementation.

Because this system is an enhancement to and not a replacement for the old order management system and since customers do much of the work entering orders in the new system, it is determined that a parallel implementation is possible to do at XYZ. The users and select customers are trained, data is converted and the new system goes live. If the new system doesn't work well, XYZ can simply turn it off to be corrected and use the old system. Eventually, the new system is shown to be fully functional and the old system is turn off in favor of the new system.

CHAPTER SUMMARY

In this chapter, we have seen how an organization can acquire the new work systems that it needs within its organization. Strong project management is needed to ensure that the correct system is acquired in a timely and cost effect manner. We outlined a process by which these new systems could be acquired and installed. First, the system is defined and the objects of the acquisition are defined. The requirements are gathered for the system. Then a decision is made as to how to acquire the system. We outlined six different ways the software could be acquired. There were three in-house development alternatives: completely in-house, in-house with consulting assistance or outsourced custom development. Alternatively, the system could be purchased and used "vanilla" in which case the organization adapts to the software or "customized" in which the software would be modified to fit the organization.

If an in-house custom development decision is made, the development can follow a traditional waterfall development approach or it can be developed using one of the agile approaches, Scrum or Lean for example. If the project is to be outsourced, the requirements of the outsourced company are determined and an RFP is written and released. Upon selection the vendor performs the design, construction and testing portions and on completion delivers the software to the purchasing company.

If a package is to be used, the desired modifications are defined and requirements developed, then the company determines to perform them either in-house of through an outsourcing contract. At the completion of the modifications the system is ready for acceptance testing and implementation.

In acceptance testing, a set of users performs various key transactions with the goal of ensuring that the software work perform as the requirements dictate. Each deviation results in a bug report which is addressed and corrected. When the functionality of the system is acceptable to the users then it is accepted and implemented into production.

There are four ways in which and system can be implemented. It be a plunge implementation in which all parts of the system are implemented at once into all the organization with the old system turned off. This was seen to be risky as the users are effectively down until the new system is corrected or the old system is restored. A pilot implementation implements the system into a small part of the organization where any bugs are corrected. Once done, it is implemented into the rest of the organization. This minimizes the impacts to the organization. A phased implementation installs a subsystem across the entire organization. This limits the impact to a single subsystem. Once that subsystem is working then another subsystem is installed until the entire system is implemented. Finally, a parallel implementation runs the old and new system simultaneously. This is a very expensive approach as it requires running both systems as the same time and additional staff might be required to operate both thems.

KEY TERMS

REVIEW QUESTIONS

1. What are the four phases of the project management life cycle?
2. What are the key events of each of the four phases of the project management life cycle?
3. What are the six phase of the software development life cycle?
4. What are the key events in each of the six phases?
5. What are the different types of feasibility?

6. What are five ways that you can acquire software?
7. What are the key questions that must be answered to determine a sourcing approach?
8. What are the goals of the investigate phase of sourcing?
9. What role does core competency play in sourcing?
10. How are Waterfall, Scrum and Lean Develop different from each other?
11. What are some of the issues that are important in outsourcing
12. What are different ways that a system can be implemented and their strengths and weaknesses?
13.

Chapter 6 – Information Systems and Business Processes

CHAPTER OBJECTIVES

After reading this chapter, you should be able to:

- Describe the characteristics of business processes.
- Briefly describe the characteristics of process-centered organizations.
- Briefly describe business process physical, document, and data flows.
- Briefly describe the procurement process.
- Briefly describe the production process.
- Briefly describe the fulfillment process.
- Describe how process flow diagrams, data flow diagrams, and business process diagrams are used to illustrate and document business processes.
- Briefly describe business process re-engineering.
- Describe the characteristics of business process management (BPM) programs.
- Identify several organization-wide business process improvement programs.
- Briefly describe the characteristics of Six Sigma initiatives.

INTRODUCTION

In the previous chapters, the relationships among business strategy, value chain activities, and business information systems (BIS) components have been unpacked and explored. In Chapters 1 and 2, major factors influencing today's competitive business environment were discussed. These factors shape the data and information that organizations need to be competitive as well as the systems that organizations require to capture, store, and process data and inform decision-making.

Chapter 3 described business strategy as a response to competitive forces and results in organizational focus on value chain activities that are especially important for achieving strategic objectives. This chapter also discussed the link between competitive strategy and information systems strategy.

Chapter 4 examined how organizations leverage the Enterprise Architecture (EA) framework to align their strategies and BIS infrastructures. It also examined the major input, processing, output, data management, and security technologies included in BIS infrastructures. And Chapter 5 described how business strategy maps to BIS investment decisions and the importance of managing the acquisition and implementation of business information systems.

So, business strategy and its connections to value chain activities, and information systems requirements, investments, and implementation has been an important theme throughout the previous chapters. Along the way, the importance of having business processes aligned with business processes has been justifiably mentioned numerous times. In this chapter, we take a closer look at the characteristics of business processes, especially cross-functional business processes, and how they connect value chain activities and information systems. We will examine three processes that are common in business organizations: procurement, order fulfillment, and production. Business process reengineering (BPR), business process management (BPM), and organization-wide business process improvement programs will also be discussed.

BUSINESS PROCESSES

A **business process** is generally described as a set of linked tasks designed to deliver a service or product to a client, typically a customer. A business process can also be defined as a set of activities and tasks that accomplish a specific organizational goal. Figure 6-1 illustrates a generic business process.

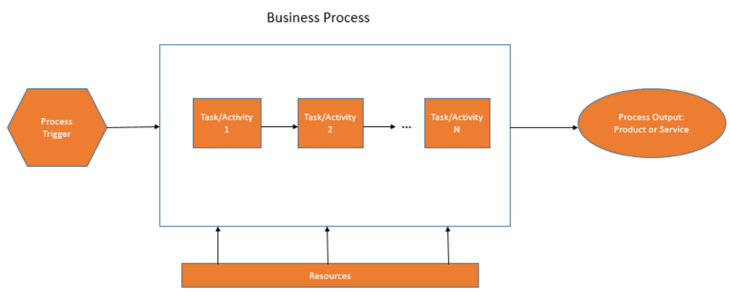


Figure 6-1: A generic business process
Courtesy: Thomas Case

So, a business process can essentially be described as a set of related activities or tasks that are structured to produce a specific service or product for a particular customer or group of customers.

Figure 6-1 also illustrates that business process tasks/activities often consume resources including energy, time, energy, and labor (effort). Hence, it is possible to assign costs to particular tasks/activities and to determine the total cost associated with completing the business process. For example, a manufacturing process that produces a customer product consumes materials (raw materials and/or components), electricity (to run manufacturing equipment and provide lighting and climate control for workers), and labor (employee time and effort required to produce the product), all of which contribute to the cost to manufacture the product.

A business process is well-designed and *effective* when it produces or service that is valued by the customer. When this happens, the process adds value to the organization (is value-adding). The magnitude of the value added by the process can be measured by the difference between what the customer is willing to pay for the product and service and what it costs the organization to produce the product or service. A well-designed process is also *efficient*. This means that it does not include unnecessary tasks/activities that drive up production costs and that it does not consume more resources than is necessary to produce the product or service.

Business processes are best understood within the context of value chain activities needed to achieve strategic objectives. Chapter3 describes how competitive strategy choices are reflected in how value chain activities are emphasized and structured. For example, when an organization chooses a low-cost, industry-wide strategy, inbound logistics, operations, outbound logistics value chain activities are structured to maximize efficiency and keep costs as low as possible. The business processes that support these activities (procurement, production, and order fulfillment) will likewise be designed to maximize efficiency and minimize costs. Figure 6-2 illustrates the connection between business strategy, value chain activities and business processes.

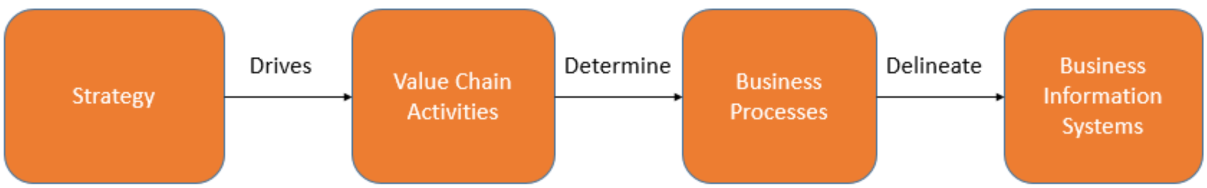


Figure 6-2: Business processes are structured to support value chain activities required to achieve strategic objectives.
Courtesy: Thomas Case

Essentially, a business process's tasks/activities are structured to achieve a business objective (the production of a product or service that is valued by customers). When the process's sequence of tasks/activities are completed, the business objective is achieved.

Types of Business Processes

There are three main types business processes: management processes, operational processes, and support processes. *Management processes* include the processes used by organizations to govern their business systems. Examples include governance processes such as those used by an organization's Board of Directors to oversee the business. Strategic management processes used by senior executives (with or without input/guidance from a Board of Directors) to identify strategic objectives and formulate strategic plans are also examples of management processes. Tactical management processes used to translate longer term strategic plans into medium-

Operational processes are core business processes within an organization's primary value chain activities. Examples include procurement processes (which support inbound logistics), production/service creation processes (which support operations), and fulfillment processes (which support outbound logistics).

Support processes are processes that support core business processes. In Porter's Value Chain Model, support processes are associated with secondary value chain activities. Examples of processes that support primary value chain activities include accounting processes, human resources recruiting processes, and technical support processes.

This chapter will primarily focus on operational processes. Three important operational processes (procurement, production, and fulfillment) and how they are inter-related are more fully described later in the chapter.

Business Process Decomposition

Some business processes are more complex and encompassing than others. A complex business process can be decomposed into several sub-processes. Each sub-process has its own attributes (trigger, tasks/activities, outcome) but contributes to achieving the business objective (outcome) of the more complex process (super-process) of which it is a part. The decomposition of a complex business process may include the mapping of sub-processes down to the task/activity level.

The Hire-to-Retire human resource management process is a complex process that encompasses numerous sub-processes. Figure 6-3 illustrates how this complex process can be decomposed into sub-processes that include their own tasks/activities. Several major sub-processes associated with the Hire-to-Retire process are depicted in Figure 6-3; these include hiring processes, development processes, reward processes, maintenance processes, and retirement processes. This figure also shows that reward processes consist of performance management and compensation management sub-processes. In this figure, the performance management process consists of performance appraisal, performance strength and weaknesses identification, and performance improvement target identification tasks/activities.

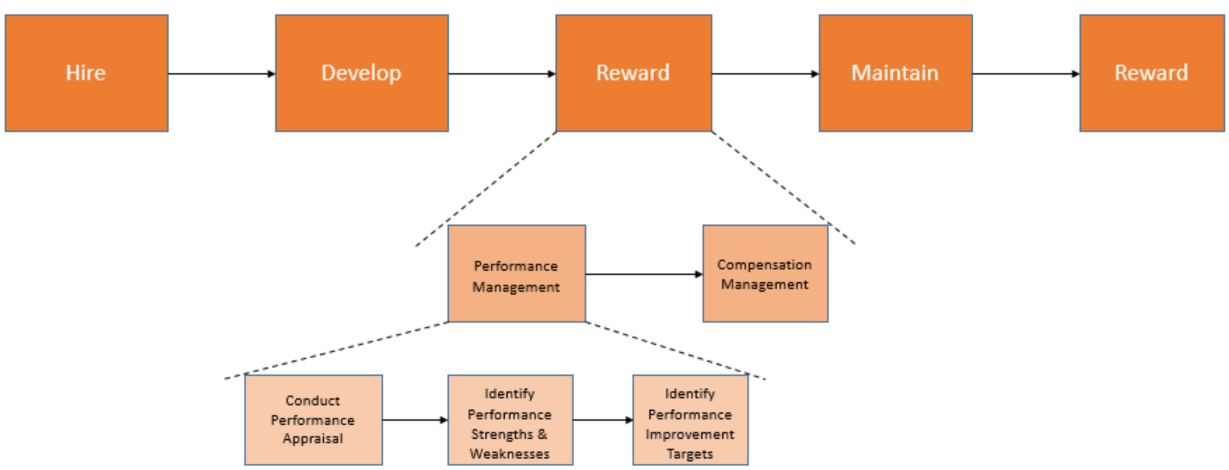


Figure 6-3: Decomposition of human resource management's Hire-to Retire process. Courtesy: Thomas Case

CROSS-FUNCTIONAL BUSINESS PROCESSES

Cross-functional business processes require multiple departments (functions) to work together to achieve the business objectives. The procurement, fulfillment, and production processes discussed later in the chapter are examples of cross-functional business processes because some their tasks/activities are completed within one functional area (department) while other tasks/activities are completed in at least one other functional area.

There numerous potential benefits associated with cross-functional business processes including improved communication, coordination, and relationships among departments involved in the processes, better and more widespread understanding of the processes' business objectives, greater upstream/downstream task/activity awareness, increased visibility/understanding of organizational processes, and better and more widespread understanding of how the organization works. Cross-training and horizontal movement of employees among departments involved with a process is another potential benefit of cross-functional business processes.

Examples of cross-functional business processes are illustrated in Figure 6-4.

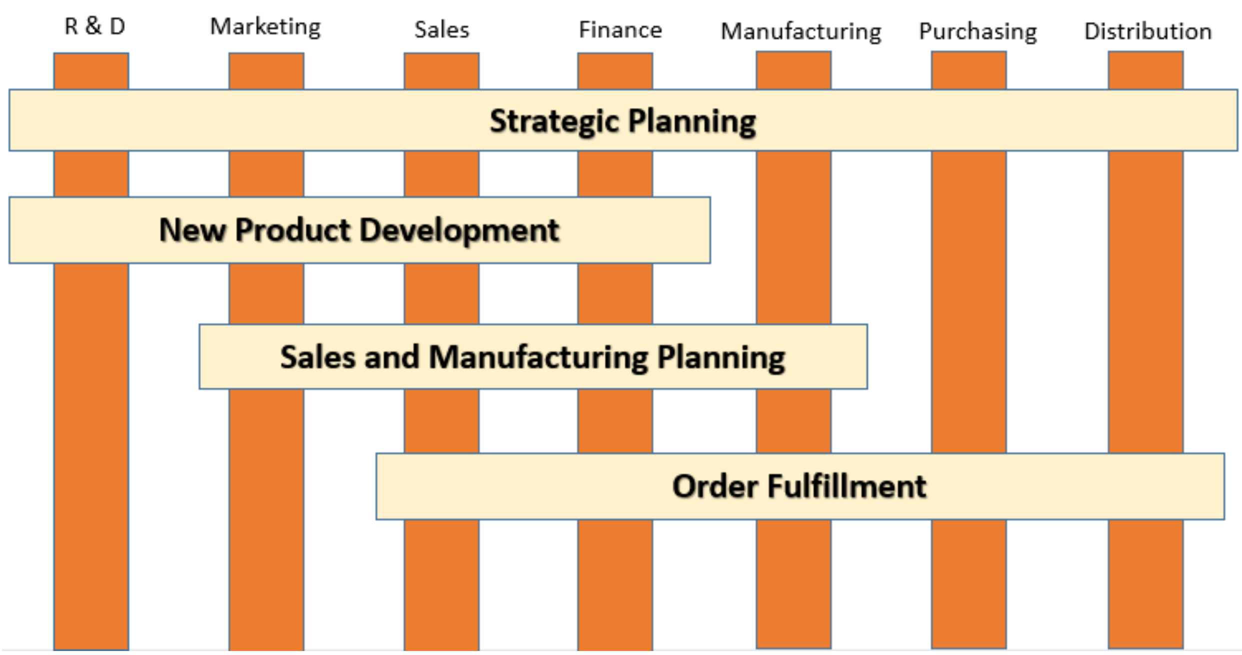


Figure 6-4: Cross-functional business process examples.
Courtesy: Thomas Case

PROCESS-CENTERED ORGANIZATIONS

In the past few decades, process-centered organization (PCO) structures have emerged as an alternative to traditional functional and product-oriented organization structures installed by organizations during the Industrial Age. PCO structures strive realign organization structures with a business's value-adding processes. In place of functional or product-oriented management hierarchies that dominate Industrial Age organization structures, in **process-centered organizations**, employees are organized into multidisciplinary teams whose goals are focused on managing the end-to-end tasks/activities associated with the business processes that deliver value to their customers.

An organization whose traditional organization structure has been centered on the functional areas depicted in Figure 6-4 (research and development, marketing, sales, finance/accounting, manufacturing, purchasing, and distribution) could become a process-centered organization by creating multidisciplinary teams focused on the cross-functional business processes depicted in Figure 6-4. For example, it could create one or more product development teams by reassigning employees who formerly worked in the organization's research and development, sales, marketing, and finance/accounting departments. The organization could also create one or more order fulfillment teams by re-deploying employees from the sales, finance/accounting, manufacturing, purchasing, and distribution departments.

While multidisciplinary teams are hallmarks of process-centered organizations, there is much more involved with evolving to a true-process centric organization including changes in business management mindsets and organizational culture. A list of additional attributes of process-centered organizations is provided in Figure 6-5.

The organization focuses on the key processes that provide competitive advantage.

The organization's leaders/managers are committed to leveraging process for business results

Employees are aware of the company's value creating operational, support, and management processes.

The organization's processes have well defined owners.

The organization invests in improving its key business processes.

The organization is structured around business processes or value streams.

The organization is focused on achieving process goals.

Process performance gets measured through metrics that focus on process efficiency, effectiveness and adaptability to changes in customer requirements.

Process management and improvement initiatives (such as business process management (BPM) and Six Sigma programs) are embraced across the entire organization.

The organization's culture values process thinking.

Figure 6-5: Attributes of a process-centered organization.
Courtesy: Thomas Case

Process-centered organization (PCO) structures are often considered to be best practice in industries where information flows and lean, rapid material flows are critical for sustained competitiveness. Removal of traditional functional boundaries typically accompany the implementation of PCO structures and the multidisciplinary teams that are created are typically empowered to be self-managing. When PCO structures work as they are supposed to core business processes that support the organization's most critical value chain activities can be run by fewer layers of management. This reduces the organization's administrative costs and has the potential to increase its overall efficiency and profitability. PCO structures enable traditional communication routes to be short-circuited and enables increased communication and information sharing across the organization.

BUSINESS PROCESS PHYSICAL, DOCUMENT, AND DATA FLOWS

bo

COMMON BUSINESS PROCESSES

An organization's **core business processes** is the set of processes that must exist for the proper functioning of the organization. These are processes that contribute directly to providing value to customers. Core processes are typically operational processes rather than support or management processes.

Because they are critical to the long-term success and survival of the organization, core processes are sometimes described as *mission critical* processes. Essentially, core business processes are the processes that the organization must do correctly and/or efficiently to be sustainably competitive in its market environment.

In this section, we will discuss three operational business processes that are common in business organizations: procurement, fulfillment, and production. The fulfillment process is a core business process for many businesses. For some organizations, procurement and/or production are also core business processes.

Procurement Process

Because the procurement process was used to illustrate business process physical, document, data, and information flows, you may find parts of this section's discussion of the procurement process to be redundant. This section strives, however, to provide some additional insight into the procurement process.

Almost every organization has a procurement process to support its value-chain's primary (core) inbound logistics activity. The process itself is sometimes called the *procure-to-pay* or *requisition-to-pay* depending on whether the initial tasks/activities in the process include the creation of purchase requisitions.

Procurement is a cross-functional business process because its end-to-end tasks/activities are performed by multiple functional areas. Multiple functions are involved in creating or processing the documents in the procurement process's document flow (see Figure 6-6). For example, business units and/or the organization's materials warehouse create purchase requisitions which specify needed goods/materials that need to be replenished. These requisitions are sent to the organization's purchasing function which batches and aggregates them into purchase orders which are sent to suppliers (vendors). Batching and aggregation of purchase requisitions is done to enable the organization to take advantage of quantity discounts offered by suppliers and to minimize shipping costs (e.g. there may be less cost involved by combining two requisitions into a single purchase order to the same supplier than in receiving two shipments from the supplier, one for each purchase requisition).

Vendor shipping documents are reviewed by the organization's shipping and receiving function which is often located at a warehouse. Personnel review shipment contents against the vendor's shipping document to verify consistency between what is stated in the document and included in the actual shipment. This verification procedure results in a good receipt document.

The vendor invoice for a shipment is received and processed by the organization's accounting function. Accounting also issues payment for the goods/materials it has received from the supplier. In many organizations, payment is made after the goods receipt, vendor invoice, and purchase order documents are compared and verified to be consistent. Comparing these three documents is often called the *three-way-match.* The three-way match is an example of an internal control for its purchasing and procurement activities.

The involvement the purchasing, shipping/receiving, and accounting functions in the creation and/or processing procurement-process documents demonstrates that it is a cross-functional business process.

The primary physical flows within the procurement process consist of the goods/materials shipped by the supplier to the purchasing organization. Vendor shipments are often received at shipping/receiving docks at customer locations. From there, goods/materials are typically moved from the receiving dock to specified storage locations in the organization's warehouse.

Figure 6-10: Procurement process physical flows
Image ID: 377736322

Key procurement process data flows include the details (product IDs, product descriptions, unit prices, and product quantities) included on purchase requisitions, purchase orders, shipping documents, invoices, and goods receipt documents. Consistency among these details in the documents for a particular purchase order is important in the three-way match and payment tasks/activities within the procurement process.

In addition to the instance- and process-level information identified in the previous section, it is important to note that the batching and aggregating of purchase requisitions by the purchasing function when creating purchase orders is another example of procurement process information flow, one that enables the content of a purchase order to be mapped to particular purchase requisitions.

Chapter 8 describes the procurement process in considerably more detail. This chapter also describes the role of various information technologies in automating the procurement process (such as electronic data interchange (EDI) and radio frequency IDs (RFIDS). Particular attention is paid to how enterprise resources planning (ERP) systems provide end-to-end support for the procurement-process.

Fulfillment Process

An organization's fulfillment process is typically classified as a core business process that directly provides value to the organization's customers. It is a process that organizations strive to do correctly and efficiently because it directly interfaces with customers and affects their perceptions of the organization and willingness to remain continue to do business with the organization.

The fulfillment process maps most directly to the outbound logistics value chain activity. However, it also is related to the sales and marketing value chain activity.

The fulfillment process is a cross-functional process whose tasks/activities involve (at a minimum) the organization's sales, finished goods warehouse, and accounting functions. The cross-functional aspects of this operational process can be observed in its document flow (see Figure 6-11. The green documents are generated by the sales function, the blue documents are generated by the accounting function, and the other documents are key documents in the fulfillment process tasks/activities that are performed in the organization's warehouse.

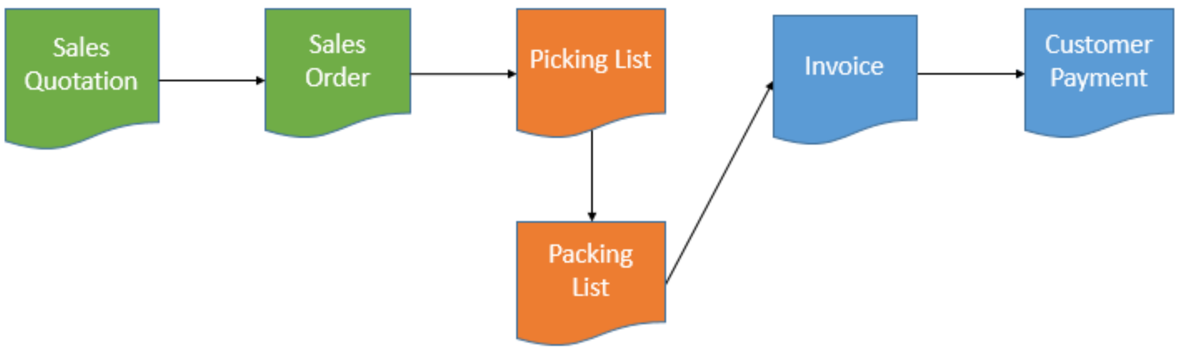


Figure 6-11: Fulfillment process document flow.
Courtesy: Thomas Case

The fulfillment process is often called the *order-to-cash* process because it involves the tasks/activities needed to receive customer orders, ship ordered goods/materials, and process customer payments. In some organizations, it is called the *quotation-to-cash* process because prior to the receipt of a sales order, the sales function provides prospective customers with a quotation which specifies the unit prices for specific quantities of particular products if an order is placed within a specified time period.

Key data flows in the fulfillment process include data about the goods/materials items included in customer orders. This include each item's product ID, product description/name, product attributes (e.g. weight, color, size), unit price, and order quantity. Product ID, description, attributes, and quantity flow from the customer order (typically received by the sales function) to the order's picking list, which is a key document in the pick/pack/ship activities carried out in the organization's finished goods warehouse. The picking list is used by warehouse personnel to locate items needed to fulfill the order (see Figure 6-12).

Figure 6-12: Warehouse order picker verifying/collecting items needed to fulfill an order.
Image ID:391811314

From the picking list, this same data flows to the packing list, the list of items included in the shipment to the customer in response to the customer order. If the customer order is small, the items order by the customer may all be placed in a single box along with a packing list (which specifies what is included in the box). If the customer order is more sizable, ordered items may be placed in multiple boxes which are shrink wrapped together for shipment to the customer (see Figure 6-13).

Figure 6-13: Order packing in a warehouse.
Image ID:129624017

Product ID and/or product description, unit price, and order quantity flow from customer orders to invoices generated by the accounting function and transmitted to customers when order shipments occur. Invoice data is compared to customer payments by the accounting function to ensure that the organization is being paid for the items that were shipped to the customer.

The primary physical flows within the fulfillment process include the movement of goods/materials at the warehouse as part of the order picking, packing, and shipping tasks/activities that take place in response to the receiving the customer order. Picking involves the removal of items from storage locations within the warehouse. Packing involves the bundling of the items needed to fulfill an order and shipping involves the transfer of the bundled items out of the warehouse to vehicle used to deliver order items to the customer.

Instance-level information associated with a particular customer order enables the organization to address customer questions such as:

- Has the order been received?
- Has the order been picked? Packed?
- Has the order shipped?
- Has the invoice been sent?
- Has payment for the order been received?

Process-level information that can be generated from the aggregation of iterations of the fulfillment process include:

- What is the average time between order receipt and shipment? Is this average time increasing or decreasing over time?
- Which customers place the most orders? What do they typically order?
- Which products are ordered most often? Which products are ordered least often?
- What is the average revenue for a customer order? On average, how much does it cost to fulfill a customer order?
- Which customers have the best payment history? Which customers habitually make late payments?
- Which products have the lowest average order-to-shipment times?
- Which products have the highest average order-to-shipment times?

The answers to such process-level questions provide insights into how the organization's fulfillment process might be improved.

The fulfillment process is described in greater detail in Chapter 9. Chapter 9 also describes how ERP and CRM systems support the fulfillment process.

Production Process

The production process includes the tasks/activities used by an organization to transform inputs (raw materials and/or components) into outputs (products and services) that are valued by customers. It is more complex than an organization's procurement and fulfillment processes and it is typically integrated with both of these processes in well-run businesses. Because the production process results in the creation of goods/services that are valued by customers, it is typically considered to be a core process.

The production process supports the operations primary value chain activity in Porter's Value Chain model. However, because it shares integration points with the procurement and fulfillment processes, the production process can also be mapped to the inbound logistics, marketing and sales, and outbound logistics activities within an organization's value chain.

In response to competitive forces in their environment, organizations adopt two common production strategies, make-to-stock, and make-to-order. The **make-to-stock** production strategy is driven by finished goods inventory levels. Finished goods are stored in one or more warehouses until they are needed to fulfill customer orders. When warehouse inventories fall below predefined levels, the make-to-stock production process is triggered to bring warehouse inventory back to acceptable levels. Apple, Inc. is an example of a company that uses the make-to-stock production strategy to ensure that it has a sufficient quantity of Macs for its Apple stores. Apple's warehouses monitor sales of Macs at Apple stores and issue production requests when the Macs needed to replenish the stores causes warehouse inventory to fall below predefined thresholds.

In the **make-to-order** production strategy, the production process is triggered by the receipt of a customer-order. This strategy is best suited for low volume, high profit margin situations where products are custom-produced to customer specification. Boeing is an example of a company that uses the make-to-order production strategy to compete within the aerospace industry. Each of the orders that Boeing receives is typically for a limited number of aircraft and order specifications are likely to vary by customer type. For example, aircraft orders from the military usually include specifications that are very different from those for orders received from airline companies.

The major tasks/activities associated with the production process are outlined in Figure 6-14. Because the production process can be quite complex, such as the manufacturing of an automobile or the assembly of an airplane, in many organizations, each of the tasks/activities in Figure 6-14 can often be decomposed into sub-tasks/activities, especially the create product task/activity.

Figure 6-14: Production Process Tasks/Activities
Courtesy: Thomas Case

In an organization that uses a make-to-stock production process, production requests originate in the organization's finished goods warehouse. Production authorization is performed by the organization's operations/manufacturing function, while the issuing of raw materials is done by the organization's raw materials warehouse. Production creation is performed by the operations/manufacturing function and the products that are produced are received by the organization's finished goods warehouse. Because multiple functions are involved in performing tasks/activities, the production process is another example of a cross-functional business process.

The production process's document flow is depicted in Figure 6-15. The *planned order* document is produced during the production process's request production task/activity. A planned order is a formal production request that specifies what finished goods need to be produced and the quantity (number of units) that is needed. A planned order also typically specified when the finished goods is needed to enable production authorizers to appropriately schedule the production of the finished goods.

The *production order* document is created during the authorize production task/activity. It is a formal commitment to produce the specified quantity of finished goods by a specific date and/or time. The production order formally commits numerous resources, including time, raw materials, work centers, and production workers to the production of the finished goods specified in the production order. Production orders are typically created by converting planned orders.

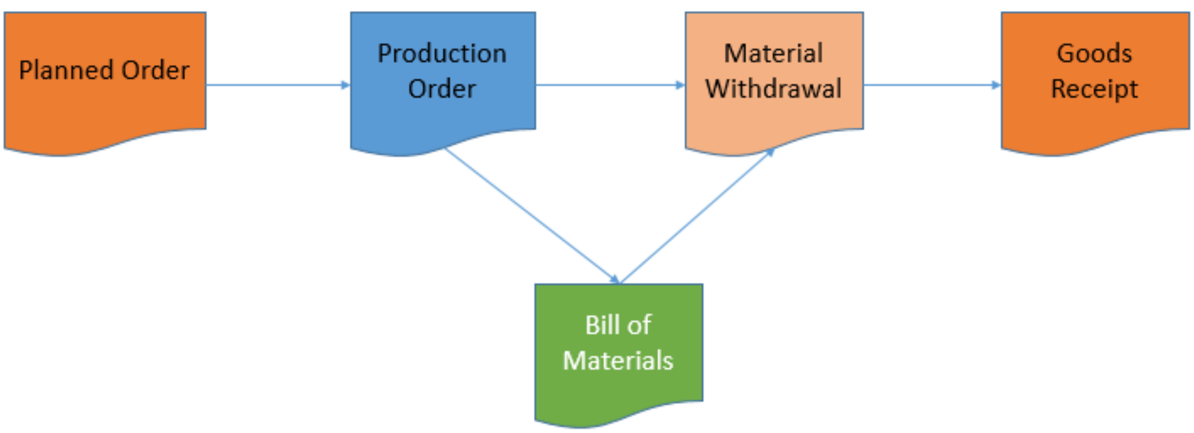


Figure 6-16: Production process document flow
Courtesy: Thomas Case

The *bill of materials (BOM)* document identifies the components (raw materials and sub-components needed to produce a single unit of finished goods. An example of a BOM is provided in Figure 6-17. The bill of materials for a finished good is used to identify the quantities of raw materials and sub-components needed to complete a production order. It is a very important input to the production process's issue raw materials task/activity.

Bill of Material for a Skateboard

Bill of Material Part No: 150-002

Part No.	Description	QTY	Unit	Unit Cost
1-115	Deck	1	EA	$ 50.00
4-556	Wheel	4	EA	$ 16.00
6-455	Bearing	8	EA	$ 10.00
4-854	Truck Bolt	8	EA	$ 2.00
2-258	Truck Nut	8	EA	$ 2.00
2-560	Gripe Tape	2	EA	$ 10.00
1-777	Axel Nut	4	EA	$ 4.00
1-983	Spacer	4	EA	$ 1.00

Figure 6-17: Bill of materials example.
Stock vector ID: 146857787 and Thomas Case

When a production order is released for production, *material withdrawal* slips specify the raw materials and/or sub-components in the raw materials warehouse(s) needed to create the quantity of finished goods specified in the production order. These formally commit specific quantities of stored raw materials and/or sub-components to the production order.

When the quantity of finished goods specified in the production order are produced during the create product task/activity (when production is confirmed), they are moved from the production area to the finished goods warehouse. During the receive finished goods task/activity, the finished goods warehouse creates a *goods receipt* document that verifies receipt of the finished goods from the production function. The creation of this document triggers the updating of the warehouse's finished goods inventory.

Data flow during the production process centers includes data about finished goods, production orders, materials and resources used during production, and storage locations of finished goods that are produced. When production is requested, the needed quantity of the finished good is identified along with when it is needed. The finished good's BOM specifies the quantities of raw materials and components needed to produce the needed quantity of the finished good.

When production is authorized and subsequently released, a commitment is made to produce a specific quantity of finished goods by a certain date. Numerous resources including raw materials/components and work centers (a **work center** is a location where specific work operations needed to produce a finished good is carried out) are committed to producing the specified quantity of finished goods in the production order. The authorization of production includes the assignment of a production order number and specifies the operations needed to produce the finished good, the work centers that will carry out the operations, and the sequence in which the operations will be performed. Preliminary estimates of the costs associated with the production order (raw materials/components, labor, and overhead, are also included in production orders.

The release of a production order includes goods issue. *Goods issue* identifies the quantities and storage locations of raw materials and/or components needed to complete the production order. The specified materials/components are assigned to the production order and their status in inventory changes from un-assigned to assigned (to ensure that individual raw materials/components are not assigned to more than one production order).

Once the actual production of the quantity of finished goods in the production order is completed, the production order is confirmed and the goods produced are placed in finished goods inventory. The *goods receipt* identifies the production order number, the quantity of finished goods received, the date of receipt, and storage location(s) of the finished goods in the finished goods warehouse. The good receipt triggers the updating of finished goods inventory levels.

There are typically more physical flows associated with the production process than the procurement or fulfillment processes. The primary physical flows associated with the production process involve the movement of raw materials/components from raw material storage locations to work centers, the movement (routing) of partially completed finished goods among work centers involved in producing the finished goods, and the movement of finished goods from the production area to finished goods storage locations.

Instance-level information (information about the status of a particular production order) of the production process enables the organization to address customer questions such as:

- Has the production order been approved?
- Has production been scheduled?
- Have the ordered products been produced?

Process-level information that can be aggregated from multiple production orders to identify opportunities to improve the production process include:

- What is the average time needed to produce each finished good?
- What is the average time needed to complete each operation in the production of a finished good?
- Which finished goods are produced most frequently?
- What percentage of production orders are completed on time? What percentage are delayed?
- What are the common causes of production delays?

The production process can be quite complex and the overview provided above does not begin to do justice to how the process is supported by BIS. A deeper dive into the production process and how ERP systems support this process and its integration with the procurement and production processes is provided in Chapter 10.

DOCUMENTING BUSINESS PROCESSES

As business organizations become more processed-centered, they recognize the value of documenting their business processes, especially the core processes that enables them to be competitive within their business environments. Documenting a business process's tasks/activities can make it easier to train new hires, maintain consistency, adhere to legal requirements and/or regulations, and identify opportunities to improve the process.

Business process documentation can range from narrative descriptions of the sequence of tasks/activities that make up the process to diagrams that visualize all or parts of the business process. No matter what type(s) of business process documentation is used, the documentation should explain why the process is important to the organization and the steps that it involves. In processes that require employees to make personal judgments, providing the context and reasons why the process exists can help employees make appropriate choices. For processes where personal judgment is disallowed for legal/regulatory reasons, contractual obligations, risk factors, etc., providing context and process rationale can help employees understand why procedures need to be exactly followed.

Best practices in business process documentation includes starting with the big picture, and then drilling down. The big picture identifies how the process fits into the organization's overall operations. Drilling down involves identifying the details, technical specifics, and procedures associated with each step in the process's sequence of tasks/activities. Ideally, the big picture overview of a process can be narratively described on a single page. Flowcharts, data flow diagrams, and business process diagrams are typically used to document the specifics associated with process steps.

Business Process Flowcharts

Business process diagrams, including business process flowcharts, illustrate how business processes are implemented. They help managers and employees understand the processes within the organizational context and help them envision potential exception scenarios for the process. Business process diagrams help managers and employees identify process improvement opportunities, including process automation opportunities. The diagrams are visual aids that help ensure that everyone is on the same page.

A **business process flowchart** provides a picture of the separate steps of a business process in sequential order. It illustrates the sequence of tasks/activities, decisions that must be made, process inputs and outputs (materials or services entering or leaving the process). It may also illustrate the people and/or time involved with each step in the process. High level business process flowcharts, such as that illustrated in Figure 6-18, typically visualize only the major steps for process and leave out details such as inputs and outputs, decisions made, and people or time involved.

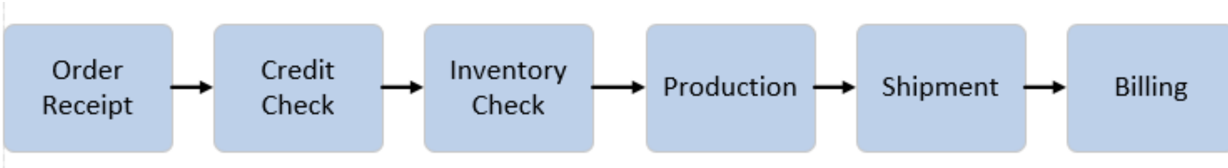


Figure 6-18: High Level Diagram of an Order fulfillment process.
Courtesy: Ryan Wilcauskas

Detailed process flowcharts about a business process, such as that illustrated in Figure 6-19, provide a much more granular picture of what the process involves.

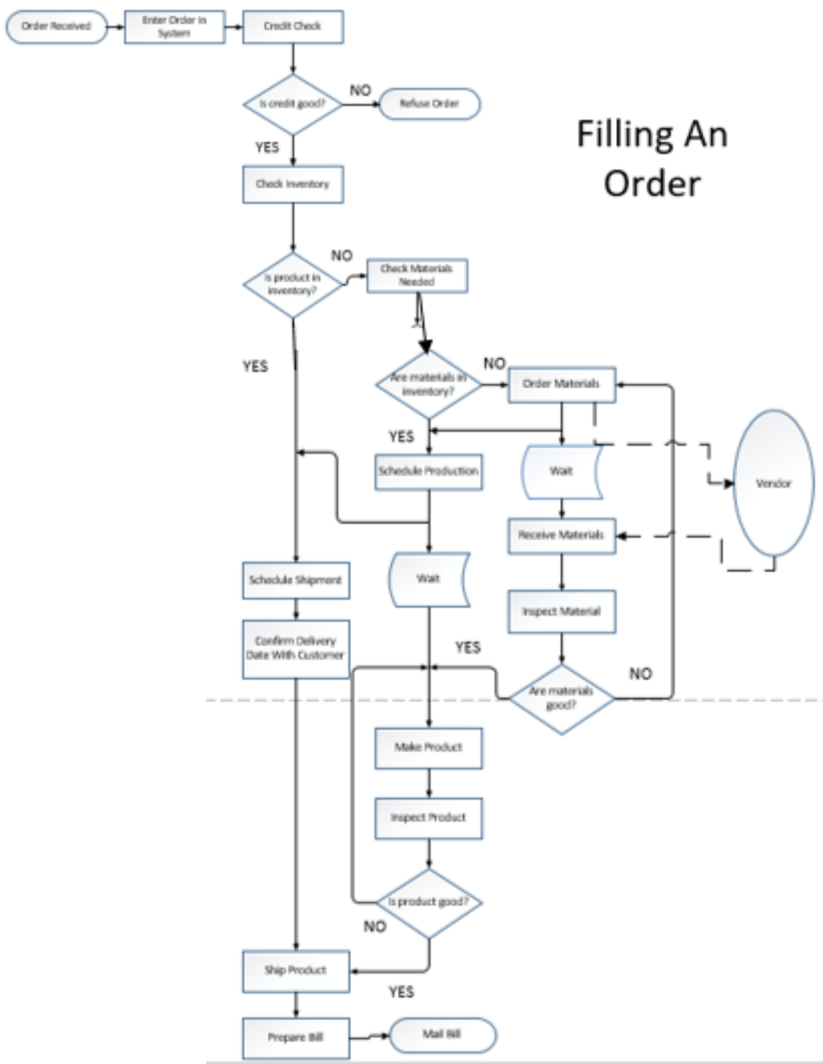
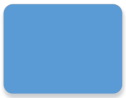
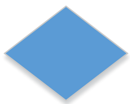


Figure 6-19: A more detailed flowchart for an order fulfillment process.
Courtesy: Ryan Wilcauskas

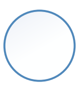
Figure 6-19 includes some of the common symbols used in detailed process flowcharts. Common flowchart symbols include:


Rectangles illustrate process steps; the text in a rectangle identifies the process step.


Arrows illustrate the direction of flow from one step or decision to another.

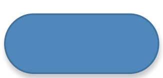

Diamonds illustrate decisions. The question addressed by the decision is written in the diamond; more than one arrow leaves the diamond, each one showing the direction the process takes in response to the answer to the question.


This symbol illustrates a time pause (delay or wait) between steps in the process.


Circles illustrate a link to another page of the process flowchart or to another flowchart. The other page or flowchart will include a circle indicating that the flow continues there.


Trapezoids depict inputs or outputs to the process flow.


This symbol represents a document created by the process.


Ellipses illustrate process start and end points.

Data Flow Diagrams

Information systems and information technologies are used to support and automate the tasks/activities performed during steps in a business process. In many instances, most or all of the tasks/activities associated with process steps are automated and/or documented by information systems and information technologies. The ability to visualize the role of information systems in business processes enables managers and employees to understand and articulate how information technologies are intertwined with the tasks/activities of process steps.

A **data flow diagram** (**DFD**) graphically represents the "flow" of data through an information system; a DFD visualizes the sequence of data processing tasks/activities involved in a business

A DFD shows data processing inputs and outputs (where data comes from and where it goes). It also illustrates where the data is stored. It does not show information about people involved with data processing or time delays between data processing steps. Hence, DFDs are often used in conjunction with flowcharts which can illustrate timing, people, and resources involved with the business process (see Figure 6-19).

Figure 6-20 illustrates a DFD diagram that illustrates some of the data processing tasks/activities associated with the order fulfillment process. Relative to business process flowcharts, DFDs diagrams include a very limited set of symbols and are typically quite easy to understand by non-technical managers and employees. In Figure 6-20, squares illustrate data processing activities, open-ended rectangles (parallel lines) illustrate data stores, rectangles illustrate data processing inputs and outputs, and arrows represent data flows among the processing activities, data stores, and inputs and outputs. In some DFD symbol sets, rounded-edge rectangles or circles are used to depict data processing activities; when circles are used to represent processing activities, the DFDs may be called “bubble charts”.

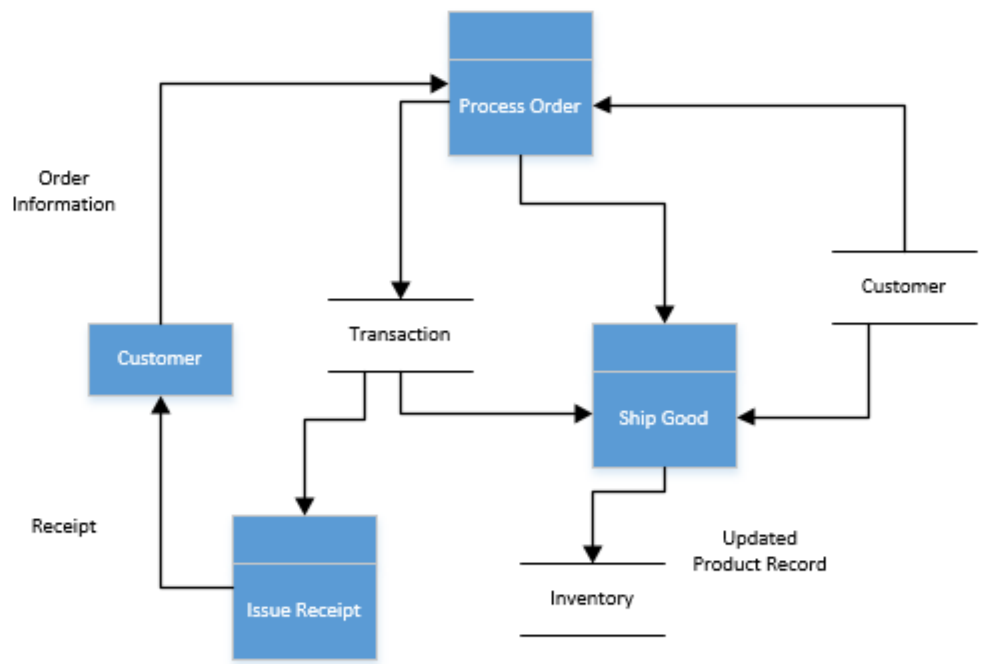


Figure 6-20: Data flow diagram (DFD) of data processing within the order fulfillment process. Courtesy: Ryan Wilcauskas

As you can see, Figure 6-20 is incomplete because it does not name each of the depicted data flows. However, it is quite easy to guess, what the names of the data flows might be. For example, the arrow between the Process Order data processing activity and Transaction data store could probably be named “transaction data”; so, could the arrows between the Transaction data stores and the Issue Receipt and Ship Good data processing activities. The arrows from the Customer data store to the Process Order and Ship Good data processing activities could be named “customer data”.

So, what does Figure 6-20 tell us about the data processing activities associated with the order fulfillment process? Well, it illustrates that when a customer places an order, the customer provides order information details (the names and quantities of the products being ordered. At the Process Order data processing activity these details are combined with customer data (customer name/ID and billing address) to process the order transaction. The Process Order data processing sends the order transaction details to both the Transaction database (which records all order transactions) and to the Ship Good data processing activity which combines the transaction details with customer data (name, shipping address, billing address). When the Ship Good data processing activity is run, the inventory database is updated; specifically, the quantity of each ordered product in the order transaction is subtracted from its current inventory level. When a payment is received from the customer, the payment is associated with a Process Order transaction and the Issue Receipt data processing activity uses the order transaction details (customer name/ID, billing address, product quantities ordered, etc.) to create a receipt which is sent to the customer.

BPMN Business Process Diagrams

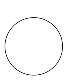
Business Process Model and Notation (BPMN) is a standard for graphically representing and modeling business processes visually in business process diagrams (BPDs) that can be easily understood by both business and IT managers. Using BPMN provides businesses with a standard way to graphically illustrate and communicate their business processes. BPMN diagrams are similar to business process flowcharts but are arguably superior to flowcharts for representing cross-functional business processes.

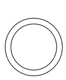
The symbols used in BPMN diagrams are grouped into four main categories: flow objects, connecting objects, swimlanes, and artifacts.

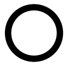
Flow Objects

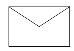
Flow objects are basic building blocks of BPMN diagrams; they represent the process concepts being modeled. Examples of flow objects are events symbols and activity symbols.

Event symbols represent the start and end of a business process as well as important processes that occur between the start and end event. Circles are used to represent process events.

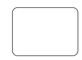
 Represents the first step of a process.

 Represents an event that occurs between a start and end event.

 Represents the final step in a process.

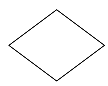
Event symbols can be styled to represent the specific process details of the process. For example, an envelope symbol  is used to represent a message.

A message may trigger the start of a process, facilitate intermediate steps in the process or signify the outcome of the final step in the process.

Activity symbols the kind of work being done with the process. Rectangles,  with or without rounded edges are used to represent process activities.

Like event symbols, activity symbols may be styled to represent process details such as sub-processes and payment transaction activities.

Gateway symbols are used to represent the separation or recombination of process flows.

Gateways are represented as diamonds  which can be styled to represent process details such as exclusive conditions or decisions, parallel/concurrent activities and the occurrence of events which cause the flow to take two or more different paths.

Connecting Objects

Connecting objects are lines that BPMN flow objects. In BPMN, there are three different types of connecting objects: sequence flows, message flows, and associations.

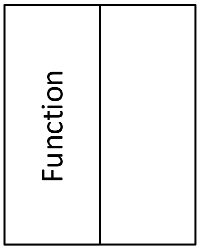
 **Sequence flow** objects illustrate the sequential order of flow objects.

 Message flow objects represent messages among process participants.

 **Association** objects illustrate relationships between flow objects and artifacts.

Swimlanes

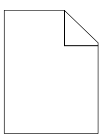
Swimlane objects visually represent business process participants. Participants can be specific entities (e.g. departments/functions) or roles (e.g. vendor, customer, or assistant warehouse manager).



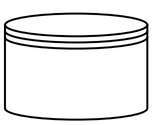
Swimlanes group BPMN flow objects by process participants to illustrate which process activities are performed by process participants. BPMN allows swimlanes to be horizontally or vertically. Lanes are sub-partitions of pools which represent a collection of process participants.

Artifacts

BPMN also includes artifact notations for modeler to describe a business process in more detail. One of the most commonly used BPMN artifact notations represent data produced by or within the business process. For example, within the order fulfillment process, the data needed to create an invoice is produced. In BPMN, data can be modeled by several types of 'data' objects including, data inputs, data outputs and data stores.



Represents data inputs that the business process depends on, or process data outputs.



Represents the ability to store or access data associated with a business process.

Figure 6-21 illustrates how the order fulfillment process can be depicted in a business process diagram using BPMN.

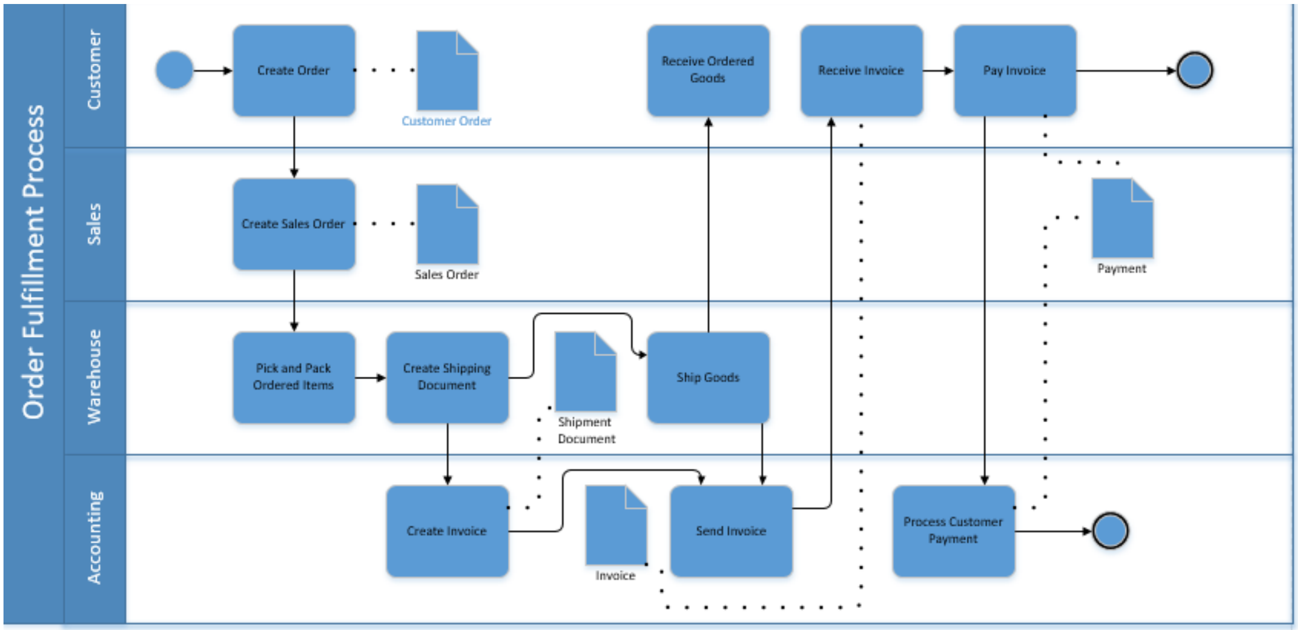


Figure 6-21: BPMN diagram of order fulfillment process.
Courtesy: Ryan Wilcauskas

BUSINESS PROCESS MANAGEMENT (BPM)

Documenting and diagramming business processes are important parts of formalized approaches for managing and improving business processes. **Business process management (BPM)** can be described as a systematic approach for making an organization's business processes more efficient, more effective, and more capable of adapting to changes in the business environment. BPM is sometimes described as the subset of business infrastructure management that focuses on optimizing and maintaining the equipment used in core operations.

BPM strives to reduce miscommunication about business processes within organizations; within many businesses, it interconnects the IT function with the business units responsible for producing the organizations goods and services. Since BPMN was created to facilitate communication among IT and business unit managers, it is widely used by organizations with BPM programs. *Business Process Execution Language (BPEL)* is also widely used in conjunction with BPM because like BPMN, it can be easily understood and interpreted by both technical and non-technical personnel.

When first introduced, BPM focused on using information technology to automate business processes. Today, however, it also encompasses human-driven processes that involve human interaction with technology.

BPM activities are typically grouped into the five major categories illustrated in Figure 6-22: design, modeling, execution, monitoring, and execution.

Figure 6-22: Categories of BPM activities
Shutterstock Photo ID: 417227668

Process *design* includes the documentation of existing (“as-is”) processes using process narratives, process flowcharts, data flow diagrams, and BPMN diagrams. It also involves the design of “to-be” processes to improve or replace existing processes. Proposed process improvements may target workflow, regulatory, market, or other competitive challenges that the organization faces.

Modeling activities take the proposed process created by design activities and applies combinations of variables (such as cost changes) to determine how the proposed process might operate under different conditions. It also typically involves running “what-if” analyses on the proposed processes to determine how the process might operate.

Executing activities involve performing or enacting process steps. For proposed processes, a computer program or simulation may be developed to provide insights into how process steps might unfold.

Monitoring activities involve tracking business processes and aggregating statistics about process performance. Tracking enables the identification of the current state of an instance of the process. For example, tracking a customer order enables the identification of current step (state) within the order fulfillment process (e.g. order has been received; order has been picked/packet; order has been delivered; invoice has been paid). Tracking also enables process level questions to be addressed such as: What is the average time to complete each step? What is the average cost to complete each step?) In general, monitoring measures fall into three major categories: cycle time measures, defect rate measures, and productivity measures. *Processing mining* tools are collections of processing monitoring methods and tools that enable process analysts to identify discrepancies between actual and ideal process execution. These assist in the identification of process bottlenecks and other factors that inhibit process performance.

For existing processes, *process optimization* activities involve the analysis of process performance data/information to identify real or potential bottlenecks, cost-saving, opportunities, and process improvement opportunities. It also involves leveraging the results of these analyses to make changes to the process design in order to bring actual process performance closer to ideal process performance.

As you can see in Figure 6-22, process optimization outcomes may result in changes to the process design, which, in turn, will result in another round of process modeling, execution, monitoring and optimization activities. The iterative nature of BPM activities illustrates that BPM is concerned with continual process improvement, which, over time, should help an organization develop business processes that are sustainably competitive.

Business Process Reengineering (BPR)

Business process reengineering (BPR) shares many of the characteristics of BPM, but typically results is more extreme revisions to business processes than the incremental process improvements that occur in well-executed BPM programs. **Business process reengineering** can be described as radical redesign of business processes in order to achieve dramatic improvements in process cycle times, productivity, and the quality of the goods/services produced by an organizations business processes. BPR strives to help businesses radically restructure how they are organized by fundamentally redesigning their business processes; BPR is sometimes called *business transformation* because of its focus of making extreme changes to business process designs.

Several major factors are associated with BPR's dramatic change initiative. One of these is the adoption of a new mindset among business managers. BPR requires to:

- Refocus company values on customer needs
- Redesign core business processes, typically using information technology to drive improvements, and
- Reorganize the business into cross-functional teams with end-to-end responsibility for a process.

In BPR, managers and employees are essentially handed a blank sheet of paper and are tasked with rethinking, redesigning, or replacing existing processes in order to deliver more value to customers. Managers and employees are asked to adopt a new value system that emphasizes customer needs. By re-organizing the organization around cross-functional teams, companies are often able to reduce the number of layers in the management hierarchy and also eliminate unproductive activities. Through leveraging information technology to improve process improvements, data dissemination and decision making is typically improved.

Organizations who embrace BPR often experience reduced costs and cycle times for their business processes. By eliminating unproductive activities and the employees that perform them, BPR helps reduce costs and cycle times associated with the business processes that are most important to customers. Reorganizing into cross-function teams decreases the need for management layers, improves information flows, and reduces errors and rework caused by multiple handoffs among functional areas. Reducing work fragmentation and establishing clear process ownership enables workers to improve the quality of customer products and services.

Six Sigma

Six Sigma is a set of tools and techniques for organization-wide business process improvement that has been adopted by numerous organizations in a wide-range of industries. It strives to improve process output quality by minimizing variability in business and manufacturing processes, especially variability caused by defects in process outputs (products or services). By identifying and eliminating the causes of output defects, process output quality is increased and the process as a whole is improved.

Six Sigma uses a set of quality-focused empirical statistical methods to drive process improvement. It also cultivates the development of managers and employees within the organization who become experts in these quality management methods. Within organizations, Six Sigma projects follow a defined sequence of steps and have goals, such as increase profits, reduce costs, increase customer satisfaction, and reduce process cycle time.

Within organizations who have adopted Six Sigma, the process “maturity” is measured by a sigma rating that identifies the percentage of defect-free outputs. A process that achieves a six sigma rating is one in which 99.99966% of process iterations produce outputs that are defect-free.

Six Sigma initiatives are based on the assumption that stable and predictable process results are vitally important to business success. Hence, sustained efforts to reduce process variation and to improve the quality of process outputs deserve organization-wide commitment, starting with top-level management.

Six Sigma ideas have been combined with lean manufacturing to create a methodology named *Lean Six Sigma.* Lean Six Sigma views lean manufacturing (which focuses on process flow and waste) and Six Sigma (which focuses on process variation and process output quality) as complementary disciplines that promote business and operational excellence. promoting "business and operational excellence". Numerous organizations use Lean Six Sigma to drive both efficiency and organization-wide innovation within all business processes.

CHAPTER SUMMARY

Business processes are sequences of linked tasks/activities that produce outputs needed and/or valued by customers. Business processes that are well designed are both efficient and effective. There are three main types business processes: management processes, operational processes, and support processes. Management processes include the processes used by organizations to govern their business systems. Operational processes are core business processes within an organization's primary value chain activities. Support processes are processes that support core business processes.

Some business processes are more complex and encompassing than others. Complex business processes are typically decomposed into sub-processes to provide additional detail about the sequence of tasks/activities that the process entails.

Cross-functional business processes are business processes that require the interaction and coordination of multiple departments (functions) to work together to complete process tasks/activities. Examples of cross-functional business processes include procurement, customer order fulfillment, and production/manufacturing processes. Cross-functional business processes are prevalent in process-centered organizations; in process-centered organizations, employees are organized into multidisciplinary teams focused on managing the end-to-end tasks/activities of business processes that deliver value to their customers.

When a business process is triggered, its tasks/activities are carried out sequentially which, when completed, result in a product or service for a customer. Three "flows" may be observed as a business process progresses through its sequence of tasks/activities to completion: physical flow, document flow, and data flow.

A business process's physical flow encompasses the physical activities associated with the business process, this may include the physical movement (flow) of products or materials in one or more of the process's tasks/activities. A business process's document flow corresponds to the sequence of business documents that are created by the process's tasks/activities. A business process's data flow corresponds to the data used and/or generated by the process's tasks and activities.

Every business process also has an information flow. This consists of information that is processed/harvested from a business process's tasks/activities. There are two major categories of business process information: instance-level information and process-level information. Instance-level information is information related to a specific iteration of business process; this is often used to answer specific questions about the current state of a process iteration. Process-level information is aggregated from multiple process instances. It enables the organization to address larger questions about the process and to identify opportunities to improve the process.

An organization's core business processes are those processes that must exist for the proper functioning of the organization and for the creation of products and services valued by customers. Core processes are typically operational processes rather than support or management processes. Because they are vital to the long-term success and survival of the organization, core processes are sometimes described as mission critical processes.

Three operational business processes that are common in business organizations are the procurement, fulfillment, and production processes. The fulfillment process is a core business process for many businesses; for some organizations, procurement and/or production are also core business processes.

A procurement process is found in virtually all organizations. This cross-functional business process supports the organization's value-chain's inbound logistics activity; it is sometimes called the procure-to-pay or requisition-to-pay process. The sequence of documents for the procurement process is: purchase requisition, purchase order, vendor shipping document, vendor invoice, goods receipt, and vendor payment. The primary physical flow is the actual receipt and storage of ordered goods from the vendor.

The fulfillment process is a cross-functional business process whose tasks/activities involve (at a minimum) the organization's sales, finished goods warehouse, and accounting functions. It maps most directly to the organization's outbound logistics value-chain activity, but it is also related to sales and marketing. The fulfillment process is often called the order-to-cash process because it involves the tasks/activities needed to receive customer orders, ship ordered goods/materials, and process customer payments. In some organizations, it is called the quotation-to-cash process because prior to receiving a customer order, the sales function provides prospective customers with a quotation. The sequence of documents for the fulfillment process is: sales quotation, sales order, picking list, packing list, invoice and customer payment. The primary physical flow includes the physical tasks associated with picking, packing, and shipping the items included in the customer order.

The production process includes the tasks/activities used by an organization to transform inputs (raw materials and/or components) into outputs (products and services) that are valued by customers. It is more complex than an organization's procurement and fulfillment processes and it is typically integrated with both of these processes in well-run businesses. The production process supports the operations value chain activity in Porter's Value Chain model. The sequence of documents in the production process is planned order, production order, materials withdraw, and goods receipt. However, a products bill of materials is another important document because it identifies the components (raw materials and sub-components) needed to produce the product. The physical flows associated with the production process include the movement of raw materials/components from their storage locations to work centers, the routing of semi-finished products among production work centers, and the movement of finished products to storage locations in the finished goods warehouse.

When organizations become processed-centered, they recognize the value of documenting their business processes. Process documentation makes it easier to train new hires, maintain consistency, adhere to legal requirements and/or regulations, and identify process improvement opportunities. Business process documentation can range from narrative descriptions of the sequence of tasks/activities that make up the process to diagrams that visualize all or parts of the business process. Business process flowcharts, data flow diagrams, and Business Process Modeling Notation (BPMN) diagrams are widely used for business process visualization.

Documenting and diagramming business processes are important parts of formalized approaches for managing and improving business processes such as business process management (BPM), business process reengineering (BPR), and Six Sigma. Business process management (BPM) is a systematic, organization-wide approach for making business processes more efficient, effective, and capable of adapting to changes in the business environment. Business process reengineering (BPR) involves the radical redesign of business processes in order to achieve dramatic improvements in process cycle times, productivity, and the quality of the goods/services produced by business processes. Six Sigma is a set of tools and techniques for organization-wide business process improvement that has been adopted by numerous organizations in a wide-range of industries. It strives to improve process output quality by minimizing variability in processes, and identifying and eliminating the causes of defects in process outputs (products or services).

KEY TERMS

Business process 2

Business process flowchart 20

Business process management (BPM) 27

Business Process Modeling Notation (BPMN) 24

Business process reengineering 28

Core business processes 10

Cross-functional business processes 5

Data flow 8

Data flow diagram 22

Document flow 7

Information flow 9

Instance-level information 10

Make-to-order 16

Make-to-stock 16

Physical flow 7

Processed-centered organizations 6

Process-level information 10

Six Sigma 29

Work center 18

REVIEW QUESTIONS

1. What is a business process?
2. Identify examples of resources consumed by business processes.
3. What are the characteristics of well-designed business processes?
4. Briefly describe the differences among management processes, operational processes, and support processes. Provide examples of each.
5. What are the characteristics and potential benefits of cross-functional business processes?
6. What are the characteristics of process-centered organizations?
7. Briefly describe the differences among a business process's physical, document, data, and information flows. Provide examples of each.
8. How does instance-level information differ from process-level information?
9. Identify several questions that can be answered by instance-level information.
10. Identify several questions that can be answered by process-level information.
11. What are core business processes?
12. What value chain activity does the procurement process support?
13. Explain how/why procurement is a cross-functional business process.
14. Describe the procurement process's document flow.
15. What is the three-way-match?
16. Describe the procurement process's physical flow and data flow.
17. Identify several questions that can be answered by procurement process instance-level information.
18. Identify several questions that can be answered by the procurement process's process-level information.
19. What value chain activities does the fulfillment process support?
20. Explain how/why the fulfillment process is a cross-functional business process.
21. Describe the fulfillment process's document flow.
22. Describe the fulfillment process's physical flow and data flow.
23. Identify several questions that can be answered by fulfillment process instance-level information.
24. Identify several questions that can be answered by the fulfillment process's process-level information.

25. What value chain activity does the production process support?
26. How does make-to-stock production differ from make-to-order production?
27. Describe the sequence of tasks/activities in the production process.
28. Describe the production process's document flow.
29. How does goods issue differ from goods receipt?
30. What is a bill of materials?
31. Describe the production process's data and physical flows.
32. Identify several questions that can be answered by production process instance-level information.
33. Identify several questions that can be answered by the production process's process-level information.
34. Why do organizations document business processes?
35. What are business process documentation best practices?
36. What is illustrated in a business process flowchart?
37. Identify and briefly describe the major symbols included in business process flowcharts.
38. What is illustrated in a data flow diagram?
39. Identify and briefly describe the symbols included in data flow diagrams.
40. What is Business Process Modeling Notation (BPMN)?
41. How do BPMN diagrams differ from process flowcharts?
42. Describe the differences between the following categories of BPMN symbols: flow objects, connecting objects, swimlanes, and artifacts.
43. What is business process management (BPM)?
44. Briefly describe the activities associated with BPM design, modeling, execution, monitoring, and optimization activities.
45. How does business process re-engineering (BPR) differ from business process management (BPM)?
46. What is Six Sigma?
47. What does it mean when a process achieves six sigma rating?
48. What is Lean Six Sigma?

Chapter 7 – Enterprise Systems and Integrated Business Processes

CHAPTER OBJECTIVES

After reading this chapter, you should be able to:

- Explain why businesses implement enterprise systems.
- Identify and briefly describe several major examples of enterprise systems.
- Identify several major enterprise systems vendors.
- Briefly describe the characteristics of enterprise systems vendor ecosystems.
- Briefly describe ERP architectures and infrastructures.
- Briefly describe the differences between ERP production, testing, and development instances.
- Briefly describe how ERP systems support integrated business processes.
- Briefly describe how ERP systems are integrated with CRM, SCM, and SRM systems.
- Briefly describe enterprise systems management and governance processes.
- Briefly describe enterprise systems data management and governance.
- Briefly describe why ERP systems are implemented to change business processes.

INTRODUCTION

Businesses adopt enterprise systems for a variety of reasons and there are several types of enterprise systems that are adopted. These include enterprise resources planning (ERP) systems, customer relationship management systems (CRM), supply chain management systems (SCM), and supplier relationship management (SCM) systems. Some businesses adopt and integrate several or all of these systems.

Due diligence is needed before adopting an enterprise system. It is important for organizations to know the enterprise system's capabilities, infrastructure requirements, potential benefits and risks, ongoing maintenance realities and costs, etc. before contracting with an enterprise system vendor. Because enterprise systems are available from a wide range of vendors, many businesses are interested in knowing more about vendor ecosystems before choosing which product to adopt. Vendor ecosystems include organizations that use the enterprise system software, vendor partners, and consulting firms that provide expertise in managing enterprise system projects.

ERP systems are the core transactional systems in the computing platforms of many businesses. CRM, SCM, and SRM systems can be integrated with ERP systems, but integration is optional rather than required. ERP systems have traditionally had a three-tier architecture that includes a user tier, application software tier, and a database tier. Today, businesses have the option of installing the ERP system on premises or getting access to it in the cloud. Best practices in ERP adoption includes installing at least three ERP instances: a production instance, a testing and quality assurance instance, and a development instance. Some organizations have different ERP instances in their major business units; others choose to have a single ERP system that is used by all of their business units.

Many organizations adopt an ERP system because it allows them to simultaneously support multiple business processes (including procurement, production, and order fulfillment) within multiple value chain activities. This enables the businesses processes to be integrated and this means the completion of tasks/activities in one process produces changes that affects the other process. For example, the receipt of a large order from a customer may necessitate the creation of a purchase order to ensure that sufficient quantities of raw materials are available to produce the products that the customer has ordered.

To get the most out of the enterprise systems that they adopt, organizations need to establish enterprise systems management and governance systems. Enterprise systems users and business managers have important roles in enterprise systems governance and best practices in enterprise systems governance often includes the creation of “centers of excellence.”

Organizations who adopt enterprise systems also need data management and governance systems. The adoption of the enterprise system often signals the organization’s readiness to become a “data-driven” business, which elevates the importance of data and information quality. Three major categories of data are found in enterprise systems: master data, transaction data, and organization data. Sound data management and governance processes are needed for each of these.

Some organizations adopt enterprise systems to force changes in business processes and operations and/or because they want dramatic improvements in productivity, efficiency, and process outputs. Using ERP systems or other enterprise systems to forcibly alter business operations is similar to business process reengineering, except in this case, numerous business processes are being changed simultaneously rather than one at a time.

WHY DO BUSINESSES IMPLEMENT ENTERPRISE SYSTEMS?

In order to operate efficiently, organizations look for ways to improve their business processes. Increasingly, companies are adopting enterprise systems and information technologies for to improve workflows and customer facing processes. **Enterprise systems (ES)** are large-scale application software packages that support business processes, information flows, reporting, and data analytics to enable an organization to track and control all of its complex business operations. They are used as central command systems for automating the business and facilitating reporting and decision making.

When successfully implemented, enterprise systems provide a wide range of potential benefits including those summarized in Figure 7-1.

Enterprise Systems Benefit	Explanation
Common data repository	Enterprise data is stored in a common database that enables easier access by all processes than having different databases for different processes.
Business process automation	ES enable organizations to streamline and automate their business processes to make them more efficient.
Scalability	ES can cost effectively accommodate growth or downsizing
Reliability	ES are typically more reliable than other IT solutions and have more uptime and less downtime.
Data security	An ES system's single data repository facilitates the use robust security mechanisms
Real-time information access	Real-time information about a business's operations is a powerful feature of enterprise systems that enables managers to quickly and efficiently improve business processes.
Reduced cost of doing business	Over the long term, enterprise systems reduce the cost of running the business; this positions the organization to be more profitable.
Standardized processes	Comprehensive and real-time data storage enables business process standardization and consistent process outputs.
Improved supply chain	Enterprise systems can streamline supply chain management through the use of data about where, when, and how customers order and suppliers deliver; this helps ensure that products are delivered to customers more reliably, and at a lower cost, than would otherwise be possible.
Regulatory compliance	Regulatory compliance requirements, including Sarbanes-Oxley, are baked into enterprise systems which help ensure that business operations comply with the regulations.

Figure 7-1: Enterprise systems benefits.
Courtesy: Thomas Case

Organizations also implement enterprise systems to improve business performance, replace legacy systems, integrate systems across multiple locations, position organizations for growth, and to remain competitive with competitors who have implemented their own enterprise systems. Organizations may also be attracted to enterprise systems' potential to reduce costs and increase process efficiencies. Cost savings are often realized by enterprise systems adopters from more efficient supply chains, reduced inventory levels, process efficiency improvements, process automation, and process integration.

Improved decision-making often occurs in organizations that adopt enterprise systems. This stems from improved data/information flow, visibility, and transparency. Real time access to enterprise systems data and information facilitates data-driven decision-making and better informed decisions. Some organizations claim that the data/information improvements promote an organization-wide "single version of the truth" about business operations and performance that enables the organization to quickly adapt to changes in the business environment.

In the 1980s and 1990s, enterprise-system adoption was primarily observed only in large organizations. This was due, in part, to the cost of infrastructure needed to run enterprise system software in addition to the cost of the software itself. Enterprise system adoption among small and medium size enterprises (SME) became more widespread during the 2000s and 2010s via the introduction of less expensive cloud-based enterprise systems software products. Smaller businesses implement enterprise systems for many of the same reasons as large corporations: to gain company-wide access to business knowledge, increase employee productivity and minimize the duplication of company data. Organizations of all sizes often realize additional benefits including teamwork support, improved response to the marketplace, increased work quality, and greater employee collaboration.

ENTERPRISE SYSTEMS EXAMPLES

There are many types of enterprise systems. Four of the most widely used types of enterprise systems are customer relationship management (CRM) systems, supply chain management (SCM) systems, supplier relationship management (SRM) systems, and enterprise resources planning (ERP) systems.

Customer Relationship Management (CRM) Systems

Customer relationship management (CRM) involves managing all aspects of a customer's relationship with an organization in order to increase customer loyalty, retention, and the organization's profits. As illustrated in Figure 7-2, three major aspects of CRM are sales force automation, customer service management, and marketing automation. *Sales force automation* involves using software to automate sales tasks and activities including sales order processing, sales force customer contact management, inventory monitoring, customer order tracking, and sales personnel performance evaluation. *Customer service management* uses software to coordinate all facets of an organization's customer service efforts. *Marketing automation* involves automate marketing actions, such as the repetitive tasks associated with e-mail marketing, social media marketing, and online e-commerce content. It also includes software for coordinating marketing and branding efforts across sales channels and for analyzing the effectiveness of marketing campaigns both within and across sales channels.

Sales Force Automation	Customer Service Management	Marketing Automation
Field Sales	Call Center Management	Campaign Management
E-commerce	Customer Contact Management	Content Management
Telephone Sales	Web-based Self-Service Management	Social Media Marketing Management
Retail Sales	Field Services Management	E-mail Marketing Management
Third-party Sales	Social Media Customer Service Management	Data Analysis and Business Intelligence

Figure 7-2: Elements of customer relationship management
Courtesy: Thomas Case

Some of the business benefits of CRM are summarized in Figure 7-3. CRM is based on the premise that organizations that understand the needs of individual customers are best positioned for sustainable competitive advantage and to reap the benefits summarized in Figure 7-3.

CRM Business Benefits
Simplify marketing and sales processes
Increase call center efficiency
Increase customer revenues
Discover new customers
Help sales staff close deals more quickly
More effective cross-selling and up-selling
Improved customer services

Figure 7-3: CRM business benefits
Courtesy: Thomas Case

CRM software support both operational and analytical processes. Operational CRM supports front-office operations that deal directly with customers; this often includes customer order transaction. Analytical CRM supports back-office operations, including data analysis (trend analysis, predictive analysis, sales forecasting, etc.). Analytical CRM relies on CRM data storage repositories (such as data warehouses) and business intelligence tools to gain insights into customer preferences and behaviors. The insights that are gained are used to personalize the organization's interactions with the organization, such as providing a personalized e-commerce experience when a customer visits the organization's web site.

As illustrated in Figure 7-4, CRM software often includes collaboration systems that facilitate communication and coordination among the front-office and back-office systems.

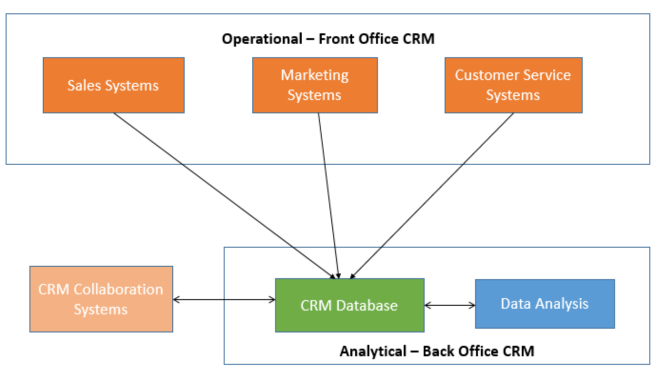


Figure 7-4: Enterprise CRM systems components
Courtesy: Thomas Case

Historically, CRM systems have their roots in sales force automation systems that were designed to support the various steps in sales process which are summarized in Figure 7-5.

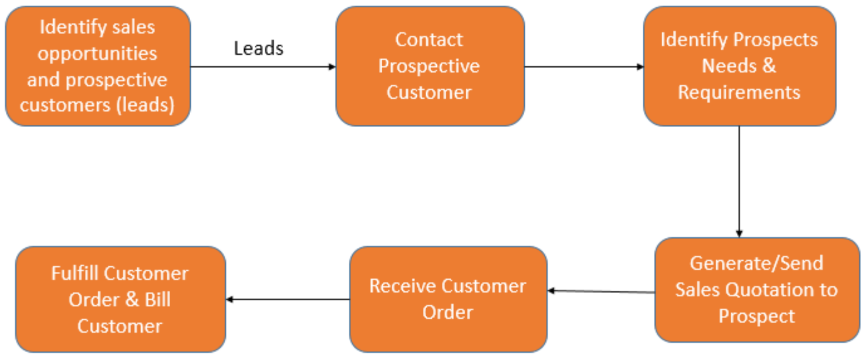


Figure 7-5: Sales process tasks/activities.
Courtesy: Thomas Case

Sales force automation systems include opportunity management systems, contact management systems, and sales management systems. *Opportunity management systems* automate the tasks/activities associated with identifying/finding new customers for future sales. *Contact management systems* maintain customer contact information, including that of prospective customers. *Sales management systems* automate each phase/step in the sales process, especially those associated with generating sales quotations and processing customer orders; these also help sales representatives organize and coordinate their accounts.

Over time, CRM systems evolved from sales force automation systems to include the elements summarized in Figure 7-2. Each of Figure 7-2's categories has been significantly impacted by social media and *social media CRM* has entered the CRM lexicon. Social media have had major impacts on both the marketing management and customer service management aspects of CRM. *Social media marketing* has emerged as an important component of marketing campaigns and in some campaigns, this overshadows traditional marketing channels such as television, radio, and print media. *Social media listening* has emerged as an important aspect of customer service management; knowing what customers and prospective customers are saying about an organization's products and services on social media positions to organization to quickly identify and respond to customer service needs.

Major CRM software vendors include Salesforce, Oracle, SAP, Adobe Systems, and Microsoft.

Supply Chain Management (SCM) Systems

A **supply chain** consists of all the entities (organizations) directly or indirectly involved in the procurement of a raw material or product. **Supply chain management (SCM)** involves the management of information flows between and among the entities in a supply chain that is needed to maximize supply chain profitability and effectiveness.

An entity in a supply chain has links to its suppliers and customers. The entity's (organization's) role in the supply chain is to transform materials received from suppliers into semi-finished or finished products (via its production process) which are distributed to its customers. A simple supply chain is depicted in Figure 7-6.

Figure 7-6: A simple supply chain.
Courtesy: Thomas Case

In most supply chains, there are considerably more entities than the three illustrated in Figure 7-6. A supplier may have its own suppliers and a customer may have its own customers. Hence, for any particular entity in a supply chain, there may be numerous levels of "upstream" and "downstream" entities. This is illustrated in Figure 7-7:

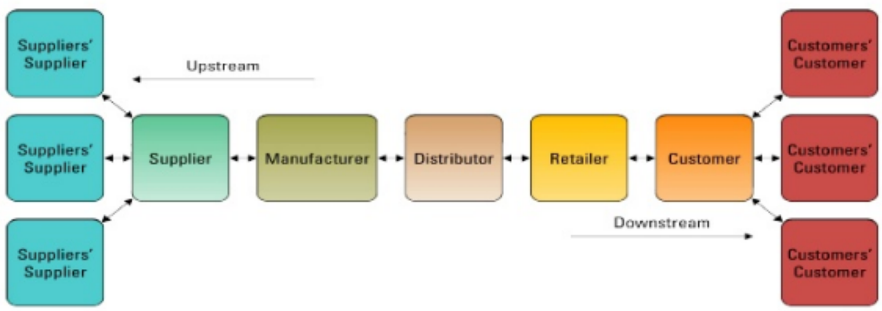


Figure 7-7: A more complex supply chain.
Source: http://www.slideshare.net/mgraham213/enterprise-systems-scm-crm-erp

Information technology is used in a supply chain to create process and information linkages within and between supply chain entities. IT is often used to enhance *supply chain visibility* –the ability to see everything that is happening upstream and downstream in the supply chain.

Potential business benefits of SCM are summarized in Figure 7-8. Benefits such as these are most likely to be realized by a supply chain when suppliers are reliable – especially when they have reliable (and predictable) prices and delivery times. Effective and efficient logistics also facilitate the realization of potential supply chain benefits. Having effective and efficient processes for transporting and storing materials and goods among supply chain entities contributes to a supply chain's competitiveness and success.

SCM Benefits
Improved supply chain visibility
Improved productivity
Improved quality of supply chain outputs
Improved cost control
Inventory reductions
Improved inventory management
Improved competitiveness in business environment
Cost savings that enable lower price points for customer products

Figure 7-8: Business benefits of SCM
Courtesy: Thomas Case

Effective supply chains also leverage information technology to realize their potential business benefits. IT contributes to integrating supply chain planning and control processes such as supply chain planning, demand and supply management, and collaborative product development among supply chain entities. IT facilitates event monitoring, inventory visibility across the supply chain, the creation of SCM dashboards, and SCM business intelligence; it also enables collaborative logistics and the creation of vendor-managed inventory (VMI) systems.

SCM software includes the software tools needed execute supply chain transactions, manage supplier relationships and control SCM associated business processes. SCM software includes demand planning software, supply chain planning software, and supply chain execution software. *Demand planning* software uses statistical tools and forecasting techniques to generate product and material demand forecasts. *Supply chain planning (SCP)* software use sophisticated mathematical algorithms to identify opportunities to improve material and product flow with the supply chain and to increase overall supply chain efficiency. *Supply chain execution (SCE)* software automates materials and product handoffs among supply chain entities. Other types of software used for supply chain management include *warehouse management systems (WMS), global inventory management systems, transportation planning* software, and *distribution management* software.

Collectively, SCM software is tasked with performing the tasks summarized in Figure 7-9. Many of these functions overlap with other will functions performed by other enterprise systems. As noted in our discussion of CRM, determining customer requirements and inventory monitoring are also important CRM functions. Sourcing, supplier management, and purchase order processing may be performed by supplier relationship management. Several of these SCM functions can also be performed by ERP systems.

SCM Software Functions
Customer requirements processing
Purchase order processing
Inventory management
Goods receipt processing
Warehouse management
Sourcing management
Supplier management
Forecasting

Figure 7-9: SCM software functions.
Courtesy: Thomas Case

Major SCM software vendors include SAP, Oracle, JDA Software, Manhattan Associates, Epicor and IBM.

Supplier Relationship Management (SRM) Systems

Supplier relationship management (SRM) is a comprehensive approach for managing an organization's engagement with the organizations that supply the goods and services that it uses. The goal of SRM is to streamline the processes that connect an organization to its suppliers and to make those processes more effective. SRM includes procurement processes but also includes a variety of processes that surround procurement such as forging mutually beneficial strategic partnerships with specific suppliers.

SRM involves separating suppliers into categories based on the value (or risks) that they can bring to the organization. Suppliers that have the potential to enhance profitability may be grouped into one category, while suppliers that could be profitability risks are likely to be placed in a different category.

When an organization enters a strategic partnership with a supplier, high levels interaction and collaboration are often required to make the business processes that connect them efficient and effective. Both parties in the organization are likely to share closely-held information with the other in order to improve the coordination of their interactions. Doing so may enable each of them to be more profitable.

Businesses that embrace SRM may realize multiple business benefits. Some of these are summarized in Figure 7-10. Similar CRM and SCM, organizations are more likely to realize SRM business benefits by appropriately leveraging SRM software. **Supplier relationship management (SRM) software** enables businesses use digital tools to manage their relationships between their buyers and suppliers and service contractors. SRM software applications grew out of earlier accounting applications that focused on tracking suppliers' expenses and contracts. SRM software is often in conjunction with SCM software because SRM is essentially a subset of an organization's SCM activities that focuses on its interactions with upstream suppliers. Procurement and/or buyer personnel use SRM software to delineate resupply strategies, administer contracts, assess supplier performance, and establish strategic supplier relationships. SRM software typically supports email and text alerts and notifications for event monitoring/management and to minimize inventory shortages or excesses. SRM collaborative planning tools enable procurement and/or buyer managers to exchange order forecasts with vendors and maintain historical buyer-supplier data.

SRM Business Benefits
Reduced procurement costs
Increased procurement process efficiency
Increased communication and coordination with suppliers
Reduced volatility in supply prices
Supply chain consolidation
Continuous improvement in procurement and supply chain processes
Better risk management
Improved product quality
Supplier-led innovation

Figure 7-10: SRM's potential business benefits.
Courtesy: Thomas Case

SRM software is designed to help organizations carry out the tasks/activities associated with each step of the procurement process. An organization's buyers use SRM software to send a request for proposal (RFP) or a request for quotation (RFQ) to multiple vendors. Competitive bidding capabilities and contract negotiation tools help organization select the best vendor for a material/product or service. SRM software is also used to create procurement process documents such as RFQs and contracts.

Web-based SRM software provides a real-time interface between the organization and its suppliers. It enables buyers to check the status of purchase orders or scheduled delivery dates. Web-based SRM enables suppliers to monitor the organization's stock levels to determine when the organization needs to be re-stocked; this is critical in vendor managed inventory (VMI) partnerships.

SRM software facilitates the sharing of forecasts with trusted suppliers. It also facilitates the identification of potential bottlenecks by analyzing past procurement process iterations with suppliers, both individually and collectively. SRM software enables businesses to compare and select suppliers based on particular combinations of a variety of factors including price and past performance (such as failure to deliver on time, faulty deliveries, or the delivery of substandard products or materials).

SRM software categories include sourcing, supplier management, electronic purchasing, operational procurement software; spend and performance analysis software is also used in supply relationship management. *Sourcing* software helps and organization find, evaluate, and engage suppliers. *Supplier management* software enables an organization to centrally manage and control supplier engagements and to improve buyer-vendor risk management. *Electronic procurement* software enables organizations to aggregate their suppliers' Web catalogs; it also facilitates electronic invoicing and payment activities. *Operational procurement* software facilitates the creation, verification, approval, transmission, and confirmation of purchase orders; it is also used to maintain adequate inventory levels (and to minimize inventory shortages) and to execute inventory-related transactions. *Spend and performance analysis* software is used to analyze procurement expenditure data in order to identify opportunities to decrease procurement costs, improve efficiency, and monitor vendor performance. It also helps an organization gain insight into what they are buying and from whom, and to determine the extent to which expected savings from sourcing efforts are being realized.

In terms of market share, the top SRM software vendors include SAP, Oracle, IBM, Infor, and Mercateo.

Enterprise Resource Planning (ERP) Systems

Enterprise resource planning (ERP) can be described as a process by which an organization manages and integrates the important parts of its day-to-day operations such as purchasing, inventory, sales, marketing, finance and human resources. When automated by software and technology, ERP enables real-time integrated management of core business processes.

ERP software links business processes and systems across an enterprise in order to streamline workflow, facilitate information sharing among different functional areas/business units, and to provide sufficient insight into a business's operations to enable data-driven decision-making. ERP software eliminates the need for functional area information systems/software to support the needs of specific business units (system does away with each department using its own software to do its work, such human resources software, accounting software, and warehouse management software). Instead of having separate databases to support different functions, an ERP system stores all company data in a single database that is used organization-wide.

The ability of an ERP system to integrate business functions and operations is illustrated in Figure 7-11. Today, to be considered a full-fledged ERP system, a software vendor's ERP product must be able to support manufacturing, human resources, accounting and finance, sales, purchasing, and inventory management processes. It must also be able to be able to serve as an integration point for an organization's SCM, CRM, and SRM systems. Because it can interface and interact with these other enterprise systems, an ERP system is widely viewed as the heart of an organization's suite of enterprise applications.

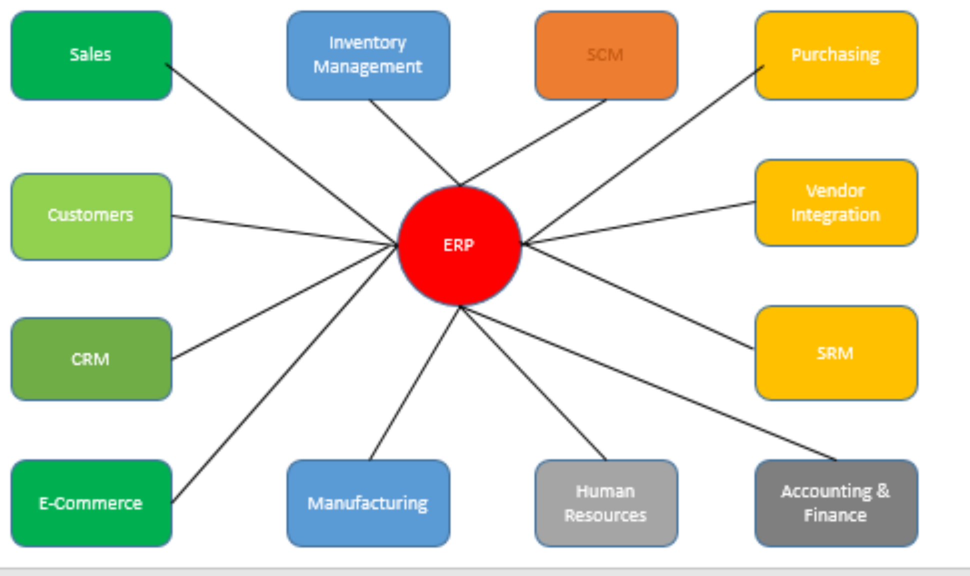


Figure 7-11: ERP Systems integrate key business processes and other enterprise systems.
Courtesy: Thomas Case

Business attraction to ERP systems goes beyond the systems' ability to integrate business processes and operations. A wide range of benefits can be realized when ERP systems are appropriately configured and utilized, including those summarized in Figure 7-12.

ERP Business Benefits
Increased competitiveness in business environment
Improved business process efficiency
Enhanced collaboration among functions and departments
Improved scalability and facilitation of organizational growth
Integrated data and information
Reduced administrative and operations costs
Streamlined processes
ERP's centralized database facilitates mobile-friendly solutions and applications
Improved reporting capabilities
Improved regulatory compliance
ERP systems are flexible, configurable, and robust
Improved customer service and responsiveness
Improved data accuracy, consistency, and security
Increased productivity
Improved forecasting

Figure 7-12: Potential ERP system business benefits
Courtesy: Thomas Case

In terms of market share, the top ERP software vendors include SAP, Oracle, Infor, Microsoft, and Epicor.

ENTERPRISE SYSTEMS ECOSYSTEMS

Major enterprise systems vendors, including SAP, Oracle, and Microsoft go out of their way to develop extensive ecosystems around their products that help establish market leadership. The ecosystems are also developed to to lock in existing customers and attract new ones.

An **enterprise system ecosystem** is comprised of three major parties: software vendors, consultancies (including both consulting firms and independent consultants), and adopting organizations (enterprise system software customers); see Figure 7-13. These parties work closely with one another to achieve common goals, such as improving the operating performance of the enterprise system software adopter.

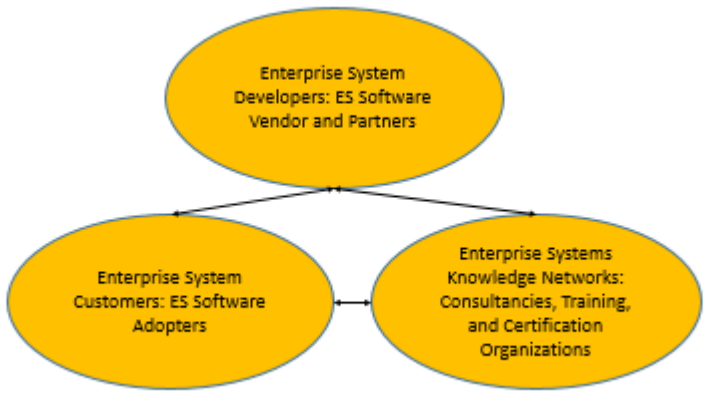


Figure 7-13: Enterprise system ecosystem components
Courtesy: Thomas Case

The enterprise system software vendor is the main source of software technologies within the ecosystem. Without the vendor's software (and all the systems design and development methodologies, programming and testing, and other efforts that make the delivery of the enterprise system software product possible), adopting organizations would be faced with the daunting task of having to build its own system from scratch at much greater cost.

However, there can be dozens (or hundreds) of other software vendors in the ecosystem. Many of these are designated as "partners" of the enterprise system vendor, often with some measure of the closeness the partnership with the ES vendor, such as the distinction of being a "gold" or "platinum" partner. Partners often have popular add-on or bolt-on software products that extend the functionality of the ES product or perform functions that the ES product does not perform very well.

Organizations that adopt the vendor's ES software are the financial source of the ES ecosystem. Without them, the ES industry would not exist. Consultancies provide a bridge between the software vendors and adopting organizations. Their presence in the ecosystem serves as a useful division of labor, which allows everyone else to focus on what they do best. Consultants are often employed by adopting organizations to oversee ES adoption, implementation, maintenance, and upgrade processes. They often bring valuable ES project management expertise and experience to the ecosystem.

An ES ecosystem can be successful a multiplayer business environment that delivers performance improvements to adopting organizations and distributes benefits to software vendors and consultancies. To be successful, the ecosystem needs to focus on development capability (the ability to help ensure the ongoing development and evolution of the ES and ancillary software to meet the evolving business needs of adopting organizations), market leadership (via the expansion of ES product scope and customer base), and maintaining harmony among the parties in the ecosystem. Most major ES vendors have successfully woven knowledge networks that help distribute consulting services to adopting organizations and provide training and certification programs promote knowledge transfer. Some ES vendors have established extensive knowledge repositories and communities to support third-party developers, consultants, and customers.

ES vendors often leverage their ecosystems to attract and retain customers. Figure 7-14 illustrates SAP's promotion of its ecosystem.

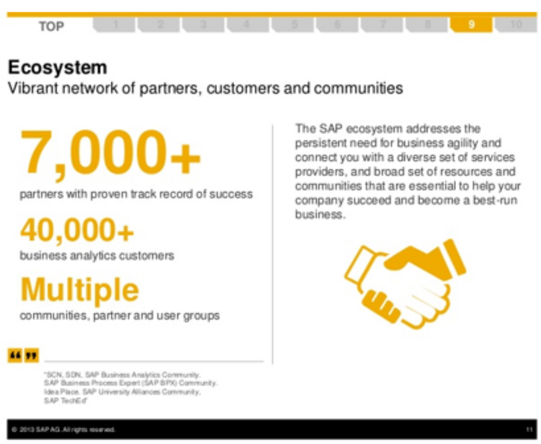


Figure 7-14: A recent overview of the SAP data analytics ecosystem.
Source: Slideshare.com and SAP AG

Major ES vendors often create partnerships with colleges and universities to facilitate the adoption and use of ES software in university-level courses. Arguably, the most extensive and successful education partnership program has been established by SAP; it is called the SAP University Alliances. In 2017, the SAP University Alliances included more than 3100 institutions in 110 different countries. The overall goals of the University Alliances include exposing students and faculty to the most current versions of SAP technologies and promoting the integration of SAP software into degree curricula. The University Alliances hold week-long faculty development workshops several times annually that teach faculty members how to incorporate SAP software into their courses. It also holds an annual academic conference to encourage curriculum sharing and networking among University Alliances schools. SAP considers the University Alliances to be an important aspect of its ecosystem.

SAP also has created an organized network of user groups within its ecosystem. In North America, the user group is called ASUG (Americas SAP User Group). ASUG chapter members tend to be clustered around major cities, but numerous chapters are state-wide or multi-state and rotate chapter meetings among cities in that state or region. ASUG meetings are typically held quarterly at SAP customer venues. These are usually day-long events that include presentation by SAP ecosystem members (customers, consultancies, and partners). SAP encourages ASUG chapters to embrace the SAP University Alliances institutions in their region and to invite students (and faculty) to their meetings to network with SAP customers, partners, and consultancies.

ENTERPRISE SYSTEMS ARCHITECTURE

An organization’s **enterprise systems architecture (ESA)** includes the architectures of all the IT systems that support the organization’s business functions. It provides a comprehensive summary of the organization’s major IT systems and the relationships among them. If, for example, an organization has adopted ERP, CRM, and SCM to support day-to-day business operations and utilizes a data warehouse as a central data repository for the business intelligence and data analytics tools that it uses to inform decision making, each of these IT systems would be included its ESA.

The ESA plays a key role in managing and evolving an organization’s IT systems and business operations. It captures both static and dynamic aspects of the organization’s IT systems as they evolve in response to changes in the business environment.

An ESA provides several organizational benefits including:

- Architecture-level analysis of IT systems. An ESA assists ES planners and designers in performing system analysis at the architectural level.
- Enhanced business/system understanding. An ESA provides a vehicle for effectively understanding an organization’s business operations. This has potential to improve business management.
- Improved business/system planning: An ESA provides a vehicle for business and IT systems planning, both strategically and in identifying local enhancements to IT system support for business functions.

- Easier restructuring and system integration. An ESA facilitates restructuring and system integration in response to changes in business operations, including large changes that result from mergers or diversification.
- Enhanced system evolution. An EAS provides a means for evaluating the impacts of major IT systems transformations including replacing old systems, decommissioning outdated systems, and adding new systems.

From an ESA perspective, an ERP system is just one of the major IT systems that support an organization's business functions. As illustrated in Figure 7-11, an organization's ERP system may have a central role in the ESA by serving as the ES that integrates its other enterprise systems and business processes. However, this does not mean that other IT systems within the organization are less important than the ERP system and the ESA helps both business managers and IT professionals understand how all major IT systems work together to support the business.

ERP ARCHITECTURE AND INFRASTRUCTURE

ERP Three-Tier Architectures

An ERP system's software architecture has traditionally been depicted as consisting of three layers. This is illustrated in Figure 7-15. Users interact with the ERP system at the presentation layer, typically via a graphical user interface (GUI). Support for integrated processes is provided at the application layer and the organization-wide database is found at the data management layer.

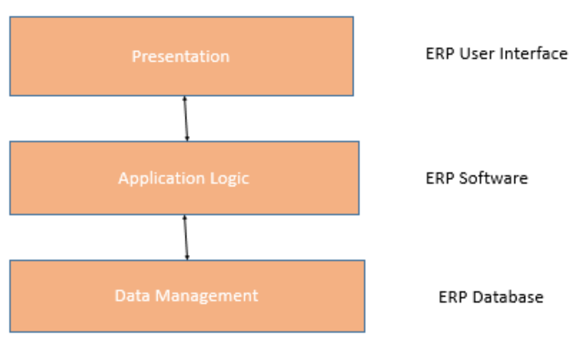


Figure 7-15: ERP software architecture tiers
Courtesy: Thomas Case

The three-tier architecture illustrates a clear separation of ERP processing tasks. Having the ERP user interface (UI) as a distinct layer from the application processing and database layers enables users to interact with the ERP software using a variety of client devices including desktop PCs, laptops, tablets, smart phones, and even dumb terminals. As you might suspect, over the last decade, much time and effort has been consumed by ERP vendors and partner organizations developing easy-to-use interfaces for mobile workers who primarily use smart phones, tablets, and laptops to interact with the ERP software.

Having distinct application and database layers in the three-tier architecture is also advantageous. The distinct application processing layer enables adopter organizations to implement the ERP software on computer hardware that suits the needs of the organization. In the 1980s and 1990s, mainframe-computers, mini-computers, servers, and server clusters were frequently used for ERP processing tasks. In the 2000s and 2010s, server clusters and application servers in data centers became the dominant hardware platforms for ERP software.

The distinct database layer has provided adopter organizations with choices about the database management system (DBMS) and storage technologies used store ERP data and transactions. For example, organizations that adopt SAP ERP could use another software vendor's DBMS to store ERP data and applications, they have not had to use a SAP database product. As a result, many SAP ERP adopters choose Oracle or DB2 (an IBM database product) as the data repository for their ERP systems. Sybase was another popular choice among SAP ERP adopters. The distinct database level also provides organizations with choices about data storage technologies. For examples, network attached storage (NAS) systems, storage area networks (SAN) and database servers and data storage systems in data centers may be used to physically store ERP data.

The ERP three-tier software architecture maps directly to client-server architectures. The adopters of ERP systems in the 1980s and 1990s typically implemented two-tier or three-tier client-server architectures such as those depicted in Figure 7-16. In the 2000s and 2010s, N-tier client server architectures grew in popularity as cloud computing became part of enterprise architectures.

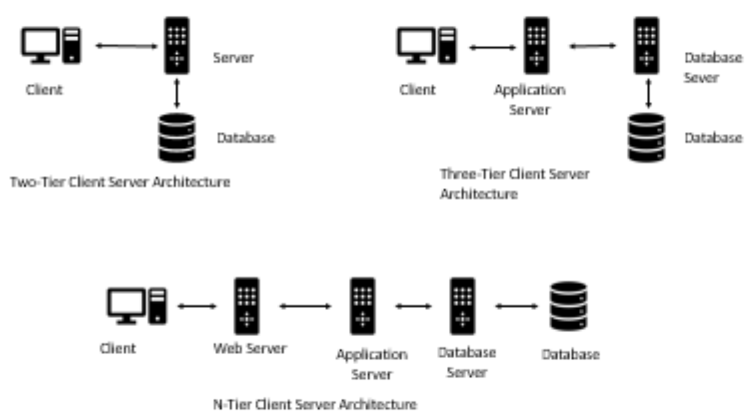


Figure 7-16: Two-tier, three-tier, and n-tier client server architectures.
Courtesy: Thomas Case

In a two-tier client server architecture, the ERP UI is located at the client tier and the ERP application software and database are located on a single server tier. ERP users interact with the ERP server to carry out business process transactions and to update ERP master data. In a three-tier client-server architecture, ERP transaction processing activities are carried out by an application server and database operations are carried out by a database server. The application server and database server communicate with one another during ERP processing transactions to ensure that master data is available to ERP applications and to store the results of ERP business process transactions.

In a N-tier client server architecture, ERP users interact with ERP application software via a Web browser. The Web server specifies the user actions to be performed by the application server and the application server interacts with the database server to ensure that required data is available for use.

So, as we move from two-tier to three-tier and N-tier client server architectures, there is increasing reliance on server-to-server communication.

ERP Infrastructures

ERP three-tier architectures can be implemented as fully on-premises, fully cloud-computing, or as a combination of on-premises and cloud-computing infrastructures. The major differences between fully on-premises and fully cloud-computing infrastructures are discussed in Chapter 4.

Historically, ERP adopters in the 1980s and 1990s typically implemented their ERP systems on-premises, often with the assistance of consultants from ES vendors and ERP consultancies. With a fully on-premises infrastructure, the adopter organization is responsible for ERP system updates and upgrades, but the ES vendor and partner organizations provide ongoing technical assistance via often pricey technical support packages. The adopter organization has the greatest control over the ERP system when it is implemented fully on-premises, including the selection of the number of client-server tiers.

In the 2000s and 2010s, some degree of cloud computing has been typically incorporated with ERP infrastructures even though ERP adopters still have the option implementing the ERP system fully on-premises. Frequently, some ERP user client devices are located on-premises in local area networks. Application servers may also be located on-premises but database servers and data storage equipment may be cloud-based. Alternatively, both ERP application processing and data management operations may be cloud-based.

Fully-hosted ERP systems are available from software-as-a-service (SaaS) solution providers. With this option, ERP users interact with cloud-based ERP software and ERP data management systems. ERP software updates and upgrades are performed by SaaS providers. When SaaS is chosen as a cloud-service for ERP, an organization essentially supports its major business processes in the cloud. This enables to organization to avoid expensive on-premises infrastructure.

Infrastructure-as-a-service (IaaS) is another potential cloud-based option for ERP adopters. As noted in Chapter 4, IaaS provides subscribers with the servers and storage technologies needed to support its applications. With IaaS-based ERP, the IaaS subscriber organization is responsible for implementing the ERP software on the hardware that it rents from the IaaS provider. Since it is also responsible for ERP software updates and upgrades, this cloud-based solution is similar to a fully on-premises implementation. After implementation, IaaS-based ERP application processing and database operations are cloud-based. The ongoing costs of this option are typically less than fully on-premises infrastructures largely because of competition among IaaS providers that makes access to cloud-based computer and data storage hardware more affordable fully on-premises infrastructure.

ERP Instances

An **ERP instance** is a distinct version of an ERP system within an organization. When ERP systems were first introduced, it was widely thought that an organization should have a single ERP system that ran on a single database to serve the entire organization. The single instance would minimize data and information duplication among functional areas or geographic divisions within the organization and would facilitate process integration and improved information quality. Relative to multiple customized ERP instances within the organization, a single-instance ERP system would enable easier ERP software upgrades.

Despite such compelling arguments for a single-instance ERP system, many organizations have installed multiple ERP instances. For example, a company with multiple product divisions (consumer, industrial, and government/military) might choose to implement an ERP instance in each of its divisions to maximize process efficiencies and service to each of customer groups. Similarly, a multinational company with divisions in North America, South America, Australia, and Europe might choose to implement an ERP instance to serve each of its geographic divisions.

Multiple instances of ERP systems may also emerge in organizations as the result of mergers and acquisitions. If a company with an existing ERP instance merges with or acquires another company with an ERP instance, it is often better to continue to run both ERP instances for a period of time than to try to immediately combine them into a single instance.

Single-instance ERP systems continue to be observed as ERP best practices, even for large, multinational organizations that understandably implemented multiple ERP instances to support their different business units. Compliance with Sarbane-Oxley, which requires the financial reports in publicly-traded companies to have a verifiable audit trail, is facilitated by single-instance ERP. With a single instance, all of a company's financial data is incorporated in one application and originates from one source; this minimizes consolidation errors and reduces the time it takes to close the books. Relative to multiple-instance ERP systems, the organizational benefits of single-instance ERP systems also include reductions in IT support costs, enablement of strategic vision, standardized and consistent data that facilitates improved analysis and decision-making, and enablement of business process management (BPM), continuous improvement, and business transformation.

Organizations that have relatively standard business processes across divisions, have older ERP instances that need to be replaced, and have multiple ERP instances from the same vendor are excellent candidates for consolidating their multiple-instance ERP systems within a single-instance.

ERP System Landscapes

An ERP instance provides support for integrated business processes for part of an organization or the entire organization. The system landscape an ERP instance includes a production platform (or production environment), which is the “live” system that is used to process ERP transactions and run the business. An instance’s system landscape also typically includes a development platform (environment) and a testing platform (environment). Ideally, each of these platforms (environments) should be isolated from one another as much as possible.

In ERP system landscape best practices, ERP developers and testers use copies of the instance’s production platform (including copies of the hardware) to avoid inadvertent changes to the production system. This essentially means duplicating the production system’s hardware platform to create two non-production instances of the ERP, one that will be used by developers and a second used by testers. Some resources can be and should be shared across the production, development, and testing environments including bug tracking systems, configuration management systems, and source code control.

When it is impossible to provide copies of the production platform to developers and testers, developers and testers should be limited to read-only access to the production system. This minimizes the chances that a developer or tester will run a program on the production platform that could have a serious business impact.

The development platform enables the organization to separate development work from the production platforms. ERP users log on to the production platform to do their jobs and ERP developers log on to the development platform to configure and/or customize the ERP. When changes to the ERP are complete and test, they can be moved from the development platform to the production platform. This separation helps ensure that developer changes and upgrades to the ERP do not affect the ability of ERP users to use the production platform to do their jobs.

The testing platform (environment) is used to test the changes and upgrades that developers want to make to the production platform. For this reason, it is very important for the testing environment to duplicate of production platform and its database as much as possible. After completing the configuration and/or customization changes in the development platform, developers can install and test the changes in the testing environment to ensure that they work as planned and do not negatively impact the testing environment’s duplicate of the production platform. ERP testing and quality assurance (QA) personnel utilize a wide range of test scenarios and test data to determine if developer changes work appropriately. Deficiencies identified by testers are fed back to developers so that configuration and/or customization tweaks can be made and tested. And, once all tests are run and passed in the testing environment, developers can install the configuration and customization changes in the live production system.

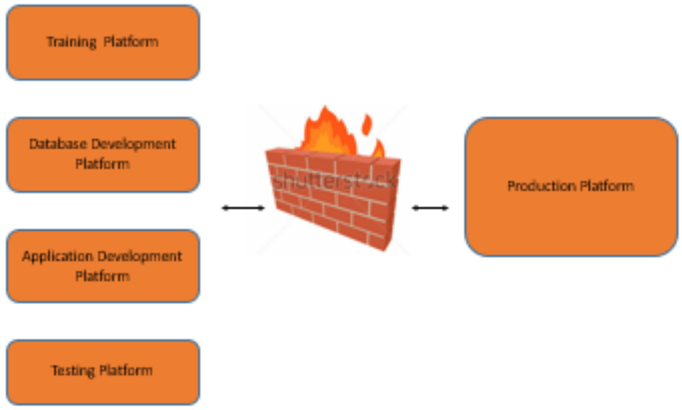


Figure 7-17: ERP instance landscapes
Courtesy: Thomas Case and Stock vector ID: 430807357

The three-environment ERP system instance landscape in considered best practices for ERP adopter organizations who have not “gone live” with their ERP system. An ERP system “goes live” when the organization begins to use it to supports its business processes and run the business. Prior to going live, the ERP adopter can use the development environment to configure and customize the ERP software and can use the testing environment to make sure that the ERP applications interact correctly with the ERP database. When the fully tested, configured and customized ERP system is copied into the production environment, the organization is ready to go live and begin using the ERP system to support its daily operations.

Organizations with mature ERP systems may add one or more other platforms (environments) to its ERP instances. Some organizations add a training platform (environments) that duplicates the production environment’s hardware and database. The training environments enables the organization to train new hires on the tasks they will perform on the ERP system using a training platform that is virtually identical to the production environment. The training environment is also used to train current employees on configuration and customization changes that will soon be rolled out to the production environment.

Organizations with mature ERP systems are increasingly adding database development platforms (environments) to their ERP system instance landscapes. This is largely in response to the role of an ERP system as a data generator for business intelligence and data analytics. It is also consistent with enterprise systems data management best practices. In the ideal ERP system, master data about customers, products, vendors, employees etc. are perfectly correct. In most ERP systems, however, perfectly clean master data is a consistent work in progress. An organization cannot use an ERP system to sell a vendor’s product to a customer without master data about the vendor, product, and customer are in the system its general ledger. Mistakes can be made when master data is added to the ERP database that can be annoying or could constrain the efficiency of the system. Examples include an incorrect routing number for a vendor’s bank account, incorrect net weight for a product, or an incorrect street number in a customer’s billing address. Organizations can take charge of cleaning up master data by adding a database development environments and employing data analysts to identify master data deficiencies and to correct them. In organizations with mature ERP systems, new master data is continually being added (e.g. new vendors, customers, product, employees, etc.) and existing master data must be updated (e.g. a change to a customer's shipping address). In addition, ERP data is the foundation for data-driven decision-making about daily operations and a key feeder to business intelligence and data analytics solutions. Hence, it only makes sense to investing in support personnel responsible for ensuring the completeness and accuracy of the master data.

ERP AND INTEGRATED BUSINESS PROCESSES

Businesses are attracted to ERP systems because of their ability to integrate business processes. Today's full-fledged ERP systems support manufacturing, human resources, accounting and finance, sales, purchasing, and inventory management processes. Many organizations also use their ERP systems to integrate their SCM, CRM, and SRM systems. The ability of an ERP system to serve as the heart of an organization's suite of enterprise applications and to integrate other key business processes is illustrated in Figure 7-11.

Core business processes supported by ERP systems include the procurement process (procure-to-pay), fulfillment process (order-to cash), and production process (plan-to produce). The document, physical, and data/information flows associated with each process are described in Chapter 6. In Chapters 8, 9, and 10, each of these processes and how they are supported by ERP systems are described in more detail. In this section, integration points among these processes are identified and briefly described.

A business process **integration point** may be described as a point/activity within a business process at which documents and their data/information moves from one application or system to another. This essentially means that a document created by one process triggers changes to one or more other processes. A classic example of an integration point is a vendor's receipt of a customer order via an EDI (electronic data interchange) link and its entry into the vendor's ERP system for processing.

There are numerous integration points among the businesses processes supported by an ERP system. For example, the creation of a delivery document in the fulfillment results in finished goods inventory reductions for the products delivered to the customer. These inventory reductions, in turn, may trigger corresponding increases in planned production orders to replace the product quantities specified in the delivery document. This is illustrated in Figure 7-18. In this example, a document in one process (fulfillment) affects a document in a second process (production).

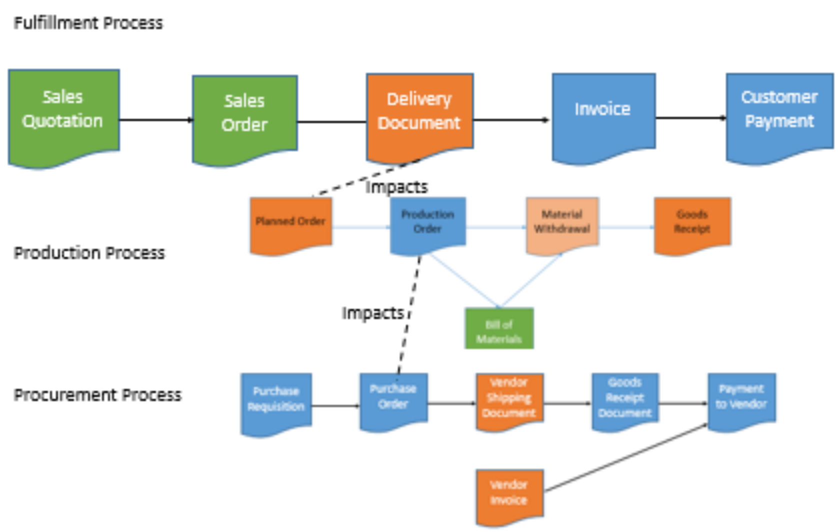


Figure 7-18: Examples of integration points among processes supported by an ERP system. Courtesy: Thomas Case

Another example is the release of a production order in the production process. When the production order is released, the quantities of raw materials needed to manufacture the product quantities in the production order are decreased in raw material inventories. These raw material inventory reductions may trigger corresponding increases in the raw material quantities ordered from vendors in purchase orders. This is illustrated in Figure 7-17. So, once again, a document in one process (production) affects the data/information in a document in a second process (procurement).

In an organization with both a CRM system and an ERP system, a customer order may once again be an integration point between the two enterprise systems. The CRM system may be configured to enable salesperson to create a customer order. The customer order may then be passed to the ERP system for processing.

A procurement order may be the integration point between an organization’s ERP system and its SRM system. The procurement order could be created within the ERP system and then passed along to ensure that procurement activities are carried out as efficiently and effectively as possible.

CRM And ERP Integration

An increasing number of businesses use both CRM and ERP systems to run their businesses. Independently, both CRM and ERP systems offer substantial business benefits such as those summarized in Figures 7-3 and 7-12. Integrating these systems has the potential to provide additional business benefits.

A CRM system manages frontend data/information about customers and enriching it with information and it enriches it with information about customer interactions with marketing and customer support. This enhances the organization's understanding of its current and prospective customers. It also helps the business manage relationships with customers, its sales pipeline, and its product upselling and cross-selling opportunities.

An ERP system handles critical backend information about customers such as that required to process orders placed by customers. This often includes purchase history, shipping and billing details, accounting and financial information, and supply chain management details.

Traditionally, CRM and ERP systems have been siloed because they have different architectures that make them difficult to integrate. When the two enterprise systems are unable to communicate with one another, it very difficult or impossible to use a single interface to track all organizational interactions with the customer. The sales and fulfillment processes are slowed when sales reps have to jump back and forth between the CRM and ERP software to track customer interactions and orders.

Robust CRM and ERP integration enables organizations to streamline their sales-oriented. business processes. Providing visibility into both frontend (CRM) and backend (ERP) systems can lead to business process simplification and increased productivity. Some ES vendors (including SAP and Oracle) facilitate CRM and ERP integration via including both CRM and ERP solutions as part of the same suite of ES software and ensuring that these systems can share data and information with one another. Other ES vendors forge partnerships with one another to ensure that their CRM and ERP products can communicate and share data and information.

A key question for many organizations with CRM and ERP systems is which system will handle customer billing. For example, one organization may want to use its CRM system to handle all frontend interactions with current and prospective customers and to use its ERP system to handle all backend interactions (picking, packing, shipping, invoicing, and payment processing) upon receipt of sales orders. A second organization may want to use its CRM to handle frontend interactions and billing (invoicing and payment processing) and to use its ERP system to handle warehouse activities (picking, packing, shipping). While it may be easier to configure the CRM and ERP solutions from a single vendor for either of these scenarios (or when partnerships exist between ES vendors), organizations must be prepared to identify ways to integrate their CRM and ERP systems to best serve the needs of their customers.

SRM And ERP Integration

As discussed previously in the chapter, a supplier relationship management (SRM) system provides the structure developing and maintaining relationships with suppliers. Hence, SRM is similar to CRM except that it is focused on suppliers instead of customers. Close, robust relationships are developed a small subset of suppliers based on the value that they provide to the organization over time; more "arm's length" relationships are maintained with less critical suppliers. Different product and service agreements are negotiated with each type of supplier.

SRM's goal is to help the organization become a better purchaser by developing its understanding of suppliers. When integrated with ERP and other back office systems, multiple procurement process improvements may be realized including:

- Streamlined procure-to-pay processes and improved productivity
- Reductions in requisitioning, purchase order processing, and supply-management cycle times
- Greater visibility of historical spending and improved spending analysis
- Improved contract compliance and governance
- Quicker creation of new contracts and proactive management of existing contracts
- Improved materials management

SRM and ERP systems can be integrated in various ways to support the procure-to-pay process. Figure 7-19 illustrates some of the typical integration options. It is important to note that SRM users typically interact with the SRM server via a browser interface. The browser interface typically includes an integrated web catalog that summarizes pre-negotiated prices for products that comply with vendor contracts. When a SRM user selects a vendor's product from the web catalog, places it in the shopping cart, and chooses "buy", one of two things may happen. In one scenario, the shopping cart item is converted to a purchase requisition in the ERP system and the ERP system assumes responsibility for the conversion of the requisition to a purchase order and the remaining steps in the procurement process. In the second scenario, a purchase order is created for the shopping cart item within the SRM system. This purchase order is then replicated in the ERP system and essentially bypasses the creation of a purchase requisition. In either scenario, the responsibility for creating the other major documents in the procurement process can be the responsibility of either ERP or SRM users.

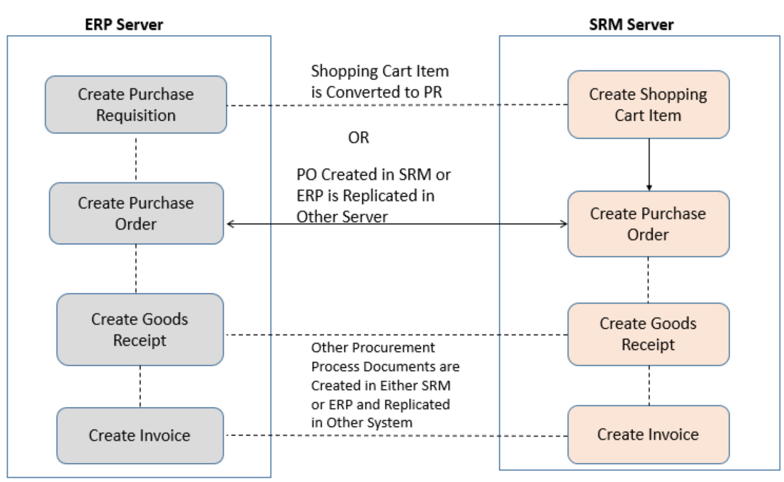


Figure 7-19: SRM and ERP integration options
Courtesy: Thomas Case

Both the SRM and ERP system have three-tier architectures with user interface, application, and database layers. This means that each PO will have associated goods receipt, invoice, and payment documents in both the ERP and SRM databases.

SCM And ERP Integration

ERP systems are primarily used to integrate and optimize business processes within the organization. SCM is used to improve business processes that span the organization's boundaries between itself and its suppliers. ERP and SCM integration has the potential to reap multiple business benefits including:

- Improved efficiency across multiple departments and organizations within the supply chain
- Improved customer service and customer retention; greater chance of repeat business from existing customers
- Automation of workflow that reduces overhead and operational costs
- IT issues/problems are less likely to create bottlenecks or impede efficiency
- Quicker adaptation of supply chain to changes in customer needs/requirements; quicker adaptation to business expansion and growth
- Products and services can be delivered to customers with greater speed, efficiency, and quality.
- ERP systems, including those from SAP, Oracle, and Microsoft, can be programmed to automatically generate purchase orders when inventory levels drop below specified minimums. Such automated purchasing can contribute to improvements in supply chain efficiency.
- ERP systems provide the opportunity to track vendor performance through metrics such as cycle time, cost, and error rates; such tracking data can be used to negotiate better terms or to justify switching vendors.

ERP systems can improve a supply chain by enabling better information integration and aggregation; undesirable variances within the supply chain can be quickly identified and addressed. ERP systems also enable real-time monitoring of supply chain activities to help ensure that supply chain processes are cost-effective and competitive. ERP systems also provide an effective way to manage procurement and materials management across the supply chain including manufacturing, warehousing, and transportation; this increases the visibility of all aspects of the supply chain and enables supply chain partners to optimize procurement, production, and inventory levels. ERP systems can also contribute to the execution of supply chain plans by providing a flexible way to establish or modify the parameters in which the supply chain should operate.

When ERP and SCM solutions are purchased from different ES vendors, middleware (software that provides connectivity between two or more software applications) or EAI (enterprise application integration) may provide the best option for integrating an organization's SCM and

ERP systems. If both systems are purchased from the same ES software vendor, integrating the two enterprise systems is typically much easier.

ERP SELECTION, IMPLEMENTION, UPGRADE, AND SUPPORT

Many factors should be considered by an organization when choosing an ERP vendor. An appropriate level of due diligence is required because deploying an ERP system can be an expensive and time-consuming process. Implementing an ERP system often involves considerable organization change and adaptation, so the change management aspects of ERP implementation cannot be overlooked.

There are numerous questions that should be considered when choosing the ERP vendor. These include:

- What is the vendor's reputation and situation?
- What technologies are included in the vendor's ERP solution?
- What are the ERP system's functionalities and ease of use?
- What are the true costs of the vendor's ERP solution
- What kind of support and training is available?

Numerous sub-questions are associated with each of these larger ERP vendor selection questions. Several of these are identified in the sections that follow.

ERP Vendor Reputation and Situation

Numerous issues are associated with gaining an accurate picture of the vendor's reputation and situation. These include:

- How long has the vendor been an ERP vendor and how well does it understand the ERP market?
- What changes have occurred to the vendor's organizational structure during the last several years? Has the vendor organization expanded from mergers and acquisition and how as the market responded to the vendor's mergers and acquisitions?
- What are the vendor's most recent products and what new products are forthcoming? How do recent products add value to the ERP solution?
- What is the future direction of the vendor's business? Does it include ongoing support and evolution of its ERP solutions?
- Does the vendor have specialized experience in providing ERP solutions to organizations of a similar size and type? Does the ERP product have a vertical solution for the organization's industry?
- What share of the ERP market has the vendor captured? How many companies have adopted the vendor's ERP product? Who are some of the major adopters?

Technologies Included in the ERP Vendor's Solution.

An organization should also strive to get a clear picture of the vendor's ERP product's technical capabilities. Some of the key issues associated with this include:

- Can the vendor's ERP solution be customized to the organization and its unique business processes or is it a turnkey solution to which the organization must adapt?
- Is the vendor's ERP product scalable? Can it handle a growing user base and/or data increases?
- Does the vendor's ERP product meet the organization's technical needs? Will the organization's end users be able to use the ERP product?
- Can the vendor's ERP product support multiple sites within the company? Can it support multiple-companies within the same parent company?

ERP Functionalities and Ease of Use

A potential adopter should strive to get answers to questions about its intended use of the vendor's ERP product. Key issues associated with this include:

- How will the organization use the ERP product to address business challenges and problems? Which ERP product functionalities will be used to address these challenges?
- How extensive and helpful is the ERP product's available documentation and help files to assist users with issues that they encounter?
- How easy is it to integrate the ERP product with the organization's CRM, SCM, or SRM systems?
- To what extent do potential users perceive the ERP product as easy to use and useful in performing their jobs in ERP product demos?

ERP Product Costs and Return on Investment

Potential adopters should also strive to get a clear picture of the costs associated with implementing the vendor's ERP product and its ongoing support. Some of the key questions associated with determining costs include:

- What are the costs associated with the ERP product's functionalities that will be used with by the organization?
- What one-time costs are associated with adopting the vendor's ERP product? What recurring costs are associated with ongoing use of the vendor's ERP product? What are the annual maintenance costs for the ERP product? What will it cost to upgrade the ERP product?
- What is the ERP product's total cost of ownership (TCO) including for all aspects of the system including the ERP software, hardware infrastructure, and ongoing support?
- Are there potential hidden costs associated with adopting this ERP product? Have other organizations adopting this ERP product experienced hidden costs?

- What is the organization's estimated return on investment (ROI) for this ERP product? What ROI has been realized by similar organizations who have adopted this ERP product?

Available Training and Support for the ERP Product

The availability, quality, and cost of user training and ongoing support can be an important consideration in choosing an ERP product and vendor. Questions that an organization should consider about an ERP product's available training and support include:

- What will the vendor do to ensure that ERP product's implementation is successful? To what extent has the vendor lived up to its promises when implementing the ERP product in similar organizations?
- What is the vendor's recommended process for transitioning from the organization's current system to the new system? Does this make sense for the organization?
- What training is available during and after the implementation of the ERP product? How do similar organizations who have adopted the ERP product assess the quality and thoroughness of available training?
- Will the organization have access to the ERP product's source code after implementation? If not, what is the vendor's process for fixing bugs and releasing product updates?
- Is the ongoing maintenance and support of the ERP product handled in-house by the ERP vendor or is it outsourced to a third-party organization?
- How extensive and robust is the ERP vendor's ecosystem for its ERP product? How many software partners and consultancies are part of the ERP product's ecosystem? To what extent is high-quality training and support available from partners and consultancies within the ecosystem?

ERP Vendor Selection Process Phases

Some organization's address the vendor selection questions summarized above within a systematic vendor selection process that includes research and requirements, vendor comparison, request for proposals/quotations, technical validation, and financial due diligence phases.

During the research and requirements phase, the organization determines what business needs would be addressed by an ERP system and whether an ERP system is appropriate for the business. This phase includes requirements gathering to determine the fit between ERP software and current operations, the ways in which ERP capabilities could improve business performance and promote beneficial changes, and the extent of top-management and organizational buy-in for ERP adoption. This phase may also include preliminary assessments of potential ERP vendors and products from online research and informed opinions from consultants and colleagues at similar organizations who have adopted ERP systems.

The vendor comparison phase involves gathering information relevant to determining which vendor products are most likely to best fit the needs of the organization. The organization is likely to want to know whether the vendor's ERP product will work with the organization's existing applications, the extent to which the vendor has experience with the organization's industry, and the extent to which the vendor understands the organization's business needs. This phase concludes with the determination of a short list of ERP vendors to which requests for proposals (RFPs), requests for quotations (RFQs) or requests for information (RFIs) will be sent in the next phase of the vendor selection process.

Vendors are provided with information about the organization in RFPs, RFQs, and RFIs and are formally asked to provide proposals, quotations, or requested information. During the technical validation phase, vendor responses are systematically evaluated using comprehensive scorecards that consider each ERP product on dimensions such as functionality and capability, usability, flexibility, improvement of internal processes, and cost. Scorecard results typically contribute to determining which vendors are invited to demo their ERP products and provide product documentation. The technical validation phase may also address whether the ERP product can be implemented in stages versus all at once, how technical problems with the software are typically handled by the vendor, how training is handled, and typically costs associated with ERP products updates.

The financial due diligence phase of the ERP vendor selection process typically involves reviewing the business case for implementing an ERP system in the organization and its anticipated ROI. The ERP vendor's reputation and position within the industry is also considered during this phase of vendor selection. The due diligence performed during this phase culminates in the selection of the ERP vendor and product and contract negotiation. Once the vendor and product is selected, the organization moves on to implementing the ERP system.

ERP Implementation Challenges and Issues

Implementing an ERP system has the potential to produce massive changes within an organization that must be carefully managed to help the organization reap the ERP system's potential benefits. Some of the critical issues associated with successful ERP implementations include top management commitment, the reengineering of existing business processes, integration of the ERP system with other business information systems, the selection and management of consultants and employees directly involved with implementing the ERP system, and the training of employees.

Top Management Commitment

Implementing an ERP system is not a simply a matter of changing software systems, rather it is much more about transforming business practices and repositioning the company to be competitive with its industry. Because of the strategic implications associated with implementing an ERP system, it is critically important for top management to be involved with choosing the ERP product and vendor and committed to ensuring implementation success.

Implementing the ERP system may affect the business's organizational structure and the culture, and it is certainly going to impact specific functional units or the entire organization. Top management must anticipate these changes and develop appropriate change management strategies and tactics. Top management involvement in every step of ERP implementation is recommended to ensure implementation success.

Research on successful ERP implementations has consistently shown that effective change management from the top is a key to a smooth ERP system rollout. Intervention from top management is often needed to resolve conflicts and ensure that everyone remains on the same page about the need and importance of the ERP system to the organization. Top management involved in managing change can help build cooperation among diverse groups in the organization. By monitoring progress of the ERP implementation project, top manage is positioned to provide direction to implementation teams and communicate its commitment to the success of the ERP implementation project.

Reengineering Business Process

ERP systems are built on industry best practices. As a result, the implementation of an ERP system typically involves reengineering the organization's existing business processes to conform to best practices. The cost and benefits of re-aligning the organization's business processes with ERP system best practices can be very high. Also, employees are likely to resist the changes that must be made. In some instances, an organization's business processes are so unique that they need to be preserved, and the ERP system should be customized to ensure ongoing support for those business processes.

ERP adopters also face a question of whether to implement the ERP software "as is" and adopt the ERP system's built-in best practice procedures or to customize the product to meet the specific needs of the company. In some instances, an organization's business processes are so unique that they need to be preserved, and the ERP system should be customized to ensure ongoing support for those business processes. When an organization customizes the ERP software to suit its needs, its total cost of implementation rises. Because of this, many organizations decide to implement the ERP system "as is" as much as possible to reduce the costs of customization and as well as future maintenance and upgrade expenses.

Integration with BIS Applications

As noted previously in this chapter, compelling arguments can be made for having a single ERP system (instance) that serves the entire organization. Many companies think that maximizing use of a single software vendor provides a "common view" that helps them efficiently serve users and maintain their systems. However, it is rarely the case that a single vendor or application can do everything a company needs. As a result, most companies have multiple software products to meet their specialized needs and these products have to be integrated with the ERP system when it is implemented.

In many organizations, the ERP system serves as the backbone for business computing and the organization's other software systems are integrated with the ERP software. In many instances, there is existing middleware from ERP vendor partners or third-party software companies that can be used to integrate software applications with the ERP backbone. When middleware is not available, organizations are challenged with developing their own interfaces for commercial software and homegrown applications.

The use of middleware and integration software also poses additional challenges when it comes to maintenance, especially when there are changes and upgrades to either ERP software or to the software that is integrated with the ERP system. Integration problems can be particularly severe if middleware is used to link the organization's ERP system to its vendor companies in the supply chain, or to link the organization's ERP and CRM systems.

ERP Consultants

Organization's rarely have sufficient resources in-house to manage ERP implementation and upgrade projects. Typically, organizations rely on external consults for ERP project management and this is why consultancies are part of ES vendor ecosystems. In the United States, each of the "Big Four" accounting firms have divisions that specialize in ERP project implementations. Most ES vendor ecosystems include other consultancies that specialize in assisting ERP adopters in implementing and upgrading their ERP systems. ERP product vendors can also be a source of ERP consultants and project management expertise.

Big ERP implementation projects can be lengthy in duration (1 to 2 years, or more) and may include dozens or hundreds of consultants. Consulting costs are an important part of ERP implementation budgets.

Selecting Employees

ERP implementation best practices call for the organization to provide an "A team" to devote to the project. Organizations that are willing to dedicate some of their best employees to the project are most likely to have successful implementations. It is important for the organization to choose internal employees with the right skill sets. Selected employees should also be experts in the company's business processes and be aware of the best business practices in the industry. Most ERP consulting firms have developed guidelines for selecting employees for the project.

Unfortunately, because of the complexities involved in the day-to-day running of the organization, it is not uncommon for functional departments to be unwilling to sacrifice their best employees to work on the ERP implementation. Despite the importance of the ERP implementation to the organization's future competitiveness, some organizations select a "B team" instead of an "A team" to work on the implementation.

Employees selected to work on the ERP implementation are often able to leverage their experience to land high-paying jobs with other organizations undergoing ERP implementations.

The knowledge and skills that they gain through their involvement with their organization's ERP implementation may present retention challenges to their employers.

Employee Training

ERP systems are complex and require rigorous training. It is often difficult for trainers or consultants to transfer knowledge in how to use the system to employees in a short period of time. Knowledge transfer can be especially slow if employees have low levels of computer literacy.

Employees are not only learning how to navigate the ERP system and use it to perform their jobs, but are typically also learning how their job has changed. In addition to learning how to use the ERP system, employees are also taught their new responsibilities. ERP users are typically empowered by the system; they may now be making decisions about buying and selling that were previously made by their supervisors. ERP users also need to learn how their data affects the rest of the company.

Organizations that adopt ERP systems quickly realize that ERP systems require continuous training and that employees should consistently have opportunities to enhance their ERP knowledge and skills. Some of this training can be provided in-house and ERP vendors and consultancies often provide training and development opportunities. Major ES vendors provide certification training and testing programs for ERP adopters. Some of these ERP certifications are recognized worldwide. SAP's University Alliances enables university students to earn entry-level certifications (such as the TERP10 certification) at highly discounted rates.

ERP Implementation Strategies

ERP adopters also have to consider which ERP implementation strategy is best for their organization. There is no single, best practices recommendation for ERP implementation so the organization must consider what strategy best fits its goals, requirements and time frames.

The two most widely used ERP implementation strategies are "the Big Bang" ERP implementation strategy and the "phased- roll out" ERP implementation strategy. The **Big Bang ERP implementation** strategy involves rolling out the ERP system all at one. All users move to the new system at the same time. This strategy requires considerable pre-implementation preparation to ensure implementation success as well as a fall back plan should something go awry during the onetime rollout.

In the **Phased Rollout ERP implementation** strategy, the ERP system is rolled out in phases according to a pre-determined plan. Relative to the Bing Bang implementation, users are faced with adapting to a series of smaller changes that are made over an extended time period until the entire ERP system is rolled out. There are different ways to do this such as module by module, business unit by business unit, or geographic location by geographic location (if the organization has multiple locations).

A third, less popular option for ERP implementation is the **parallel adoption** strategy. This implementation strategy involves running the new ERP system alongside the old system(s) that it is replacing for a period of time. This enables users to learn the ERP system while still working on the old system. When sufficient comfort levels with the ERP system are achieved, the old system can be left behind and the switch to the new system can be made using either a Big Bang or phased rollout implementation.

Some of the major pros and cons associated with each of these ERP implementation strategies are summarized in Figure 7-20.

ERP Implementation Strategy	Pros	Cons
Big Bang	Everyone in company moves forward on same day.	High risk.
	Shorter implementation time.	Thorough testing is needed prior to implementation.
	Implementation pain is condensed, not drawn out.	Employee learning is sink or swim.
	Lower implementation costs.	Performance may decline as users adapt to new system.
Phased Rollout	Less risk than Big Bang.	Longer time to fully implement the ERP system.
	More time for users to adapt to new system.	State of continuous change can be disruptive.
	Performance less likely to decline as users adapt to the ERP system.	Less focused than Big Bang.
	Skills learned in early phases smooth transition to later phases.	Temporary bridges between old and new systems may be needed.
Parallel Adoption	Less risk than Big Bang or Phased Rollout.	More expensive than Big Bang or Phased Rollout.
	Users learn ERP while working on old system.	Employees enter data in both systems which can be inefficient and can breed data problems.
	Slower than Big Bang but faster than Phased Rollout.	

Figure 7-20: ERP Implementation Strategy Pros and Cons
Courtesy: Thomas Case

ENTERPRISE SYSTEMS MANAGEMENT AND GOVERNANCE

After implementing an enterprise system (ERP, CRM, SRM, or SCM), the adopter organization is faced with managing and governing the system. As noted in the previous section, the primary reasons for adopting an ERP system are often strategic in nature. The organization is looking for a system that will be the backbone of its business computing platform and that will help the organization be more competitive in its industry and business environment. An ERP system will change the enterprise's technical platform but the main reasons for doing so are driven by the desire to transform business processes, business performance, and business competitive. Hence, after implementing an ERP system (or any other enterprise system), it is important to establish enterprise systems management and governance structures that are more business than technically focused.

Adopters of SAP enterprise applications are encouraged by the vendor and the consultancies in its ecosystem to establish a center of excellence. An enterprise system **center of excellence (CoE)** can be described as a team, entity, or shared facility that provides ongoing leadership, research, best practices, support and/or training for an enterprise system. A CoE is established to provide a support organization and governing body for the enterprise system that will oversee the provision of resources, funding, and enterprise systems strategy and roadmap.

As a post-implementation support organization, a CoE should include a mix of *process owners* (enterprise systems the "super-users" on the business side of the organization with intimate knowledge of core business processes), functional application experts and IT technical experts. The CoE should also include individuals focused on new initiatives (such as the rollouts of additional modules) in response to changing business needs. Overall, the CoE should provide a bridge between the organization's IT professionals and business users that is established in a way to provide sustainable business-focused support for the enterprise system.

Establishing governance for the support organization is a critical step in creating a CoE. The governance structure that is established should provide strategic direction and accountability, for all ES initiatives. The governance structure should also provide a framework that enables the organization's business units to work collaboratively with IT on process standardization and ES/business alignment across the organization. A CoE governance structure often includes an executive steering committee, a program/project management group, a support services team, and a power users group.

Once established, some of the key functions and roles of the CoE include:

- Business support - Business analysts on COE governance teams work with application developers to support ES users.
- ES projects & implementations - Business analysts within the COE organization work with application development teams to roll out new ES functionality.
- Technical support for the ES system.
- Training - ES knowledge transfer to ES users.
- Help/support desk – Provides ES support to ES users and super users.
- Information management – Provides a central contact point for ES related information, enhancements and new developments.
- Post go-live analysis – Reviews post-implementation status of business processes; seeks to identify flawed/broken business processes, deficient ES configuration, ES user unwillingness to use ES, insufficient training, and data management issues.
- Change management -- Provide guidance on how to manage change associated with the ES platform and ensures that changes are made in a controlled manner that does not

put the production instance at risk and helps ensure the realization of ES business benefits.

- Internal marketing – of the services offered by the COE to ES users.

Some the major focus areas and goals of an ES center of excellence are summarized in Figure 7-21.

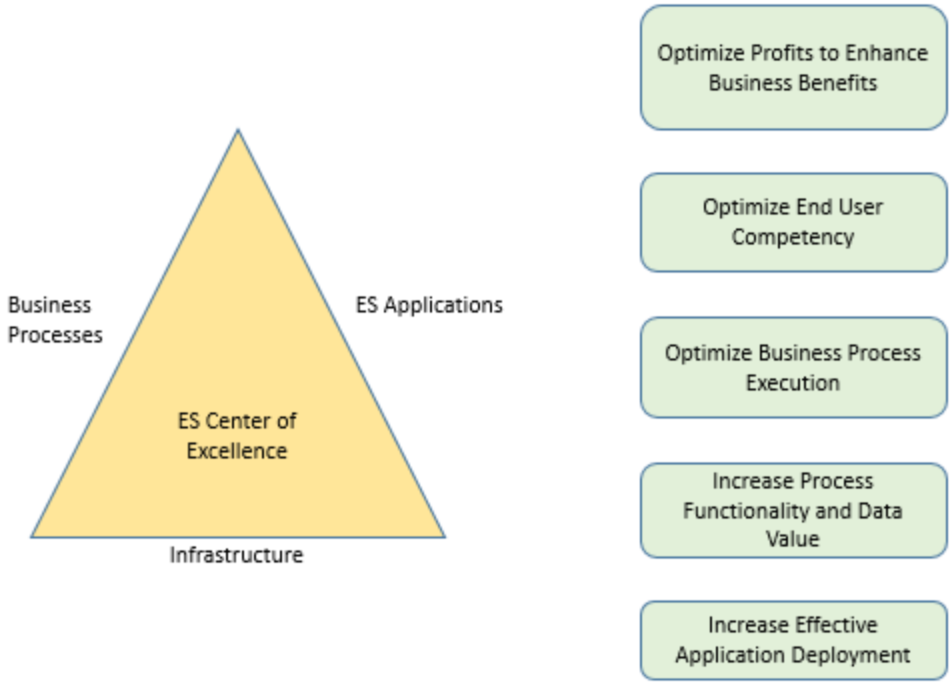


Figure 7-21: ES CoE focus areas and goals.
Courtesy: Thomas Case

Enterprise Data Management

Data is often described as the lifeblood of an information system and organizations that implement enterprise systems typically want to harvest the data that these systems generate to support data-driven decision-making. Because enterprise systems are data-centric, ES adopters are typically challenged to develop data management and governance structures to ensure that their data provides business value.

Enterprise data management has emerged as a priority and essential business requirement for many organizations. Its overall objective is to ensure that the organization has trust and confidence in the data that is essential to achieving its business strategy. **Enterprise data management (EDM)** can be described as an organization's ability to effectively create, integrate, disseminate and manage data for its enterprise systems, business processes, and internal and external entities that require accurate and timely data delivery. An overriding goal of EDM is the elimination of organizational conflicts and issues that result from the mismanagement of data and information.

Of necessity, EDM focuses on software applications, infrastructure, business logic and policies that the organization uses to manage enterprise data flow. EDM governance requires the collaboration of the organization's IT department and its business units.

EDM requires a strategic mindset for choosing appropriate data management processes, technologies and human resources (e.g. data owners, data governance and stewardship committees, data architects and data analysts). EDM can prevent a major challenge to an organization because it requires alignment among multiple stakeholders (including IT, operations, finance, executive managers, end-users, and sometimes external stakeholders – such as customers, suppliers and business partners). It is also challenging because it focuses on the creation and use of common data that does not have a clear "owner."

EDM typically encompasses the creation, documentation and enforcement of operating policies and procedures associated with data changes such as changes to data models, data cleansing, data normalization, metadata, and data dictionaries/glossaries. It also typically oversees data ownership and stewardship and data security. A typical EDM challenge is the ability to ensure consistency among data from internal and external sources. In many circumstances, these different data sources use inconsistent terms and definitions to describe the same data. Such inconsistency makes it difficult do data mapping and cross-referencing, to exchange data among applications and systems. Data inconsistencies also inhibits the organization's ability to automate business processes and integrate enterprise systems.

While EDM is fundamentally a data content challenge, there are technology issues that must be addressed. Organizations with enterprise systems need to have functional data storage platform, a comprehensive data model and a robust infrastructure for sharing data among applications and systems. Building the data storage platform and determining how data is integrated across business applications is an important aspect of EDM.

Master Data Management

Organizations with enterprise systems are especially concerned with master data because it is shared across applications and business processes. Examples of master data include data about customers, vendors (suppliers), materials, products, and employees. The presence of master data in an ES database (such as an ERP database) enables the data to be used to self-populate data fields in the screens and user interfaces used within a business process. For example, entering or selecting the number that uniquely identifies a customer, enables data about the customer (such as the customer's billing address) to self-populate the screen used to create an invoice for a customer order.

Because it can be shared across business processes and applications, it is important for an organization's master data to be accurate and up-to-date. This means that master data management is often a key aspect of its EDM processes. **Master data management (MDM)** includes the operational and governance processes, policies, standards, and tools that an ES adopter deploys to ensure consistent data definitions and management of its critical data. At a basic level, (MDM) can be viewed as a systematic approach for improving an organization's data quality that is operationalized through the policies and procedures established by data governance group. As a result, MDM strives to ensure that an organization does have competing and potentially inconsistent versions of the same master data. In many organizations, the overall goal of their MDM initiatives is to provide ES users with "single version of the truth" that can be trusted and used to inform business decisions.

In essence, MDM is a subset of EDM that focuses on master data. Similar to EDM, MDM can be a major challenge to an organization to get right because it requires alignment among multiple stakeholders (including IT, business managers, data owners, end-users, and external stakeholders – such as customers, suppliers and business partners). Not surprising, MDM governance structures often include representatives from key stakeholders.

ENTERPRISE SYSTEMS AND BUSINESS TRANSFORMATION

Since their introductions, some organizations have purposely adopted and implemented ERP systems and other enterprise systems in order to achieve dramatic improvements in productivity, efficiency, and process outputs. In essence, top managers of the organizations leverage enterprise systems to force the organization to make major or radical in business processes and operations that the organization might otherwise be unwilling or unable to make. This is essentially a strategic decision to make organizational changes that top management thinks is necessary to ensure sustained competitiveness and survival.

Because this is top-down organizational change that borders on being (or is) radical in nature, it typically stirs significant resistance among organizational employees. High volumes of communication and education programming are often needed to explain to employees why top management considers the ES implementation to be critical for improving organizational performance and competitiveness. Employee resistance sometimes persists throughout and beyond the ES implementation and delays the realization of the ES's business benefits.

Such top-down, heavy-handed business transformation via ES software implementation shares some of the goals of business process reengineering (BPR) – which is described in Chapter 6. Like BPR, leveraging an ES to force organizations to change can be viewed as a form of business transformation because focuses on making extreme changes to the organization's business process design. It is also similar to BPR, leveraging ES software to change business processes involves the use of IT for process improvement and typically attacks an organization's functional silos and forces the creation of cross-functional process teams. However, when an ES is used to change business processes, the intent is typically to force the organization to conform to the business process best practices that are built into the software; i.e., to force the organization to adapt to the software. In “clean slate” BPR, there is no clear mandate about how the process should change and how IT is to be used within the changed process.

Another difference between using ERP systems or other enterprise systems to forcibly alter business operations and BPR is in the number of business processes that are changed. When a Big Bang ES implementation takes place numerous business processes are being changed simultaneously. With BPR, attention may be focused on one process at a time, rather than on multiple processes.

Business process management (BPM) programs are often established subsequent to using either BPR or enterprise systems to change business processes and operations. Such programs are established to build a process-focused continuous improvement mindset with the organization. BPM programs are discussed in Chapter 6.

CHAPTER SUMMARY

Organization’s adopt enterprise systems for a variety of business reasons. Enterprise resources planning (ERP) systems, customer relationship management systems (CRM), supply chain management systems (SCM), and supplier relationship management (SCM) systems are examples of enterprise systems (ES) that are commonly adopted by organizations. Some businesses adopt and integrate several ES.

Due diligence should be conducted by an organization before adopting an ES. It is important for organizations to know the ES’s capabilities, infrastructure requirements, potential benefits and risks, ongoing maintenance realities and costs, etc. before contracting with an enterprise system vendor. Because enterprise systems are available from a wide range of vendors, organizations are often interested in knowing more about vendor ecosystems before choosing which product to adopt. Vendor ecosystems include organizations that use ES software, partner organization, and consulting firms that provide expertise in managing enterprise system implementation projects.

ERP systems are the core, backbone, transactional systems in many businesses organizations. CRM, SCM, and SRM systems can be integrated with ERP systems, however, integration is optional rather than required. ERP systems have traditionally had a three-tier architecture that includes a user tier, application software tier, and a database tier. Today, businesses have the option of installing the ERP system on premises or getting access to it in the cloud. Best practices in ERP adoption includes installing at least three environments for each ERP instance: a production environment, a testing and quality assurance environment, and a development environment. Some organizations have different ERP instances in different business units; others choose to have a single ERP instance that serves the entire organization.

Many organizations adopt an ERP system because it allows them to simultaneously support multiple business processes (including procurement, production, and order fulfillment). This enables the businesses processes to be integrated and this means the completion of tasks/activities in one process produces changes that affects one or more other processes. ERP systems also play a central role in the integration of an organization's enterprise systems. There are numerous business benefits associated with ES integration, so it is not surprising that ES integration is the norm, rather than the exception, for most organizations.

Many factors should be considered by an organization when choosing an ERP vendor and an appropriate level of due diligence is required before selecting an ERP vendor and product. Some of the issues considered when choosing an ERP vendor include the ERP vendor's reputation and market position, the ERP product's functionalities and ease of use, the ERP product's costs and ROI, and the training and support is available for the ERP product.

Implementing an ERP system often involves considerable organization change and adaptation, so the change management aspects of ERP implementation cannot be overlooked. Some of the critical factors associated with ERP implementation success include top management commitment to the ERP system, the reengineering of business processes, the availability of ERP consultants, the quality of employees selected to work on the ERP implementation project, and the extent and quality of ERP training that is available to members of the organization.

Three ERP implementation strategies may be used to roll out the ERP system. In Big Bang implementation, the ERP system is rolled out all at once. In phased rollout implementation, the ERP system is rolled in stages over an extended period of time. A third, but less popular ERP implementation strategy is the parallel adoption strategy. In this approach, users are trained on the ERP system while the system(s) that the ERP system will replace continue to be used to run the business until ERP training is complete.

To get the most out of the enterprise systems that they implement, organizations establish enterprise systems management and governance processes. Enterprise systems users and business managers have important roles in enterprise systems governance and best practices in enterprise systems governance often includes the creation of "centers of excellence."

Organizations who adopt enterprise systems also need enterprise data management (EDM)and governance systems. The adoption of the enterprise system often signals the organization's readiness to become a "data-driven" business, which elevates the importance of data and information quality within the organization. Three major categories of data are found in enterprise systems: master data, transaction data, and organization data. Sound data management and governance processes are needed for each of these, but many enterprise system adopters develop master data management (MDM) governance structures as a subset of their EDM initiatives.

Some organizations adopt enterprise systems to force changes in business processes and operations and/or because they want dramatic improvements in productivity, efficiency, and process outputs. Using ERP systems or other enterprise systems to forcibly alter business operations is similar to business process reengineering, except in this case, numerous business processes are being changed simultaneously rather than one at a time.

KEY TERMS

Big Bang ERP implementation 33

Center of excellence (CoE) 35

Customer relationship management (CRM) 4

Enterprise data management (EDM) 36

Enterprise resources planning (ERP) 11

Enterprise systems (ES) 2

Enterprise system architecture (ESA) 15

Enterprise system ecosystem 13

ERP instance 19

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Integration point 22

Master data management (MDM) 36

Parallel adoption 34

Phased rollout ERP implementation 33

Supplier relationship management (SRM) 9

Supplier relationship management software 9

Supply chain 6

Supply chain management (SCM) 6

REVIEW QUESTIONS

1. What are the characteristics of enterprise systems (ES) and why are they implemented by organizations?
2. What business benefits may be realized by organizations that adopt enterprise systems?
3. What is customer relationship management (CRM)?
4. What business benefits may be realized by organizations that adopt CRM systems?
5. Briefly describe the differences among sales force automation, customer service management, and marketing automation.
6. Briefly describe the differences between the analytical and operational components of CRM software.
7. What is a supply chain?

8. What does supply chain management (SCM) involve?
9. How is IT used in a supply chain?
10. Briefly describe the business benefits of SCM.
11. Identify and briefly describe the functions performed by SCM software.
12. What is supplier relationship management (SRM)?
13. Briefly describe the business benefits of SRM?
14. Identify and briefly describe the major categories of SRM software.
15. What is enterprise resources planning (ERP)?
16. Briefly describe how ERP software integrates business processes.
17. Briefly describe the role of ERP systems in integrating ES?
18. Identify and briefly describe the business benefits of ERP systems.
19. Identify and briefly describe each of the major components of enterprise systems ecosystems.
20. Briefly describe an organization's enterprise systems architecture (ESA)?
21. Identify and briefly describe the business benefits of ESA?
22. Briefly describe each of the tiers of ERP software architecture?
23. Briefly describe how ERP software architecture maps to client/server computing.
24. Briefly describe the differences among two-tier, three-tier, and n-tier client server computing.
25. Briefly describe the differences among fully on-premises, fully in-the-cloud, and hybrid ERP infrastructures.
26. What is an ERP instance?
27. Why are single-instance ERP systems considered to be ERP system best practices.
28. Briefly describe the similarities and differences among the following ERP instance environments: production, development, testing.
29. Why may training and database development environments be included in an ERP instance?
30. What is a business process integration point?
31. Identify and briefly describe examples of integration points within an ERP system.
32. What are the business benefits of integrating an ERP system and a CRM system?
33. Briefly describe how ERP and CRM systems can be integrated.
34. What are the business benefits of integrating an ERP system and a SRM system?
35. Briefly describe how ERP and SRM systems can be integrated.
36. What are the business benefits of integrating an ERP system and a SCM system?
37. Briefly describe how an ERP system and SCM system can be integrated?
38. Identify the major questions that an organization should address when choosing an ERP vendor. Also identify several issues associated with each major question.
39. Briefly describe what happens during each of the following phases of the vendor selection process: research and requirements, vendor comparison, request for proposals/quotations, technical validation, financial due diligence.
40. Briefly describe each of the critical issues associated with ERP implementations.

41. Briefly describe the characteristics, pros, and cons of each of the following ERP implementation strategies: Big Bang, phased rollout, parallel adoption.
42. What is a center of excellence (CoE)?
43. Why do organizations establish CoEs after implementing an ES and what organizational groups typically are represented within the CoE?
44. Identify and briefly describe the major functions/roles of a CoE.
45. What is enterprise data management (EDM)?
46. What does EDM typically encompass?
47. Identify and briefly describe several EDM challenges.
48. What is master data management (MDM)?
49. What does MDM encompass and what are its major goals?
50. What are the similarities and differences between using ES and BPR to change business processes?

Chapter 8 – ERP and Procurement

CHAPTER OBJECTIVES

After reading this chapter, you should be able to:

- Describe an organization's procurement process.
- Identify and briefly describe the differences between strategic and operational procurement.
- Identify several procurement process goals and measures.
- Identify procurement process actors and their roles.
- Describe the procurement process's document flow.
- Describe the procurement process's data and information flow.
- Identify the physical flows within the procurement process.
- Describe how the procurement process is automated by electronic data interchange (EDI).
- Describe how vendor-managed inventory (VMI) automates the procurement process.
- Describe how ERP systems support and automate the procurement process.
- Briefly describe e-procurement systems.

INTRODUCTION

The procurement process is the sequence of activities used by an organization to obtain needed materials. Virtually every organization has a procurement process. The procurement process is associated with the inbound logistics component of Porter's value chain. Purchasing is an important aspect of the procurement process; it is often the responsibility of an organization's purchasing department and purchasing is identified as a secondary activity within Porter's value chain model.

There are three fundamental activities associated with an organization's procurement process: (1) ordering needed materials from suppliers; (2) receiving ordered materials; and (3) paying the supplier. In most organizations, these activities are carried out by actors in multiple departments or functions. This means that the procurement process is often a cross-functional business process.

Major documents in the procurement process include purchase requisition, purchase order, goods receipt, invoice, and payment. Purchase requisitions are typically aggregated into purchase orders to take advantage of quantity discounts and economies of scale. A purchase order lists the materials/products to be ordered from a supplier (vendor) and their quantities. Suppliers often include a shipping document with each shipment to their customers; the shipping document specifies the materials/products in the shipment and their quantities. When ordered goods are received by the organization, the receiving unit creates a goods receipt document that specifies what is included in the vendor's shipment. The goods receipt document is compared to the organization's purchase order and to the vendor's invoice for shipped goods in an internal control process called the "three-way match". When the values in these documents align, vendor payment can be authorized.

Detailed data about materials/products is carried on many of the documents in the procurement process, especially on purchase requisitions, purchase orders, goods receipt documents, and invoices. The primary physical flow in the procurement process is the receipt and subsequent storage/handling of ordered goods.

An organization's procurement process may be automated by several business information systems. Electronic data interchange (EDI) was the first technologies used to automate procurement. With EDI the format of business documents, such as purchase orders, invoices, and payment documents are standardized and exchanged electronically between the purchasing organization and the supplier. Extranets, and business-to-business exchanges can also be used to link organizations to their suppliers. Some organizations establish close partnerships with key suppliers and implement vendor-managed inventory (VMI) systems. With VMI, a supplier is able to monitor inventory levels within a customer's computing system; the supplier does this in order to automatically ship materials/products to the customer when inventory levels fall below pre-specified levels. The supplier essentially creates a purchase order on behalf of the customer and ships the materials/products that the customer needs to replenish.

ERP systems and supplier relationship management (SRM) systems may also be used to streamline the procurement process. The ability to support and automate procurement is a major reason why some organizations adopt ERP systems. ERP systems can be used to support all phases of the procurement from requisitions to payments. As discussed in Chapter 7, SRM systems can also be used to automate the procurement process and are increasingly used by purchasing departments to support strategic sourcing and e-procurement.

WHAT IS THE PROCUREMENT PROCESS?

Within an organization, **procurement** is the overarching function that includes the activities and processes to acquire needed goods and services. Procurement is broader in scope than **purchasing** which includes the activities used by the organization to order and receive goods and services. Purchasing is a subset of the procurement process that; purchasing is essentially the process used by the organization to order goods and typically includes activities for requesting goods, request approvals, purchase order creation, and receipt of ordered goods. Procurement goes beyond purchasing by encompassing the establishment of fundamental requirements for goods and services, sourcing activities such strategic vetting, vendor selection, establishing payment terms, and contract negotiation. Figure 8-1 summarizes some of the major differences in the range activities associated with procurement and purchasing.

Procurement Activities	Purchasing Activities
Identification of needed goods/services	
Purchase request authorization	
Purchase request approval	
Identification of suppliers	
Vendor inquiries and/or RFQs	
Vendor evaluation and selection	
Contract negotiation	
Purchase order creation	Purchase order creation
Goods receipt	Goods receipt
Invoice receipt and recording	Invoice receipt and recording
Three-way match	Three-way match
Payment to supplier	Payment to supplier

Figure 8-1: Procurement and purchasing activities
Courtesy: Thomas Case

The procurement process has different identifiers within an organization depending on range of goods and services acquisition activities being discussed. In many organizations, procurement is referred to as the "procure-to-pay" process or cycle. Other organizations use "requisition-to-pay" to describe their procurement processes. Generally speaking, the "procure-to-pay" process is more likely to include both strategic and operational procurement activities, while "requisition-to-pay" is more likely to be limited to operational procurement (purchasing) activities.

Procurement is often considered to be a part of an organization's supply management function; within an organization, the **supply management function** encompasses the activities associated with identifying, acquiring and managing the products and/or resources needed to run the organization including physical goods, information, services, and other needed resources. Inbound logistics, procurement, and materials management are key aspects of an organization's supply management function.

Procurement is also widely viewed as a form of *business-to-business (B2B)* commerce because it involves the process of buying goods and services from another company. When viewed as an aspect of B2B commerce, the goal of procurement process is to buy a needed product or service for the most favorable price. This goal is most easily achieved when organization is positioned to buy the needed product or service from multiple competing vendors.

Strategic and Operative Procurement

There are two forms of procurement: strategic and operative procurement. *Strategic procurement* includes the development of long-range plans for ensuring timely supply of goods and/or services that are critical to an organization's core business objectives. Strategic procurement includes the assessment of the organization's demand for a product or service, establishing a strategy for acquiring needed goods and services, supplier evaluation and selection, contract negotiation, and supplier integration. These aspects of strategic procurement are summarized in Figure 8-2. *Operational procurement* includes the creation of purchase orders, goods receipt, and accounting activities including supplier payments.

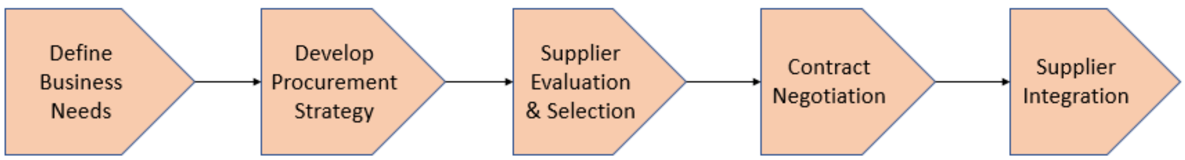

Figure 8-2: Strategic procurement activities
Courtesy: Thomas Case

Strategic procurement begins with identifying and defining the organization's need for a good or service. This includes the specification of the business requirements for the good or service. The organization's internal stakeholders (consumers) of the good or service are consulted to determine precise requirements for the good/service. business A strategy for procuring the needed good or service is developed next. This step focuses on establishing an approach, timetable, and budget for acquiring the needed good or service and identifying potential suppliers (sources). After establishing a strategy for procuring the good or service, the organization is positioned to evaluate and select a supplier. This step may involve making potential suppliers aware of the organization's need for the product or service via the dissemination of requests for quotations (RFQs) and/or less formal types of inquiries (such as phone calls). The objective of this step is to select the "right" supplier of the good or service; the right supplier may not be the cheapest, but is the supplier that is best positioned to satisfy the organization's business requirements and timetables. Once the best supplier for a product or service is identified, contract negotiation occurs; this step concludes with a signed contract between the organization and supplier that is that is typically legally binding. The final step of strategic procurement illustrated in Figure 8-2 is vendor integration. This involves working out the details needed to ensure that the supplier is fully prepared to receive purchase orders and satisfy all aspects of its contract with the organization.

Supplier relationship management (SRM), which is discussed in Chapter 7, is frequently described as a strategic procurement system because it focuses on joint value creation that is based on trust and collaboration with a limited number of suppliers. SRM software helps procurement managers complete the strategic procurement activities summarized in Figure 8-2. It also helps organizations monitor supplier performance after strategic partnerships are formed with suppliers. SRM systems help organizations reduce procurement costs and reduce supply disruption risks. SRM can help the organization become a "preferred" customer by its suppliers and reduce price volatility for the materials that it needs.

While an SRM can also support the activities associated with operational procurement, it is typically integrated with the organization's ERP system and is configured to allow the ERP system to support most of the operational tasks. Such SRM and ERP integration enables the SRM to primarily play a strategic role for the organization. SRM and ERP integration is discussed in Chapter 7.

Manufacturing organizations engage in two major types of procurement: direct and indirect. **Direct procurement** focuses on acquiring the materials and goods that the manufacturer consumes in the production process to produce finished goods. The quantities of materials and goods in a direct materials purchase order is typically high; purchase order frequency for direct materials is also high. **Indirect procurement** involves acquiring the materials need to maintain or repair production equipment; it also involves acquiring materials used in the organization's general operations, such as office supplies. Indirect materials are often called *MRO (maintenance, repair, and operations)* materials. The purchase order frequency for MRO materials can be moderate to high depending on how rapidly they are consumed by the organization.

A third type of procurement focuses on the acquisition of the facilities, equipment, tools, and services that the organization needs to produce the finished goods and services that its sells to customers. These types of materials are called *capital goods and services.* The procurement of capital goods and services is more strategic in nature than direct or indirect procurement.

The major differences among direct, indirect, and capital goods/services procurement are summarized in Figure 8-3.

Dimension	Direct	Indirect	Capital Goods & Services
Type of goods purchased	Materials and other goods used in the production of finished goods sold to customers	Maintenance, repair, and operating (MRO) supplies used to support production	Materials such as buildings, equipment, tools, and computers that are used to produce finished goods
Purchase frequency	High	High/moderate	Low
Purchase quantity	High	Low	Low
Value	Depends on industry	Low	High
Number of suppliers	Low	High	Depends on industry
Nature	Operational	Clerical	Strategic
Impact of supply disruption	High	High/moderate	High

Figure 8-3: Differences among direct, indirect, and capital goods/services procurement.
Courtesy: Thomas Case

Disruptions in the supply of any of these types of materials can bring the manufacturing of finished goods and services to a halt. Hence, all three forms of procurement must be performed effectively by manufacturers.

PROCUREMENT PROCESS GOALS AND MEASURES

Because procurement is an umbrella includes several business functions, such as supply management, it is often considered to be considered the organization's corporate strategy. As a result, the alignment of procurement and corporate strategy is often viewed as a goal of procurement. Improving the organization's competitive position within its industry is an example of strategic goal for procurement.

Strategic Goals

Procurement can contribute to corporate strategy in several ways. Applying procurement rigorous methodologies to external spending can help the organization achieve *cost leadership* within its industry. Cost leadership is one of strategies identified in Porter's Competitive Forces model. By being able to procure the supplies its needs at less expense than its competitors, the organization is better positioned to achieve cost leadership within its industry.

Strategic procurement also has the potential to drive growth within companies that strive to compete within their industry via product or service differentiation. This is most likely to be achieved when procurement contributes to faster and/or better product innovation. Collaborative relationships among key suppliers and the organizations marketing and R&D can foster ideas for new or improved products and services; this can also reduce new product/service development time and time-to-market.

A third way that procurement can contribute to corporate strategy is by creating sustainable advantage within the industry. By building in mechanisms that enable the organization to monitor and have in depth knowledge of its supply markets, the organization is better positioned to control its value chain and create strategic advantages that are difficult for competitors to copy.

Strategic procurement can also help an organization reduce risk and improve supplier performance. Risk is reduced by having plans in place to ensure supply continuity in the event of disruption to the operations of one or more suppliers. Inferior supplier performance (frequent late deliveries, unacceptable levels of defective supplies in deliveries, poor supplier service, etc.) can more than offset favorable unit prices. Hence, strategic procurement includes plans for continuously improving supplier performance.

Operational Procurement Goals

Multiple operational procurement and purchasing goals can be identified. These include:

- Providing an uninterrupted flow of the materials, supplies, and services needed to operate the organization.
- Minimizing inventory investment and loss.
- Finding and retaining competent suppliers.
- Reducing procurement process cycle time.
- Improving vendor payment processing time.
- Minimizing the number/percentage of “emergency” procurement orders.

Key Performance Indicators (KPIs)

Key performance indicators (KPIs) are established by many organizations to analyze data related to procurement performance goals and to identify specific actions for improvement. Like other KPIs, procurement KPIs are S.M.A.R.T (specific, measurable, attainable, realistic and time based) criteria that are developed in conjunction with suppliers and other stakeholders to measure important procurement process elements. These are typically established during contract negotiations with suppliers in order to have agreed upon measures of supplier and procurement process performance. KPIs for supplier performance quality and costs are frequently used as procurement process measures.

Examples of KPIs for supplier performance quality include:

- Contract compliance: For example, the extent to which the supplier complies with pricing and delivery agreements specified in the contract.
- Delivery time: For example, comparing actual delivery times to those quoted in the contract. This might consider the percentages of on-time, late, and early deliveries.
- Defect rate: This considers the percentage of defective goods received in supplier deliveries. This might be measured in faults per unit or defects per million. Ideally, reduced defect rates are realized over time.
- Procurement cycle time: This might measure the average time between purchase order submission and goods receipt or the time between purchase order submission and supplier payment.

KPIs for procurement process costs include:

- Total cost: This considers the total amount of procurement cost savings from one year to the next after controlling for changes in the volume of procured goods and services. This serves as a measure of procurement’s contribution to the organization’s financial success in terms of P&L (profit and loss).
- Cost avoidance: Costs savings realized by delaying an increase in supplier prices or similar mechanisms that result in procurement spending be less than it would have been without cost avoidance mechanisms being used.

- Pipeline cost reductions: Cost reductions realized from negotiated cost savings with suppliers. This may result from resourcing a good/service or supplier or from negotiated contract changes.

As discussed in Chapter 12, procurement KPIs are often monitored and displayed in dashboards in real time. This enables procurement managers to stay on top of the elements of the procurement process that are associated with overall organizational performance and success.

PROCUREMENT PROCESS ACTORS

There are numerous actors and roles who are involved with carrying out procurement process tasks and activities. These include business unit personnel, purchasing personnel, warehouse personnel, and accounting personnel.

Personnel is business units initiate purchase requisitions when inventory levels for direct or indirect (e.g. MRO) materials fall below specified thresholds. Inventory threshold levels for individual direct or indirect materials are set in accordance with historical consumption and replenishment rates. For example, if the organization consumes an average of 10 cases of copier paper per day and the average time to receive copier paper from the supplier after submitting a purchase order is five days, the inventory threshold for a purchase requisition should be at least 50 cases (five days X 10 cases per day) to ensure that the organization does not run out of copy paper before the replenishment shipment arrives from the supplier.

Direct materials are typically stored in raw materials warehouses that are often physically adjacent to close to the organization's production facilities. This means that *warehouse personnel* are responsible for monitoring direct materials inventory levels and initiating purchase requisitions. In many organizations, the individuals who create purchase requisitions are not empowered to approve them. For direct materials, this means that the requisition is sent to a warehouse manager for approval before it is passed along the organization's purchasing unit.

Business unit personnel are often charged with monitoring the inventory levels of indirect materials. For office supplies, the monitoring of inventory levels and initiation of purchase requisitions is performed by clerical workers who may or may not be empowered to also approve the requisition. When they are not empowered, the purchase requisition is sent to the business unit manager for approval before it is sent to the purchasing unit.

Purchasing unit personnel aggregate purchase requisitions to create purchase orders. This means that a larger number of purchase requisitions typically converts to a smaller number of purchase orders. For example, if the purchasing unit receives requisitions for cases of copier paper from multiple business units on the same day, it will typically bundle the number of copier paper cases specified in the requisitions into a single purchase order to send to a supplier. Such aggregation/bundling of requisitions often enables the organization to take advantage of quantity discounts that have been negotiated with suppliers. Since purchase orders are usually legally binding agreements between buyers and sellers, they typically must be approved by a purchasing manager before being sent to suppliers.

Shipping/receiving personnel and/or warehouse personnel are responsible for receiving the materials/goods that are ordered from suppliers. The contents of shipments are typically inspected for damage or obvious defects and the quantities of materials/goods received are checked against the quantities specified in the purchase order. If everything checks out, a goods receipt document can be created and approved.

Accounting/finance personnel are responsible for receiving invoices from suppliers (vendors) and issuing payments to suppliers after comparing data/information in supplier invoices to data/information in purchase orders sent to suppliers and data/information good receipt documents associated with supplier shipments. The procedure used by accounting/personnel to reconcile the data/information in an invoice with the data/information in the purchase order and goods receipt document is called the **three-way match**. The three-way match is an internal, accounting control procedure used when processing an invoice received from a vendor or supplier; its purpose is safeguard the organization's assets by avoiding making payments for incorrect and perhaps fraudulent invoices. The "three-way" refers to the three documents involved in the matching process:

- The *invoice* which received from the supplier (vendor). This becomes part of the organization's accounts payable when it is approved.
- The *purchase order* that was prepared by the organization and sent to the supplier (vendor).
- The *goods receipt document* (receiving report) that was prepared by the organization after receiving the shipment of goods in response to the purchase order.

The "match" in the procedure name refers to the comparison of the quantities, price per unit, terms, etc. appearing on the supplier's (vendor's) invoice to the information on the purchase order and to the quantities received in the supplier's (vendor's) shipment. Once the information in the vendor's invoice has been validated by the three-way match, it can be further processed for payment.

The supplier/vendor is arguably another actor in the procurement process. The supplier/vendor receives the purchase order from the organization, aggregates, packages, and ships the ordered goods, invoices the organization for products shipped, and processes payments received in response to invoices.

PROCUREMENT PROCESS DOCUMENT AND DATA FLOW

When the procurement process is triggered, its tasks/activities are carried out sequentially. Like any business process, the procurement process includes four types of flows: physical, document, data, and information.

As noted in Chapter 6, a business process's *physical flow* encompasses the physical activities associated with the business process including the physical movement (flow) of products or materials. In the procurement process, products/materials are physically transferred (shipped) from a vendor (supplier) location to the purchasing organization's location and once the shipped products/materials are inspected and compared to products/materials specified in the purchase order, the products/materials are often moved from the point of receipt to inventory storage locations. For the procurement process, these product/material movements are the process's physical flows.

In Chapter 6, a business process's *document flow* was described as the sequence of business documents that are created by the process's tasks/activities. For many business processes, physical (paper) documents were used before they were automated by computing technologies. Many of the document names associated with today's automated business processes are carry overs from pre-computerization times when paper documents were used. And, auditors continue to refer to the sequence of documents created by a business process as a "paper trail" that can be used to audit the process for consistency and correctness.

The sequence of documents created by procurement process tasks/activities is illustrated in Figure 8-4. The blue documents in Figure 8-4 are generated by procurement process tasks/activities that take place at the purchasing organization; the other documents (shipping document and invoice) are generated by the vendor (supplier).

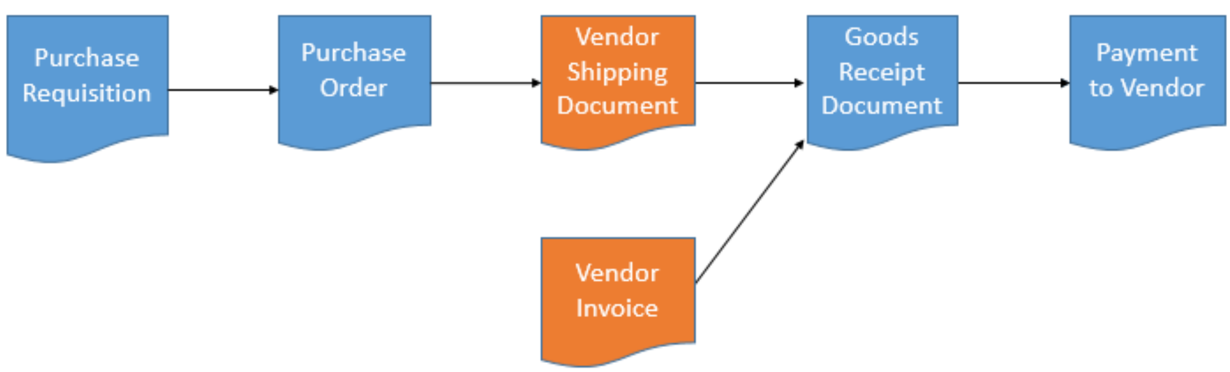

Figure 8-4: Document flow in the procurement process.

As noted in Chapter 6, a business process's *data flow* corresponds to the data used and/or generated by the process's tasks and activities. Some of the data in a business process's data flow is included in the process's documents. Figure 8-5 illustrates some of the data that is typically included in a purchase order (PO) document. When creating a PO to send to a supplier, the purchasing organizations needs to identify the quantities of the goods/materials it wants to purchase from the supplier. Doing so often involves specifying a product (item) code, product (item) description, unit price, and quantity for each product it wants to order from the supplier. Typically, the purchasing organization also provides a shipping address, billing address, and date on the purchase each PO document that it sends to suppliers. For tracking purposes, a unique identifier is assigned to each PO.

Figure 8-5: A subset of data included in a purchase order (PO).
Image ID:55770625

Some of the data included in a PO are also included in other procurement process documents. For example, product code and/or product description, and quantity are typically included in the shipping document (packing slip) that accompanies the goods/materials that the supplier ships to the purchasing organization in response to receiving the PO (see Figure 8-6); these are also included in the goods receipt document created by the purchasing organization upon receipt of the goods/materials shipped by the supplier. The invoice sent by the supplier (vendor) for the shipped goods/materials also includes product quantity and unit price data (see Figure 8-7). Ideally, these quantities and prices match those that the purchasing organization included on its PO document. So, within the procurement process, data elements on the PO document “flow” from to other procurement process documents that are subsequently created by process tasks/activities.

Figure 8-6: Example of data included in a vendor shipping document (packing slip).
Image ID:64765399

Figure 8-7: Some of the data included on a vendor invoice.
Image ID:375221635

Every business process also has an information flow. A business process's *information flow* essentially consists of information that is processed/harvested from a business process's data flows. There are two important categories of business process information: instance-level information and process-level information.

Instance-level information is information related to a specific iteration of business process. In the procurement process, instance-level information includes the information associated with an individual purchase order. For example, the purchasing organization may want information/answers that address questions such as:

- Has the vendor received the purchase order?
- Has the vendor shipped the goods/materials specified in the purchase order?
- Do quantities shipped match the quantities in the PO? Are there any backorders?
- Has the vendor sent invoice for goods/materials shipped in response to the PO?
- Has the vendor received payment for the invoice associated with the PO?

Each of these questions can be mapped to specific tasks/activities and process documents.

Process-level information is information about the business process that is aggregated from multiple process instances/iterations. This category of information enables the organization to address larger questions about the process, some of which may provide insight into how the process might be improved. Examples of questions that can be addressed from process-level information about the procurement process includes:

- What is average time from sending a PO to goods receipt?
- What is the average time from PO submission to goods receipt per vendor?
- What is the average time from PO submission to goods receipt per good/material?
- Which vendors consistently deliver on time? Which vendors habitually deliver late?
- What goods/materials to we order most often?
- Which vendors do we buy from most often?

FACTORS/ISSUES THAT COMPLICATE THE PROCUREMENT PROCESS

There are multiple factors/issue that may complicate an organization's procurement process. These include, the scope of the organization's supply chain, legal issues, backorders, returns process, and payment terms.

Supply Chain Scope

An organization's procurement process be quite complicated when its supply chain is international in scope. When buyers and suppliers are in different countries, complexity of the procurement process may be increased by different currencies, tax systems, tariffs, and duties. In addition, shipments from suppliers in other countries may be delayed by customs clearing processes. While the number supply chains that are international in scope is increasing in response to the globalization of the economy, the degree to international supply chain complicate the procurement process should not be overlooked.

Legal Issues

Buyers and suppliers often establish legally binding contracts before transacting business with one another. This means that a purchase order is often considered to be a legally binding document. When a buyer sends a PO to a supplier, the buyer is legally bound to pay the supplier for the goods/materials that are shipped in response to the buyer's purchase order. Such legal requirements require a buying organization to exercise discipline in its purchasing and procurement process to ensure that it does not violate its supplier contracts.

Contractual agreements between buyers and suppliers often specify a FOB point. **FOB** is a shipping term stands for "free on board". When the specified FOB point is the supplier's location, the buyer takes ownership of the goods/materials being shipped as soon as the shipment leaves the supplier's location. From the supplier's perspective, the sales transaction is complete when the shipment leaves its location. The buyer owns the goods/materials while they are en route to the buyer's location and is responsible for any delivery charges. In the buyer's accounting system, inventory that is en route is booked as an asset even though the shipment has not arrived.

When the specified FOB point is the buyer's location, the buyer does not take ownership of the goods/materials until the shipment arrives at its location and is inspected and accepted. If the shipment arrives in perfect condition and the buyer accepts the shipment, the quantities of the goods/materials in the shipment are added to the buyer's inventory – this completes the sales transaction when the FOB point is the buyer's destination.

Needless to say, it is in the supplier's best interest to have its location as the FOB point and it is in the buyer's best interest to have its location as the FOB point. So, when contracts are created between buyers and suppliers, FOB points are specified to indicate which party is responsible for shipping costs and when ownership of assets changes hands.

Payment terms are also specified in contracts between buyers and sellers. These specified when payment is due and whether the buyer will receive a discount for paying quickly. We will address payment terms as a separate issue after we have discussed a couple of other complicating factors/issues.

Backorders

When a supplier cannot ship the quantity for a good/material specified in a buyer's purchase order, the difference between the specified and shipped quantity may be backordered. This happens when the vendor's supply of a good/material included in the purchase order is less than the quantity specified in the buyer's PO. When backordering is allowed in the purchasing contract between a supplier and buyer, it essentially means that the supplier can sell inventory to the buyer that it does not have at the time that it receives the PO.

Because they are exceptions to a supplier's fulfillment process and a buyer's procurement process, backorders create complications for both suppliers and buyers and increase the inventory management challenges of both. For, suppliers, shipments of backordered inventory may take priority over shipments for newly received orders. Buyers often pressure suppliers to make rush shipments of backordered goods/materials to minimize disruption to their procurement, manufacturing, and fulfillment processes. When contractual arrangement allow backorders, the percentage of items backordered and the number of backorder days become important measures the supplier's service quality and the effectiveness of its inventory management processes.

Returns Processes

Damaged, incorrect, or incomplete shipments initiate a **returns process**; this involves the buyer physically shipping the deficient goods/materials back to the supplier and verifying that the supplier needs to send another shipment to overcome the deficiency. Return processes are exceptions to the supplier's fulfillment process and the buyer's procurement process. This is costly and frequently unpleasant on both buyers and sellers, so steps are typically taken on both sides to minimize returns.

The responsibility for shipping costs for returns is often dictated by the FOB point specified in the contract between a buyer and seller. When the FOB point is the buyer's location, the buyer is not obligated to accept the shipment until it is inspected and the goods/materials are determined to be in perfect conditions. In this situation, the supplier is typically responsible for shipping costs associated with returns. When the FOB point is the supplier location, shipping costs for returns are often the responsibility of the buyer.

When it is necessary to for a buyer to return ordered goods/materials to a supplier, inventory management challenges are faced by both sides. The buyer may not sufficient goods/materials for its manufacturing or fulfillment processes and the supplier is challenged to replace damaged goods/materials in an expeditious manner.

Payment Terms

Payment terms specify how and when a buyer will pay a vendor (supplier) for the goods/materials specified in a purchase order. Typically, the byer is responsible for paying the supplier either on the date the company receives the invoice or on the date the company receives the shipment – whichever is later. Suppliers typically reserve the right to levy finance charges, if the buyer fails to make payment within the specified terms.

Payment terms are typically specified when contracts are created between buyers and sellers. Negotiated payment terms may be included on purchase orders sent by buyers and on invoices sent from suppliers to buyers. Some common types of business-to-business payment terms include:

- Net nn, where nn specifies the number of days before the full amount specified in the invoice is due. For example, if the invoice stipulates Net 10, payment is due 10 days after the invoice date.
- X% mm/Net nn where X is a discount expressed as a percent of the total invoice amount – the buyer receives the discount if payment is made within mm days. For example, if the invoice stipulates 1% 10 Net 30, the buyer will receive a 1% discount if payment is

made is 10 days; otherwise the total invoice amount is due 30 days after the invoice date.

PROCUREMENT PROCESS AUTOMATION

Before computers automated procurement process and purchasing activities, these processes were largely paper-based and purchase orders were sent by buyers to suppliers by mail or a courier service. In some instances, the quantities of the goods/materials that buyers wanted to purchase were communicated to suppliers in phone calls. The advent of fax machines meant that POs could be transmitted to vendors, and invoices could be transmitted to purchasing organizations as facsimile documents. Bank process automation, including Automated Clearing House (ACH), enabled buyer payments to be deposited in vendor bank accounts.

In addition to these types of technology support for procurement and purchasing activities, several specialized forms of procurement process automation have emerged. This includes what has come to be called e-procurement as well as vendor-managed inventory (VMI) and procurement support by enterprise resource planning systems (ERP) and supplier relationship management (SRM) systems.

E-Procurement

There are two major forms of electronic procurement (e-procurement): electronic data interchange (EDI) and online marketplaces. Some solutions used by today's organizations are hybrid mixtures of EDI and online marketplaces.

Electronic data interchange (EDI) provides buyers and sellers with a pre-defined, standardized way of exchanging business documents including quotations, purchase orders, purchase order receipts/confirmations, and information. In EDI, the structure and content of business documents are standardized to enable their contents to be transmitted electronically between the computer systems of buyers and sellers. See Figure 8-8.

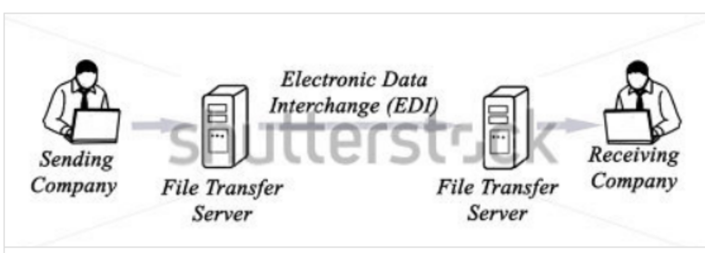

Figure 8-8: Electronic Data Interchange
Stock illustration ID: 435474676

When EDI was first introduced, electronic documents were exchanged over telephone lines using modems or via point-to-point dedicated circuit that connected the buyer's computer system to the supplier's computer system. The central idea of EDI has always been direct connections among buyer and vendor computer systems. In order to reduce telecommunication costs, many organizations now use specialized value-added networks (VANs) or virtual private network (VPN) connections to exchange EDI documents. Since the 2000s, the public Internet has become the dominant network for EDI connections among buyers and sellers.

Online marketplaces are business websites that serve as intermediaries between buyers and sellers. Many online marketplaces facilitate connections among buyers and sellers and are often described as supply chain enablers. Many online marketplaces require both buyers and suppliers to purchase/lease specialized software that enables them to access and use online marketplaces services. Some online marketplaces levy entry fees to join the marketplace and all levy fees on buyer-seller transactions. In addition to establishing relationships between buyers and sellers and providing a venue for them to transact business, online marketplaces typically provide inventory management, shipment tracking, financing, and process improvement services.

Some e-procurement solution providers offer hosted applications that enable buyers to manage requests for quotations (RFQs), purchase orders, invoices, and goods receipts. Online business-to-business auction sites also play important roles in e-procurement activities for some organizations.

The most widely cited impacts of e-procurement include cycle time, process cost, and inventory holding reductions. In some instances, e-procurement has resulted in price reductions for ordered goods/materials. Because e-procurement typically increases procurement process efficiency, staff members often have more time to devote to valuing-adding activities.

Vendor Managed Inventory (VMI)

Vendor managed inventory (VMI) involves collaboration among suppliers and buyers to streamline inventory management and order fulfillment. The goal of VMI is increased communication among buyers and suppliers that results in better alignment among business objectives and supply chain operations for both.

The information exchange between the buyer and supplier enables the identification of buyer on-hand inventory levels that trigger supplier replenishment orders. In VMI, buyers typically allow suppliers to monitor the inventory levels of the goods/materials they order from suppliers. When the on-hand inventory level falls to the order point, VMI software automatically sends a purchase order to the supplier and a PO acknowledgement to the buyer. In some instances, order points are established to support just-in-time inventory management initiatives.

When a VMI arrangement is established between a buyer and a seller, the responsibility for managing the inventory of the goods/materials that the buyer purchases from the supplier from the buyer to supplier. In some arrangement, the supplier retains ownership of the inventory at the buyer's location until it is sold to buyer customers. The supplier essentially becomes a business partner that is responsible for maintaining adequate inventory levels at the buyer's location(s). So, from the perspective of buyers, an important determinant of VMI success is establishing partnerships with suppliers who will dependably monitor and replenish inventory levels. Additional potential business benefits for buyers are identified in Figure 8-9.

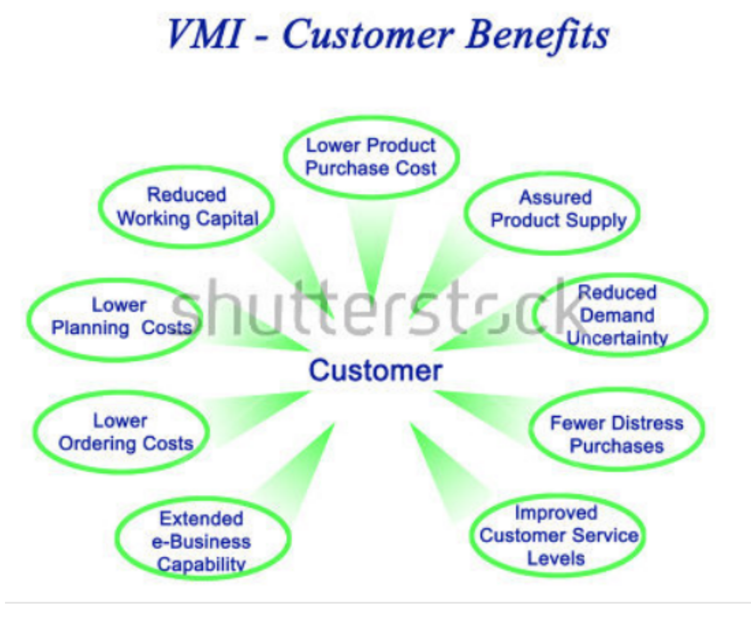

Figure 8-9: Buyer Benefits of Vendor Managed Inventory
Stock illustration ID: 442965811

Benefits also accrue to suppliers or manufacturers involved in VMI partnerships (see Figure 8-10). These start with have locked-in customers and increased customer loyalty. With VMI partnerships, repeat sales are guaranteed and are likely to continue as long as the supplier dependably meets the needs of its customer. Over time, the supplier is able to better forecast and manage its operations to meet customer needs; the supplier is also likely to have a more predictable cash flow.

Figure 8-10: VMI Benefits for Suppliers and Manufacturers
Stock photo ID: 447071560

Enterprise Systems

As we mentioned in Chapter 7, enterprise systems, including supply chain management (SCM), supplier relationship management (SRM) and enterprise resources planning systems provide automated support for numerous procurement process and purchasing activities.

SCM systems provide support for multiple activities to the procurement process including purchase order processing, inventory management, goods receipt processing, warehouse management, and supplier management (see Figure 7-9 and its related discussion). SRM systems provide more extensive and targeted support for the procurement process that often results in increased procurement process efficiency, reduced procurement costs, enhanced communication and coordination with suppliers, and continuous improvement of the procurement process (see Figure 7-10).

Web-based SRM software provides a real-time interface between the organization and its suppliers. It enables buyers to check the status of purchase orders and scheduled delivery dates. Because it enables suppliers to monitor buyer stock levels, web-based SRM is often an important part of vendor managed inventory (VMI) partnerships.

As noted in Chapter 7, SRM software typically supports e-procurement by enabling buyers to aggregate their suppliers' Web catalogs, accept electronic invoices, and make electronic payments. SRM software also facilitates the creation, transmission, and confirmation of purchase orders and the execution of inventory-related transactions.

Enterprise resources planning (ERP) systems integrate an organization's SCM and SRM systems. And, ERP systems are capable of providing end-to-end support for the procurement process in organizations that lack SCM and/or SRM systems.

PROCUREMENT PROCESS AND ERP SYSTEMS

ERP systems automate the creation and transmittal of documents created by buyers during the procurement process. This is illustrated in Figure 8-11.

Vendor (supplier) and vendor products/materials data are stored in ERP databases as *master data.* Master data is relatively permanent data in an enterprise system database that only needs to be entered once. After it is in the database, master data can be used in any process where it is needed. A vendor's banking information (bank account number, routing number) may also be stored as master data. In general, master data contributes to the automation of a business process by populating fields in a process's electronic documents.

The presence of vendor master data in the ERP database facilitates the creation and transmittal of purchase requisitions. As illustrated in Figure 8-5, purchase requisitions and purchase orders specify the quantities of the products/materials to be ordered. Purchase requisitions originate in business units as they monitor the inventory levels of the direct, indirect, and capital goods/services that they consume. In many instances, vendor identifiers (e.g. supplier ID) and product names/codes are specified in purchase requisitions. When an electronic purchase requisition is created in an ERP system, a wide range of vendor and product data can be added by simply entering, or looking up, a vendor or product name or code. Each requisition created in an ERP system is saved with a unique document number that is saved in the ERP database.

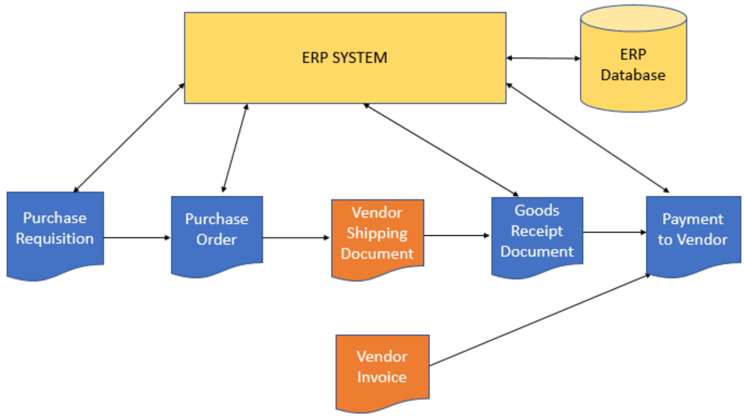

Figure 8-11: ERP Document Flow Support in Procurement Process

In SAP ERP, the navigation and initial screen for creating a new purchase requisition is illustrated in Figure 8-12.

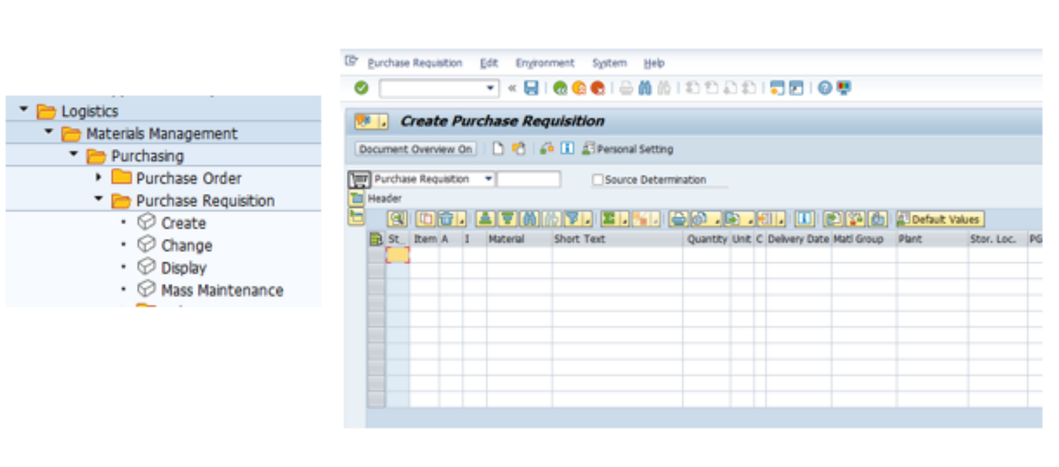

Figure 8-12: SAP ERP Navigation and Purchase Requisition Creation Screen.

In an ERP system, requisitions are periodically bundled into purchase orders by purchasing agents or managers; the purchase orders that are subsequently electronically transmitted to vendors (suppliers). Bundling is done because multiple business units may be requesting goods/materials from the same vendor; rather than sending the vendor multiple POs that each includes relatively few goods/materials, the vendor can instead be sent fewer POs that include orders for larger numbers of goods/services. Each PO created by an ERP system is saved with a unique document number within the ERP database and each PO can be linked to at least one purchase requisition. The SAP ERP navigation and one of the screens for creating purchase orders are illustrated in Figure 8-13. In this figure, the SAP ERP screen for Automatic Creation of Purchase Orders from Requisitions option for purchase order creations is displayed.

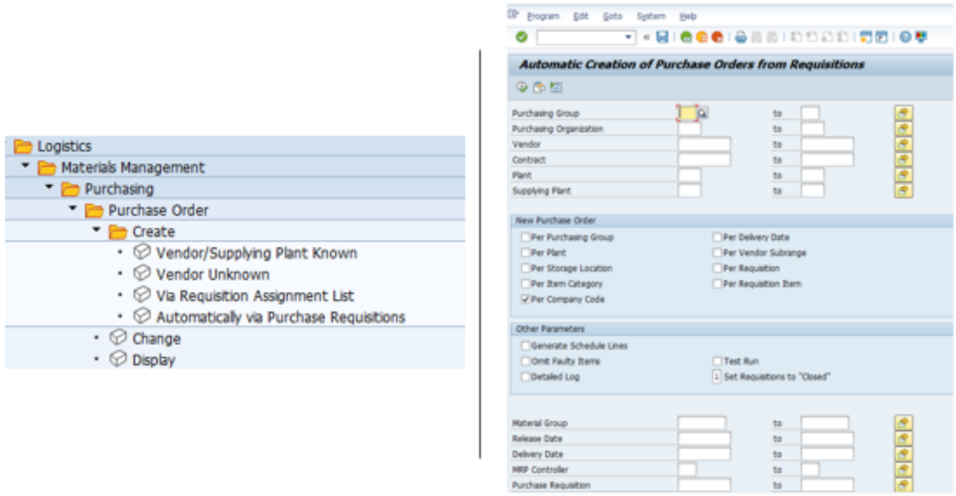

Figure 8-13: SAP ERP Navigation and Automatic Creation of Purchase Orders from Requisitions Screen

For a buyer, the next significant step in the procurement process is the creation of the goods receipt document. Once the shipment from the supplier is received, and inspected, agents at the receiving dock or warehouse create the goods receipt document to verify that the shipment has been received and to specify the quantities of the goods/materials included in the shipment. Since vendor shipments are sent in response to buyer POs, the creation of the goods receipt document can be automated by linking it to the PO. Linking the PO to the goods/receipt document enables data/information from the PO to be imported into the goods receipt document. The SAP ERP navigation and initial screen used to create the goods receipt document are illustrated in Figure 8-14.

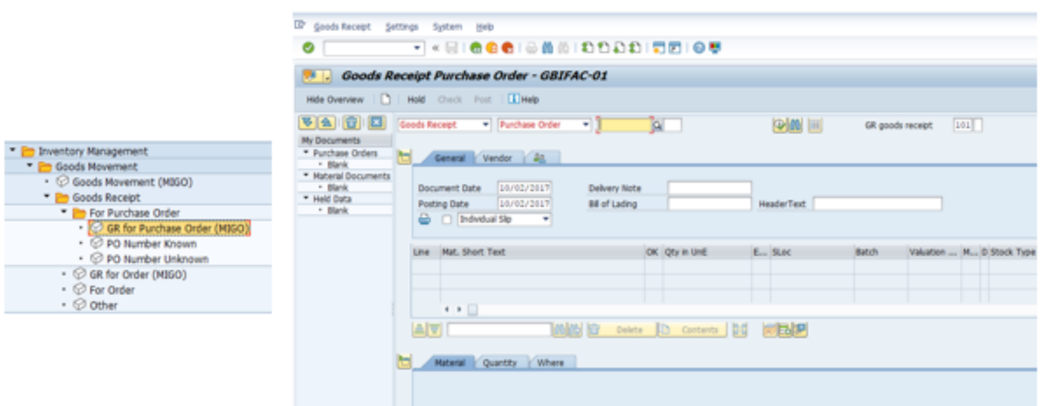

Figure 8-14: SAP ERP Navigation and Goods Receipt for Purchase Order Screen

Once the goods receipt document is created, accounting personnel can compare its contents to that of the PO and the invoice that is received from the vendor (supplier). An ERP system enables the electronic receipt of invoices from vendors, however, because the invoice is sent is response to a PO, accounting personnel assist in entering and saving the invoice as a uniquely numbered document in the ERP database. The SAP ERP Navigation and invoice entry screen are illustrated in Figure 8-15.

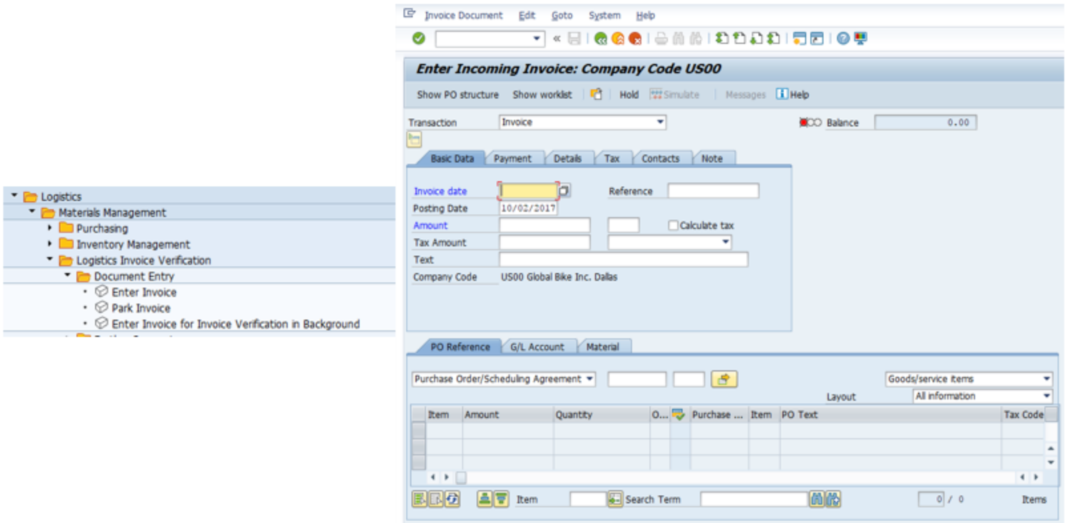

Figure 8-15: SAP ERP Navigation and Enter Incoming Invoice Screen

When the invoice document is saved to the ERP database, accounting is positioned to complete the three-way match process that was described earlier in the process. This process compares the data/information in the PO, goods receipt, and invoice documents. If everything checks out, a payment for the invoice can be issued. If there are discrepancies, payment may be delayed until the differences are reconciled. The SAP ERP navigation and post outgoing payments screen are illustrated in Figure 8-16.

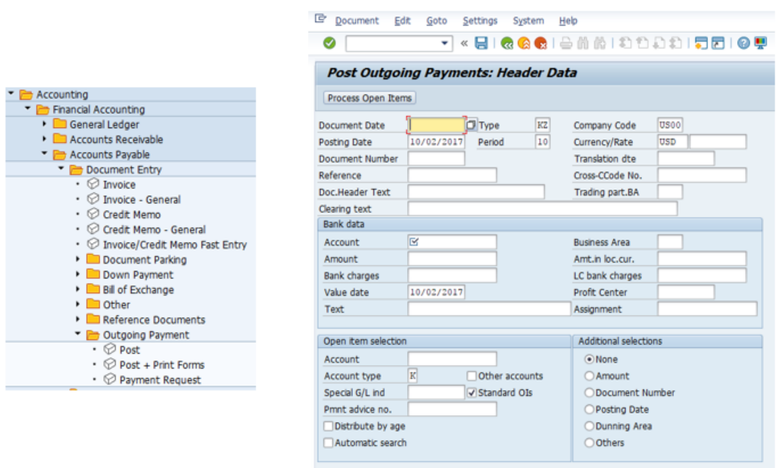

Figure 8-16: SAP ERP Navigation and Post Outgoing Payments Screen

Payment is typically considered the final document in the document flow for the procurement process, however, many vendors often acknowledge the payments with payment receipts. These too can be logged as unique documents within ERP databases that are logically linked not only to payments but to POs, requisitions, and good receipt documents.

ERP systems have offered strong support for procurement processes since they were first introduced. Over time, they have evolved to interact with other enterprise systems (including SCM and SRM) and procurement automation systems (such as EDI) to improve procurement process efficiency and effectiveness. The procurement process data/information generated and saved by ERP systems is often used to create procurement process dashboards and analytics that can be used for the continuous process improvement.

CHAPTER SUMMARY

The procurement process is found in virtually every organization. It is best understood within the context of the value chain's inbound logistics activities. Purchasing, a secondary activity in Porter's value chain model, is an important aspect of the procurement process. "Procure-to-pay" and "requisition-to-pay" are other names for procurement and purchasing processes. Procurement is often considered to be part of an organization's supply management and business-to-business (B2) commerce functions.

There are two forms of procurement: strategic and operative. Strategic procurement includes the development of long-range plans for ensuring timely supply of goods and/or services that are critical to an organization's core business objectives. Operational procurement includes the creation of purchase orders, goods receipt, and accounting activities such as supplier payments. Strategic procurement has the potential to drive growth within companies that strive to compete within their industry via cost leadership or product or service differentiation. Operational procurement ensures provides the uninterrupted flow of the materials, supplies, and services needed to operate the organization.

Manufacturing organizations engage in two major types of procurement: direct and indirect. Direct procurement focuses on acquiring the materials and goods that the manufacturer consumes in the production process to produce finished goods. Indirect procurement involves acquiring the materials need to maintain or repair production equipment as well as materials used in the organization's general operations, such as office supplies; indirect materials are often called MRO (maintenance, repair, and operations) materials.

Key performance indicators (KPIs) are established to analyze data related to procurement performance goals and to identify specific actions for improvement. KPIs for supplier performance quality and costs are frequently used as procurement process measures.

There are numerous actors and roles who are involved with carrying out procurement process tasks and activities. These include business unit personnel, purchasing personnel, warehouse personnel, and accounting personnel. Personnel is business units initiate purchase requisitions when inventory levels for direct or indirect materials fall below specified thresholds. Purchasing unit personnel aggregate purchase requisitions to create purchase orders. Shipping/receiving personnel and/or warehouse personnel are responsible for receiving the materials/goods that are ordered from suppliers. Accounting/finance personnel receive invoices from suppliers (vendors) and issue payments to suppliers after comparing invoice data/information that in purchase orders and good receipt documents in the three-way match process.

The purchase process's document flow includes purchase requisition, purchase order, goods receipt, vendor invoice, and invoice payment. The process's physical flows consist of the shipment of goods/materials from the supplier to the buyer. Key data/information flows include the quantities and prices of goods/materials in purchase orders, shipments, and invoices. Instance-level information enables questions related to a specific purchase order to be asked and answered. Process-level information enables the identification of ways/opportunities to improve the procurement process.

Procurement processes can be complicated by differing tariffs, currencies, and tax systems when a supply chain is international in scope. Because POs are typically legally binding, organizations must have disciplined purchasing and procurement processes to ensure that contracts are not violated. Purchasing contracts and POs often specify payment terms and free-on-board (FOB) points at which ownership changes from supplier to buyer. Procurement processes can also be complicated by backorders and returns processes.

An organization's procurement process may be automated by several business information systems. Electronic data interchange (EDI) was the one of the first technologies used to automate procurement. With EDI the format of business documents, such as purchase orders, invoices, and payment documents are standardized and documents are exchanged electronically between the purchasing organization and the supplier. Online marketplaces and business-to-business exchanges can provide linkages among buyers and suppliers.

Some organizations establish close partnerships with key suppliers and implement vendor-managed inventory (VMI) systems. With VMI, suppliers are responsible for monitoring inventory levels at buyer locations and automatically ship materials/products to the customer when inventory levels fall below pre-specified levels.

Enterprise systems such as SCM, supplier relationship management (SRM), and ERP systems may also be used to streamline the procurement process. The ability to support and automate procurement is a major reason why some organizations adopt ERP systems. ERP systems can be used to support all phases of the procurement from requisitions to payments.

KEY TERMS

REVIEW QUESTIONS

1) What is procurement?
2) How does purchasing differ from procurement?
3) Why is procurement part of an organization's supply management function?
4) Why is procurement a form of business-to-business (B2B) commerce?
5) How does strategic procurement differ from operational procurement?
6) What are the goals and potential benefits of strategic procurement?
7) What are the goals and potential benefits of operational procurement?
8) How does direct procurement differ from indirect procurement?
9) What are key performance indicators (KPIs)?
10) Identify several examples of KPIs for supplier performance quality.
11) Identify several examples of KPIs for procurement process costs.
12) Identify the major actors in the procurement process.
13) Describe the major responsibilities of each of the major actors in the procurement process.
14) What is the three-way match?
15) Describe how accounting personnel conduct the three-way match.
16) Describe the sequence of documents in the procurement process's document flow.
17) Describe the procurement process's physical flow.
18) Identify key data included in purchase orders.
19) How does instance-level information differ from process-level information?
20) Identify several questions that can be answered by procurement process instance-level information.
21) Identify several questions that can be answered by procurement process process-level information.
22) Identify several factors/issues that can complicate an organization's procurement process.
23) How may supply scope complicated the procurement process?
24) What are some of the legal issues associated with procurement and purchasing?
25) What is a FOB point? What FOB point is preferred by vendors? What FOB point is preferred by buyers?
26) What are backorders? How do backorders complicate procurement?
27) What are returns processes? How do returns processes complicate procurement?
28) Identify several types of e-procurement.
29) What is electronic data interchange (EDI)? How does EDI automate the procurement process?
30) What are online marketplaces? How do online marketplaces automate procurement?
31) What is vendor-managed inventory (VMI)? How does VMI automate the procurement process?
32) What benefits accrue to buyers in VMI partnerships? What benefits accrue to suppliers/manufacturers?
33) How do enterprise systems automate the procurement processes? Provide examples.
34) Describe how enterprise resources planning (ERP) systems provide end-to-end support for the procurement process.

Chapter 9 – ERP and Order Fulfillment

CHAPTER OBJECTIVES

After reading this chapter, you should be able to:

- Describe how organizations process and fulfill sales orders
- Identify and briefly describe major fulfillment strategies
- Identify several fulfillment process goals and measures.
- Identify fulfillment process actors and their roles.
- Describe the fulfillment process's document flow.
- Describe the fulfillment process's data and information flow.
- Identify the physical flows within the fulfillment process.
- Describe how the fulfillment process is automated and supported by CRM, EDI, warehouse automation systems, warehouse management systems, and ERP systems.
- Describe how SAP ERP systems support and automate the fulfillment process.

INTRODUCTION

In many organizations, the fulfillment process is a core business process that provides value to customers via the delivery of goods/services that they need. It is a process that most organizations strive to do correctly and efficiently because it directly interfaces with customers and affects customer perceptions of the organization and their willingness to continue to buy products or services from the organization.

The fulfillment process maps most directly to the outbound logistics value chain activity. However, it also is related to the sales and marketing activity in the value chain.

The fulfillment process is a cross-functional process whose tasks/activities involve (at a minimum) the organization's sales, finished goods warehouse, and accounting functions. The fulfillment process is often called the *order-to-cash* process because it involves the tasks/activities associated with receiving customer orders, shipping ordered goods/materials, and processing customer payments. In some organizations, it is called the *quotation-to-cash* process because prospective customers are provided with quotations which specifies the unit prices for specific products for a specific time duration.

The major documents in the fulfillment process include quotations, sales orders, pick lists, packing/shipping documents, invoices, and customer payments. Key data flows in the fulfillment process include data about the goods/materials items included in customer orders such as product ID, product description, product attributes (e.g. weight, color, size), unit price, and order quantity. This data is used by the organization's warehouse to perform the pick/pack/ship activities needed to create shipments to send to buyers. It is also used to create packing lists and invoices.

The primary physical flows for the fulfillment process are aggregation, packing, and shipping of products that takes place in the warehouse in response to the receiving a customer order. Instance-level information enables the organization to address customer questions such as “has my order shipped?” Process-level information aggregated from multiple fulfillment process iterations provide insights into how the organization’s fulfillment process might be improved.

Electronic data interchange (EDI) provide computer-system to computer-system links between buyers and sellers. It has been used to facilitate and automate the fulfillment process. Warehouse management systems (WMS) and customer relationship management (CRM) systems also provided automated support for fulfillment process activities.

Support for all fulfillment process tasks/activities are provided by ERP systems. We will illustrate how support for this process is provided by SAP ERP.

SALES AND DISTRIBUTION PROCESS OVERVIEW

The fulfillment process is a key process that supports an organization’s sales and distribution functions. **Sales** involves the exchange of products/services for money or services. In most instances, sellers receive money for the products or services they sell to customers, but in some instances, they may receive something besides money (such as a service) in the exchange. Perhaps the most important aspect of sales is that it is often the organization’s only revenue generating function. From a systems perspective, an organization needs sales revenue to be able to continue to procure the goods/materials it needs from suppliers to sustain its operations. And, sales revenue needs to exceed cost of goods sold for the organization to make a profit.

Distribution involves the tasks/activities associated with making a seller’s product or service available to a customer. Distribution can be accomplished directly or indirectly. In some instances, customers acquire needed products or services directly from manufacturers (producers) or service providers. In other instances, customers acquire products or services indirectly from producers or service provides via intermediaries or indirect distribution channels.

Like other core business processes, fulfillment and sales and distribution processes may be best understood within the context of Porter’s value chain. Sales (selling) activities map most directly to the sales and marketing activity within the value chain. Distribution maps to the value chain’s outbound logistics activity.

Because sales and distribution helps an organization integrate with its customers, it is widely viewed as being part of an organization’s logistics function. Integration points between sellers and customers include providing quotations to customers, receiving sales orders (e.g. via phone, Internet or EDI), shipping ordered products, and billing customers for the goods that they have received. The tasks/activities associated with each of these integration points is critically important to customer perceptions of sellers. Virtually any deficiency at any seller/customer integration point can make customers reluctant to do repeat business with the seller. So, these are activities that seller's want to perform correctly and efficiently for every customer and every order.

FULFILLMENT STRATEGIES

The fulfillment process can vary significantly by country, industry, and company. If an organization has a wide range of products and/or types of customers, it may use more than one fulfillment process. As is the case for procurement, an organization's fulfillment process may be complex if its distribution channel is international is scope.

One of the best vehicles for appreciating fulfillment process variation is to consider fulfillment strategies. Five major order fulfillment strategies are described below.

Make-to-stock (MTS). Companies that use make-to-stock fulfillment sell products to customers from their finished goods inventories. Customers are limited to the purchasing products that are in stock; customized products cannot be ordered or requested when this fulfillment strategy is used.

The target number for each product in finished goods is determined by a sales forecast. For this reason, the make-to-stock strategy is sometimes called *build-to-forecast* fulfillment. If the sales forecast is too high, the finished goods warehouse may have excess inventory for a product; if the forecast is too low, the company may have *stock-outs* and sacrifice sales revenue it could have realized if its finished goods inventory was better aligned with customer demand. Hence, the success of MTS fulfillment depends on the accuracy of sales forecasts, especially for companies that experience seasonality in product demand.

Make-to-stock fulfillment is widely used in companies that sell directly to customers via retail outlets. It is popular among companies that seek high sales volumes and offer competitive prices to customers. It is especially common among retail, office supply, and grocery companies. MTS is also used in some wholesale and distribution companies which serve as intermediaries between producers and customers. The grocery store depicted in Figure 9-1 illustrates the make-to-stock strategy at the store level.

Figure 9-1: Make-to-Stock Fulfillment
Stock photo ID: 573204253

Make-to-Order (MTO). Make-to-order fulfillment is used by companies that produce products with a standard design, but allow aspects of the final product to be customized by customer specifications. This fulfillment strategy is used in high-cost, low-volume industries that manufacture specialized products that meet very specific customer requirements; for example, companies that build high-end aircraft (such as Gulfstream) and automobiles (such as Jaguar). MTO is sometimes called *build-to-order (BTO)* fulfillment because changes are made to the standard design in responses to customer orders.

Significant collaboration between suppliers and customers is needed for this fulfillment strategy to be successful. This is especially true when the customer desires high levels of customization to the standard design. Extensive customization to the standard design can cause variability in product completion time and expense. Customers who place orders may have to wait weeks, months, or years before the product they ordered is assembled and delivered.

Figure 9-2: Make-to-Order Fulfillment
Stock photo ID: 1801344

Engineer-to-Order (ETO). In contrast to MTO fulfillment, in engineer-to-order fulfillment, there is no standard product design. With ETO, the final product is designed and built to customer specifications. Each product in ETO has some unique characteristics that make it different from similar products. This means that each ETO project results in a one-off product. The ETO fulfillment process has an identifiable design phase which is typically characterized by considerable dialog with the customer. Designers, typically engineers, may develop several iterations of diagrams and designers to align the product with customer specifications. In the construction industry, the ETO process is sometimes called the design-to-build process.

There can be considerable variability in process completion time and expense with ETO fulfillment. Like MTO, the ETO process cycle may last for weeks, months, or years.

Figure 9-3: Engineer-to-Order Fulfillment
Stock illustration ID: 73622977

Assemble-to-Order (ATO). With assemble-to-order fulfillment, the product ordered by the customer is built from an existing stock of existing components. The customer often has a variety of choices for each product component to choose from. Once all the component choices are made and the customer order is finalized, the product is built for the customer.

Because the customer product is essentially assembled from an existing stock of components, ATO fulfillment is sometimes called *assemble-to-request* fulfillment. By being able to choose the components to be included in the final product, the customer often experiences sense of personalized product customization.

ATO fulfillment has become popular for the fulfillment of customer orders for footwear, apparel, and accessories. It is also widely used in the assembly of “customized” computers. For example, in 2018, personal computer customers have a choice over which processor to include when they order a computer. If they are on a tight budget, they may choose an older i3 or i5 Intel processor, if not thy may order the latest generation of the i7 processor. When the order is placed, the specified processor will be installed.

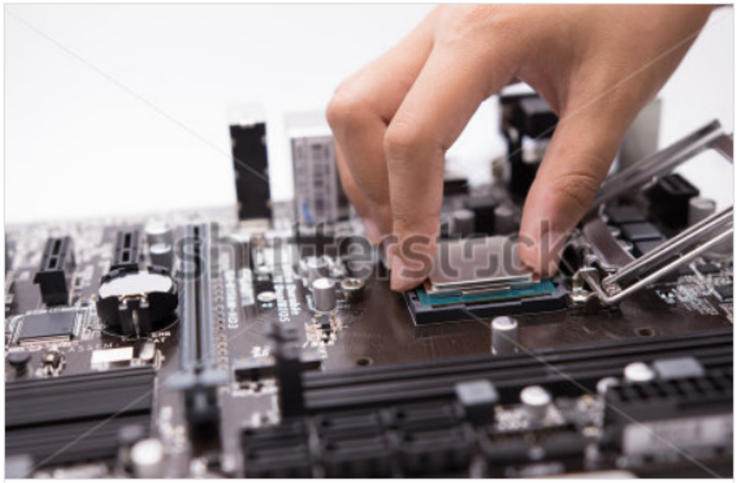

Figure 9-4: Assemble- to-Order Fulfillment
Stock photo ID: 508880557

Digital Copy (DC). Historically speaking, this is the newest order fulfillment strategy. It can into being with the advent of digital products and the ability to store a company's digital assets and inventory as single digital masters or in digital repositories. In DC fulfillment, copies of digital assets are created on-demand. In the past, this often involved burning a copy of the digital asset on a CD and shipping it to the customer. Today, DC distribution typically involves customer downloads and storage on customers' storage devices.

Digital assets include application programs, mobile apps, e-books. Some business research firms, including Gartner, also distribute their research papers via digital downloads.

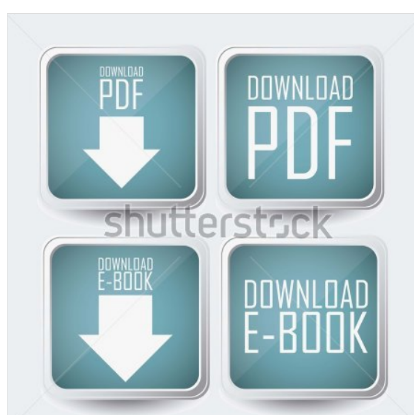

Figure 9-5: Digital Copy Fulfillment
Stock vector ID: 120739960

It is important to note that there can be considerable variation from company to company in how each of the fulfillment strategies is implemented. It is also important to note that some companies may utilize more than one of these fulfillment strategies if it sells a wide range of products or serves multiple types of customers.

While is important for you to be aware of the different types of fulfillment strategies, it is impossible for us to address the vagaries of the fulfillment process for each process in a single chapter. So, to conserve space and to maintain consistency, we will focus on make-to-stock fulfillment in the remainder of this chapter. As we did for the procurement process, we will consider fulfillment process goals and measures, actors, document and data flow, and fulfillment process automation. We will also describe how fulfillment process activities are supported by SAP ERP.

FULFILLMENT PROCESS GOALS AND MEASURES

Understanding fulfillment process goals and measures begins by considering its major tasks and activities, such as those illustrated in Figure 9-6. These include the receipt and processing of customer orders, order picking and packing, and shipping the goods specified in the order.

Figure 9-6: Major Fulfillment Process Tasks and Activities.
Stock illustration ID: 424970452

Fulfillment process experts commonly identify two areas that determine the overall success of the make-to-stock fulfillment process: order accuracy and order cycle times. **Order accuracy** is essentially the ratio of error-free orders to total orders shipped. The closer order accuracy is to 100%, the better because this translates into customer's being shipped the exact products and quantities that they ordered. When customers receive exactly what they order in a timely manner, they are likely to be satisfied with the supplier and are more likely to do repeat business. Hence, increased order accuracy is a goal in most companies that use make-to-stock fulfillment.

Since order accuracy can be diminished at virtually any point in the fulfillment process, all actors involved in fulfilling a customer order must pay attention to the details in each order.

Order cycle time is essentially the amount of time between the receipt of a customer order and when the customer's order is shipped. Shorter cycle times enable product sales revenues to be realized more rapidly; these also contribute to customer satisfaction and the likelihood of repeat sales. In general, shorter order cycle time is an important goal in companies that use make-to-stock fulfillment.

Since order cycle time can be improved at virtually any point in the fulfillment process, all actors involved in fulfilling a customer order should strive to complete their tasks and activities as quickly as possible.

Both order accuracy and order cycle times can be affected by the fulfillment process tasks and activities that are carried out in the finished goods warehouse. In the warehouse, the products ordered by customers are picked from storage locations and packaged for shipment. Hence, *pick rates* (the volume of products picked per hours) and *pack rates* (such as the number of customer orders packed for shipment per hour) contribute to order cycle time while *picking errors* and *packing errors* impact order accuracy.

Many organizations that use make-to-stock fulfillment monitor the performance of individual aspects of the process. Companies often use *order entry/keying measures* for sales order processing, *pick/pack/ship accuracy measures* for warehouse accuracy, and *billing accuracy measure*s for monitoring/measuring accounting activities for the fulfillment process.

Other common measures and key performance indicators for the fulfillment process are illustrated in Figure 9-7.

Metric/Measure	Comments
Percentage of on-time shipments	Number or orders shipped on or before requested ship date to total orders shipped.
Average delivery lead time	The average time it takes to deliver a customer order.
Fulfillment cost per order	Amount spent to complete an order.
Return rate	Number of orders returned to number shipped.
Returns processing	Cost to process returns.
Customer retention rate	Percentage of customers who place additional orders.
Customer satisfaction level	Percentage of customers satisfied with their experience with the company's fulfillment process.

Figure 9-7: Examples of Fulfillment Process Measures and KPIs.
Courtesy: Thomas Case

Some companies use a **perfect order metric (POM)** to evaluate the overall performance of their fulfillment process. For an individual order, the metric is achieved when the delivered order is complete (accurate), on-time, is not damaged, and includes the correct documentation. When the company's response to all customers orders is considered, achieving a 100% perfect order metric average is a very ambitious goal.

As Figure 9-6 suggests, inventory management is important to the success of the fulfillment process. As a result, *inventory precision* (the amount of inventory in stock relative to the sales forecast or customer demand) may be used to measure the quality of this aspect of the fulfillment process. *Inventory turnover* (the amount of time it takes to sell the inventory of a product that the company carries) may also be a key metric. Inventory turnover is calculated by taking the cost of goods sold and dividing by average inventory level.

Successful inventory management is also affected by the accuracy of sales forecasts. Inventory precision is likely to be high when the algorithms used to generate sales forecasts yield accurate results. Inaccurate sales forecasts can result in stock outs (when the sales forecast is less than actual customer demand) or excess stock (when customer demand is less than the sales forecast). Because stock outs and excesses contribute to lower inventory precision, when the occurrences of these conditions increase, the algorithms used to generate sales forecasts may need to be adjusted.

FULFILLMENT PROCESS ACTORS

Like other cross-functional business processes, actors from multiple business functions contribute to successful order fulfillment. At a minimum, the fulfillment process involves coordinated efforts from actors in the sales and marketing, finished goods warehouse, and accounting functions.

Actors in sales and marketing are responsible for responding to customer inquiries, creating sales quotations, receiving and processing customer orders, and transmitting customer order details to personnel in the finished goods warehouse. *Sales and marketing personnel* may also be involved creating sales order contracts with customers; this is especially likely in distribution companies that serve as supply chain intermediaries between producers and buyers.

A customer inquiry is typically a formal request from a customer about one or more products that the customer is interested in buying. It may be submitted as a *request for quotation (RFQ)* that essentially asks the seller to specify a selling price for a specified quantity of a product it is interested in purchasing. After an inquiry has been received sales personnel respond by creating a quotation that is sent back to the customer; the quotation specifies the best price and conditions that the seller can offer. If the customer is satisfied with the quotation, it may respond to the seller by sending it a sales order.

A sales order is essentially an agreement between a seller and buyer that specifies the products to be delivered, the quantity of each product, and date on which the items are to be delivered to the customer. When the sales order is sent in response to a quotation, the seller is also responsible for complying with the terms of the quotation, such as product price.

Sales personnel are responsible for entering sales order details into information systems that support the fulfillment process and ensuring that these details are transmitted to the finished goods warehouse(s) that will be involved in fulfilling the customer's order.

Warehouse personnel are responsible for receiving sales orders from the sales and marketing function. They are also responsible for aggregating and packing specified quantities of the products specified in the customer order and readying the order for shipment and delivery.

Preparing an order for shipment involves picking and packing. *Picking* involves retrieving ordered products/materials from storage locations in the warehouse. The personnel in warehouse responsible for picking activities are called *order pickers*, or *pickers.* To facilitate their tasks, order pickers use documents called *pick lists* or *picking lists* that associate details from the customer order (products and quantities) with storage locations in the warehouse. This is illustrated in Figure 9-8.

After the products needed to fill a customer order have been picked and aggregated, they are packed and readied for shipment. These tasks are carried out by *packing personnel* in the warehouse. For small consumer orders, all the items need to fill an order may fit in a single box (see Figure 9-9). Large orders for business customers may require multiple pallets and lots of shrink wrap for order packing.

Figure 9-7: Warehouse order picker verifying/collecting items needed to fulfill an order. Image ID:391811314

Figure 9-9: Order packing in a warehouse.
Image ID:129624017

When an order is packed, a shipping document is created for inclusion in the order packaging. The shipping document specifies the items and quantities included in the shipment. This document has a variety of names including *packing slip*, packing list, packaging slip, shipping list, shipping manifest, waybill, bill of parcel, delivery docket, or delivery list. No matter what it is called, it accompanies the shipped order to inform the customer of what is included in the shipment.

Other warehouse personnel may be responsible for loading packed customer orders into delivery trucks or onto other delivery vehicles (see Figure 9-10).

Figure 9-10: Forklift driver moving packed customer orders from warehouse to delivery truck.

Stock photo ID: 425439460

Accounting personnel involved with the fulfillment process are responsible for customer billing and payment processing. This includes creating and sending invoices and processing customer payments. Legally, a company cannot invoice a customer for an order until the order is picked, packed, and shipped. If the sales contract between buyer and seller states that FOB point is the buyer's location, ownership of the shipped products does not shift to the buyer until the shipment is delivered.

The shipper realizes sales revenue via the receipt and processing of customer payments so the rapidity with which billing and payment processing can be critical to ensuring adequate cash flow.

FULFILLMENT PROCESS DOCUMENT AND DATA FLOW

The cross-functional nature of the make-to-stock fulfillment process can be observed in the flow of its key documents (see Figure 9-11. The green documents are generated by the sales function, the blue documents are generated by the accounting function, and the other documents are key documents in the fulfillment process tasks/activities that are performed in the finished goods warehouse.

Other documents that may be part of a company's fulfillment process include customer inquiries, sales scheduling agreements, sales contracts, credit memos, and debit memos.

As noted in the previous section, quotations are often generated by sales and marketing personnel in response to customer inquiries. A **sales quotation** or *price quote* is prepared in response to a potential buyer's request-for-quotation (RFQ). Its key contents are a list of products and/or services and prices. Sales and marketing personnel create sales quotations to entice prospective buyers to purchase the products or services for the quoted prices.

Important data found in sales quotations includes a unique identifier, seller contact information, customer contact information, product list and details (descriptions, quantities, prices), total and itemized costs, tax details, delivery date, payment terms and conditions (seller payment method preferences, expected payment date, and incentives for early payments), and quotation expiration date.

A sales quotation submitted in response to a RFQ can be either accepted or rejected by the buyer. If the buyer accepts the quote, the seller typically converts the quote into a sales order which indicates that the buyer is ready to purchase products from the seller.

A company's existing customers may directly order items from the company in the absence of a sales quotation. Business customers submit purchase orders (POs) as part of their procurement processes (the procurement process is described in Chapter 8). Many companies refer to the orders they receive from business partners (customers) as *customer purchase orders*. When a customer purchase order is received from a business partner, it is converted to a sales order.

A **sales order (SO)** is usually an internal document that is used to track a customer order through the fulfillment process. It is essentially an agreement between seller and buyer that specifies the items to be delivered to the buyer, their quantities, and the delivery date. Each sales order includes a unique identifier (e.g. a sales order number) along with the product ID, product description/name, product attributes (e.g. weight, color, size), unit price, and order quantity for each product in the customer order. When a sales order is created in response to a sales quotation, much of this data flows from the sales quotation document to the sales order document.

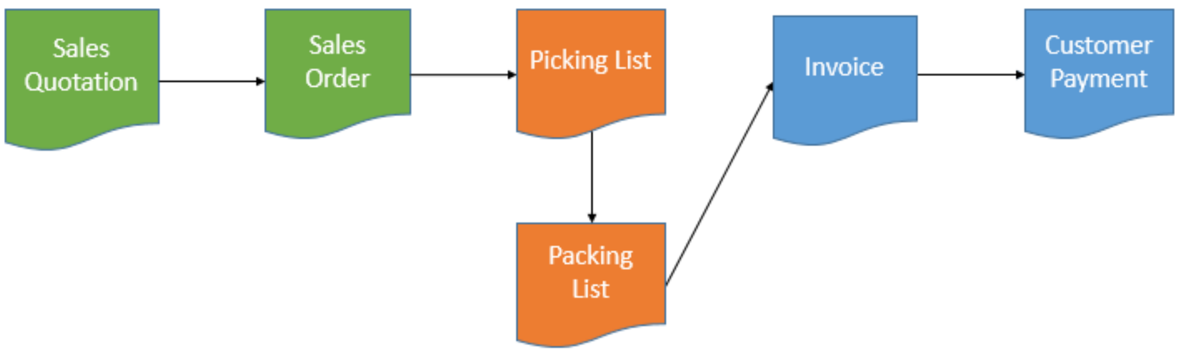

Figure 9-11: Fulfillment process document flow.
Courtesy: Thomas Case

When customer order details are passed to the finished goods warehouse, product ID, description, attributes, and quantity flow from the sales order to a picking document, which is a key document in the pick/pack/ship activities carried out in the warehouse. The picking document (*picking list*) is used by order pickers to locate ordered items. It associates ordered items with warehouse storage locations. In larger warehouses, storage locations may be specified in considerable detail, such as aisle, shelf, and bin.

Sales order details also flow to the shipping document (*packing list*) that specifies the ordered items included in the shipment to the customer. At a minimum a packing slip includes customer shipping address, item names and quantities included in the shipment. Today, most packing slips also also include product IDs, product descriptions, and unit prices, item subtotals, taxes, total prices, and shipping date.

If the seller does not have a sufficient quantity of an ordered product in inventory, the packing slip may include backorder details that specify the shortage quantity. *Backorders* are exceptions to the fulfillment process that can cause headaches for both sellers and buyers. For sellers, backordered items may require special shipments to the customer and bearing the expenses associated with the shipments. However, in some instances, it may be possible for sellers to include backordered items in scheduled shipments to the customer. For buyers, backorders mean delayed receipt of ordered items; this may translate into empty shelves and reduced sales revenues and profits when ordered items are resold to the buyer's customers. It also means that buyers may have to process special shipments or scheduled shipments that include both regular and backordered quantities. For both sellers and buyers, backorders may cause issues in reconciling invoices and payments.

Figure 9-12: Packing Slip
Stock vector ID: 169545326

In make-to-stock fulfillment, customer billing address, customer ID, product ID and/or product description, item quantity, and unit prices also flow from sales orders to the invoice generated by the accounting function and transmitted to customers when an order is shipped. Invoices also typically include item subtotals, taxes, total amount due, and payment terms. When customer payments are received, the accounting function often compares data/information on invoices to that included on packing slips to ensure consistency and to also ensure that the organization is being appropriately paid for items shipped to the customer.

Figure 9-13: Customer Invoice Example
Stock photo ID: 156096752

The receipt and posting of customer payments is the final step in the fulfillment process document flow. In practice, customer account reconciliation often accompanies the receipt of customer payments, so accounting personnel may have to do more than just post payments. Many sellers acknowledge payment receipt by notifying buyers that their payment has been received.

Fulfillment Process Physical Flow

The primary physical flows within the fulfillment process include the movement of products/materials within the warehouse as part of the order picking, packing, and shipping tasks/activities. Picking involves the removal of items from warehouse storage locations to the area in which packing activities take place. Once packed, bundled items are moved out of the warehouse to delivery vehicles. Some companies own the delivery vehicles that are used to move ordered items to buyer locations. Others partner with logistics companies to handle customer deliveries.

Fulfillment Process Instance- and Process-level Information

Instance-level information associated with a single order enables the organization to address customer questions such as:

- Has the order been received?
- Has the order shipped?
- Has the invoice been sent?
- Has payment for the order been received?

Process-level information that can be generated from the aggregation of iterations of the fulfillment process include:

- What is the average time between order receipt and shipment? Is this average time increasing or decreasing over time?
- Which customers place the most orders? What do they typically order?
- Which products are ordered most often? Which products are ordered least often?
- What is the average revenue per customer order? On average, how much does it cost to fulfill a customer order?
- Which customers have the best payment history? Which customers habitually make late payments?
- Which products have the lowest average order-to-shipment times?
- Which products have the highest average order-to-shipment times?

The answers to such process-level questions provide insights into how the organization's fulfillment process might be improved.

Additional Fulfillment Process Documents

As noted previously, considerable variation exists from company to company in how they fulfill customer orders. While the sequence/order of the major documents is consistent across organizations, additional documents may also be included in the fulfillment process in some companies. Several of these are identified and briefly described below.

Sales Scheduling Agreement. A sales scheduling agreement includes content like that for a sales order. In a scheduling agreement, the customer orders specified quantities of specified items; price and conditions are agreed upon and delivery is arranged. However, the agreement schedules multiple deliveries to the customer over a specified time.

Sales Contract. A sales contract is an agreement between a company and a customer for goods or services over a specified time. Sales contracts can be structured in a variety of ways. Some specify the quantity (total number) of items to be sold to customer over the time period. Others specify the total value of items to be sold to the customer over a period of time. A sales contact may also be based on value by specifying that items sold to the customer cannot exceed a specified total value amount.

Like backorders, customer returns can complicate the fulfillment process for both sellers and buyers. However, there will be times when customers want to return ordered items to the seller. In some instances, this may be because there were errors in the seller's fulfillment activities that resulted in the customer receiving the wrong items. In other cases, order goods may be damaged during shipping and arrive in unusable condition. There are also times when the customer no longer wants or requires the items that are shipped; the probability of this happening increases when deliveries are made after promised delivery dates.

Companies typically have returns policies that are communicated to customers when orders are submitted and/or when ordered items are shipped. When the returned items are processed, a credit is issued to the customer in the form of a refund or a sales document called a *credit memo.* The credit memo essentially specifies the adjustment (decrease) to the customer's accounts payable entry in the company's chart of accounts (general ledger) that is needed to account for the items that were returned. Credit memos can also be processed if the customer has been charged a price that is above the agreed amount, if a discount has not been applied, or if they have been charged for shipping when the order included free shipping.

A *debit memo* is the opposite of a credit memo. A debit memo specifies the amount that the customer's accounts payable entry in the chart of accounts should be increased if the customer has been undercharged for items on a sales order. Because undercharges typically result from internal mistakes, debit memos typically have no impact on customer payments. The difference between what the customer was charged and should have been charged is reconciled by the debit memo and the customer is not asked to compensate the company for the undercharged amount.

FULFILLMENT PROCESS AUTOMATION

Because it is typically an organization's only revenue generating process, considerable time and attention has been devoted to developing software and technologies to support the fulfillment process. Some of the major solutions and technologies are described below.

Customer Relationship Management (CRM) Systems

Customer relationship management (CRM) involves managing all aspects of a customer's relationship with an organization. The goals of CRM include increased customer loyalty, retention, and sales, as well as increased profits.

Three major aspects of CRM are sales force automation, customer service management, and marketing automation. These are illustrated in Figure 9-14.

Sales force automation involves using software to automate sales tasks and activities including sales order processing, sales force customer contact management, inventory monitoring, customer order tracking, and sales personnel performance evaluation. *Customer service management* uses software to coordinate all facets of an organization's customer service efforts. *Marketing automation* involves automating marketing actions, such as those associated with e-mail marketing, social media marketing, and online e-commerce content. Marketing automation also includes using software to coordinate marketing and branding efforts across sales channels and to analyze the effectiveness of marketing campaigns both within and across sales channels.

CRM software supports both operational and analytical processes. Operational CRM involves front-office operations that deal directly with customers including customer order transactions. Analytical CRM supports back-office operations such data analysis (trend analysis, predictive analysis, sales forecasting, etc.). Analytical CRM relies on CRM data storage repositories (such as data warehouses) and business intelligence/analytics tools to gain insights into customer preferences and behaviors. These insights are used to personalize the organization's interactions with the customer, such as providing a personalized e-commerce experience when a customer visits the organization's website. They are also used to refine fulfillment process sales forecasts.

Sales Force Automation	Customer Service Management	Marketing Automation
Field Sales	Call Center Management	Campaign Management
E-commerce	Customer Contact Management	Content Management
Telephone Sales	Web-based Self-Service Management	Social Media Marketing Management
Retail Sales	Field Services Management	E-mail Marketing Management
Third-party Sales	Social Media Customer Service Management	Data Analysis and Business Intelligence

Figure 9-14: Major Aspects of Customer Relationship Management

Courtesy: Thomas Case

As illustrated in Figure 9-15, CRM software often includes collaboration systems that facilitate communication and coordination among the front-office and back-office systems.

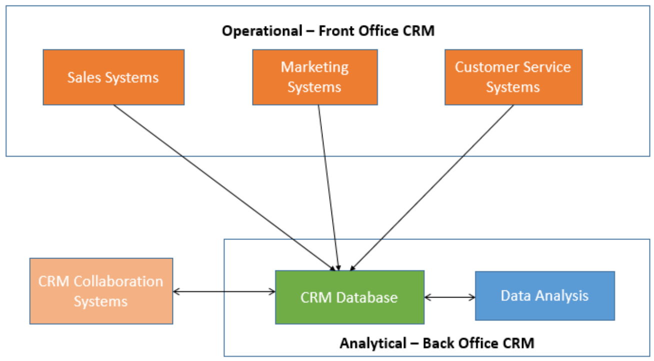

Figure 9-15: CRM Systems Components
Courtesy: Thomas Case

Today's CRM systems primarily emerged from *sales force automation systems* that were designed to help sales personnel convert prospective customers (leads) into buyers. Common steps in this part of sales process are illustrated in Figure 9-16.

Sales force automation systems include opportunity management systems, contact management systems, and sales management systems. *Opportunity management systems* automate the tasks/activities associated with identifying/finding new customers for future sales. *Contact management systems* maintain customer (and prospective customer) contact data/information. *Sales management systems* automate each phase/step in the sales process, especially those associated with generating quotations and processing customer orders.

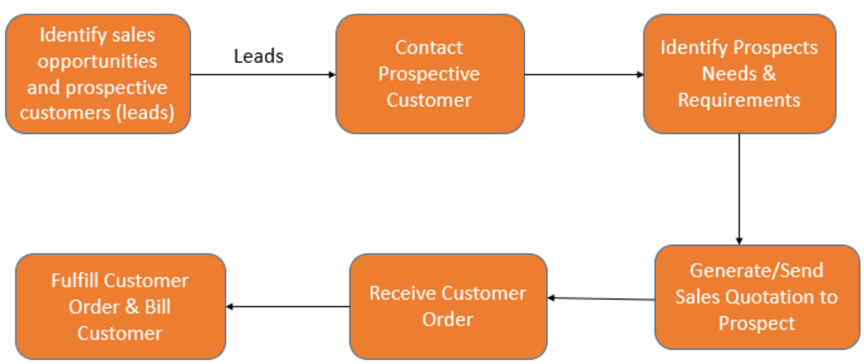

Figure 9-16: Sales process tasks/activities.
Courtesy: Thomas Case

Social media have affected all CRM system components, especially CRM's marketing management and customer service management components. *Social media marketing* is typically an important part marketing campaigns and in some campaigns, it overshadows traditional marketing channels such as television, radio, and print media. *Social media listening* has become an important part of customer service management; this enables companies to know what customers and prospective customers are saying about their products and services and to quickly identify and respond to customer service needs.

Because of the support that they provide to front office fulfillment tasks/activities, especially those related to transmitting sales quotations and processing sales orders, CRM systems play an important role in automating the fulfillment process. As noted in Chapter 7, a company's CRM system(s) is often integrated with its ERP system(s) to enable sales orders to be handed off to the functions outside sales and marketing that carry out fulfillment process tasks/activities. Salesforce, Oracle, SAP, Adobe Systems, and Microsoft are among the major CRM software vendors.

Electronic Data Interchange (EDI)

Historically, EDI systems have been supporting the fulfillment process longer than most of the other fulfillment process automation solutions and technologies described in this chapter. As noted in Chapter 8, EDI is the electronic exchange of standardized business documents between the computer systems of two companies and historically, EDI was the B2B (business-to-business) e-commerce system.

EDI, in its basic form, is illustrated in Figure 9-17. In the fulfillment process, the buyer transmits its order to a supplier (seller) using the standard EDI procurement order (PO) document, the EDI 850 document. The supplier's computer system receives the customer (PO) and often acknowledges order receipt via EDI 855 (purchase order acknowledgment) document. It then hands off the PO content to the computer system(s) that the company uses to process and fulfill customer orders. When the order is picked, packed, and shipped, the supplier can send a standard EDI invoice document (the EDI 810 document) to the customer; the supplier may also send a standard EDI *advance ship (shipping) notice (ASN)* document to notify the buyer of impending deliveries. The ASN is like a packing list; the ASN is EDI document 856.

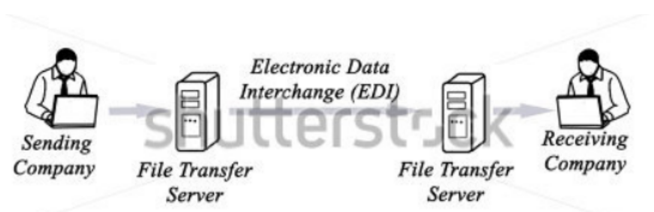

Figure 9-17: Using EDI to Submit Customer Purchase Orders to Vendors
Stock illustration ID: 435474676

As shown in Figure 9-18, EDI documents may be transmitted between companies over point-to-point communication connections (typically leased circuits) or via third-party EDI networks (value-added networks). Today, EDI documents may also be exchanged via the public Internet using VPN tunnels; VPN tunnels represent a logical equivalent to point-to-point leased circuits and are typically less expensive.

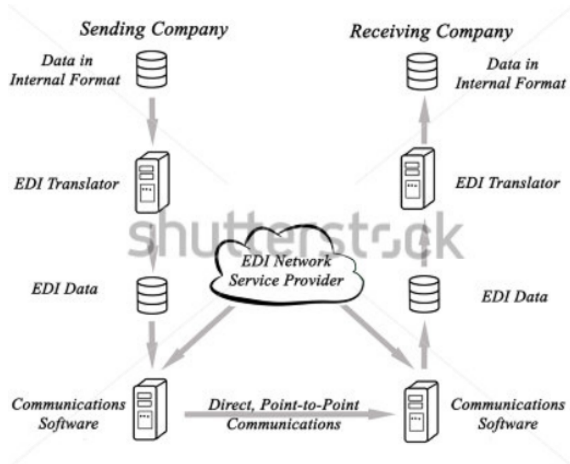

Figure 9-18: EDI Communication Options
Stock illustration ID: 438971296

Payments for EDI facilitated customer order fulfillment typically involves ACH (Automated Clearing House) transfers between buyer and seller bank accounts. In some instances, a buyer may be able to initiate an ACH payment to a supplier by sending an EDI 820 document to its bank.

Warehouse Automation Systems

Fulfillment process cycle times have been positively impacted by technologies and systems that support pick-pack-ship tasks/activities in warehouses. As Figure 9-19 illustrates, warehouse personnel responsible for order picking and inventory management have benefited from advancements in wireless devices such as tablets, handheld terminals, and wireless label printers.

Figure 9-19: Examples of Warehouse Automation Technologies.
Stock vector ID: 200874497

Google Glass, and other augmented reality applications have been developed for order pickers that re-arrange items in an order to optimize the speed with which the order can be picked. When one item is picked, the location of the next item is displayed along with the quickest path to the next item's location, the path with the fewest number of steps.

In some warehouses, robotic order picking and packing technologies have been implemented (see Figures 9-20 and 9-21). These technologies are widely viewed as the future of warehouse picking and packing.

Figure 9-20: Robotic Order Picking
Stock photo ID: 683749849

Figure 9-21: Robotic Packing
Stock photo ID: 418422856

Radio frequency identification (RFID) tags and being increasing affixed to items stored in and shipped from warehouses. These have dramatically improved inventory counting speeds and goods movement tracking. As illustrated in Figure 9-22, RFIDs are increasing affixed to packed boxes. This helps shippers verify instantly whether all the items needed to fulfill a customer order have been loaded into a delivery vehicle.

Figure 9-22: RFID Tag on Packed Box Ready for Shipment
Stock vector ID: 523835614

The fulfillment process tasks/activities that take place in warehouses is typically supported by warehouse management system software. A **warehouse management system (WMS)** is a software application that supports the day-to-day operations in a warehouse. WMS programs enable centralized management of tasks such as tracking inventory levels and stock locations. WMS software guides inventory receiving and put-away, optimizes order picking, packing, and shipping, and advises on inventory replenishment. These are all consistent with the overall purpose of a WMS --- providing warehouse managers with the information needed to efficiently control goods/materials movement within the warehouse.

The benefits associated with adopting and using a WMS can include:

- Reduced fulfillment time

- Increased inventory accuracy
- Improved customer service
- Better utilization of warehouse space
- Increased warehouse productivity
- Reduced warehouse labor cost

When such benefits are realized, positive impacts on fulfillment process measures and KPIs, such as those described previously in this chapter.

A WMS can also help reduce the likelihood of errors associated with shipping products handled by the warehouse. It can also help a company fulfill orders more rapidly by quickly pinpoint the locations of ordered products within the warehouse.

Today, a high-end WMS system also support RFID tracking. No matter how complex it is, WMS systems may be standalone applications (either on premise or cloud-based) or part of an Enterprise Resource Planning (ERP) system.

Enterprise Resource Planning (ERP) Systems

An ERP system can provide end-to-end support for the fulfillment process. This is illustrated in Figure 9-23. The ability of ERP systems to provide automated support for most fulfillment process tasks/activities has historically been a driver of ERP system adoption and use.

ERP systems save customer and product data in their databases as master data. This enables the saved data about customers and products to be used populate electronic documents within the fulfillment process's document flows. Hence, once customer data is in the database, it can be automatically brought into quotations, sales orders, packing lists, and invoices. Product descriptions, IDs, and details can also be automatically brought into these same documents.

Each quotation that is created and transmitted to an existing or prospective customer is saved with a unique document number in the ERP database. When a quotation is accepted by a customer, it can be used to create and save a uniquely identified sales order document in the ERP database. A unique sales order document can also be created and saved when an order is received from a customer in the absence of a quotation. The unique sales order number that is generated for each customer order is used to track the order as it progresses through the fulfillment process's subsequent tasks/activities.

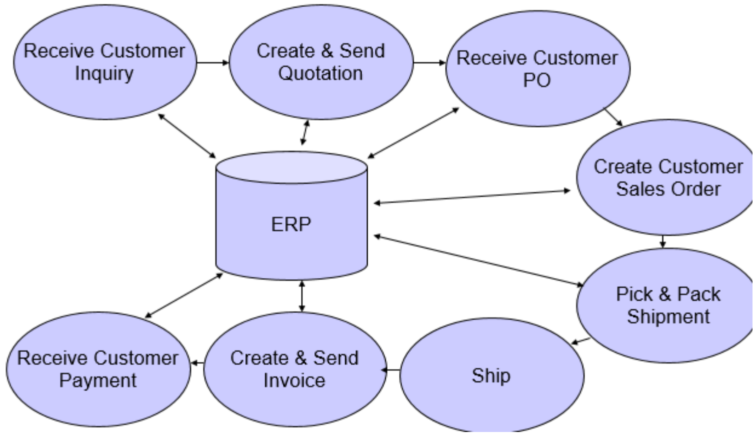

Figure 9-23: ERP System End-to-End Fulfillment Process Support
Courtesy: Thomas Case

In the finished goods warehouse, the ERP system can automatically generate a pick list and packing list for a customer order from the product and quantity details on the sales order. Accounting personnel can also use details from the sales order to automatically generate an invoice. Like the other fulfillment process documents, the pick list, packing list, and invoice are each saved to the ERP database with unique document numbers.

When a customer payment is received, the ERP system associates it with an invoice and sales order. In the ERP system, the sales order remains open until its payment is posted to the chart of accounts.

Most ERP systems enable the document flow associated with a sales order to be viewed should a question arise about what tasks/activities associated with the order have been completed. Figure 9-24 illustrates the document flow for a standard order in SAP ERP.

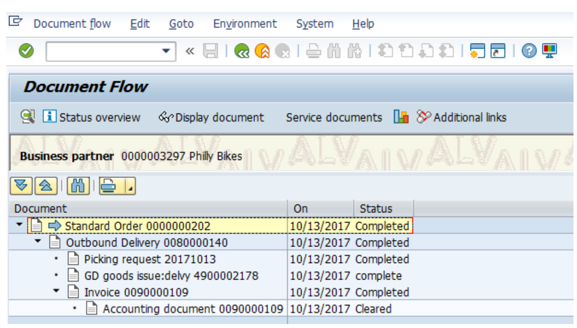

Figure 9-24: Fulfillment Process Document Flow in SAP ERP
Courtesy: Thomas Case

THE FULFILLMENT PROCESS AND SAP ERP SYSTEMS

Like other ERP systems, SAP ERP provides end-to-end support for fulfillment process tasks and activities. It can be configured to support any organization's fulfillment process. Because the fulfillment process is viewed differently from company to company, only part of SAP ERP's potential breadth of support for the fulfillment process may be used. Some companies may refer to fulfillment as the “order-to-cash” process and may only use SAP ERP to support fulfillment process tasks from the receipt of a customer order to the receipt of the customer payments. Other companies may refer to their fulfillment process and “inquiry-to-cash” because they also leverage SAP ERP capabilities to support pre-sales activities.

In traditional SAP-speak, the bulk of the fulfillment process is supported by SAP ERP’s Sales and Distribution (SD) module. SAP users can support pre-sales activities using the SD module’s Sales Support component. This component assists with the sales, distribution, and marketing of the company’s products or services to customers. It creates and tracks customer contacts and communications, including phone records, e-mail, and face-to-face meetings and can link these to any inquiries or orders that are received. Initial customer contacts are often sufficient to create a customer record in the SAP ERP database. The SAP ERP navigation and initial screen for creating a customer is illustrated in Figure 9-25.

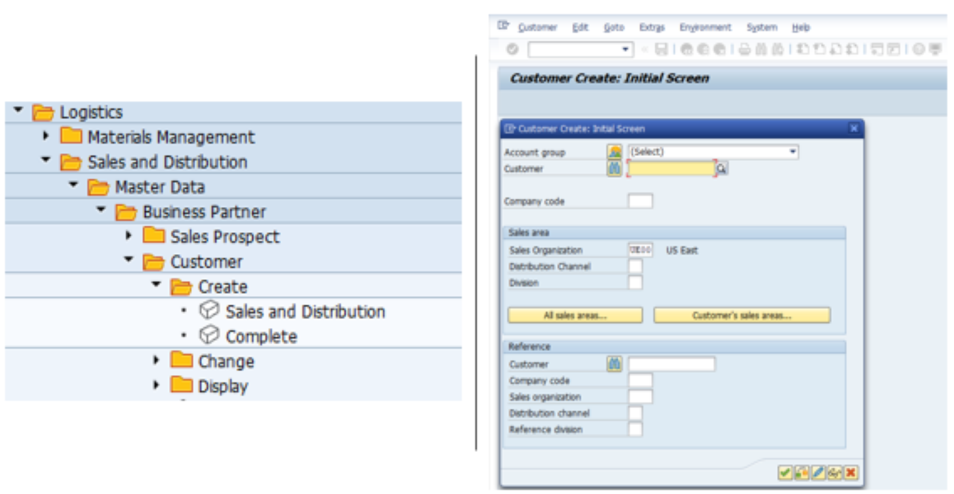

Figure 9-25: SAP ERP Navigation and Initial Screen for Pre-Sales Creation of Customer Record
Courtesy: Thomas Case

Each customer in the SAP ERP database has a unique customer number (ID) and is saved as master data so that it can be accessed by any process or transaction that needs. Customer record details can be saved or updated once and subsequently used in any process supported by the ERP system where it is needed.

For control purposes, SAP ERP does not allow the creation of quotations or sales orders for customers without records in the SAP ERP database. So, before products can be sold to a new customer, a customer record must be created in the database.

As may be observed in the SAP ERP navigation for Create Customer (see Figure 9-25), SAP ERP includes capabilities for entering and saving data about prospective customers (Sales Prospect). The SAP ERP navigation illustrated in Figure 9-26 depicts where this ERP system’s SD module supports other pre-sales activities. Several of these fall under Sales Support. Others including entering information from customer inquiries, and sales quotation creation fall are included as Sales activities.

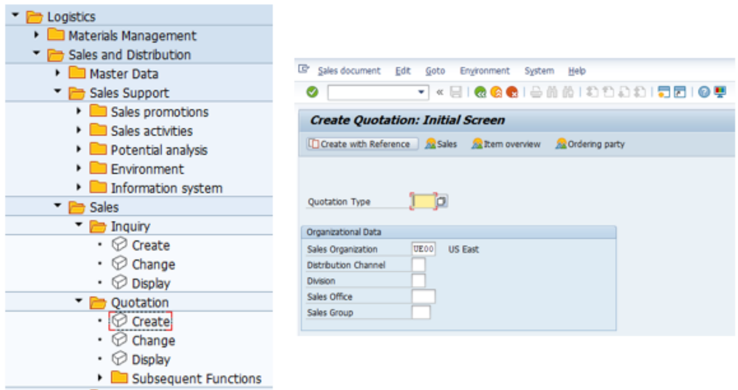

Figure 9-26: SAP ERP Navigation and Initial Screen for Sales Quotations
Courtesy: Thomas Case

As previously in this chapter, an inquiry is a customer (or prospective customer) request for information or a quotation. Inquiries may be made by phone, web form, e-mail, mail, social media, or other contact channels that the company supports. RFQs submitted by customers typically include details about the products/materials and quantities that they are interested in purchasing.

It is important to note and inquiry is really nothing more than an expression of interest in the company's products. Customers who submit inquiries have no obligation to accept any subsequent sales quotations that companies send them.

The SAP ERP navigation for entering customer inquiry information and creating sales quotations is very similar. This is illustrated in Figure 9-26. A customer must have a record in the SAP ERP database before inquiry data/details can be entered. So, if an inquiry is received from a prospective customer without a customer record in the database, a customer record must be created before the inquiry data/details can be logged. A customer inquiry is saved with a unique document number in the SAP ERP database.

When a customer record exists in the SAP ERP database, sales personnel can use SAP ERP to create and save sales quotations sent to existing or prospective customers. As noted previously in this chapter, a sales quotation specifies prices that will be charged for specified products and product quantities. Quotations also typically include payment terms and/or discounts for early payments. Like any other SAP ERP document, each sales quotation is saved with a unique document number in the database.

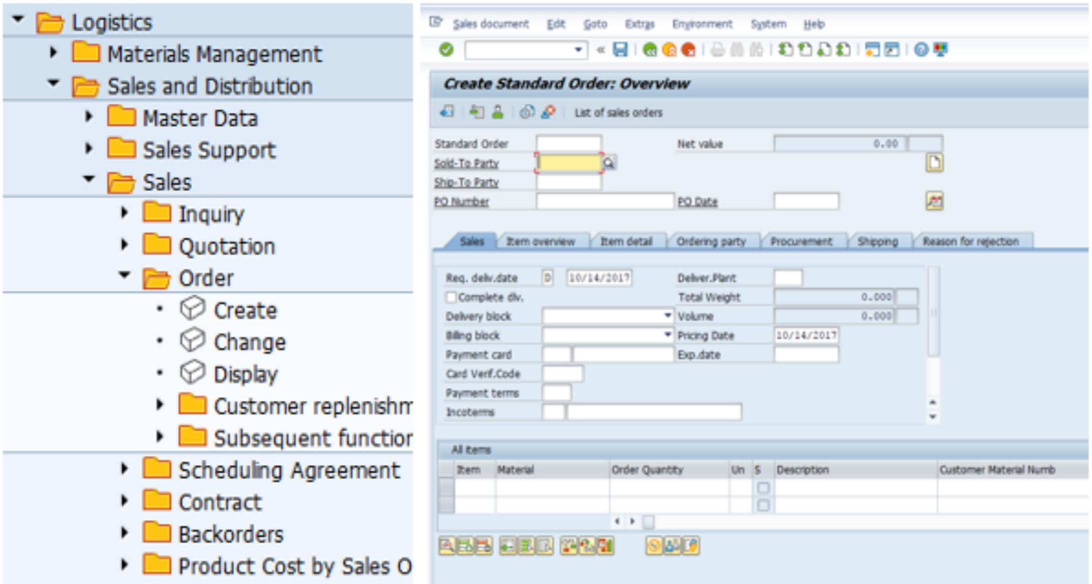

Figure 9-27: SAP ERP Navigation for Creating a Sales Order and Standard Order Creation Screen
Courtesy: Thomas Case

Sales orders can be created for customers with customer records in the SAP ERP database. A customer inquiry or sales quotation is not required to create a sales order, but if these documents exist, sales order can be linked one or both documents. When a sales order is linked to a sales quotation, the product, quantity, and price details from the quotation flow to fields in the order creation screen to facilitate the completion of the sales order. Each sales order is saved with a unique sale order number in the SAP ERP database and is the primary document used to track the subsequent steps in the fulfillment of the customer order.

The sales order specifies the key data/information that is needed to process the order. This includes, the shipping point, the shipping destination, the items and quantities to be shipped, the availability of ordered items in the warehouse, and item prices. Data/information needed by the ERP's *materials resources planning (MRP)* module is also captured by the sales order; much of the data required by the MRP relates to product inventory levels and product replenishment requirements.

In SAP ERP, the initiation of the fulfillment process tasks/activities that take place in the warehouse, the picking, packing, and shipping of ordered items, begins with the creation of an *Outbound Delivery document*. The delivery document can be created with or without reference to a sales order. When linked (referenced) to a sales order, sales order details (customer data, delivery date, items and item quantities, item preferences, etc.) flow to fields in the Outbound Delivery document to facilitate the completion of the document. When the Outbound Delivery document is saved, SAP ERP assigns a unique document number. By saving the document, SAP ERP confirms that the order items are available in sufficient quantities in the warehouse and that the company can meet the specified delivery date.

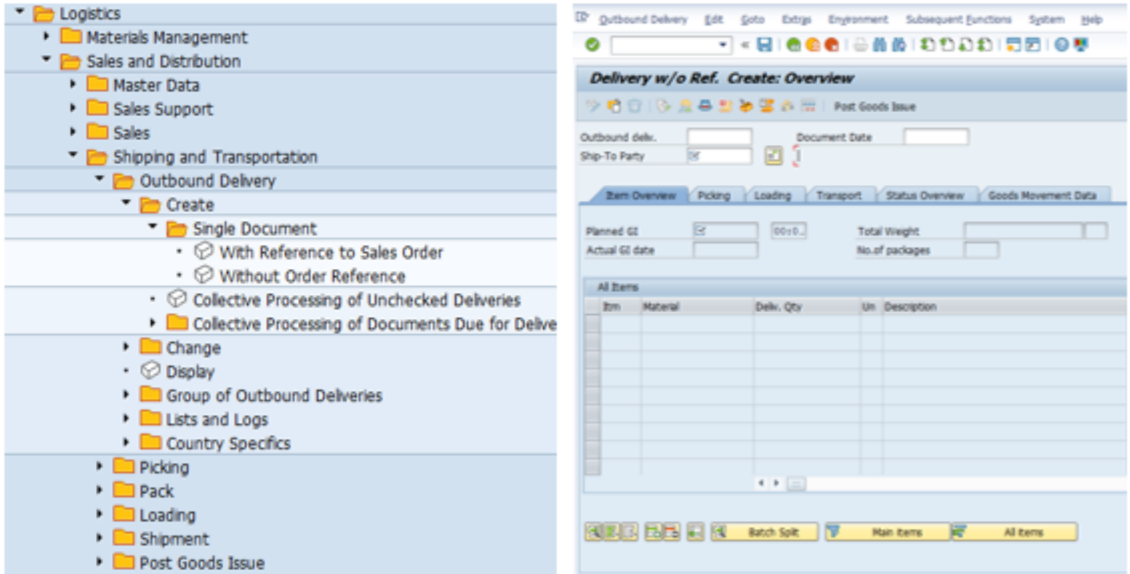

Figure 9-28: SAP ERP Navigation and Outbound Delivery Document Creation Screen. Courtesy: Thomas Case

When the ordered items are picked from warehouse storage locations and moved to the packing area, changes are made to the Outbound Delivery document. Completion of the picking process is indicated on the Outbound Delivery document's Picking tab. This is located to the right of the Item Overview tab in Figure 9-28. On the Picking tab screen, the storage locations of picked items are entered along with the quantity of picked items. These changes to the Outbound Delivery document indicate that the specified quantities have been removed from their storage locations and packed for shipment to the customer.

The Outbound Delivery document screen includes a Post Goods Issue button. This is located above the Document Date box in Figure 9-28. Clicking the Post Good Issue button indicates to SAP ERP that the order has shipped. When this change to the Outbound Delivery document is made, legal ownership of the products is transferred to the customer. The company's inventory is reduced for the items included in the order by the quantities specified in the delivery document. Adjustments are also made to the company's general ledger. Cost of Goods increases, as does Accounts Receivable. This completes the pick-pack-ship activities within the warehouse and positions accounting personnel to complete the billing activities for the order.

One the order has shipped, remaining tasks/activities in the fulfillment process, invoicing and processing the customer payment are carried out by accounting personnel. Figure 9-29 illustrates the SAP ERP navigation to Billing. This figure also displays the first screen used for invoice creation – Maintain Billing Due List. Details from the sales order and/or delivery document flow to the billing document (invoice) that is sent to the customer. Like other SAP ERP documents, the invoice is saved to the database with a unique document number.

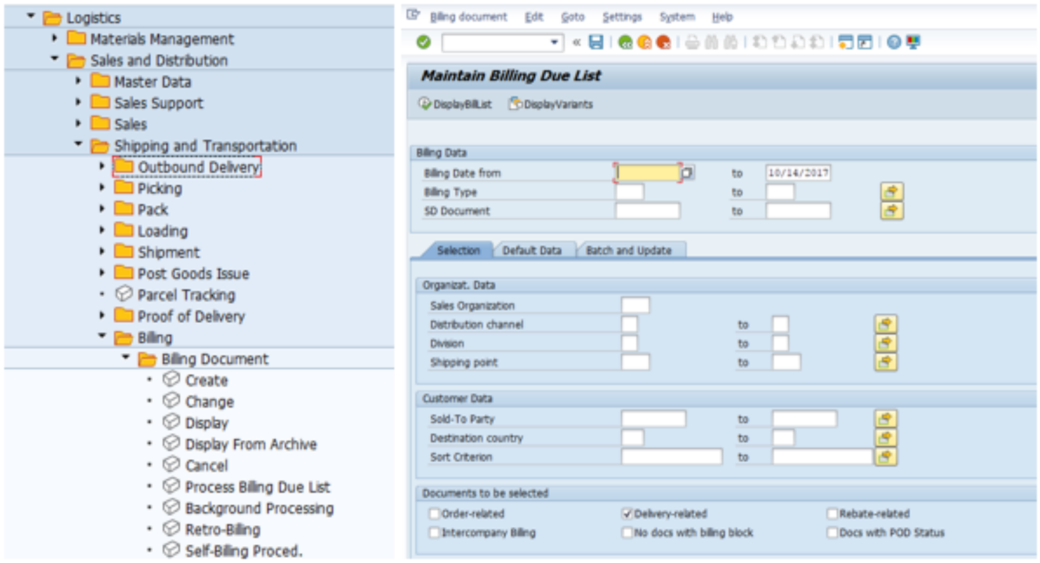

Figure 9-29: SAP ERP Navigation and Initial Invoice Creation Screen. Courtesy: Thomas Case

When the customer responds to the invoice by submitting a payment, payment receipt is recorded and saved to the database. SAP ERP navigation to part of the system used to record (post) customer payments to the general ledger is illustrated in Figure 9-30. When the payment is posted, SAP ERP automatically adjusts Accounts Receivable and Assets to reflect the sales revenue that it has realized by fulfilling the customer order.

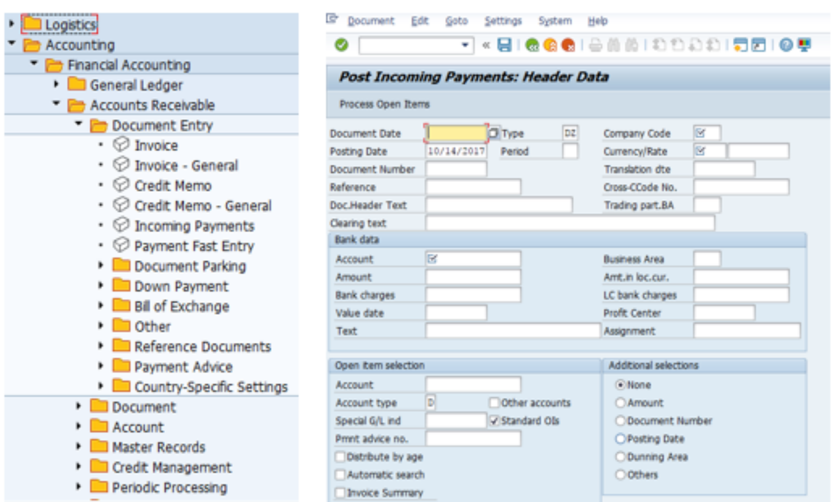

Figure 9-30: SAP ERP Navigation and Initial Screen for Posting Customer Payments. Courtesy: Thomas Case

As you can see, SAP ERP provides support for all aspects of the fulfillment process, including pre-sales activities. You can also see that the document flow within SAP ERP aligns to the document flow that is typical for the fulfillment process. SAP ERP's ability to integrate fulfillment process tasks/activities that are carried out by different functional areas (sales, warehouse, and accounting) is one of the reasons why it commands a larger market share than any other ERP system.

CHAPTER SUMMARY

The fulfillment process is often the only revenue generating process that a company has. The purpose of the fulfillment process is to provide value to customers by providing them with needed products or services. Because it is a process that interfaces directly with customers, most organizations strive to make their fulfillment processes efficient and error free. This can be seen in the metrics and KPIs that companies use to measure fulfillment process performance and success.

The fulfillment process is best understood within the context of the value chain's outbound logistics activity. However, the fulfillment process's pre-sales and sales activities also relate to the sales and marketing activity in the value chain.

The fulfillment process is a cross-functional process whose tasks/activities involve the organization's sales, warehouse, and accounting functions. The fulfillment process is often called the *order-to-cash* process because it includes the processing of customer orders from order receipt to processing payments for the items they purchase. The fulfillment process is called the *quotation-to-cash* process in companies that provide prospective customers with sales quotations designed to convince them to place orders.

The major documents in the document flow for the fulfillment process include quotations, sales orders, pick lists, packing/shipping documents, invoices, and customer payments. Key data flows item details, quantities, and prices from sales orders to delivery documents and invoices.

The primary physical flows for the fulfillment process are the order picking, packing, and shipping tasks/activities in the warehouse. Instance-level information enables the organization to address customer questions such as "has my order shipped?" Process-level information sheds light on opportunities to improve the fulfillment process.

Customer relationship management (CRM) systems are software systems that support company pre-sales and sales activities. They are designed to increase customer retention and to convert prospective customers into buyers. Electronic data interchange (EDI) provides computer-system to computer-system links between buyers and sellers. It allows several fulfillment process documents to be electronically exchanged including customer purchase orders and invoices. The fulfillment process has benefitted from advances in warehouse automation technologies, especially wireless technologies, augmented reality, and robotics. The evolution of warehouse management systems (WMS) has also had positive impacts on the fulfillment process in many organizations. ERP systems can provide end-to-end support for the fulfillment process. This is one of the primary reasons why ERP systems, such as SAP ERP, are widely used in organizations of all sizes.

KEY TERMS

Assemble-to-order (ATO)	5
Customer relationship management (CRM)	17
Digital copy (DC)	6
Distribution	2
Engineer-to-order (ETO)	5
Make-to-stock (MTS)	3
Make-to-order (MTO	4
Order accuracy	7
Order cycle time	8
Perfect order metric (POM)	9
Sales	2
Sales order (SO)	13
Sales quotation	12
Warehouse management system (WMS)	22

REVIEW QUESTIONS

1) Describe the differences between sales and distribution.
2) What are the major characteristics of the make-to-stock fulfillment strategy? What types of companies use make-to-stock fulfillment.
3) Explain why sales forecast accuracy is important in make-to-stock fulfillment.
4) What are the major characteristics of the make-to-order fulfillment strategy? What types of companies use make-to-order fulfillment.
5) Briefly describe the characteristics of each of the following fulfillment strategies: engineer-to-order, assemble-to-order, digital copy.
6) What is order accuracy?
7) What is order cycle time?
8) Identify and briefly describe several metrics used to measure warehouse pick-pack-ship activities.
9) What does it take for a customer order to achieve a perfect order metric (POM)?
10) Identify and briefly describe several metrics that are used to evaluate the overall fulfillment process.

11) Identify and briefly describe metrics used to evaluate warehouse inventory management.
12) Briefly describe the fulfillment process tasks/activities performed by sales personnel.
13) Briefly describe the fulfillment process tasks/activities performed by warehouse personnel.
14) Briefly describe the fulfillment process tasks/activities performed by accounting personnel.
15) Identify the documents included in the fulfillment process and the sequence in which they are created.
16) What is a customer inquiry?
17) What is a request for quotation (RFQ)?
18) What data/information is typically included in a sales quotation?
19) What is a sales order? What data/information is included in a sales order?
20) What is a picking list? What data/information is included in a picking list?
21) What is a packing list? What data/information is included in a packing list?
22) When are ordered items placed on backorder? How do backorders impact sellers and buyers?
23) What data/information is included in an invoice?
24) Briefly describe the fulfillment process's physical flows?
25) What types of questions can be answered by fulfillment process instance-level information? Provide examples.
26) What types of questions can be answered by fulfillment process process-level information? Provide examples.
27) What does sales force automation involve?
28) How does operational and analytic CRM support the fulfillment process?
29) Briefly describe how EDI is used to support the fulfillment process.
30) Identify several numbered EDI documents that are exchanged between sellers and buyers.
31) Identify several examples of technologies used to automated the fulfillment process tasks performed in warehouses.
32) What is a warehouse management system (WMS)? How do WMSs support the fulfillment process?
33) Explain how ERP systems provide end-to-end support for the fulfillment process.

Chapter 10 – ERP and the Production Process

CHAPTER OBJECTIVES

After reading this chapter, you should be able to:

- Describe the production process.
- Identify and briefly describe major production strategies.
- Identify several production process goals and measures.
- Identify production process actors and their roles.
- Describe the production process document flow.
- Describe data and information flow within the production.
- Identify physical flows within the production process.
- Describe how the production process is automated and supported by MRP, MRP II, ERP, robotics, and 3-D printing.
- Briefly describe the major characteristics of Industry 4.0.
- Describe how the production process is supported by SAP ERP.

INTRODUCTION

The production process includes the tasks/activities used by an organization to transform inputs (raw materials and/or components) into outputs (products and services) that are valued by customers. It is more complex than procurement and fulfillment processes and it is integrated with both procurement and fulfillment in well-run businesses. Because the production process creates (produces) goods/services that are valued by customers, it is typically a core business process.

The production process is best understood within the context of operations in Porter's Value Chain model. In Porter's model, operations is a primary value chain activity. However, the production process shares integration points with procurement and fulfillment processes, it also is affected by inbound and outbound logistics activities within an organization's value chain.

Because the products sold to customers in an organization's fulfillment process are produced/manufactured by its production process, its production and fulfillment process strategy have the same name. Hence, common production process strategies include make-to-stock (MTS), make-to-order (MTO), engineer-to-order (ETO), and assemble-to-order (ATO); each of these is described in Chapter 9.

Warehouse and manufacturing personnel are key actors in the production process. Warehouse personnel monitor inventory levels in both raw materials and finished goods warehouses. They are also involved in moving raw materials/components to the production area and for moving manufactured products to the finished goods warehouse. Manufacturing personnel are responsible for scheduling and completing production orders. Production order completion may involve a wide range of manufacturing personnel performing specialized tasks at different work centers.

Key documents in the document flow for the production process include planned orders, production orders, bill of materials (BOM), materials withdrawal, and goods receipt documents. A planned order specifies the quantity of a finished good to be manufactured/produced. When all the materials/components necessary to produce the product quantity in a planned order are available, the planned order is converted to a production order. A bill of materials (BOM) specifies the materials/components needed to produce one unit of the product. A materials withdrawal document indicates the movement of the materials/components needed by a production order from the raw materials warehouse to the production location. A goods receipt document specifies the movement of products produced for a production order from the production location to the finished goods warehouse.

Data flow during the production process includes inventory data about finished goods, and inventory data, including storage locations, for materials/components used in production. Data and information about existing planned order and production orders, is also needed for production order efficiency. Data from product BOMs flow to materials withdrawal documents. When a production run is complete, data in the goods receipt document is used to update finished good inventory.

Physical flows in the production process include the movement of materials/quantities from storage locations in the raw material warehouse to the production area and the movement of finished goods to storage locations in the finished goods warehouse after a production run is complete. During manufacturing, the product being produced flows among work centers until its complete.

Instance-level information about a production order enables the organization to answer questions such as “Has production been scheduled?” and “Have the products been produced?” Process-level information provides insights into opportunities to improve a company’s production process.

Historically, materials requirements planning (MRP) systems were some of the first information systems used to support the production process. These evolved into materials resources planning (MRP II) and subsequently to ERP systems. Today’s ERP systems provide end-to-end support for the production process, even for organizations that do very complex and specialized manufacturing. You will get a glimpse of how one ERP system, SAP ERP, supports the production process in this chapter’s final section.

Robotics and 3-D printing (additive manufacturing) have transformed manufacturing in many organizations. Industry 4.0 provides a blueprint for next generation manufacturing and information systems that support the production process.

PRODUCTION/MANUFACTURING STRATEGIES

Several types of manufacturing exist and deserve brief description because they provide context for understanding production/manufacturing strategies. **Manufacturing** can be generally defined as the process of converting raw materials, components, or parts into finished goods that are valued by customers or meet customer expectations or specifications. It is important to keep in mind that manufacturing is undertaken to produce goods that customers will buy.

In some organizations, the production/manufacturing process is essentially an assembly process. **Assembling** involves putting components together to produce a finished product. Assembly lines have traditionally been common in automobile manufacturing and as Figure 10-1 illustrates, this is still common today. In this figure, front seats are lined up to be added to the vehicles being assembled.

The components used in assembling are often semi-finished goods produced and supplied by other organizations. A *semi-finished good* is an input used in the production of another good, including a finished good. Semi-finished goods are also called intermediate goods or producer goods. Companies that make semi-finished goods may make them and then use them in their production process. Alternatively, they may make them and then sell them to other companies for use in their production processes. Some companies buy (procure) all the semi-finished goods used to produce their finished goods from other companies. For example, one automobile manufacturer may manufacture car engines (intermediate goods) and then install them in the vehicles they produce. Another car manufacturer may purchase car engines from a car engine producer and then install them in the vehicles its assembles.

Figure 10-1: Vehicle Assembly in Automobile Manufacturing.
Stock photo ID: 601688123

When assembly involves using semi-finished goods produced by other companies, the organization's semi-finished goods inventory must be monitored and purchase orders must be sent out in time to ensure that its inventory of semi-finished goods is not depleted.

To some, an organization's production/manufacturing process only includes *manufacturing* when it creates something from raw materials. If it does not involve transforming raw materials into a finished good, it is not manufacturing. The general definition of manufacturing also allows for assembling finished goods from components/parts and/or using a combination of raw material transformation and assembly.

When the semantics are sidelined, two major categories of manufacturing can be identified: discrete and process. **Discrete manufacturing** involves the production of distinct, countable items. Because individual items are produced by discrete manufacturing, a serial number or unique identifier can be assigned or affixed to each item that is produced. Automobiles, televisions, smart phones, appliances, and furniture are examples of items produced by discrete manufacturing.

Process manufacturing is the manufacturing/production of finished goods by combining supplies and ingredients according to formulas or recipes. Examples of process manufacturing goods include food, beverages, gasoline, pharmaceuticals, plastics, and chemicals. Breweries, chemical plants, and oil refineries are examples of process manufacturing facilities. Figure 9-3 illustrates process manufacturing in a cheese factory.

Figure 10-2: Discrete Manufacturing Outputs.
Stock photo ID: 454730713

Figure 10-3: Process Manufacturing in a Cheese Factory.
Stock photo ID: 124781137

Some organizations invest in specialized equipment and factory designs to enable repetitive manufacturing. **Repetitive manufacturing** is a type of mass production that makes high numbers of identical units in a continuous flow. This is increasingly used to manufacture products that have a continuous and steady demand, that is, products that are always in demand when they get to the end of the production lines. Food products and medical supplies are examples of products that are likely to always be in demand.

When producers are confident that the products they produce will be in demand, they can invest in manufacturing equipment and factory designs that are very fast and highly efficient. Some organizations dedicate manufacturing lines to the repetitive manufacturing of products that have steady and continuous demand. Dedicating a manufacturing line to one product minimizes setup time and streamlines the production process. Repetitive manufacturing assembly lines are typically highly automated often involve robotics and electronic controls.

A company may use repetitive manufacturing to produce its own products or to produce products for other companies and people. Figure 9-4 illustrates repetitive manufacturing in a commercial brewery.

Figure 10-4: Repetitive Manufacturing in a Commercial Brewery.
Stock photo ID: 288689447

Manufacturing Strategies

In general, a company's **manufacturing strategy** consists of the objectives and action plans implemented by its manufacturing function to ensure medium- to long-term sustainable advantage its competitors. Manufacturing strategy is a response to competitive forces in the external environment, especially the operating and industry components of the external environment (these are described in Chapter 2).

The production and fulfillment processes are closely tied in producer organizations. As a result, the production/manufacturing strategies that organizations adopt share the name of the fulfillment process with which they are coupled. Four common production/manufacturing strategies are make-to-stock (MTS), make-to-order (MTO), assemble-to-order (ATO), and engineer-to-order (ETO).

The **make-to-stock (MTS)** production strategy is driven by finished goods inventory levels. Finished goods are stored in one or more warehouses until they are needed to fulfill customer orders. MTS is usually a "build-ahead" production approach in which production plans are based on sales forecasts and/or historical demand and production takes place before customer orders are received. Products are stored in warehouses in anticipation of customer demand. In some instances, MTS production may be reactive to customer demand. If customer orders result in warehouse inventories falling below predefined levels, the make-to-stock production process may be triggered to bring warehouse inventory back to acceptable levels.

Key competitive elements of this production strategy are low-cost and consistent quality. When the production process is efficient and the products produced have sufficient quality to keep pace with customer demand, this strategy can help a company maintain its competitiveness. Because it is designed to match production and inventory to consumer demand, the success of the MTS production strategy is often determined by the accuracy of the demand forecasts that are used to determine how much to produce.

In the **make-to-order (MTO)** production strategy, the production process is triggered by the receipt of a customer-order. This strategy is best suited for low volume, high-cost (and high profit margin) situations where products are custom-produced to customer specification. Products are not produced until confirmed orders are received. It is widely used to produce low-volume and/or highly customized products. Flexibility and customization are key competitive priorities for MTO production. Examples of products produced by MTO production include high-end, specialized medical equipment and aircraft.

Boeing is an example of a company that uses the make-to-order production strategy to compete within the aerospace industry. Each of the orders that Boeing receives is typically for a limited number of aircraft and order specifications are likely to vary by customer type. For example, aircraft orders from the military usually include specifications that are very different from those for orders received from airline companies.

In **assemble-to-order (ATO)** production, products are assembled from components when orders are received. Rapid fulfillment (fast delivery of ordered products), customization, and flexibility are competitive priorities for ATO production. In ATO production, production involves the use one or more base (standard) modules onto which options can be added according to specifications in the customer order. High-end personal computers (PCs) are examples of products produced using ATO production.

In **engineer-to-order (ETO)** production, products are designed from scratch and are subsequently manufactured and delivered to a customer. The receipt of a customer order triggers the design activity. Designing the product may consume many engineering hours and may involve significant collaboration with the customer. This approach is used for very low volume and on-off products, such as a Mars rover.

PRODUCTION PROCESS GOALS AND MEASURES

The goals, measures, and KPIs for a company's production process typically align with its production strategy. However, across companies and manufacturing strategies, some commonalities exist. For example, in companies that use MTS, MTO, and ATO, improving productivity, asset utilization, and efficiency are typically identified as production process goals. Manufacturing firms often measure the achievement of production execution, production cost, production quality, and inventory management goals and they often have KPIs for capacity utilization, production yield, overhead costs, machine efficiency, and production plan adherence.

Production quality measures include scrap percentage, rework percentage, and inspection pass rates. Inventory management measures include inventory turns and inventory on hand quantities. Examples of metrics used in successful manufacturing firms are identified and briefly described below.

Manufacturing cycle time. The cycle time of a business process is the total amount of time it takes to complete all the tasks/activities in the process. In manufacturing, it measures the time it takes for a product to make its way through all the production process work centers and machines to become a finished good. The total time a product spends in the manufacturing system from beginning to completion is the product's *total manufacturing cycle time*. Reducing manufacturing cycle time can contribute to time to reduced costs and improved customer responsiveness.

Changeover time. Changeover is the process of converting a production line or manufacturing machine from producing one product to another. Changeover time measures the time it takes to make this switch. Changeover time is sometimes called *setup time* because the result is a machine or entire production line that is set up to produce a different product. Improving changeover time means completing the changeover in less time. Reducing setup time can contribute to increased asset and facility utilization, and improved customer responsiveness. Tracking changeover time provides insights into how setup times can be reduced.

Throughput. Throughput measures the average number of units being produced by a machine, production line, or manufacturing facility over a specified period of time (e.g., units per minute, hour, shift, day, month, etc.). Tracking throughput enables manufacturers to identify average production rates and trends. Improving throughput contributes to productivity, efficiency, and asset utilization improvements. It may also contribute to improved customer responsiveness.

Capacity utilization. This metric measures how much of the total manufacturing output capacity is being utilized at a given point in time. It tracks the degree to which potential output levels are realized. Capacity utilization is calculated as a percentage of total potential output and provides insight into the manufacturing facility's slack (unused capacity). When the facility is operating at full capacity, capacity utilization is 100%. When capacity utilization is less than 100%, opportunities may exist to increase throughput. Changeover time and number of changeovers impacts capacity utilization.

Overall Equipment Effectiveness (OEE). OEE is a globally recognized as a best practice measure and key performance indicator of efficiency and productivity in a range of industries. OEE assesses quality, speed (performance) and downtime (availability) and is used to measure the overall effectiveness of a production line or a piece of production equipment. An OEE score of 100% is perfect production; this is achieved by manufacturing high quality units, as fast as possible, with no downtime. OEE contributes to capacity utilization, throughput, and manufacturing cycle time.

Schedule/production attainment. *Schedule attainment score* (or *production attainment score*) measures actual production as a percentage of the scheduled production. It measures the extent to which target production levels are met in with a set time. Lower percentages may indicate that the production line and/or production equipment is not operating at optimal levels. Lower percentages may also indicate that production scheduling adjustments are needed. Schedule attainment can be impacted by changeover time and it typically impacts capacity utilization and throughput levels.

Planned maintenance percentage (PMP). Planned maintenance percentage (PMP) is widely used to indicate the percentage of the total number of maintenance (staff) hours spent on planned maintenance activities in a given time period. This is essentially a ratio metric, which indicates how often scheduled (planned) maintenance takes place relative to unplanned (emergency) maintenance. A high ratio indicates that most maintenance is planned. Since unplanned maintenance is typically more costly than planned maintenance, PMP also measures the extent to which total maintenance costs are under control.

Availability. Availability is the ratio of operating time to planned production time. *Operating time* is planned production time minus downtime (any period of time in which production is stopped). As noted above, availability is included in the OEE calculation. Availability is impacted by unplanned maintenance.

Yield. Manufacturing/production yield is one of the oldest and most widely used metrics. The two most common yield measures are first pass yield and overall yield. *First pass yield* is percentage of products that are manufactured correctly and to specifications the first time, without scrap, re-run or rework. It is the number of useable/sellable units coming out of the production process divided by the number of units going into the production process over a set period of time. *Overall yield* is the percentage of products produced in a given time period that may, or may not, require re-work to fall within compliance and quality standards. This includes the useable/sellable first pass units and units that achieve acceptable compliance and quality levels after rework. Units that cannot achieve compliance and quality levels after rework and have to be discarded/scrapped factor into *scrap percentage* calculations. As you might suspect, improvements in first pass yield and overall yield rates and reductions in scrap rates are desired outcomes in most manufacturing facilities.

Customer rejects/returns. This measures the frequency with which customers reject (refuse to accept) products or request returns because the products they receive are low-quality or out-of-specification. This essentially measures a producer's quality standards and quality assurance processes. Low first pass and overall yield rates often contribute to higher reject/return rates.

Supplier quality. This measures the percentage of good quality (useable) materials coming into the manufacturing process from a supplier. *Supplier defect rate* measures the percentage of low quality (unusable) materials received from a supplier. Both measures are important because they are related to first time and overall yield rates as well as customer reject/return rates. It is challenging to manufacture high-quality products from substandard supplier materials. Trends is supplier quality and defect rates provide insights into which suppliers' relationships are worthwhile to maintain and which are not.

Several fulfillment process metrics may also be used as KPIs for the manufacturing/production process. These include *customer fill rate*, *on-time delivery*, and the *perfect order metric (POM).* Customer fill rate measures the percentage of orders that are shipped in full and on time as a percentage of total orders. In the manufacturing context, customer fill rate indicates the frequency with which production is sufficient to complete the number of ordered units by the delivery date. Customer retention and repeat business is more likely when fill rates and on-time deliveries are high. As noted in Chapter 9, a *perfect order metric (POM)* for an order is achieved when the delivered order is complete, on time, and not damaged. Customer returns/rejects should be negligible for manufacturing organizations with POMs close to 100%.

PRODUCTION PROCESS ACTORS

Depending on the manufacturing/production strategy it follows, a company's production process may include actors from the engineering function, raw materials warehouse, production/manufacturing, and finished goods warehouse. Engineers perform design work in engineer-to-order (ETO) production and may be involved in some make-to-order (MTO) manufacturing processes. However, raw materials warehouse personnel, production/manufacturing personnel, and finished goods warehouse personnel typically have roles in the production process for most companies.

For the sake of consistency, we will describe the major actors that are involved in make-to-stock (MTS) production. However, before we do this, it is important to ensure that you understand the difference between the raw materials warehouse and the finished goods warehouse. Personnel in both warehouses have important roles in the MTS production process.

In a manufacturing facility, the **raw materials warehouse** stores the raw materials and components used in (consumed by) the manufacturing/production process to build the finished goods that are sold to customers. Raw materials and components are acquired from suppliers via the company's procurement process. From an accounting perspective, raw materials cost is recognized in inventory at the point of acquisition and is an asset on the company's balance sheet. Because of the costs associated with raw material and component inventory acquisition and management, it is important for raw materials warehouses to be organized and well-managed.

Figure 10-5: Worker Retrieving Components in Raw Materials Warehouse.
Stock photo ID: 494860162

When materials/components are moved from the raw materials warehouse to manufacturing/production work centers, it *becomes work in progress (WIP inventory*. In the accounting system, the withdrawal of materials/components results in a reduction in raw materials inventory level.

Finished goods warehouses stores the finished goods produced by the company's manufacturing/production process. These are the goods that are sold to the company's customers. Customer orders are filled via the company's fulfillment process from the products stored in its finished goods warehouse(s). It is important for finished goods warehouses to be organized and well-managed to facilitate the fulfillment of customer orders.

When a manufacturer sells finished goods stored in its finished goods warehouse(s), it incurs revenue. When products are sold, the manufacturer's accounting system also calculates *costs of goods sold (COGS)* – for each unit of a product, the cost of goods sold includes its raw materials/components cost and the labor costs involved with manufacturing/producing the product.

Figure 10-6: Completed Bicycles in a Finished Goods Warehouse.
Stock photo ID: 548252878

The major tasks/activities in the production process are summarize in Figure 10-7. Because the production process can be very complex, such as the manufacturing of an automobile or airplane, each of the tasks/activities in Figure 10-7 can often be decomposed into sub-tasks/activities, especially the create product task/activity.

Figure 10-7: Major Production Process Tasks/Activities
Courtesy: Thomas Case

In the make-to-stock production process, production requests typically originate in the organization's finished goods warehouse. *Finished goods warehouse personnel* monitor finished goods inventory levels and average daily sales rates relative to sales forecasts and/or historical demand levels. When their monitoring activities indicate that warehouse inventory levels may fall short of sales forecasts and actual customer demand, they either initiate production requests to bring finished goods inventory levels up to appropriate levels and send these requests to manufacturing/production personnel or they communicate the products and product quantities to manufacturing/production personnel who are responsible for creating production requests. Finished goods warehouse personnel are also responsible for receiving and putting away (storing) finished goods produced in the manufacturing/production area and for completing the pick-pack-ship activities in the fulfillment process.

Production authorization is performed by the organization's *manufacturing/production personnel*; some companies refer to manufacturing/production as the operations function. Manufacturing/production personnel are also responsible for production scheduling.

Authorization and scheduling often involve prioritizing production requests and identifying the best sequence in which to produce the requested products. When the manufacturer stores finished goods in multiple warehouses, production requests for the same product from two or more warehouses may be combined into a single production order. When production is authorized, a production order (run) is placed in the queue of scheduled production orders.

When a production order is released for production, manufacturing/personnel at work stations in the production area monitor and/or perform the production tasks in the sequence needed to produce the product. A **work center** is a location where work needed to produce a product is carried out. It may be a machine, a group of machines, a production line, an assembly area, or a person or group of people responsible for completing a specified set of operations. As a product is produced, it is routed among work centers until it is completed. **Product routings** specify the sequence of work centers used to produce a product. In manufacturing facilities that produce multiple products, there can be significant variation among product routes.

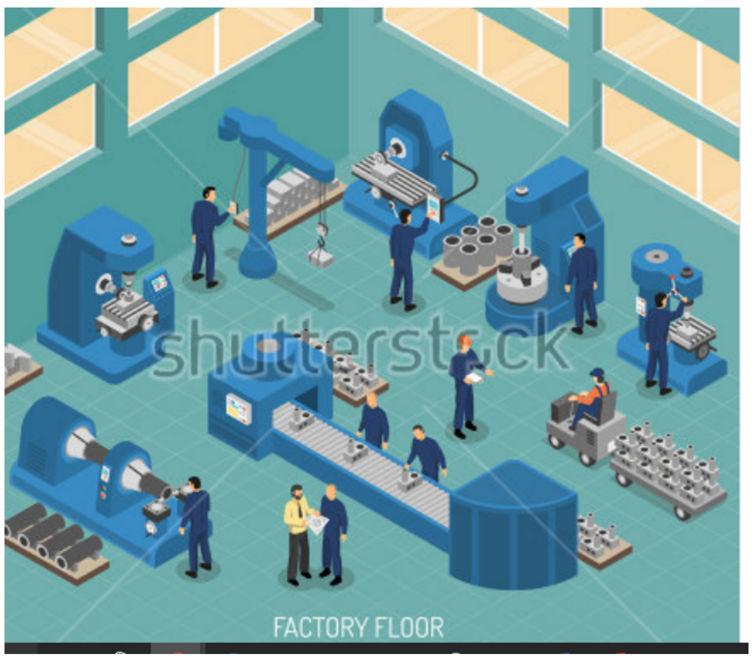

Figure 10-8: Example of Work Centers in a Manufacturing Facility.
Stock vector ID: 596821205

When a production run is completed (when all the units specified in the production order have been produced, manufacturing/production personnel confirm that the specified units of the product have been produced. After the end of a production run is confirmed, the finished goods that have been produced are moved to storage locations in the finished goods warehouse. In practice, some finished goods may be moved to a finished goods warehouse before the production order is confirmed and confirmation indicates when all units in the order have moved out of the production area.

Maintenance personnel are the subset of manufacturing/production personnel who are responsible for changeovers between production runs and the maintenance of manufacturing equipment. Changeovers include production line tear downs and set ups during which the equipment and/or production line configuration needed to produce one product is re-configured to produce the next.

When a production order is released, the raw materials and components needed to produce the specified quantity of products to be released are moved from the raw materials warehouse to work centers in the production area. *Raw materials warehouse personnel* are responsible for ensuring that these materials movements take place. Raw materials warehouse personnel are also responsible for monitoring raw material and components inventory levels and initiating purchase requests when inventory levels in the raw materials warehouse fall below the levels needs to meet sales forecasts, historical demand, and the actual volume of customer orders. This often requires coordination with the company's sales function and personnel in the finished goods warehouse.

PRODUCTION PROCESS DOCUMENT, DATA, AND INFORMATION FLOW

The document flow for the production process is depicted in Figure 10-9. The *planned order* is created by the production process's request production task/activity. A planned order is a formal request that for production specifies what finished goods need to be produced and the quantity (number of units) that is needed. A planned order also typically specified when the finished goods is needed to enable production authorizers to appropriately schedule the production of the finished goods.

Key data in a planned order is the product to be produced, the quantity needed, and when the product is needed. In an ERP system data about the product (name, ID, description) is stored as master data. Each product has an associated bill of materials (BOM) described below, which specifies the materials/components needed to create a single unit of the product.

Like a purchase requisition in the procurement process, a production request does not become a production commitment until someone (a production manager formally acts on the request. A production manager can reject or modify the planned order, combine it with other planned orders, or authorize the requested production by converting it to a production order.

The *production order* document is created during the authorize production task/activity. It is a formal commitment to produce the specified quantity of finished goods by a specific date and/or time. The production order formally commits numerous resources, including time, raw materials, work centers, and production workers to the production of the finished goods specified in the production order. Production orders are typically created by converting planned orders, but they may be generated directly without reference to a planned order.

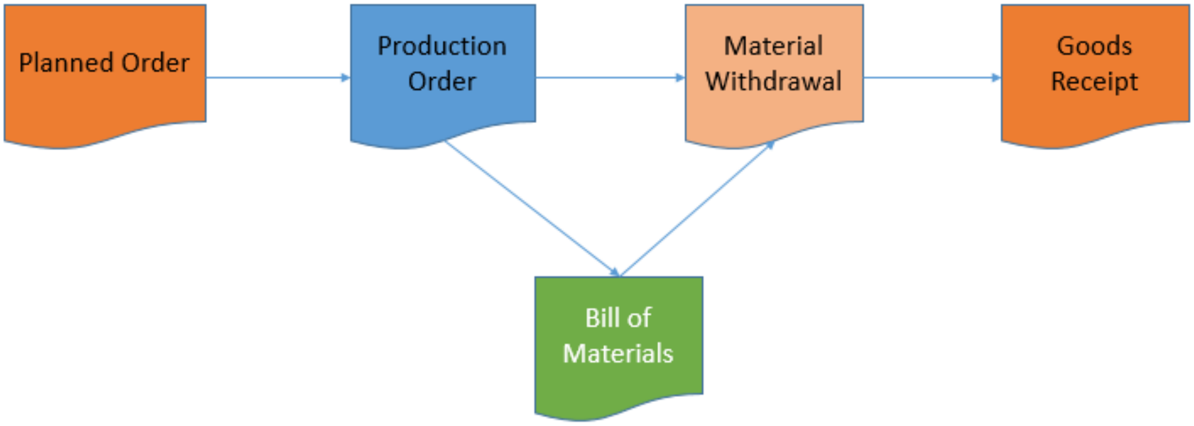

Figure 10-9: Production Process Document Flow
Courtesy: Thomas Case

Much of the data included in a planned order is also included in a production order (product to be produced, quantity, and date needed). A production order typically also references to the product's bill of materials, product routing in the manufacturing/production area, and the work centers in which manufacturing/production operations will be carried out.

The **bill of materials (BOM)** document identifies the components (raw materials and sub-components needed to produce a single unit of a finished good. An example of a BOM is provided in Figure 10-10. The bill of materials for a finished good is used to identify the quantities of raw materials and sub-components needed to complete a production order. This is a very important input to the production process's issue raw materials task/activity.

The creation of a production order generates multiple outcomes including scheduling, availability checks, reservations, purchase requisition creation, and preliminary costing. Scheduling determines the date(s) when the required production operations will be performed and the capacities of work centers that will be needed. Scheduling uses production order data and work center parameters to determine when production will take place. Availability checks determine whether the resources (materials components, work center capacities) needed to complete the production order are available. If they are, material and work center reservations are made to set the needed resources aside to ensure that they cannot be used for other purposes. If there are insufficient quantities of materials/components to complete the production order, purchase requisitions are generated to acquire them. Preliminary costs are determined from the materials/components costs and production (work center labor and set up) needed to complete the production order and any associated overhead costs.

Bill of Material for a Skateboard

Bill of Material Part No: 150-002

Part No.	Description	QTY	Unit	Unit Cost
1-115	Deck	1	EA	$ 50.00
4-556	Wheel	4	EA	$ 16.00
6-455	Bearing	8	EA	$ 10.00
4-854	Truck Bolt	8	EA	$ 2.00
2-258	Truck Nut	8	EA	$ 2.00
2-560	Gripe Tape	2	EA	$ 10.00
1-777	Axel Nut	4	EA	$ 4.00
1-983	Spacer	4	EA	$ 1.00

Figure 10-10: Bill of materials example.
Stock vector ID: 146857787 and Thomas Case

Materials/components needed to complete a production order are moved to work centers when the production order is released for production. The release of a production order generates the creation of one or more *material withdrawal* slips that specify the raw materials and/or sub-components in the raw materials warehouse(s) needed to create the quantity of finished goods specified in the production order. These formally commit specific quantities of stored raw materials and/or sub-components to the production order. The key data needed to issue goods (materials/components) to a production order includes the production order number, materials/components quantities, and the work centers to which the materials will be moved.

After the quantity of finished goods specified in the production order are produced by the create product task/activity, production is confirmed. The confirmation indicates that the complete product task in the production process has taken place. The key data associated with production confirmation includes the quantity of products that were produced (typically along with how many required rework or were scrapped). Confirmation data also includes the operations that were completed, that dates and times when the operations began and finished, the work centers in which the operations were performed, and the manufacturing/production personnel who performed the operations. In sum, confirmation formally records that the work associated with the production order has been completed. It also updates the status of the production order.

When production is completed and confirmed, the finished goods are moved from the production area to the finished goods warehouse. During the receive finished goods task/activity, a *goods receipt* document is created by finished goods warehouse personnel. This documents that verifies receipt of the goods produced for the production order. The creation of this document triggers the updating of the warehouse's finished goods inventory. Key data in the goods receipt document includes production order number, quantity received, date received, and storage location.

Data Flow

To summarize, data flow during the production process includes data about finished goods, production orders, materials and resources used during production, and storage locations of finished goods that are produced. When production is requested, the needed quantity of the finished good is identified along with when it is needed. The finished good's BOM specifies the quantities of raw materials and components needed to produce the needed quantity of the finished good.

When production is authorized, scheduled and subsequently released, a commitment is made to produce a specific quantity of finished goods by a certain date. Numerous resources including raw materials/components and work centers are committed to producing the specified quantity of finished goods in the production order. The authorization of production includes the assignment of a production order number and specifies the operations needed to produce the finished good, the work centers that will carry out the operations, and the sequence (product routing) in which the operations will be performed. Preliminary estimates of the costs associated with the production order (raw materials/components, labor, and overhead, are also included in production orders.

The release of a production order includes goods issue. **Goods issue** identifies the quantities and storage locations of raw materials and/or components needed to complete the production order. The specified materials/components are assigned to the production order and their status in inventory changes from un-assigned to assigned (to ensure that individual raw materials/components are not assigned to more than one production order).

Once the actual production of the quantity of finished goods in the production order is completed, production is confirmed and the goods produced for the production order are placed in finished goods inventory. The *goods receipt* identifies the production order number, the quantity of finished goods received, the date of receipt, and storage location(s) of the finished goods in the finished goods warehouse. The good receipt triggers the updating of finished goods inventory levels.

Physical Flow

Typically, there are more physical flows associated with the production process than the procurement or fulfillment processes. The primary physical flows associated with the production process involve the movement of raw materials/components from raw material storage locations to work centers, the movement (routing) of partially completed finished goods among work centers involved in producing the finished goods, and the movement of finished goods from the production area to storage locations in the finished goods warehouse.

Instance- and Process-Level Information

Instance-level information (information about the status of a production order) of the production process enables the organization to address customer questions such as:

- Has the production order been approved?
- Has production been scheduled?
- When will production take place?
- Have the ordered products been produced?
- When will the ordered products be delivered?

Process-level information aggregated from multiple production orders can be used to identify manufacturing/production process patterns as well as opportunities to improve the process. It enables to the organizations to address questions such as:

- What is the average time needed to produce each finished good?
- What is the average time needed to complete each operation in the production of a finished good?
- Which finished goods are produced most frequently?
- What is the average quantity of a production order for each finished good?
- What is the first-time pass rate for each product? What is the average re-work percentage? What is the average scrap rate?
- What percentage of production orders are completed on time? What percentage are delayed?
- What are the common causes of production delays?
- What is the average daily capacity utilization?

Integration with Other Processes

An organization's production process can be quite complex, and part of its complexity stems from its integration with the organization's fulfillment and procurement processes. As we described in Chapter 6, the intersections among business processes are sometimes called integration points. An **integration point** between two business process is a task/activity within a business process at which data/information in a process document triggers changes to data/information in one or more documents in a second process. Essentially, this means that a document created by one process triggers changes to one or more other processes.

As Figure 10-11 illustrates, the production process has integration points with both the fulfillment and procurement process. The creation of a delivery document in the fulfillment process results in finished goods inventory reductions equal to the number products included in the customer delivery. The finished goods inventory reductions, may, in turn, trigger the creation of production requests (planned orders) to restore finished goods inventory depleted by customer orders. In brief, the contents of Delivery Document in the fulfillment process may result in the creation of a Planned Order document in the production process.

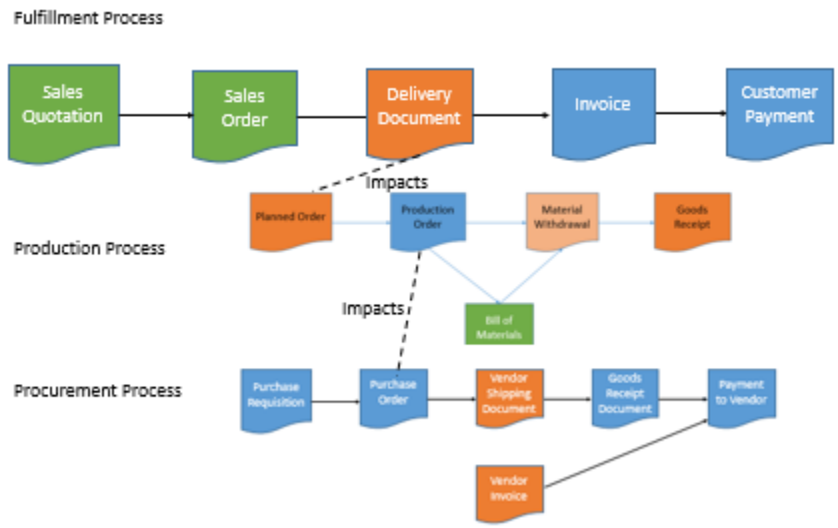

Figure 10-11: Examples of integration points among processes supported by an ERP system. Courtesy: Thomas Case

When a planned order is converted to a production order and scheduled for production, the quantities of raw materials/components needed to manufacture the specified product quantities are assigned to the production order. If available raw materials/components are insufficient, the authorization/scheduling, and release of a production order will trigger the creation of purchase requisitions to ensure that raw materials/components inventory level will be sufficient. So, as Figure 10-11 illustrates, once again, the contents of a Production Order in the production process affects the data/information contents for Purchase Requisitions in the Procurement Process.

The presence of integration points among an organization's fulfillment, production, and procurement processes influences an organization to adopt information systems that can support integrated processes. This can be observed in the systems that are used to provide automated support for the manufacturing/production process.

MANUFACTURING/PRODUCTION PROCESS AUTOMATION

Historically, the manufacturing/production process has been supported by materials requirements planning (MRP), materials resources planning (MRP II), and ERP systems. Today, 3-D printers and robotics are increasing included in production areas. Industry 4.0 provides insights into how manufacturing/production automation is expected to evolve in the years ahead.

Material Requirements Planning (MRP)

A **Material Requirements Planning (MRP)** system is a computer-based inventory management and production planning system. Historically, MRP systems first appeared the 1960s and in the 1970's they became some of the first business software applications to be widely adopted. MRP is essentially an approach for creating production schedules and material plans that are based on supply chain lead times.

Manufacturers were attracted to MRP systems because of their potential to improve efficiency and accuracy in production scheduling and inventory management. MRP systems are designed to help managers address three fundamental production questions:

- What products should be produced?
- How many units should be produced?
- When are the products needed?

The data used by an MRP system to answer these questions includes:

- A forecast of the products that need to be produced in the next (few) month(s).
- Existing customer orders
- Existing purchase orders
- Existing production orders
- The bill of materials (BOM) of the materials/components required to produce each product
- The time required to manufacture products in the existing production schedule
- Existing raw materials/components inventory
- Existing finished goods inventory
- Planning factors such as reorder points and safety stocks

Several of these inputs are illustrated in Figure 10-12.

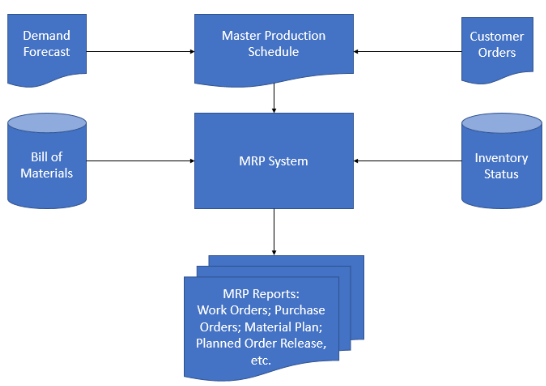

Figure 10-12: MRP System Overview
Courtesy: Thomas Case

When the MRP software program is run, its uses the data identified above to determine the net requirements for the materials needed to produce each product for each period of the planning horizon (e.g. for the next month or quarter). This includes the calculation of net requirements for raw materials, component parts, and sub-assemblies used to build the product. The MRP software first calculates the gross requirements, then subtracts out existing inventory levels and adds safety stock levels to determine net requirements.

The main outputs of MRP processing includes planned orders (to meet demand forecasts for the planning horizon), released orders (to meet current demand), and changes to planned orders made by production managers (cancellations, quantity changes, date changes). An MRP run may also generate purchase requisitions for raw materials/components.

Using a MRP system can help a manufacturing organization in several areas including inventory management (via inventory level and carrying cost reductions), materials management (by determining materials requirements and shortages) and production planning (by determining needed manufacturing functions, product delivery schedules, and materials purchasing).

It is important for you to understand what MRP software does, because it is still in use. It was included in MRP II systems and it is also found in today's ERP systems. MRP II systems essentially added new functionality to MRP software, and ERP systems expanded MRP II capabilities. So, MRP capabilities are included in both MRP II and ERP Systems.

Materials Resources Planning (MRP II)

By the 1980s, manufacturers began seeking production planning and inventory management solutions that could also forecast inventory requirements and integrate with their accounting systems. Manufacturing Resources Planning (MRP II) systems added such functionality to all the capabilities offered by MRP.

MRP II is often described as a computer modelling technique for analyzing and controlling complicated manufacturing/production operations. MRP II facilitates the development of a detailed production schedule that considers machine and labor capacity, scheduling the production runs according to the arrival of materials. MRP II outputs include labor and machine schedules. Data about the cost of production, including machine time, labor time and materials used, and number of units produced, is passed from the MRP II system to the organization's accounting and finance systems.

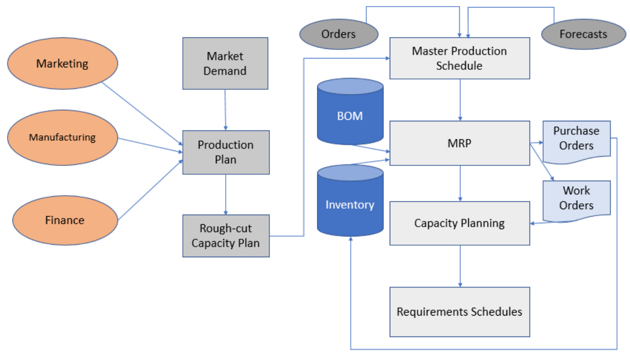

Figure 10-13: Overview of MRP II
Courtesy: Thomas Case

By collecting a wide range of manufacturing data, including parts, assemblies and resources, MRP II systems can predict the lead time and cost of every production component for any manufacturing condition. When a new order is received, MRP II can calculate how much production work will be needed, when the needed production can start, and when the ordered products can be delivered. In addition to production, MRP II systems also track customers, suppliers and accounting functions.

MRP II systems also enable just-in-time (JIT) manufacturing. Raw materials/components purchase orders and component assemblies can be made "Just in Time". The effects of new orders, changes in production or machine capacity, material shortages, changeover delays and other manufacturing disturbances can be easily calculated and tracked by MRP II systems.

Other benefits of MRP II systems include:

- Accurate delivery predictions
- Accurate costing for every stage of production
- Improved control of every stage of production
- Improved manufacturing facility usage
- Rapid response to changing conditions.

Enterprise Resource Planning (ERP) Systems

Enterprise resource planning (ERP) systems evolved from MRP II systems. Like MRP II, ERP roots go back to MRP. MRP helped companies plan material purchases, MRPII added detailed scheduling and production controls; ERP extends both MRP and MRP II by integrating the information flow among all departments/functions within an organization including finance, marketing, production, shipping, and human resources. A properly configured ERP system improves communication and monitoring and gives all departments/functions real-time access to status of a customer order.

As Figure 10-14 illustrates, MRP, MRPII, and ERP are essentially iterations of the same type of system. These are software programs designed to help businesses better manage their costs, control inventory, meet customer delivery expectations, and track and improve their internal processes.

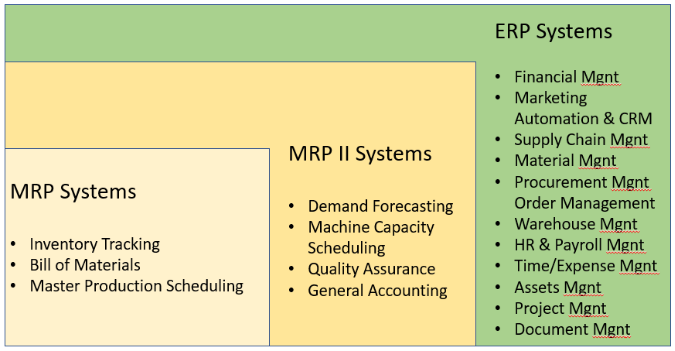

Figure 10-14: Cut from the Same Cloth: MRP, MRP II, and ERP.
Courtesy: Thomas Case

So, an ERP is essentially an approach for managing and integrating the important parts of an organization's day-to-day operations such as purchasing, inventory, sales, marketing, finance and human resources. From a big picture perspective, ERP software enables real-time integrated management of core business processes.

ERP software links business processes and systems across an enterprise to streamline workflow, facilitate information sharing among functional areas/business units, and data-driven decision-making about business operations. ERP software eliminates the need for functional area information systems/software to support the needs of specific business units such human resources software, accounting software, and warehouse management software. Instead of having separate databases to support different functions, an ERP system stores all company data in a single database that is used organization-wide.

The ability of an ERP system to integrate business functions and operations is illustrated in Figure 10-14. Today, to be considered a full-fledged ERP system, a software vendor's ERP product must be able to support manufacturing, human resources, accounting and finance, sales, purchasing, and inventory management processes. It must also be able to be able to serve as an integration point for an organization's SCM, CRM, and SRM systems. Because it can interface and interact with other enterprise systems, an ERP system is widely viewed as the heart of an organization's suite of enterprise applications.

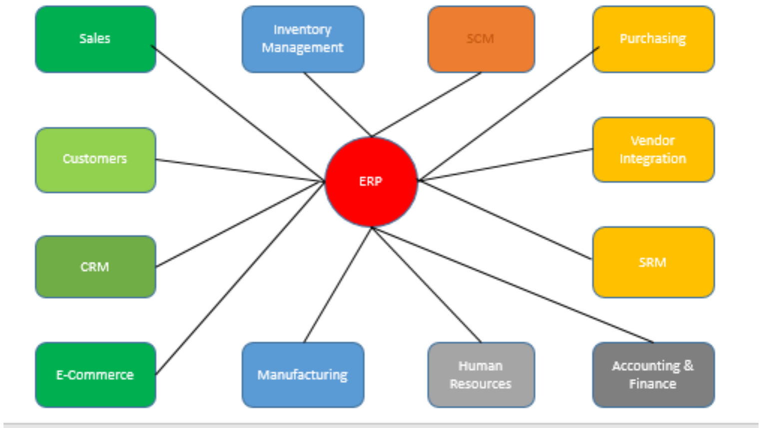

Figure 10-14: ERP Systems integrate key business processes and other enterprise systems.
Courtesy: Thomas Case

In addition to the improved manufacturing capabilities described for MRP and MRP II systems, ERP systems can help businesses realize a wide-range of other benefits when they are appropriately configured and utilized. Some of these are summarized in Figure 10-15.

ERP Business Benefits
Increased competitiveness in business environment
Improved business process efficiency
Enhanced collaboration among functions and departments
Improved scalability and facilitation of organizational growth
Integrated data and information
Reduced administrative and operations costs
Streamlined processes
ERP's centralized database facilitates mobile-friendly solutions and applications
Improved reporting capabilities
Improved regulatory compliance
ERP systems are flexible, configurable, and robust
Improved customer service and responsiveness
Improved data accuracy, consistency, and security
Increased productivity
Improved forecasting

Figure 10-15: Potential ERP Business Benefits
Courtesy: Thomas Case

Warehouse Management Systems (WMS)

Because the production process includes more materials and goods movement than either the procurement or fulfillment process, standalone and ERP-integrated warehouse management software is widely used to support and automate manufacturing and production. As noted in Chapter 9, WMS software programs enable centralized management of warehouse tasks such as tracking inventory levels and stock locations.

In manufacturing environments, a WMS facilitates the optimization of raw materials, work-in-progress, and finished goods movements. Essentially a WMS is inventory tracking software which monitors the movement of materials stored in a warehouse. The WMS is notified if any new item is added or removed.

A WMS system can either be used as a standalone solution or it can be integrated with an ERP system to improve the overall business efficiency. Today's WMS systems are quite complex and data-intensive; they a massive volume of data each day. Most of today's ERP systems include integrated WMS to make the business operations fast, smooth and efficient. However, while WMS can be a part of ERP, there are have distinct differences. ERP modules support the entire business, whereas WMS only deals with warehouse related tasks. Examples of the data/information exchanged between WMS and ERP systems are illustrated in Figure 10-16.

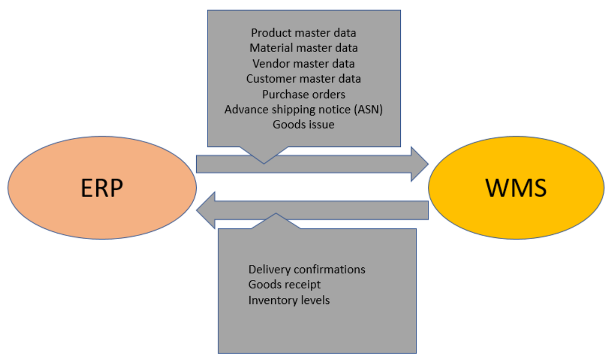

Figure 10-16: Examples of Information Exchanged by WMS and ERP Systems.
Courtesy: Thomas Case

A more extensive description of warehouse management systems is provided in Chapter 9.

Robotics

Robots are increasingly used in manufacturing settings. Millions of industrial robots are used in today's manufacturing facilities and they are reshaping how manufacturing is performed.

An **industrial robot** is a programmable manipulator designed to move materials, parts and tools, and perform a variety of tasks in manufacturing and production settings. They are often used to perform tasks that are dangerous or unsuitable for human workers. Typical applications of robots include welding (see Figure 10-17), painting, assembly, product inspection and testing, packaging and labeling, and palletizing. They can complete their programmed tasks efficiently, rapidly and with precision.

Some robots are programmed to repeatedly carry out specific actions without variation and with high levels of accuracy. Such robots are likely to be found in repetitive manufacturing facilities. The actions that these robots perform are determined by programmed routines that specify the sequence, direction, distance, acceleration, velocity, and deceleration of a series of coordinated motions.

Other robots are much more flexible as to the orientation of the object on which they are working. In some instances, the robot must first determine the task that needs to be performed on the object before it begins working on it. Guidance for such flexible robots may be provided by visual sensors and machine vision sub-systems linked to computers or controllers. Artificial intelligence (AI) is also increasingly used to support industrial robot flexibility.

Figure 10-17: Industrial Robotics in an Automobile Manufacturing Facility.
Stock photo ID: 605472758

Robots are increasingly being used for product assembly. In automobile manufacturing, robotic assembly of components such as water pumps, gearboxes, and engines has become commonplace. Assembly robots are also used to build computers, household appliances, consumer electronics, and medical devices. Many of these products have been engineered with modular designs that are conducive to robotic assembly. Figure 10-18 illustrates the use of assembly robots to manufacture 3D printers.

Figure 10-18: Robotic Assembly of 3D Printers.
Stock illustration ID: 563892433

Assembly robots can assemble components that are too small for intricate for humans to assemble quickly and accurately. Assembly robots are ideal for:

- Manufacturing tasks that require both speed and precision, such as applying adhesives and sealants.

- Applications where cleanliness is essential, such as pharmaceuticals and medical device assembly.

Unlike human assembly workers, assembly robots don't get tired, make mistakes, and they aren't prone to repetitive motion injuries, like carpal tunnel syndrome.

Robotic assembly typically lowers manufacturing costs and increases efficiency, production capacity, and product quality. Today, industrial robots are mature technologies and low-risk, high-return investments.

Additive Manufacturing (AM)

Additive manufacturing (AM) is as the process of joining materials to make objects from 3D model data, usually layer upon layer. This process is also known as *3D printing*, it involves the use of a computer and special CAD software communicates with the printer so that it "prints" in the desired shape. 3D printer cartridges loaded with different materials "prints" the object's shape in wafer thin layers. These layers are repeatedly printed on top of each other, and fused together until the shape is complete.

Better understanding and appreciation of AM is gained by contrasting it with subtractive manufacturing. *Subtractive manufacturing* methods start with a solid block of material and then cut away excess material to create a finished part or product. Additive manufacturing, however, builds up a part or product layer by layer using geometry described in a 3D design model.

Relative to subtractive methods, additive manufacturing often results in lower manufacturing costs and reduced material waste. When appropriate materials are used, AM also can result in extended end-product life and improved product performance.

Advances in material science contributes to the increasing use of 3D printing. Materials used in today's 3D printers include conductive metals, structural metals, ceramic materials, conductive adhesives, dielectric materials, semiconductor materials, and biological materials. Materials may be blended during 3D printing to create new alloys that make products stronger and/or improve their performance. Additive manufacturing is being used to fabricate aerospace, medical, and consumer electronic devices and the range of products being manufactured via 3D printing is rapidly increasing. Figure 10-19 illustrates the use of 3D printers to manufacture auto parts.

Figure 10-19: 3D Printers Manufacturing Automobile Parts.
Stock illustration ID: 285350012

Traditional manufacturing techniques can produce a very wide range of shapes and designs, but 3D printing takes manufacturing to a new level through its ability to produce an even greater range of shapes. Objects that can't be manufactured in one piece with traditional methods can be produced via 3D modeling and printing. For example, when shapes with a scooped out or hollow centers and produced using traditional methods, the scooped out or hollow centers are typically made by welding or using adhesives to bind components to one another. With 3D printing, the same shape can be produced as a single piece that is more structurally sound because it does include weak spots (such as welds) that can be stressed or compromised.

Industry 4.0

Industry 4.0 is described as the next phase of the digitization of manufacturing. As Figure 10-19 illustrates, several factors are contributing to Industry 4.0 including:

- Increases in data volumes, and computational power
- Increasing connectivity including the Internet of things (IOT)
- Advances in analytics and business-intelligence (BI) capabilities,
- New forms of human-machine interaction, including touch interfaces and augmented-reality systems,
- Improvements in transferring digital instructions to the physical world, such as advanced robotics and 3-D printing, and
- Advances in machine learning, machine-to-machine (M2M) communications, and artificial intelligence.

Figure 10-20: Majors Drivers of Industry 4.0

Stock vector ID: 602588612

As Figure 10-21 summarizes, Industry 4.0 represents the fourth major era of industrial automation and mechanization. Industry 4.0 would not be possible without the digitization of data, big data analytics, cloud computing, the Internet of things (IoT) and advances in industrial robots, additive manufacturing, and warehouse automation technologies.

Other names for Industry 4.0 is include *smart manufacturing*, *smart factory*, and *intelligent industry*. It is closely related to the *Industrial Internet of Things (IoT)* which is sometimes called the *Industrial Internet*. The shop floor of the smart factory of the future is envisioned to include automated product routing among fully-automated work centers whose machines communicate and coordinate with one another using machine-to-machine (M2M) communications.

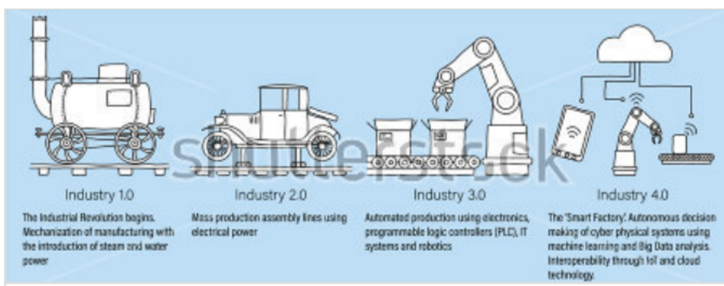

Figure 10-21: Industry 4.0 as Successor to Previous Manufacturing Generations
Stock vector ID: 661236052

The short-term objectives of manufacturers with Industry 4.0 initiatives typically include automation, manufacturing/production process improvement, and production/productivity optimization. Longer term goals include enhanced innovation and migration to new business models that supplement product sales revenue with revenue from information and services.

Given advances in other IoT areas and industrial automation, it is not too difficult to envision a future manufacturing scenario in which raw materials/components arrive at manufacturing facilities in driverless vehicles that are unloaded by robotized fork lifts and where robotic pickers deliver needed materials to industrial robots and 3D printers in manufacturing work centers. The scenario could also include robotic delivery and put-away of finished products, robotic packaging and palletizing, and robotized fork lifts loading driverless delivery vehicles.

There may be some truth in industry pundit jokes that opine that the factory of the future will have two employees, a man and a dog. The man's job is to feed the dog and the dog's job is to keep the man away from the machines.

The scope of Industry 4.0 extends well-beyond what is reasonable to include in an introductory MIS book. However, some mention is justified because it is another manifestation of how closely intertwined business processes and information systems have become. Industry 4.0 underscores that business processes and information systems will become even more intertwined in the years ahead.

MANUFACTURING/PRODUCTION AND SAP ERP

ERP systems are adopted by manufacturers because they have end-to-end production process support capabilities. Numerous manufacturers migrated from MRP, to MRP II, and then to ERP systems because ERP systems enabled tighter integration among production, procurement, fulfillment, and other business processes. SAP ERP has been adopted by a wide-range of manufacturers who are often recognized as leaders within their industries.

Like those that support the procurement and fulfillment processes, the modules that support the production process are found within SAP ERP's Logistics navigation. As Figure 10-22 illustrates, SAP ERP supports both discrete and process manufacturing. This figure also illustrates that SAP ERP is also capable of supporting repetitive manufacturing.

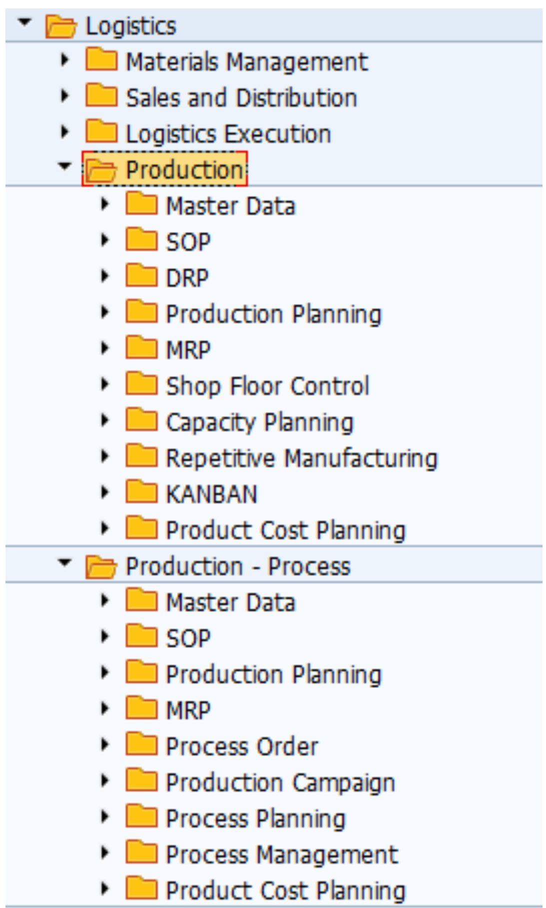

Figure 10-22: SAP ERP Navigation for Discrete and Process Manufacturing.
Courtesy: Thomas Case

As noted previously in the chapter, the bill of materials (BOM) is one of the most important documents in the production process document flow. The SAP ERP navigation used in discrete manufacturing settings to create, change or display a BOM is illustrated in Figure 10-23. Figure 10-10, found earlier in this chapter, shows that a BOM for finished product produced by discrete manufacturing processes includes the parts/components and quantities of parts/components needed to build a single product.

The data/information in a SAP ERP BOM can be quite extensive and detailed. In a SAP ERP BOM, each part/component has a unique identifier (ID) in the ERP database that is associated with a vendor/supplier and general ledger entry so that every part/component used in the production process can be accounted for. In the ERP database, each part or component can be associated with the work center(s) in which it is used. Because the same part/component may appear in more than one BOM or manufacturing process, it is stored as master data in the SAP ERP database.

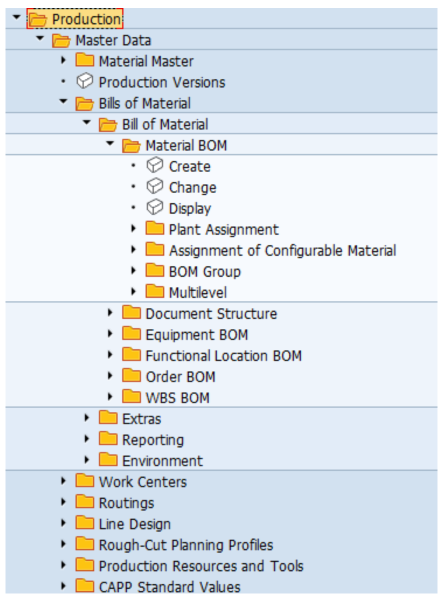

Figure 10-23: SAP ERP Navigation for BOM Creation or Modification for Discrete Manufacturing. Courtesy: Thomas Case

Figure 10-23 also illustrates SAP ERP navigation to the parts of the ERP software that support work centers in the production area and product routing among the work centers that is needed to produce a product.

In process manufacturing, BOMs are essentially recipes for making a unit of the finished product. As Figure 10-24 illustrates, SAP ERP navigation for process manufacturing does not include support for BOMs. Instead, it provides capabilities for creating, modifying, and displaying the recipe for each finished product. Product recipes specify the ingredients and ingredient quantities needed to produce a unit of the finished good (e.g. quart, liter, gallon, barrel). Like the individual parts/components in discrete manufacturing BOMs, each ingredient in each recipe is uniquely identified in the ERP database and is associated with its supplier and has a general ledger entry.

Figure 10-24: SAP ERP Navigation to Product Recipes in Process Manufacturing. Courtesy: Thomas Case

The navigation to planned order creation is SAP ERP is located within the ERP system's MRP folder. SAP ERP includes a wide variety of MRP parameters that enable the MRP software to calculate net requirements in a manner that is closely aligned to the complexity of the organization's production planning and manufacturing/production process.

As may be observed in Figure 10-25, when a planned order is created, the needed quantity of the product is identified along with the date when the specified quantity is needed. The bill of materials (BOM) for the finished product is accessible via the Create Planned Order screen. Creating and saving a planned order results in the creation of a uniquely numbered planned order document in the ERP database.

In make-to-stock (MTS) production, planned orders may be automatically generated when the MRP software is executed. The MRP software determines the products and product quantities that need to be produced from finished goods inventory levels, sales forecast levels, and customer orders. In this instance, the MRP software may also generate the creation of purchase requisitions for raw materials/components quantities that are not currently on hand to produce planned orders.

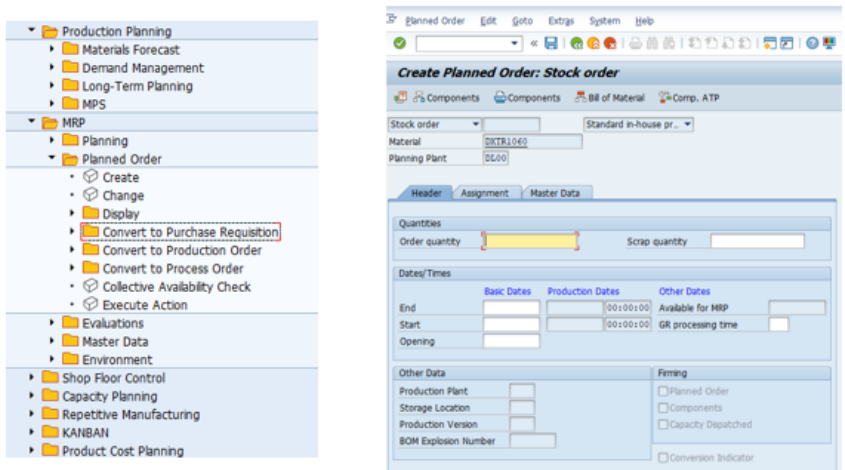

Figure 10-25: SAP ERP Navigation and Planned Order Creation Screen.
Courtesy: Thomas Case

SAP ERP supports three ways of converting planned orders to production orders. This includes the conversion of a single planned order, the conversion of part of a planned order (this is called a partial conversion), or the simultaneous (collective) conversion of all existing planned orders. Figure 10-26 illustrates the SAP ERP navigation and initial screen for the collective conversion of existing planned orders.

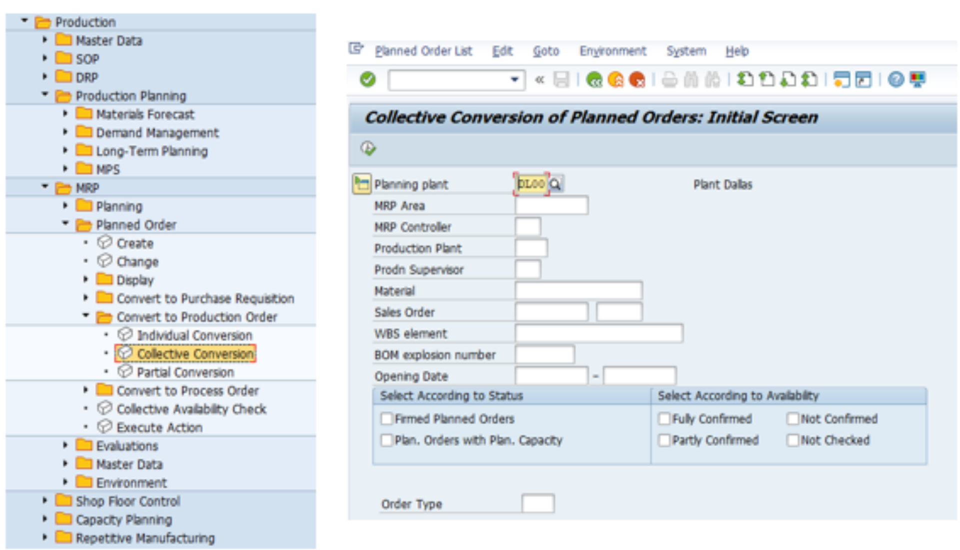

Figure 10-26: SAP ERP Navigation and Initial Screen for Converting Planned Orders to Production Orders.
Courtesy: Thomas Case

If there is there are insufficient quantities of raw materials/components on hand to produce the quantity of the finished goods in the planned order, SAP ERP will not convert to planned order to a production order. It will return an error message indicating that it cannot be converted. When this happens, the conversion of the planned order can be delayed until the required raw materials/components have been procured. Alternatively, the production manager can change the quantity specified in the planned order to match the quantities of raw materials/components that are available.

When a planned order is converted to a production order, a uniquely numbered production order document is saved to the ERP database. The conversion process also results in “issuing/assigning” the raw materials/components needed to produce the specified quantity of finished goods to the production order. When the goods issue document is saved to the ERP database, raw materials/components inventory levels are decreased. Figure 10-27 illustrates the SAP ERP navigation and initial screen for goods issue in the production process. As may be observed in this figure, the production order associated with goods issue document can be accessed through the Goods Issue screen.

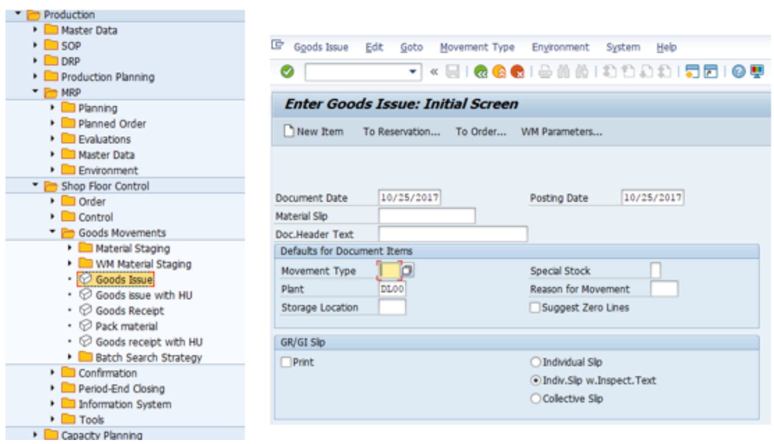

Figure 10-27: SAP ERP Navigation and Initial Screen for Goods Issue.
Courtesy: Thomas Case

When the production order is completed and confirmed, the specified quantity of finished goods is moved from the production area to the finished goods warehouse. This goods movement is verified by the creation and saving of a uniquely numbered Goods Receipt document in the ERP database. When the Goods Receipt document is saved, the product’s finished goods inventory level is increased. The SAP ERP navigation and initial screen for the creation of a Goods Receipt document in the production process is illustrated in Figure 10-28.

The delivery of finished goods from the production area to the finished goods warehouse completes the production process. At this point, the finished goods are handed off from the production process to the fulfillment process, which, as you have seen in Chapter 9, is another core business process that an ERP system can support from end-to-end.

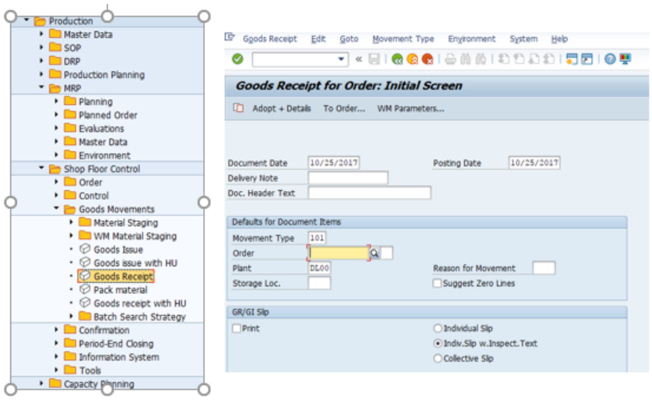

Figure 10-28: SAP ERP Navigation and Initial Screen for Goods Receipt.
Courtesy: Thomas Case

CHAPTER SUMMARY

The production process converts raw materials, components, or parts into finished goods that customers will buy. The finished goods that are manufactured/produced are valued by customers or meet their expectations or specifications. In some organizations, the production/manufacturing process is essentially an assembly process that involves putting components together to produce a finished product.

Two major categories of manufacturing can be identified: discrete and process. Discrete manufacturing involves the production of distinct, countable items. Process manufacturing is the produces finished goods, such as food, beverages, and gasoline, by combining supplies and ingredients according to formulas or recipes. Repetitive manufacturing is a type of mass production that makes high numbers of identical units in a continuous flow; it is widely used to produce products that have a continuous and steady demand, such as food products and medical supplies.

An organization's manufacturing strategy consists of the objectives and action plans implemented by its manufacturing function to ensure medium- to long-term sustainable advantage its competitors. Make-to-stock (MTS), make-to-order (MTO), assemble-to-order (ATO) and engineer-to-order (ETO) are well-known manufacturing strategies.

Production process goals for companies that use MTS, MTO, and ATO include improving productivity, asset utilization, and efficiency. Manufacturing firms often have measures for production cost, production quality, and inventory management goals and they often have KPIs for throughput, capacity utilization, production yield, overhead costs, machine efficiency, and production plan adherence.

Manufacturing facilities typically include two warehouses: raw materials and finished goods. The raw materials warehouse stores the raw materials and components used produce the finished goods that are sold to customers. The finished goods warehouse stores the finished goods produced by the manufacturing/production process. The production area of a manufacturing facility is organized into work centers. A work center is a location where a specified set of operations needed to produce a product is carried out; this may be a machine, a group of machines, production line, an assembly area, or a person or group of people responsible for completing the work. When a product is produced, it is routed among work centers until it is completed. Product routings specify the sequence of work centers used to produce a product.

Warehouse and manufacturing personnel are key actors in the production process. Warehouse personnel monitor inventory levels in both raw materials and finished goods warehouses. They are also involved in moving raw materials/components to the production area and for moving manufactured products to the finished goods warehouse. Manufacturing personnel are responsible for scheduling and completing production orders. Production order completion may involve a wide range of manufacturing personnel performing specialized tasks at different work centers. Maintenance personnel are the subset of manufacturing/production personnel who are responsible for changeovers between production runs and the maintenance of manufacturing equipment.

Key documents in the document flow for the production process include planned orders, production orders, bill of materials (BOM), materials withdrawal (goods issue) slips, and goods receipt documents. A planned order specifies the quantity of a finished good to be manufactured/produced. When all the materials/components necessary to produce the product quantity in a planned order are available, a planned order can be converted to a production order. A bill of materials (BOM) specifies the materials/components needed to produce one unit of the product. A materials withdrawal (goods issue) document specifies the quantities of materials/components in the raw materials warehouse needed by a production order. A goods receipt document is generated when a production order is completed, and the end of the production run is confirmed; it specifies the quantity of finished products moved from the production area to the finished goods warehouse.

Key data in the production process data flow includes finished goods data, data about planned and production orders, and materials and resources used during production. A planned order is a production request that specifies the quantity of the finished good to be produced and the date when it is needed. The BOM specifies the quantities of raw materials and components needed to each unit of the finished good identified in the planned order. When a planned order is converted to a production order, numerous resources (including raw materials/components and work centers) are committed to producing the specified quantity of finished goods. The conversion of a planned order to a production order includes goods issue; this identifies the quantities and storage locations of raw materials and/or components needed to complete the production order. When the specified quantity of finished goods is produced, production is confirmed, and the finished goods are moved to finished goods inventory. The goods receipt identifies the production order number, the quantity of finished goods received, the date of receipt, and storage location(s) of the finished goods in the finished goods warehouse. The good receipt triggers the updating of finished goods inventory levels.

Physical flows in the production process include the movement of materials/quantities from storage locations in the raw material warehouse to the production area and the movement of finished goods to storage locations in the finished goods warehouse after a production run is complete. During manufacturing, the product being produced moves among work centers until its complete.

Instance-level information about a production order enables the organization to answer questions such as “Has production been scheduled?” and “Have ordered products been produced?” Process-level information provides insights into opportunities to improve a company’s production process.

An organization’s production process has integration points with its fulfillment and procurement processes. An integration point is a task/activity within a business process at which data/information in a process document triggers changes to data/information in one or more documents in a second process. For example, decreases in finished goods inventory resulting from the creation of a delivery document in the fulfillment process can trigger the creation of one or more planned orders in the production process. Similarly, the goods issue associated with the conversion of a planned order to a production order can trigger the creation of purchase requisitions/orders in to procurement process to replenish raw materials inventory.

Historically, materials requirements planning (MRP) systems were some of the first information systems used to support the production process. These evolved into materials resources planning (MRP II) and subsequently to ERP systems. Warehouse management systems (WMS) support the production process by enabling centralized management of warehouse tasks, such as tracking inventory levels and stock locations, for both the raw materials and finished goods warehouses.

Manufacturing/production processes have been automated by robotics and additive manufacturing (AM). Millions of industrial robots are being used in manufacturing facilities and their numbers are steadily increasing. Industrial robots are used for welding painting, assembly, product inspection/testing, packaging, labeling, and palletizing. The use of robotics typically lowers manufacturing costs and increases efficiency, production capacity, and product quality.

Additive manufacturing (AM) is also called 3D printing. Relative to traditional manufacturing methods, AM typically reduces scrap rates, and can produce a wider range of shapes and designs. This process involves the use of special CAD software communicates with the 3D printer so that it “prints” in the desired shape in wafer thin layers. These layers are repeatedly printed on top of each other, and fused together until the shape is complete.

Industry 4.0 is described as the next phase of the digitization of manufacturing; it represents the fourth major era of industrial automation and mechanization. Industry 4.0 would not be possible without the digitization of data, big data analytics, cloud computing, the Internet of things (IoT) and advances in industrial robots, additive manufacturing, and warehouse automation technologies. Industry 4.0 is sometimes called smart manufacturing, smart factory, and intelligent industry. It is closely related to the Industrial Internet of Things (IoT) which is also called the Industrial Internet. The shop floor of the future smart factory is envisioned to include automated product routing among fully-automated work centers whose machines communicate and coordinate with one another using machine-to-machine (M2M) communications.

Today’s ERP systems provide end-to-end support for the production process, even for organizations that do very complex and specialized manufacturing. In SAP ERP, the navigation to parts of the ERP that support the production process are located within the Logistics folder. Because SAP ERP can support discrete, process, and repetitive production, it is the most widely used ERP system in large corporations.

KEY TERMS

Additive manufacturing (AM)	26
Assemble-to-order (ATO)	6
Assembling	3
Bill of materials (BOM)	14
Discrete manufacturing	4
Engineer-to-order (ETO)	6
Finished goods warehouse	10
Goods issue	16
Industrial robot	24
Industry 4.0	27
Integration point	17
Make-to-order (MTO)	6
Make-to-stock (MTS)	6
Manufacturing	3
Manufacturing strategy	5

Materials requirements planning (MRP)	19
Materials resources planning (MRP II)	20
Process manufacturing	4
Product routings	12
Raw materials warehouse	10
Repetitive manufacturing	5
Work center	12

REVIEW QUESTIONS

1) The production process is best understood within which value chain activity?
2) What is manufacturing?
3) What is assembling?
4) Describe the characteristics of semi-finished goods.
5) Describe the characteristics of discrete manufacturing.
6) Describe the characteristics of process manufacturing.
7) Describe the characteristics of repetitive manufacturing.
8) Identify examples of products produced by each of the following: discrete manufacturing, process manufacturing, repetitive manufacturing.
9) Describe the characteristics of manufacturing strategy.
10) Describe the characteristics of make-to-stock (MTF) production.
11) Describe the characteristics of make-to-order (MTO) production.
12) Describe the characteristics of assemble-to-order (ATO) and engineer-to-order (ETO) production.
13) Describe how each of the following production process metrics are calculated: manufacturing cycle time, changeover time, throughput, capacity utilization, schedule attainment, first pass yield.
14) Describe the characteristics of raw materials warehouses.
15) Describe the characteristics of finished goods warehouses.
16) Identify and briefly describe the major tasks/activities performed by each of the following production process actors: raw materials warehouse personnel, manufacturing/production personnel, maintenance personnel.
17) Describe the production process document flow.
18) What are work centers?
19) What are product routings?
20) Describe the physical flows in the production process.
21) Describe the key data included the following production process documents: planned orders, production order, material withdrawal slips, goods receipt.
22) Describe the contents of a bill of materials (BOM).
23) Provide several examples of questions that can be answered from production process instance-level information.

24) Provide examples of questions that can be answered by production process process-level information.
25) What is an integration point?
26) Provide examples of production process integration points.
27) What are the characteristics of a MRP system?
28) What fundamental production process questions can be answered by a MRP system?
29) What data is included in a MRP software program run? How does the MRP program calculate net requirements?
30) How does MRP II differ from MRP?
31) How does ERP differ from MRP II?
32) Describe how a warehouse management system (WMS) supports the production process.
33) What is an industrial robot?
34) What types of manufacturing/production tasks are performed by industrial robots?
35) Identify systems used to support industrial robot flexibility.
36) What are the characteristics of assembly robots?
37) What is additive manufacturing (AM)?
38) Identify several ways in which additive manufacturing is superior to traditional manufacturing.
39) What is Industry 4.0? Identify the factors that are driving Industry 4.0.
40) Describe the short- and long-term goals of Industry 4.0.

Chapter 11: Business and the Web: e-Commerce and Social Media/Collaborative Technology E-commerce

CHAPTER OBJECTIVES

After studying this chapter, you should be able to

- Discuss the economics of information and its impact on competition
- Discuss different types of e-commerce models
- Discuss social media and its impact on competition
- Discuss the importance of collaboration and how it is enabled by technology

INTRODUCTION

As we discussed previously, technology changes the way business is done. In the 21st century, the internet has created new capabilities to do commerce and collaborate that did not exist previously. It changes our relationship to goods and to each other in ways that could only be imagined 50 years ago. By means of technology, we can present our goods and products to more customers with more richness to present them the opportunity to buy; we can work with others at different places and times; we can touch our customers and create relationships with them. This chapter covers these topics pointing out how we need to compete using these technologies.

First, we consider information economics. Information and Information products are much different from physical products. Information can be replicated, modified, sold and located in many more places than physical products can. Historically, information was confined in physical objects that limited what we can do with it, but now with the internet and other technologies, information is set free from physical limitations setting up the ability to provide it to more customers. We can now *reach* more customers with greater *richness* that we were before. This new capability has disrupted certain industries and created new ones.

Next, we consider e-commerce. It is now expected that a business has a website and hence a barrier to entry. It is also assumed that you can sell and interact with customers electronically. Business has adopted various models of monetizing the internet. We are familiar with companies that sell directly to us. But they also create marketplaces, provide content, aggregate information, navigate for us, and many other ways. Each of these approaches has different requirements for success.

Beyond this traditional approach to using the internet, an extension to the traditional commercial approach is Web 2.0. In Web 2.0, we see web applications and technologies are "never finished" but rather are updated as needed to improve the products. These products are also dependent upon *user-generated content*. Content provided by users in addition to that provided by the enterprise. Handling this content is an important consideration for all businesses now. Companies must have a policy for handling and responding to customer interactions with you.

The rise of social media such as Facebook, Twitter and Pinterest have created the ability to create social networks. Businesses can use social networks to perform such functions as promotion, customer service, marketing and HR functions. These social networks also provide the capability for organizations and individuals to increase their *social capital* with others. By using social networks, companies can increase the number of contacts, interact with them to increase social capital and exploit their social capital to perform these functions.

Lastly, technology provides the opportunity for us to collaborate with each other in ways that were previously unimagined. Technologies such as Skype and Google Drive allow us to work together with each other even we aren't in the same place or even at the same time. These new capabilities allow companies to increase their competitive capabilities by working across the globe and around the clock.

The importance of these technologies is to be able to touch more companies with your products and services to be able to compete more successfully.

INFORMATION ECONOMICS[1]

The new forms of technology described in this chapter perform a disruptive function from past ways of doing business in the way that they change the relationship between physical goods and information and information goods. This section describes the difference between these two types of goods and how technology treats them differently.

Information Assets are goods that are made up of information or data. For example, the content of an encyclopedia or book, Google results or bank account information are information assets in that they provide information to us. Information assets are very different from physical assets such as a machine or a building.

Physical assets are those things you can see, feel and touch. They are tangible. Information assets on the other hand are intangible. You can see, feel or touch them. For example, you can touch a building, but you cannot touch your bank account balance. That is held as magnetized areas on a disk drive somewhere. Both require significant effort to create. Because it is intangible, you can copy an information asset many times. Each time its costs virtually nothing.

[1] Much of the content and terminology in this section is drawn from "Blown to Bits" by Evans and Wurster, Harvard Business School Press, 2000.

	Physical asset	Information Asset
Nature	Tangible – you can touch it and feel it	Intangible
Cost to Create	High	High
How many times can you can sell it	Once	Many times.
Cost to replicate	High	Essentially zero
Cost to modify	High	Low
Susceptibility to wear and tear	High	Zero – Can become obsolete or false
Type of goods	Quality can be inspected once for all.	Experience. Need to be tried to determine the quality.

Table 11-1: Difference Between Physical and Information Assets.

However, you can't copy or modify a physical asset usually without significant effort and cost. An information asset can be copied or modified usually without that much effort. Physical assets wear out but information assets don't. They can become obsolete or false but they don't wear out. Similarly, you can sell a physical asset only once. Once you give it to the buyer you cannot sell it again. To so is called fraud. However, you can sell and information asset many times. A physical asset is located only in one place; however, information assets can be in many places. Finally, information assets are **experience goods**, goods you must try to determine the quality. All new products are experience goods. But some goods like a new entry on a blog must be experienced for the quality to be determined.

Some implications of these characteristics is that information is customizable. You can modify it to fit the need. For example, I can summarize all the sales information by region and determine which region is the highest grossing sales region. Information is also time valued. It can become obsolete or less valuable with time. The sales achieved in 1st quarter 1979 are probably worth less today than they were in 1980. Because information goods have low costs to replicate and don't wear out, they can achieve significant gross margins. If the cost to replicate an information assets is zero, then just about all you make from selling it is profit.

In the past, information assets had to be contained in physical assets. This restricted the availability of the information asset to the availability of physical asset. For example, the Rosetta stone (Figure 11-2) which is a decree of Egyptian king Ptolemy V from 196 BC written in Egyptian and Greek is bound to the physical limitations of the stone on which is it written very costly to create, modify and copy. You also had to be in the same physical proximity to read it. However, when written on a book, the cost to produce and copy has come down. This makes it much easier to disseminate to many people. With a printing press, you can make many copies. Later, television and radio made it possible to send information to many people and to have more dynamic if one way interaction. With the internet, we now have the capability to interact with many people over great distances with great content for next to zero cost.

To illustrate this restriction, consider a grocery store shelf (figure 11-3). A grocery store shelf serves two functions. First, it is a “billboard” which displays the goods for sale, their prices, condition and availability. Standing at the shelf, the shopper can examine what goods are for

Figure 11-1: The Rosetta Stone

Figure 11-2: Grocery store shelf

sale, how many of them are there and their prices. They can also handle the product and examine its condition (is it past its sell by date?). The shelf also serves an inventory function. It stocks the goods for sale in a place where they are preserved.

However, this dual-purpose function represents a compromise between the information and inventory functions. For the “billboard” function you would want to maximize the amount of space to display many wares that were for sale. However, the inventory function seeks to minimize cost and hence reduce space. This compromise is everywhere when information is combined with physical assets, e.g. a newspaper would like to provide more and more information however, it is limited for cost considerations to a certain number of pages. This compromise reduces the value of the item. This compromise is known as the reach-richness tradeoff.

Reach and Richness

Reach refers to home many people you can share information with. **Richness** refers to the quality of the information provided to the viewer of the information. When you use physical assets to hold information such as in the Rosetta stone, a newspaper or a grocery store shelf, you must compromise richness to get reach and vice versa. For example, consider the grocery store shelf. Standing in arms reach of the shelf you get excellent information richness. You can examine all that information that we described before. However, only a few people can stand

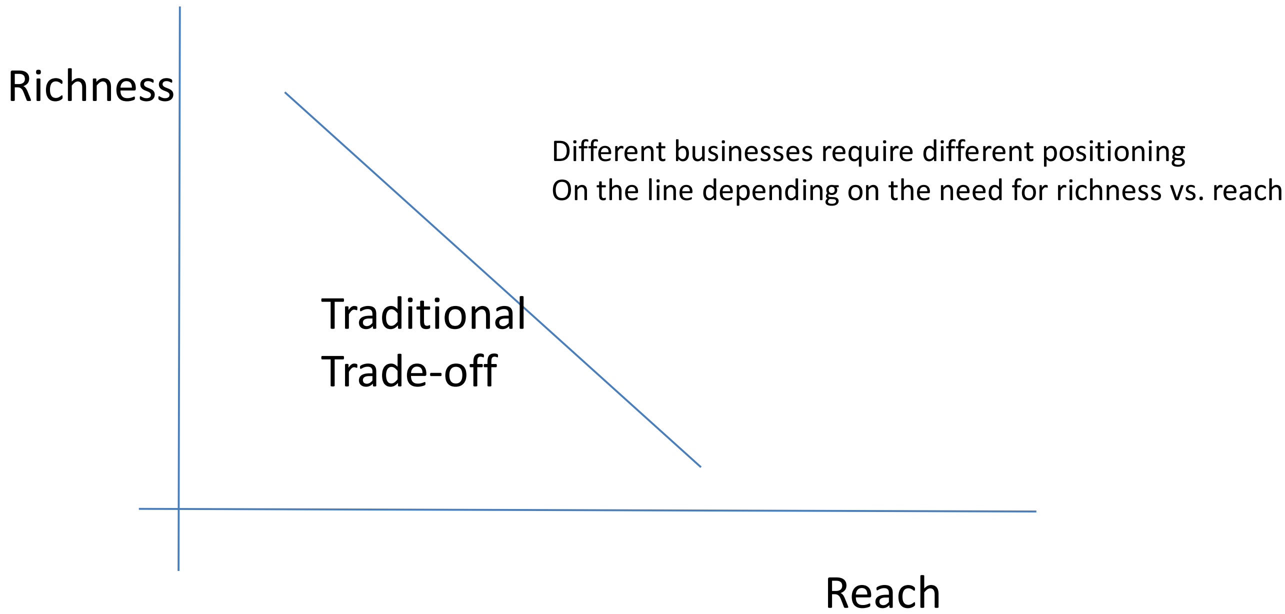

Figure 11-3: Reach – Richness Tradeoff Before Separating Information from Physical Goods

that close to the shelf. If we put a live video of the shelf on television, many more people can see it, but they can't pick up the item and look at the sell by date or see how many are behind the first one on the shelf. Thus, reach has been increased but richness has decreased. This trade-off is illustrated in figure 11-3.

if we can separate the information from the physical object we can release value. For example, when we use the internet to display what items there are, how many of them, their sell-by dates, etc. this allows us to condense the amount of space needed to display the goods and thus reduce cost thus eliminating the trade-off (figure 11-5). The widespread connectivity and standards employed by the internet allow us to expose more and more people to the information without loss of quality.

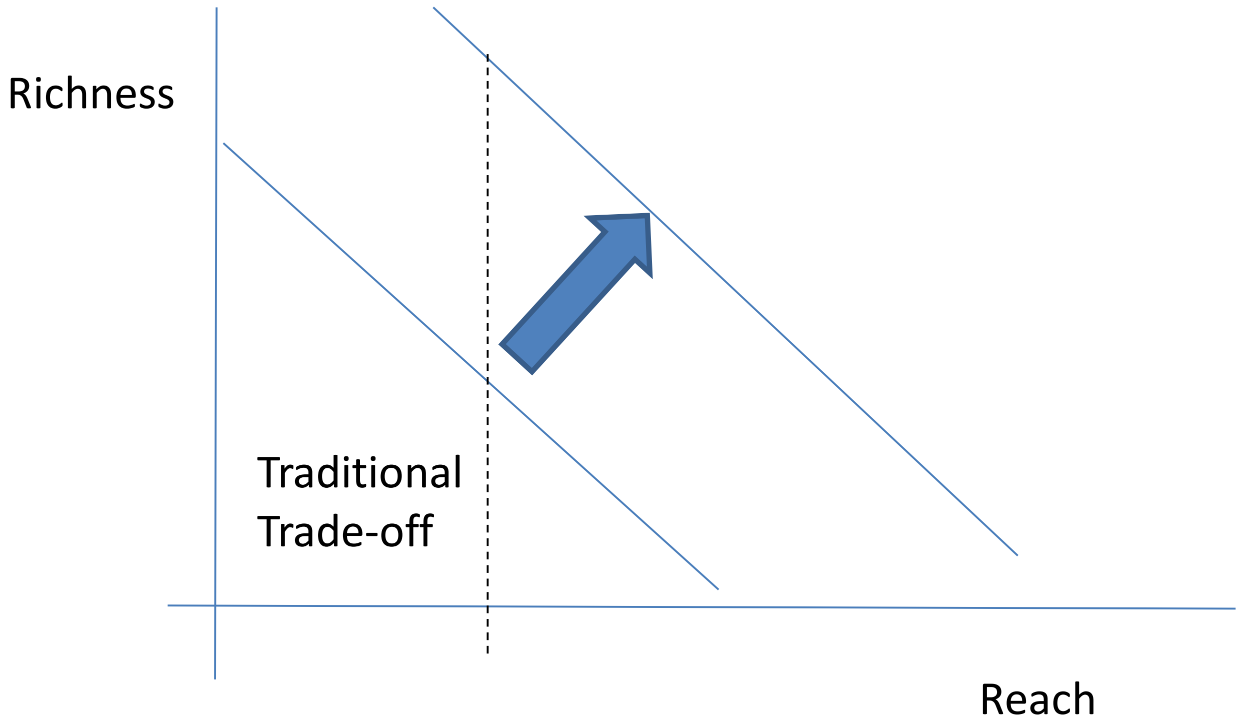

Figure 11-4: Reach vs. Richness after Separating Information from Physical Assets

Thus, the amount of information richness for a certain number of people can increase dramatically.

Impact of the Destruction of the Reach vs. Reachness Compromise on Business

This blowing up of the reach vs. richness tradeoff can impact significantly how business is conducted. Consider the example of a newspaper. In the old world, prior to the rise of the internet, the newspaper provided news, opinion, financial information, advertising and entertainment to readers (figure 11-5). The value proposition was that they were able to provide this content to a large number of readers. They monetized this through charging for advertisements and for subscriptions to the paper and single copies and paid for journalistic, financial and entertainment content. They could keep the costs down to the readers through the economies of scale provided by large scale printing presses.

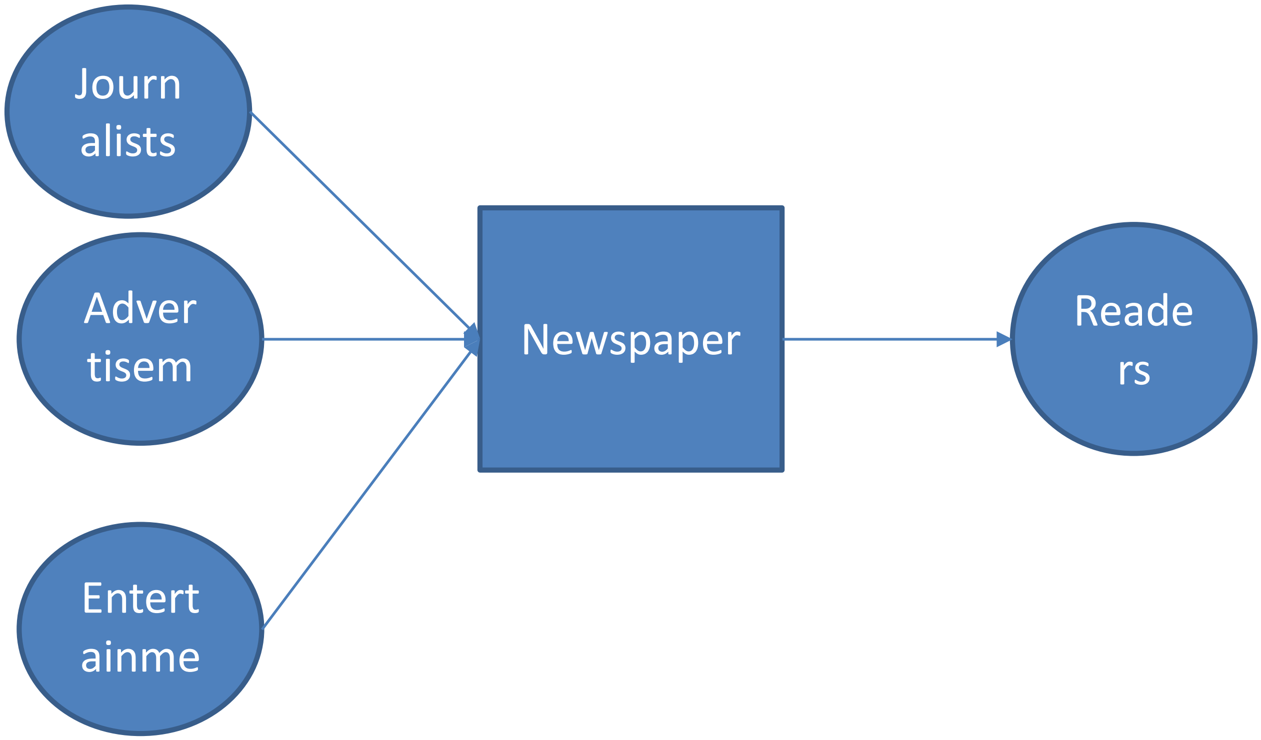

Figure 11-5: The Newspaper Model Prior to the Internet

The value of this bundle has been deconstructed via the ability to separate information from the physical content of the newspaper. Because of the internet, the printing press is no long necessary. For example, with the rise of sites such as Monster.com and Dice.com, it is no longer necessary or even convenient to look at the newspaper for job openings. They can look at those websites and get information about jobs than was available in the newspaper. Craigslist.com has challenged their dominance on for sale ads. Similarly, they can get more up to date information about stock prices and other financial information than reading the morning paper. Similarly, they can get richer entertainment from the YouTube and various network sites than they can from the paper.

Additionally, this change has resulted in **disintermediation**, the elimination of the middle man from the equation. Some journalists have gone out on their own and created their websites or joined others in new sites that provide their journalistic information and opinion on their own.

As a result, the value proposition of the newspaper has been blown up. Newspapers have been facing increasing revenue decreases as advertisers spend their money elsewhere and readers decline to subscribe. As a result, some newspapers have repositioned themselves as content providers. Using their edited new services to provide content to others and as a for pay option to readers on the internet, e.g. WSJ.com.

What 21st century business people need to acknowledge about this is that the deconstruction of traditional methods of operation changes the way business is done. If you refuse to adapt to them, then your competitor's will have an opportunity to gain competitive advantage. Staying the same is not a long-term successful strategy, almost any change to adapt is better than no change.

E-COMMERCE[2]

In this section, we look at **e-commerce**, the conducting of business activites over the internet and other communication networks. This includes any kind of business transaction including buying, selling, customer service, marketing, and any information based business activity. Over the last 20 years, e-commerce has gone through several developmental phases.

Web 1.0

The first phase of e-commerce was the recognition that sales transactions could be performed over the internet. This recognition created a wholly new direct sales channel for companies. Customers could self-service including finding and researching products and then purchasing those items over the internet. During this phase, various types of commerce became common that still exist today.

Business to Consumer (B2C). This is when customers deal directly with businesses. This form of business. This category includes online retailers such as Walmart.com and Dell.com where firms offer goods and services to consumers in exchange for money. A subset of this is **Business to Employee (B2E)** where the business interacts with its employees. Typically, this takes the form of transactions around payroll and benefits and other HR considerations, but it can also include such things as discount programs, tickets, packages and other company perks. A variation of this approach is **Consumer-to-Business (C2B)**, where consumers sell provides or services to businesses. An example, here is priceline.com where consumers name their own prices to purchase airline tickets and hotel stays.

Companies operating in this category can be classified in three different categories: **bricks-and-mortar**, operating real life store fronts without a web presence; **bricks-and-clicks,** operating both real life store fronts and having a web presence; and **pure-play**, having no real-life stores and operating only on the internet. Walmart is an example of a bricks-and-clicks approach, operating stores all over the world along with a web presence while Amazon.com is a pure-play competitor having no real-life stores.

Business to Business (B2B). This occurs when businesses deal with other businesses. These may take the form of tailored interfaces for businesses. For example, a business might have a B2C presence but then offer an set of pages tailored to businesses and their specific needs. The B2B segment is the largest segment of e-commerce gathering about 85% of all e-commerce volume.

[2] Much of the content and terminology including the notation for the modeling methods is taken from "Place to Space" by Weil and Vitale, Harvard Business School Press, 2001.

There are three different ways in which these kinds of sites are structured. They are termed sell-side marketplaces, buy-side marketplaces and exchanges.

Sell-side exchanges operate very similarly to B2C type storefronts. Business customers come on to the side, select and purchase goods. They may use features such as auctions and catalogs. **Buy-side exchanges** facilitate the procurement functions or organizations. Here the company offers to procure various items and potential suppliers may sell to them. Features used here are reverse auctions, in which companies bid to provide items, the lowest price winning. **Electronic Exchanges**, facilitate a marketplace where many buyers and sellers can interact to sell and procure items.

In the B2B world, many of the relationships are custom established between buyers and sellers. For example, a make-to-order manufacturer may agree to purchase as certain amount of material from a supplier. They then establish an electronic mechanism by which to order these materials from the supplier and for the supplier to bill and receive payment for their goods. These are known as **private exchanges**.

Consumer to Consumer (C2C). This type of venture connects consumers with other consumers. Examples of this type of venture include eBay.com. In this form, the company forms a marketplace where consumers buy and sell by connecting with other consumers. The transaction may be an auction or a direct purchase transaction. Similar sites include craigslist.com, Uber and Alibris.com.

In this form of business, the website forms a marketplace for goods to be exchanged. Sellers list their items and buyers either bid or outright purchase the items on the site. The site coordinates payment and fulfillment of the purchase between the buyers and sellers.

eGovernment: Government to Consumer (G2C) or Government to Business(G2B): This type of relationship exists when governments create the ability for the public to interact with them for government services. Types of functions here can be information dissemination such as providing forms and instructions or paying fees and taxes. Voting is another nascent area in this space.

Web 1.0 Business Models

In this section, we look at the predominant ways for an organization to structure their approaches to e-Commerce. In each approach, we will be looking at the participants, the firms, customers, suppliers and allies in the business; how the relationships between the participants are structured and how the money, products and services and information flows in each. The models we will look at include: direct-to-consumer, full service provider, whole of enterprise, Navigators, virtual communities, and content providers.

Direct to Consumer

In this model, the business does business directly with consumers. Associated with the B2C type of organization, it is also used in the sell-side exchange model of the B2B world. Figure 11-7, illustrates the relationships in the direct to consumer model.

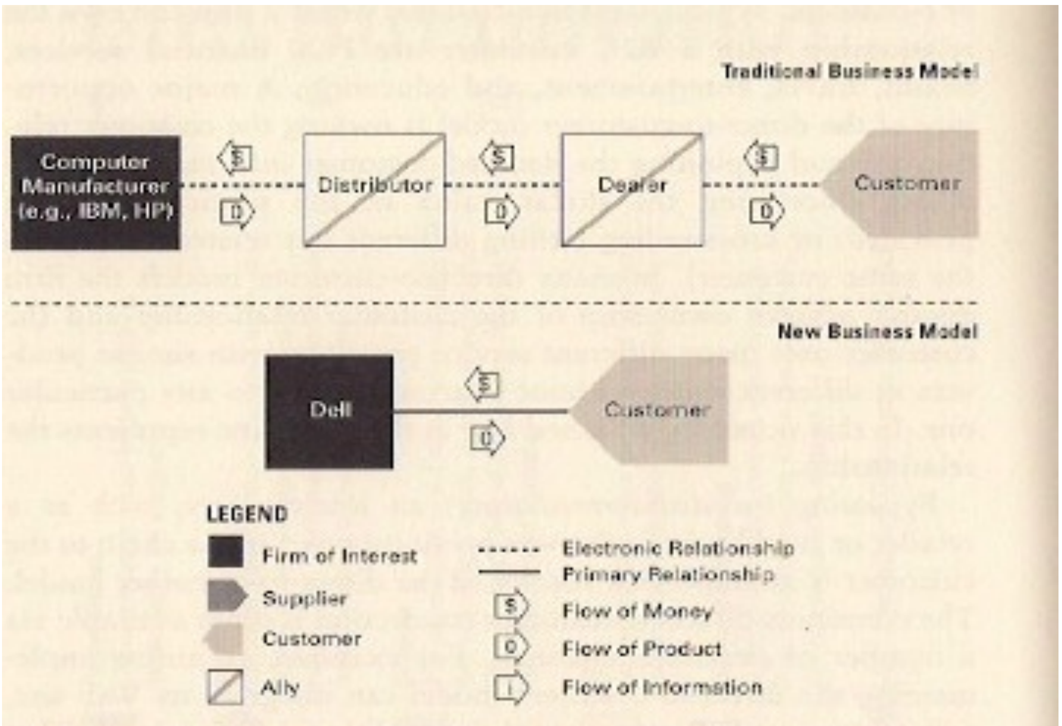

Figure 11-6: Dell's Direct to Consumer Model (Weil and Vitale, Place to Space, p. 40)

Before the internet became viable as a direct sales channel, companies formed long supply chains. They sold large quantities to distributors. The distributor in term broke down these quantities and sold smaller quantities to dealers which in turn sold single units to customers. Manufacturers built to stock based on forecasts derived from either information from the distributors or distributors orders. Where lack of information on demand arose from farther up in the supply chain, the bullwhip effect often developed.

In the direct sales model, the distributor and dealer are disintermediated and the manufacturer sells directly to the customer. The benefits of this approach are that the manufacturer now owns the customer relationship and receives the direct information about customer desires. They can build to order as they now know precisely what the customer wants and can ship directly. Because of the disintermediation, they can sell at lower prices. In addition to lower prices, the customer gets faster response and can self-configure their items.

Issues in this model include dealing with customers directly including customer service and returns. Also since the manufacturer is now selling in very small units, they need to build either an extensive logistics network like Amazon or outsource logistics to a company such as UPS or Fed Ex as L.L. Bean has done. They will also have to build and customer service organization geared to providing support to individual end-user customers instead of large distributors.

Channel conflict is also a major issue for bricks-and-clicks companies. In the early days of Web 1.0, this was conflict with existing direct sales forces. Today it takes the form of how to manage both the web channel and the non-web channels. Poorly managed, the direct-to-customer will cannibalize the non-web channels such as direct sales forces or stores. Care must be taken to ensure that the web channel adds new customers, not just take existing sales from stores or the direct sales force. One of the ways this can be done is by targeting each of the channels at a different market, e.g. direct small customers to the web site and business customers to the direct sales force. Or, one can do **web-to-store sales** where the sales is made online but the fulfillment is performed in the store.

To be successful in this model, one key is to reduce the cost of customer acquisition. Pure-play competitors have the issue of building brand awareness which drives up the cost of customer acquisition. Bricks-and-Clicks companies have an easier time of it since there is already brand awareness. For both, building repeat customers is a key objective. Repeat customers reduces the cost of customer acquisition. It also allows them to build on the relationship and gather data about their wants and needs for analytical purposes.

Full Service Provider

In this model, the company attempts to provide total coverage of customer needs in a domain. In this model, the company provides a one-stop shopping center for customers looking for a kind of item. As shown in figure 11-8, the full service provider has relationships with a number of suppliers from which it purchases its goods and then sells them to customers. It may also provide a marketplace for suppliers and customers to interact as well. Customers purchase through a single shopping basket products from all the suppliers whether owned by the company or from a third party.

The keys to success here is ensuring a strong relationship with the customer. Because the full-service provider owns the relationship and the data with the customer, it can follow the trends of demand and tailor its offerings accordingly. To be a one-stop-shop, it needs to have a large variety of products, one approaching a complete list of everything available in that category.

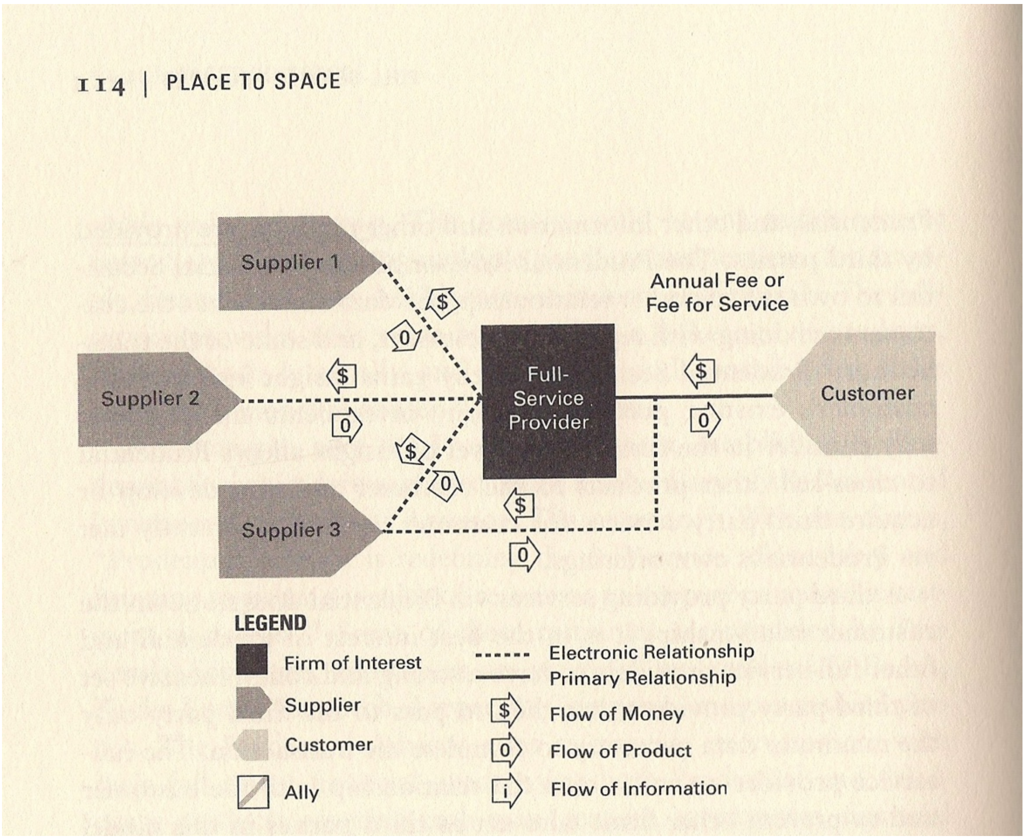

Figure 11-7: Full Service Provider (Weil and Vitale, Place to Space, p. 114)

It should thus be a leader in its domain which will lend brand credibility and trust.

Whole of the Enterprise

The whole of the enterprise approach is used to provide a single interface to a large organization. It is provided in two different versions: **front page**, in which an umbrella web page provides links to individual business unit web pages; and **integrated** in which the entire operation is provided in an integrated manner to the customer. Governments have typically pioneered this approach although very large organizations adopted the front page approach in the early days of web 1.0.

As show in figure 11-9, the single point of contact provides a landing page for the customer. There may be access to the individual business units but majority of traffic is designed to flow first to the landing page and then to the business units. When done in an integrated manner, the transactions are handled through the main website with interactions with the business units. In the front page version, the front page serves as a navigator, directing customer to the place where their business can be done.

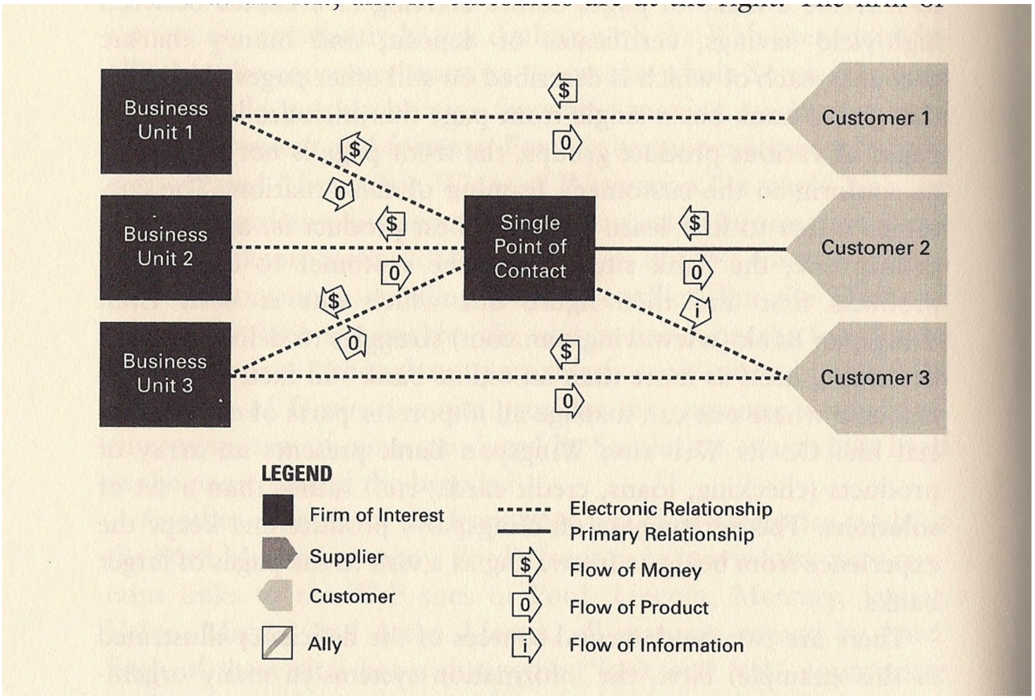

Figure 11-8: Whole of the Enterprise Approach (Weil and Vitale, Place to Space, p. 134)

In the integrated model, customers may be directed to pages where they can reference product groups or handle life events. For example, there may be a product group that is designed to handle small businesses which would be the one stop shop for them. It would handle such things a business licenses, vehicle tags and taxes, inventory tax, and other services. A life event channel might handle everything that has to do with a certain life event such as moving, transfer cable access, water and gas hookups, homestead exemption changes, etc.

To be successful in this model, the key factor is to change user behavior to use the new model instead of continuing to go the business units directly. The company would have to consider creating compelling life events for each customer and grouping the right functions together to encourage use. Business unit processes would also have to change to work with this new model.

Navigators

In this model, the company provides consolidation/aggregation/connections between groups of people, websites and companies. These companies are new business models that came about as the result of the separation of information and physical products based on the rise of the internet. These companies can provide such functions as search, price, sale, fulfillment, surveillance and enforcement. The classic example of this category is eBay. On eBay, one can search for and find items to buy, bid or purchase the items establishing the price, it provides a way to complete the transaction through its ally Paypal, it provides fulfillment through the capability to print shipping labels. Additionally, it surveils, watches the activities of the market to inform sellers about what is going on and to regulate the market from trading in forbidden items (e.g. nazi paraphernalia) and brand name knock-offs and to eliminate abuses such as spamming or abuse.

This model show in figure 11-9 shows that eBay controls the relationship with the buyer and the data surrounding the transaction. All transactions are done via the eBay marketplace and the PayPal or equivalent product fulfillment mechanism ally. It makes its money through the listing, transaction and other fees that it charges the sellers. The sellers and buyers control the transactions.

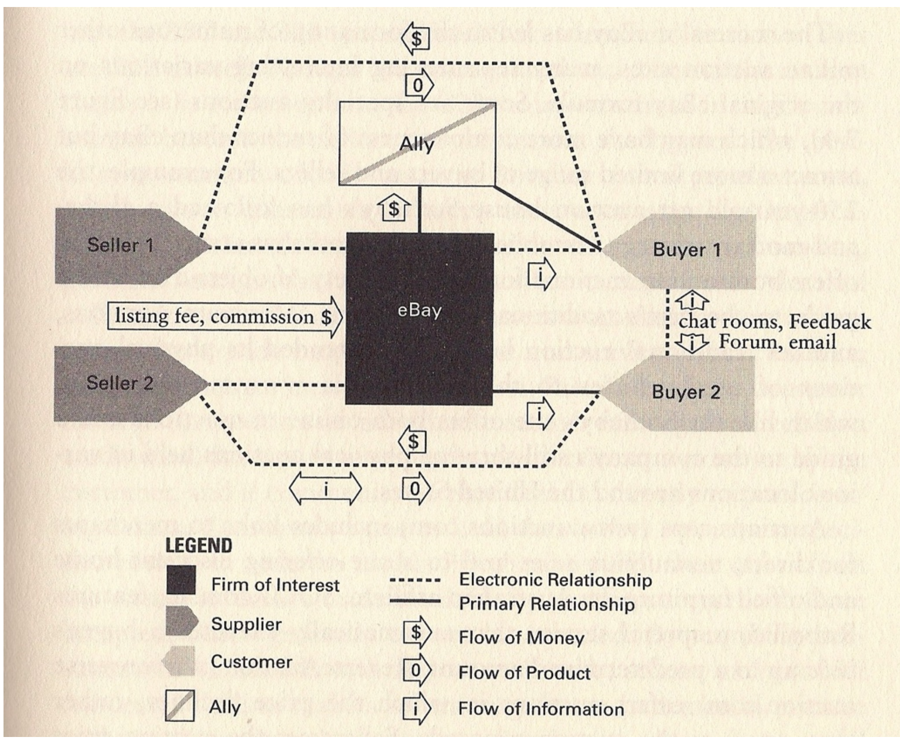

Figure 11-9: Navigator Business Model, eBay example (Weil and Vitale, Place to Space, p. 157)

Another site, Bookfinder.com, aggregates all available books for a particular ISBN and then performs the sale by transferring the buyer to the individual site to complete the order. In this case, bookfinder does not provide a complete marketplace, but rather an aggregator function to provide information to the book buyer to make an informed solution. It receives its revenue from a commission on each book purchased through its referral mechanism.
Another category in this segment, is the portal, an aggregation of information resources. Yahoo.com is an example of this type. It aggregates articles from various information sites, weather as well as a search function. It derives revenue from various advertisements on the

site. As users click through, Yahoo gains a small fee. Additionally, it sells placed advertisements and outsourced functions.

To be successful in this type of business, the company must have sufficient infrastructure to handle all of the transactions entered by the users. It must also generate sufficient volume in transaction fees to cover the cost of this infrastructure. Finally, it must have sufficient "**stickiness**", the ability to attract and keep users to the site. Typically this occurs because of network effects. For example, eBay can attract and keep both buyers and sellers because the buyers come because the merchandise they want to find is there and the sellers come because the buyers are there. Between those two forces eBay has a virtuous cycle of growing buyers and sellers to its site.

Virtual Community

A **virtual community** is an "aggregation of individuals or business partners who interact around a shared interest, where interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms" (Porter 2004). In a virtual community, community members interact with each other around the topic of the company or its products and the community members interest in those. Virtual community owners receive revenue from advertising, clickthrough fees, commissions, direct sales to community members and membership fees.

As shown in figure 11-10, a virtual community fosters interactions between content suppliers and community members. Some suppliers will pay for advertisement on the community site and for click throughs to their site as well as a commission on their products. Members interact with each other to discuss the shared interest of the community. The community owner owns the customer relationship but does not own the customer data or transaction. Those belong to the suppliers. Governance is done by means of formal or informal rules or by means of moderation.

Since the community owner is paid for by advertising, the community becomes more valuable as the community grows and interacts. It is important therefore that the community owner act to maintain the **vibrancy** of the community. Vibrancy is measured in terms of how the community is growing and how much interaction there is between the members.

Virtual communities can be fostered around the products and services offered by a company. For example, eBay has fostered a virtual community around its marketplace by offering seller and buyer forums, moderated by eBay employees. Similarly, companies like Chipotle have used Facebook to encourage a community to develop around its product.

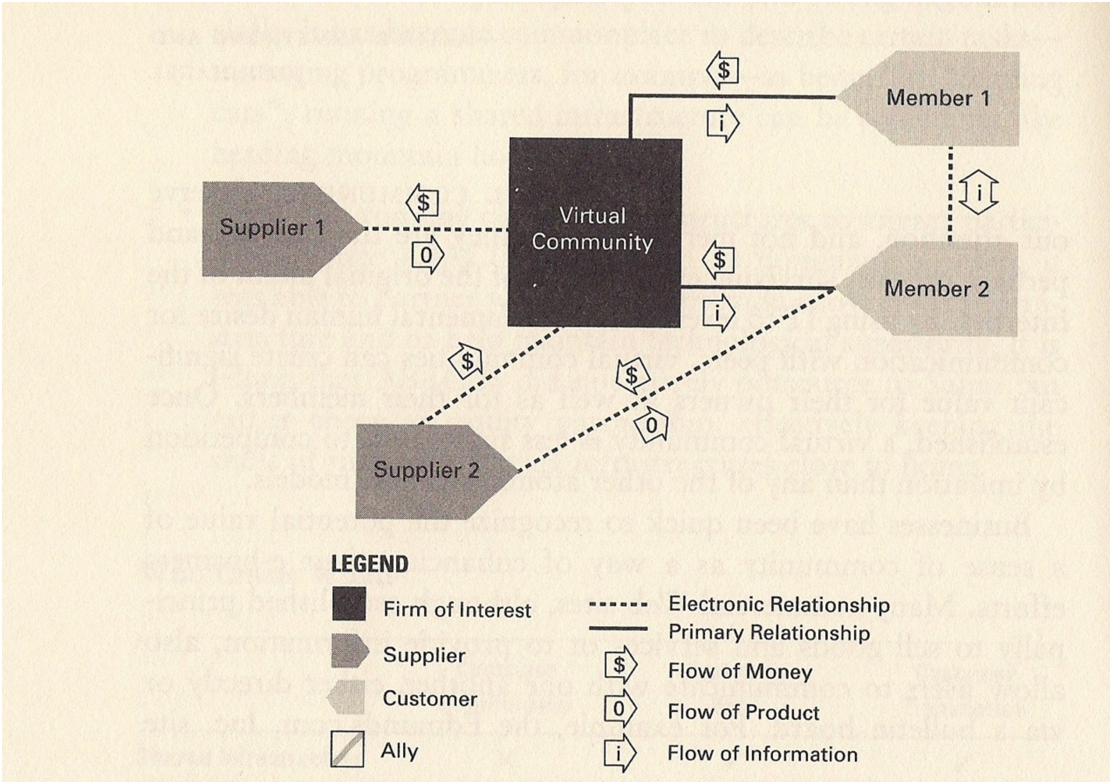

Figure 11-10: Virtual community business model (Weil and Vitale, Place to Space, p. 204)

An example of a virtual community is that of Tidefans.com. A fan site for boosters and supporters of University of Alabama athletics, especially football, Tidefans was created in 1999 and is the largest free virtual community related to University of Alabama athletics. Most activity on BigUFans.com comes from discussion about the football program. During the 2011-2012 season monthly activity saw an average of 2.9 million page views, 1075 new posts, 167,000 unique visitors, and 89 topics started. Daily activity included 1,017 signed in users and 5new users. A typical visit consisted of 5.2 page views. The demographics were typically male (92%), college graduate (72%), and of middle to upper income (71%). During the offseason prior to the 2011-2012 season, there were 2 million page views a month.

As a free membership site, Tidefans makes revenue by advertising sales. Since the rate that Tidefans can charge for its advertising is dependent on the activity of the site, especially pageviews, gaining activity on Tidefans.com is an important activity. Toward that end, Tidefans is a heavily moderated site. There are six administrators and 17 moderators of Tidefans that work to keep the topics on the forum of BigUFans.com relevant and free of spam and incendiary comments. Because of the work of the staff, one of the major advantages of BigUFans.com over their competitors is that the community feels the OC has more positive messages that are free of advertising, spam, flame wars, and off-topic postings. Additionally, Tidefans.com gives different level user status automatically to users that post a certain amount, regardless of how many users read their messages.

Content Provider

A **content provider** is an organization that creates and provides content (information, products, services in digital form through third parties. The typical customer for their services are portals/navigators who aggregates their data with others for form their pages. Content providers typically own the relationship with and are paid by the aggregators but not with the ultimate end users. So, they do not own any of the aspects of the customer relationship either the transaction, the data or the relationship itself. As a result, they do not need to conform themselves to any of the requirements of the end user customers but rather to the aggregators.

Figure 11-11 shows the fundamental relationship between the content provider and the aggregator. The content provider provides domain specific data to the aggregator for which they are paid. The aggregator in turn adds it as the value proposition to its customers.

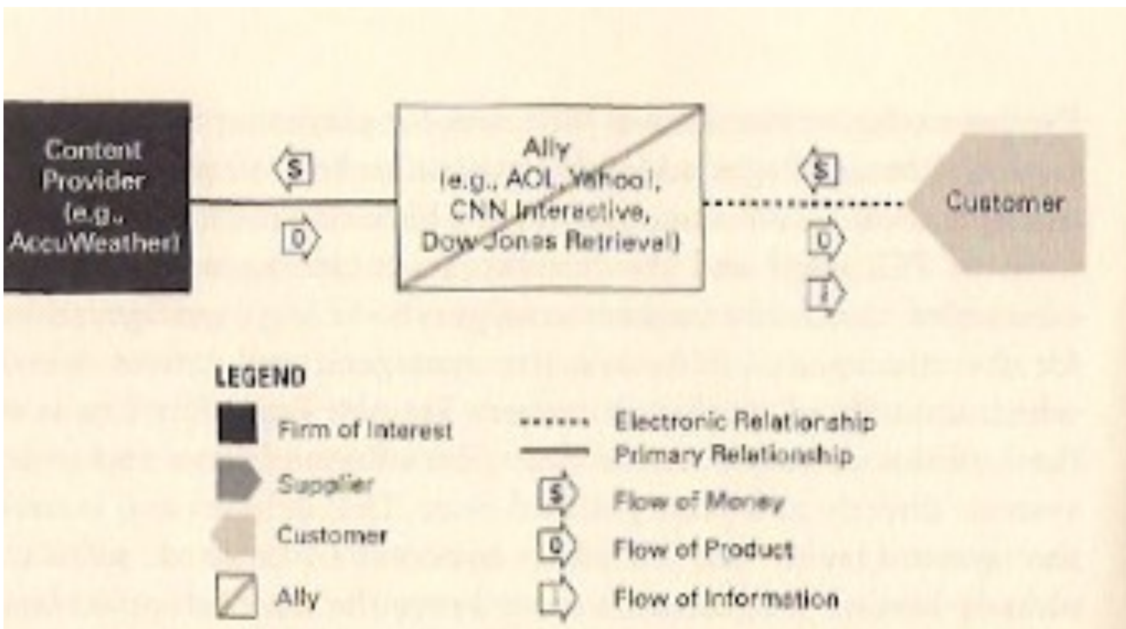

Figure 11-11: Content provider business model (from Weil and Vitale, Place to Space, p. 42)

Aggregators often purchase content because it is too expensive to produce themselves for the value provided. For example, Wallstreet Journal purchases sports news (Soumitra Dutta, Zeitungen gehen online: Eine Herausforderung für alte Medien, in: Thomas Bieger, Nils Bickhoff, Rolf Caspers, Dodo zu Knyphausen-Aufsess, Kurt Reding (Hrsg.), Zukünftige Geschäftsmodelle, Konzept und Anwendung in der Netzökonomie, Berlin, Heidelberg, New York, 2002, pp. 117-150). Other examples of content providers might be Weather.com and accuweather providing weather services and Dow Jones providing financial information.

The keys to success for content providers are to ensure that you are the best in class in your field, that your company's name is attached to the content that your company provides, and that your company has a strong network of aggregators that you supply.

Each of these models that has been described here are the "pure" or "atomic" type of models. They can be combined to create e-commerce initiatives. For example, a company might create a marketplace for bringing together certain kinds of buyers and sellers and then forms a virtual community around them to foster tighter ties to the marketplace and to resolve problems and provide support to the users of the marketplace.

Ecommerce and ERP integration

To accomplish Web 1.0 e-commerce, a tight integration to the company's ERP system is required. During the Web 1.0 time period, it was recognized that to provide rapid, accurate response to the customers' orders, it was necessary to have an automated connection to the order entry system. Without that, the level of effort of rekeying the transaction data and the subsequent delays and errors were unacceptable. They also recognized that very accurate inventory was required to prevent having to cancel orders due to inventory stock outs. Prior to this integration, companies often needed to extract orders from the web site and re-enter into their order management system with the accompanying errors and omissions. Integration of the web presence resolved this problem.

WEB 2.0

After the turn of the 21st century, advances in technology enabled more capability beyond static pages. What was new was the advent of **web applications** such as Facebook and YouTube that had much more functionality. A web application functions much like a desktop application except that it is constructed of webpages and interactive content. The web applications enabled two way conversations whereas Web 1.0 with its static text and images was one way. They provide an interactive user experience.

This two-way conversation with users provides the ability for users to be co-creators of the site experience. Examples of this conversation include such things as **reputational systems**, ways in which users can rate their experience. Examples include the feedback systems employed by eBay and Amazon and other sites. These systems allow buyers and sellers to rate their experience with others and service as a guide to others about the quality of those being rated. Some characteristics of web 2.0 web applications are as follows:

User generated content which as its name implies is content generated by users. Web 1.0 was all website talking to the users of the site. In Web 2.0, there is now the capability for users to create some, some, major parts or all the application. In addition to reputational systems, examples include comments sections found in many websites; images and videos posted in response sections. Some web applications are all user generated content, e.g. Facebook, users create their pages for themselves, their groups or organization and then post "updates" to which others respond with comments or like or dislike comments; YouTube in which users post videos and others respond or mark like or dislike.

Emergent Structure. This means that the structure of the site is not set by purposive activity of the web site owners as it was in Web 1.0. Rather the contents of the site are the result of user activity mixed with website owner activity. For example, Second Life, is an almost entirely resident generated world in which the residents of Second life have create an immense array of things with which to outfit one's Second Life including, hair, skins, shapes, clothes, homes and buildings, furniture, musical instruments, and entire worlds for people to explore.

An additional feature of the emergent structure is the fact that the web application is updated continuously rather than part of a fixed update schedule. EBay and Facebook update their applications without notice to users, adding or changing features. This contrasts with traditional applications such as Microsoft office which changes in annual or bi-annual updates.

Another feature of web 2.0 is **tagging**. This is the use of keywords or phrases for classification or taxonomy purposes. These tags describe a piece of information. For example, in Twitter, users will put a **hashtag**, a tag preceded by a "#", to classify their tweet. By applying identical hashtags users indicate their continuity with a idea, #web2.0. This type of tagging is known as **social tagging**. From these tags, a folksonomy can be created. A **folksonomy** is a taxonomy or classification of content derived from how people are tagging the content by aggregating and compiling these user generated tags. An emergent form of tagging is **geotagging**, the putting of tags on maps to identify places of interest.

Some examples of web 2.0 applications are as follows. Weblogs or **blogs** are online journals that let people post their own comments, graphics and videos. The **blogosphere** is the universe of blogs. Some people use Facebook as a place for their blogs. Others have regular columns on webpages. Other places for blogs can be specially created areas for blogging such as bluehost, iPage or hostgator. One of the key platforms used on the blogging hosts is Wordpress, an open source content management system. Over 19% of the interest uses Wordpress to create the webpage or blogs (http://www.webhostingbest10.com/best-blog-hosting). Blogs are important as a source of ideas and opinions about products and services. **Microblogging** refers to blogs that all the user to write a short message and then transmit it. This includes such technologies as **Text Messaging** or applications such as **Twitter**. Twitter allows you to send 140 character messages know as Tweets.

Really Simple Syndication (RSS) is a web format for publishing frequently updated works. It allows automatic reception of information you want without have to surf thousands of websites. People join the syndicate and when changes are made, they are notified. It requires a piece of software called a newsreader. Many news sites such as the Wall Street Journal and Fox News allow you to subscribe to various RSS feeds and select the reader you wish to use. In figure 11-13, which shows a typical RSS sign up form, you select the content desired and the reader. The content arrives at your reader as it is available.

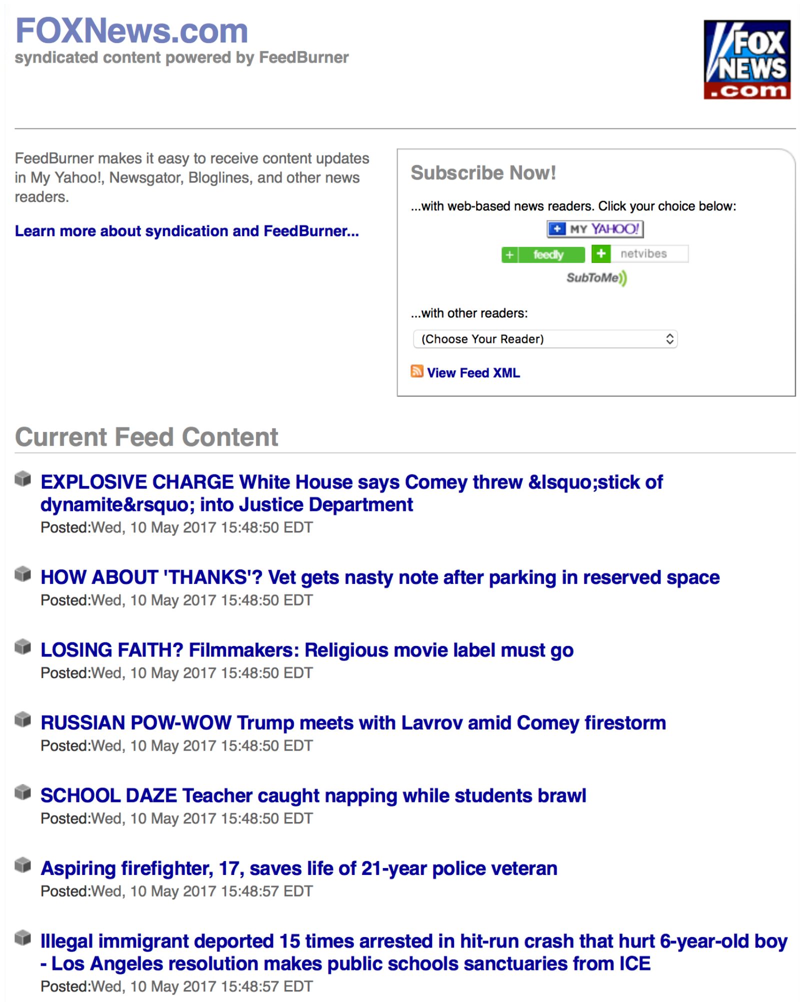

Figure 11-13: Fox News RSS signup page

Wikis are collaborative web pages that allows users to management content. The most famous wiki is Wikipedia (www. Wikipedia.org). **Wikipedia** is the web based free content encyclopedia. According to the website "Since its creation in 2001, Wikipedia has grown rapidly into one of the largest reference websites, attracting 374 million unique visitors monthly as of September 2015.[1] " As of May, 2017, there were about 70,000 active contributors working on more than 41,000,000 articles in 294 languages and 5,402,417 articles in English." (https://en.wikipedia.org/wiki/Wikipedia:About)

Wikipedia allows user to look up information based on title. What is interesting here is that Wikipedia is created and maintained by users. Anyone can edit any article. This approach creates both advantages and disadvantages. First, it is an open and democratic encyclopedia. Anyone can begin, add to, edit or delete content from any article. People are not privileged except based on the community perception of their contributions. On the other hand, it leaves the site open for what Wikipedia terms vandalism which is "editing … deliberately intended to obstruct or defeat the project's purpose which is to create a free encyclopedia …" (https://en.wikipedia.org/wiki/Wikipedia:Vandalism) as well as mistakes and errors. Wikipedia believes that over time with good faith editing and work by the entire community, Wikipedia can be a significant source of knowledge. The example of Wikipedia shows that wikis are a convenient way to share knowledge.

When a website uses content providers to provide content for their site, the result is a **Mashup**. This integration is usually accomplished through **Application Programming Interfaces or APIs**. These are interfaces provided by websites to allow access to their content. Programmers on the mashup write program code to access the APIs and extract the data.

Netcasting includes posting audio files (**podcasting**) and video files (**videocasting**) on the web for public consumption. Examples include such applications as YouTube in which user developed videos are created and then uploaded for public viewing and iTunes U where universities post course content and other audio and video files for public access.

SOCIAL MEDIA AND BUSINESS

A significant subset of Web 2.0 applications is those termed **social media**. Social media applications allow sharing of information across a network of users. Examples include such applications as Facebook, LinkedIn, Twitter, Instagram and Pinterest. Growth in social media use has been enormous. Facebook has grown from 150 million users in 2008 to 1.15 billion users in 2013 to 1.8 billion in January 2017(https://www.searchenginejournal.com/growth-social-media-2-0-infographic/77055/, http://www.smartinsights.com/social-media-marketing/social-media-strategy/new-global-social-media-research/). Facebook is currently the most popular social media platform with 80% of online adults using it. This is compared to about 35% using Instagram, Pinterest, LinkedIn and Twitter.

The purpose of social media is to build social relationships and communities of interest. The different social media platforms target different audiences. For example, Facebook and Google + target general social networking across all individuals and organizations. LinkedIn focuses on business networking. Thus, different platforms will bring different capabilities to the users.

In the business world, social media can be used to perform many different functions in the realm of marketing and customer service.

Marketing

Branding. Social media can be used to create or maintain a brand, the perception of your product or service, within the community. The way a Facebook page for a business is created and how the interaction is performed communicate an image of the company to community. How rapidly a company responds to complaints or concerns and how they respond speaks to the community of what kind of company they are.

Viral Marketing. Using social media can create "buzz" around the company and its products. Word of mouth can be created that will create much more visibility and awareness for their products. Using such methods as promoting posts on Facebook; providing incentives for bloggers to mention your product; tweeting about your product and creating and promoting YouTube videos can all be used to create an image and aware of your product.

Market Research can be done via social media. This includes both using the media to collect information and the technical data collection about your users' comments and actions. Social Media Analytics such as Sentiment Analysis can help companies understand issues with their products and services and allow them to act to improve their operations. Companies can perform data analysis on their twitter feeds or mentions of their name on Twitter to understand what their customer base is discussing about them.

Customer Service

Social Media Listening can be a very important technique. Here, company employees listen and respond to comments on Facebook, Twitter and other social media sites. This provides the company with information on how the customers are talking about their products at any time. The response that the company gives provides the customers with a sense of community with the company changing its image from a faceless organization to someone with which they have a relationship. Social Media Listening can also allow companies to take corrective action sooner than would normally happen. A company monitoring social media looking for tweets or posts regarding it would be able to see customers talking about dissatisfaction and would be able to respond very quickly to their complaints.

Social Networking

Social Networking is another technique that can be done via social media. Many of the techniques discussed above require a community dedicated to the product or service of the company. Creating the community is not a trivial undertaking. While some of this can be done by means of boosting posts and pages in Facebook. Getting them to stay and keeping a vibrant community often requires social networking.

Social networking mean using social media to build **social capital**. Social capital can be thought of as the bank of good will held by others about you or your organization that you can call upon to help you with your activities. You have social capital with each person that you are in contact with and with each interaction with them you either build up your bank of capital or spend some of your capital. Based on your interactions, you can potentially have a large bank of capital or even a negative balance. This is what you have to draw on when you need to access them for something that you need. Therefore, it is necessary that you build your social capital long in advance of your need.

To build social capital you must first establish relationships and then build capital with those with whom you have relationships.

Establishing Relationships

The object of this step is to identify those who have the resources that could potentially help you or your company in business and then establish a relationship with them. Figure 11-14 provides and illustration of a social network. You are found at the left side of the graph. You have relationships with A, B and C. B has a relationship with D and E. The dotted line is the boundary of your organization. Suppose that you want to access the expertise that person D has or that you want to make sales calls on the organization in which D and E are in. To do either of those you will need to establish relationships with D and E.

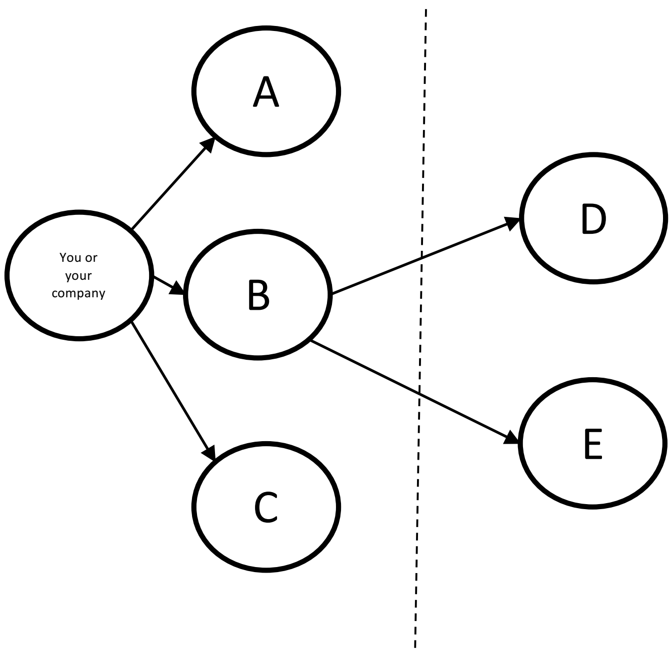

Figure 11-13: A Social Network

Social Media such as LinkedIn assists you with this identification process. LinkedIn allows you to make "connections" with other people who have a LinkedIn account. By making these connections you will be able to see who they are connected to. You can then either connect with them yourself or you can as your connection to provide you a contact. Another way would be to increase the number of your Twitter followers or Facebook book page likes.

Building Capital with Your Connections

Once you have made a connection, the next step is to build a connection with your contact. As we discussed above, you build social capital by your interactions. Below are four different ways your interactions can create positive social capital. We term them here **social capital currencies**, different types of social capital. You can build social capital by enhancing your contact's ability to do their jobs (**task related currency**), enhancing their position in the organization (**position related currency**), providing inspiration for their work (**Inspiration**

Currency) or by strengthening your social relationships (**Relationship Currency**). To increase the task related currency, you can do some of the following things: Lending or giving money, budget increases, personnel, etc.; helping with existing projects; Taking unwanted tasks; providing task support, quicker response time; providing information that would be helpful for them to do their job. To help others advance in their positions, you can assist them in gaining promotion; providing recognition and visibility and perhaps the strongest form of this currency providing opportunities to connect with others. Perhaps most powerful form of currency because it is the most motivating is inspiration capital. You provide this to people by giving them a vision of doing important things; or a vision of excellence, doing them well; or ethical correctness, doing the right things. Finally, relationship capital can be built by forming a relationship that transcends professional boundaries. The most basic form of this capital is simply listening to people and them providing acceptance, support and understanding.

Type of Currency	Definition	Examples
Task Related	Help them do their jobs	Giving or lending money or personnel, Help with existing projects or Taking unwanted tasks, Providing information
Position Related	Advance their position	Give them promotion, recognition or Visibility Connections
Inspiration Related	Motivation to Support You	Vision, Excellence Ethical Correctness
Relationship Related	Creating a relationship that transcends the organization or profession	Listening and Providing acceptance, understanding and support

Table 11-2: Types of Social Captial

Obviously, social capital needs to be built in advance of needing to call upon that capital. One should work on 1) identifying those people who might have resources on which you would need to call; 2) Making connections with them; and 3) Building your social capital through the various currencies available to you.

Using social media, you can build your social capital by providing information to your contacts to help them do their jobs. For example, providing information on ways your products or services can help make them more productive. Similarly, sponsoring them to more connections creates position related currency for you. Making them a page moderator or recognizing them as an expert provides position currency.

Social Media and HRM

A focus on social capital can also benefit HR processes. Finding and recruiting personnel can be a very tiresome and expensive process. Both employers and job seekers are increasing searching for one another online. No longer are employers placing classified advertisements in the newspapers. Increasingly they are placing the job listings on online sites and search social media for potential candidates such as such as Monster (www.Monster.com), CareerBuilder (www.careerbuilder.com) or aggregator sites such as ziprecruiter (www.ziprecruiter.com) which posts their job on many different jobsites. Employers have increasingly found that using the job profiles on LinkedIn can provide a ready list of candidates for a position. So, job seekers would be advised to search for publically advertised jobs on job specific websites and to post their qualifications and availability on both social media and job search sites.

Crowdsourcing

Using crowds to provide input into decisions and development activities is becoming another major purpose of social media. An intelligent **crowd**, a diverse collection of independently deciding individuals gathered to make decisions and predictions, is better than individuals or even experts, at making those decisions. As defined by Surowieki (The Wisdom of Crowds, 2005), an intelligent crowd has independence diversity of opinion, decentralization and a way of aggregating votes. Independence means that there is no significant external force acting upon them to make them decide one way or another. Diversity means that the members of the group will have different opinions on the subject. Decentralization means that they come at the problem from different directions or fields of expertise. They have private information that others may not have. A way of aggregating votes means that there is a mechanism for making the decision. An intelligent crowd is different from a mob mentality or mob action because in those cases the mob is not independent or diverse.

Surowiecki provides as an example as story related by Sir Francis Galton. In 1906, Galton went to a county fair to observe a guessing content where the entrants would guess on the weight of of an Ox after slaughtered and dressed. Now Galton believed in the rule by experts. He was expecting that the crowd would get it totally wrong since there were many in the crowd who had no knowledge whatsoever of Oxen. To his great surprise, he found that the average guess by the crowd came very close to the final weight of the Ox.

Crowds will fail if the lack some of the characteristics of an intelligent crowd. First, if the crowd is not sufficiently diverse, such that they have homogeneous opinions, you will not get a good decision. Crowds will also fail if the decision is made in sequence and the votes of those going first are made public. In this case, subsequent decisions are influenced by the previous decisions. Crowds with a herd mentality or groupthink will also not arrive at good decisions because they are not sufficiently independent.

Social Media help increase the wisdom of crowds by facilitating the use of **Crowdsourcing**, using the wisdom of crowds to participate in decision-making or design. A survey can be created on Facebook that will allow users to provide feedback on potential slogans for products. For example, the Constitution Party, a political party advocating a return to constitutional government, created a survey on their Grassroots Facebook group to provide feedback on a new logo and a new slogan. Crowdsourcing is also used for technical support. For example, user forums are forms of crowdsourcing in which the community is used to propose answers to other community members technical problems.

Crowdfunding is the use of crowds to perform venture funding. Sites such as Gofundme.com , kickstarter.com, Indiegogo.com provide places for entrepreneurs, artists and other to propose to the crowd to support new technology projects, movies, art, charitable works and many other projects.

Social Media Policy and Ethics

Managing your company's approach to social media takes some time and consideration. There are number of issues that arise when considering the use of social media. First, the amount of money to be spent on funding social media operations. To create communities and properly interact with them requires funding an organization to perform that function. If you want to have one hour response to issues and questions raised on your Facebook page, you will need to have personnel assigned to perform that function. Alternately you could use software to monitor and alert organization members to respond to people. Either way, it requires a funding commitment to perform that function. This issue raises another problem, computing your **return on the investment** in social media is at best indirect. Return on Investment is a financial ration of the net income divided by the amount of money expended to achieve that return. Consider the customer service activity of interacting with customers on your Facebook page. You can compute how much it costs to perform the function, but how do you compute the increase in sales that results from that activity?

Another question is how to handle the UGC associated with the social media. Remember that are depending on our users to create the communities and populate the content associated with social media. The question arises here when we have content that we don't agree with or like on our website or Facebook page. What do we do? There are three major issues that can arise with UGC. First, what do we do with off topic comments especially those that are inflammatory or just down right nutty? One of the tasks of the moderators of your site is to identify and remove this information.

Second do we with negative comments about our products and services? There are three possible options here. First, we can ignore it and just leave it there. Second, we can delete it. Third, we can respond and explain it. Ignoring it and leaving it on the site signals that our site is not just a site that allows only positive comments and thereby creates in image of being more trustworthy and transparent. However, if the negative comment is incorrect, not responding to the comment allows users to have the wrong impression of the company. The other extreme response is to delete it. This removes the negative impression but just opposite of the one just considered, it creates the image that no negative comments are allowed creating the impression that the site is only there to promote our products and therefore not allowing users to see both sides. The third approach does not ignore the comment nor does it delete it but rather responds to it. If the comment is true, we acknowledge the truth of the comment, then provide an explanation of why it occurred and what was done about it. If this is the first time the company has heard of the complaint, prompt action should be taken and then recorded in responding to the comment.

Finally, what about employees comments on the page. Are employees of the organization encouraged or even allowed to comment in an unofficial capacity in social media about the products and services of the company? If so, what can they say and not say, how should they say it? How do members of the organization charged with responding to the customers in social media do so? What can they respond to on their own initiative and what do they need to escalate to leadership? All of these questions need to be considered as part of a **Social Media Policy**, the principles by which the organization will utilize social media. Some guiding principles for this policy should be honesty and integrity, we always tell the truth even when not convenient for us and we tell it promptly. Second, we are transparent and open. We don't hide things we tell the whole story and explain it to our customers. All of these considerations should be addressed in your Social Media Policy.

COLLABORATION

The internet and social media also enable more collaboration between individuals and organizations. The Merriam-Webster dictionary defines **collaboration** as "to work jointly with others or together especially in an intellectual endeavor" (https://www.merriam-webster.com/dictionary/collaborate). For the purposes of this section, we want to emphasis the idea of working jointly. When we collaborate, we often work together to accomplish a task. In so doing, we iteratively develop our deliverable and through constructive feedback improve it with each iteration so that at the end we have the best product the team can produce. In contrast, **cooperation** for which the Merriam-Webster second definition is "association of persons for common benefit" (https://www.merriam-webster.com/dictionary/cooperation), emphasizes the idea of working separately. Here each member produces their own work and at the end they join their individual activities together to make the deliverable.

In college group assignments, it is often found that groups tend to cooperate rather than collaborate. They may divide up various parts of the assignment and then close to the due date, they join the various pieces together with relatively little review and iteration. Very seldom do they take the time to work simultaneously on a deliverable or take the time to iterate through multiple versions. As a result, sometimes projects seem like what they area, the product of several individuals addressing various parts of the project with little integration and often with conflicting ideas. If collaboration were used, these issued would have been resolved by constructive criticism and iterative development.

Whether cooperating or collaborating, there are two key aspects to team work: time location and geographical proximity. **Time location** means is the clock time at which the different team members are working. Often there are wide disparities in the clock time between team members. For example. Team members in Auckland, New Zealand will be approximately 18 hours ahead of those in Atlanta, Georgia USA. **Geographical proximity** refers to the physical location at which the team members work. Team member in the same place are in close geographical proximity which those that are far apart are in dispersed proximity.

These two aspects create differences in how the teams work together. Teams that can meet at the same time can use synchronous communications. Those who cannot work at the same time must user asynchronous communications. Teams that may not be able to meet in the same room or at the same time are referred to as **virtual teams** meaning that must collaborate in different ways than those times that are co-located and usually must use technology to communicate with each other. Teams that can meet at the same time can use **synchronous communications**. Those who cannot work at the same time must user **asynchronous communications.** Table 11-3 illustrates how these two aspects drive the selection of communications technologies for collaboration.

	Synchronous	Asynchronous
Co-located	Microsoft Office Applications Google Docs Normal speech communications Shared Whiteboards	Google Docs Sharepoint Dropbox Email Discussion Forums
Not Co-located.	Skype WebEx Screensharing GoogleDocs VideoConferencing	Google Docs Sharepoint Dropbox Email Discussion Forums

Table 11-3: Collaboration technologies

Meetings where the team can work face-to-face in the same room can go on as they have for millennia: with just voice and paper or shared whiteboard communications. Alternatively, they can use technology to assist. The group members can display an MS Office document on a screen while they discuss it. Google Docs provides the capability for users to simultaneously edit documents. Thus, each team member can be at their own device working on the document and discussing the contents.

Where users are not in the same space, they can again use GoogleDocs to share and edit a document together while using a conference call technology such as Skype for voice communications technologies. Alternatively, if this is a presentation style of meeting, they can use WebEx or GoToMeeting to provide screen sharing capabilities in a webinar settings. **Screensharing** refers to allowing all the member so the team to see one of the members' desktops from their PC. A **webinar** is a contraction of "web based seminar" in which a presentation is performed online. Attendees see the computer screen often with presentation slides of the presenter. **Videoconferencing** refers to when each of the participants to the meeting is present in video on the conference. Each attendee will be required to have a camera on their computer with which to show their face. Skype and WebEx for example provide this capability.

Where team members must work asynchronously. Technologies that allow work sharing are employed. Here again technologies like GoogleDocs, Sharepoint and Dropbox allow users to work on documents at different times and put them in an agreed upon place for reference by other team members. Discussion forums such as a Facebook page are useful for where asynchronous opinion sharing can take place.

Media Richness and Collaboration Technology

When selecting collaboration technology, one must consider the "richness" of the medium in comparison with the type of communication to be done. As discussed above, different media have different richness. This variation in richness affects the dynamics of the meeting by way information is provided. For example, in a videoconference, a relatively rich medium, you can see the facial expressions and hear the voice inflection of the participants like what you can in face-to-face meeting. In Facebook postings however, a relatively non-rich medium, you only see the text and therefore do not have access to the facial expressions and voice inflections. Therefore, in a less-rich medium there is a greater potential for misunderstandings. Anyone who has participated in a seemingly endless Facebook flame war can attest to this fact.

Therefore, one must attend to the purpose of the meeting while selecting collaboration technology. Where sensitive subjects such as negotiations are taking place where it is important to have correct understanding of nuances, a richer medium should be selected. On the other hand where less critical goals are in view such as simple information transfer, a less rich medium can be used.

CHAPTER SUMMARY

In this chapter, you have seen how online business is done. We've covered how the internet technologies changed information economics. The internet eliminated the compromises necessary between reach and richness that existing before it. With web applications, businesses can now offer a richer experience while reaching more customers. This has resulted in an impact to how business is done. It disintermediated many businesses such as newspapers by the liberation of information from the physical carrier of it.

Web 1.0 technologies got transaction processing moved to the web. Using transaction processing websites, business could offer to sell products and services over the web. We saw various different business models by which this could occur. Direct-to-Consumer disintermediated the middlemen, distributors and retailers and allowed manufacturers to deal directly with customers. The full-service provider approach tries to create a one-stop-shop for all the customers' needs in a certain market. The whole of the enterprise approach integrated various different enterprises to give a common view for the entire company. Navigators are new with the internet providing a way for customers to find what they are looking for. Content providers are specialized firms providing content to other organizations' web sites. Virtual Communities provide a way to interact with all the customers of an organization to create buzz about and market the company's products and services.

Web 2.0 provides interactive capabilities to customers. Organizations can now interact and have a two way conversation with them. Using techniques such as netcasting, mashups, reputation systems, wikis, RSS feeds, it allows for user generated content to co-generate business for the organization. Social Media such as Facebook and Twitter, allow social interaction with customers and others. It facilitates marketing activities such as branding activities and viral marketing and market research. It further supports customer service actions by letting organizations know about issues much sooner than they otherwise wood. Social media also supports social networking by facilitating the creation of connections to those who we are interested in building a relationship with as well as means for increasing our social capital with them. A key application here is in HRM where we can recruit and hire candidates for positions. Social media also facilitates crowdsourcing and crowdfunding in that it allows your customer and suppliers to participate in the creation and funding of new products and services. All of this requires the organization to think through how social media will be handled within the organization. How it will be resourced and level of service provided to it, how negative comments will be handled and how organization members will deal with social media.

Internet technology also enables collaboration between team members in distant locations and on different working schedules. Different technologies exists to support the various geographical and time proximities to enable teams to collaborate.

The internet technologies provide a wide range of capabilities for 21st century business people to seek competitive advantage in their marketplaces. They have become necessary features of business that all business people will need to understand while doing business.

KEY TERMS

REVIEW QUESTIONS

1. What the differences between information and physical assets?
2. What compromises are made when we put the information asset inside a physical asset such as a book or a newspaper?
3. What is the effect on reach and richness when we separate information assets from physical assets?
4. How does blowing up the reach vs. richness tradeoff facilitate disintermediation?
5. What was the recognition that sparked Web 1.0?
6. What aim do B2C, B2B, C2C and G2C all have in common?
7. What does the direct to consumer model do to the traditional supply chain?
8. What are the keys to success for each of the different Web 1.0 business models?
9. What is the difference between a Web 1.0 application and a Web 2.0 application?
10. How can social media be used to support marketing? Customer Service?

11. How does social networking assist companies in recruiting? You in getting a job?
12. What are some of the issues that must be covered in a Social Media Policy?
13. What is the difference between collaboration and cooperation? How can you know when you are collaborating vs. cooperating.
14. What are the dimensions that drive your decisionmaking about which technologies to use to support collaboration for a team?

Chapter 12: Business Intelligence Methods and Ethical Principles

CHAPTER OBJECTIVES

After studying this chapter, you should be able to

- Discuss the nature of business intelligence and its roles in business decision making
- Discuss the process by which analytical questions are resolved
- Perform simple analytical analyses
- Discuss the key technologies used in the analytical process.

INTRODUCTION

Caesars Entertainment Corporation is "the world's most geographically diversified casino-entertainment company" (http://caesarscorporate.com). But it wasn't always that way, begun over 77 years ago as Harrahs it was a Nevada based corporation running casinos. In the 80s and 90s, the company faced a decision, to compete with other casino companies by building ever bigger and more expensive gaming facilities or to try to retain existing customers by building strong relationships with them (https://hbr.org/2003/05/diamonds-in-the-data-mine). Led by then CEO Phil Satre, Harrahs embarked on a company loyalty program, the first in the industry. They first got to know their customers by building a database about them based on data from their Total Gold player card program and then analyzing that 300 gigabyte database. This database include demographic information including addresses, ages, genders, as well as information about their gambling and spending habits.

They analyzed this data and clustered their customer base into about 100 different segments each with its own characteristics, spending and gambling habits. Surprisingly, they found that 26% of the customers generating 82% of the revenue and they were not the high rollers instead they turned out to be the middle-class folks who had the money and time to spend playing slot machines. They found that these customers reacted better to offers of free chips than hotel rooms and food because they were into the excitement of gambling itself (https://hbr.org/2003/05/diamonds-in-the-data-mine). From this they were able to calculate the "customer worth" of each individual segment. This led to the development of an industry first reward system, Total Rewards, that targeted these customers who received better service, and personalized communications. They teamed this with an emphasis on customer service and became leaders in the gaming industry. Today Caesars is a company that is run "by the numbers". Data driven decision making is the key to keeping Caesars on top in the industry. The capability to gain business intelligence is driven by the capability to capture and process larger and larger amounts of data.

The story of Harrah's transformation should advance the idea to you that managing by analytics is not just a "nice to have" but is actually a requirement for successful competition in the 21st century. Driven by the technological improvements described in chapter 1, in the last 20 years we have achieved the capability to store and analyze huge masses of data which we could not have done in previous times. "Big Data" analytics is being adopted not just by industry leaders such as Harrah's but is now making its way into the mainstream of all companies. It's becoming a key differentiator between companies and will become simply routine in the future.
In this chapter, we will look at business analytics and learn what it is and how to perform analytical analysis.

WHAT IS BUSINESS INTELLIGENCE?

Numerous terms are used for the practice of gathering information from data to support decision making. Hugh Watson defines **Business intelligence** (BI) as a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions (Watson, Bi and How I Teach It, SAIS 2012). The term **Analytics** by itself refers to the data analysis part of BI (Watson, ibid). In each organization, BI activities should occur in an enabling environment.

Figure 12-1 shows the structure of such an enabling BI environment.

Insert Stock photo ID: 420420982

Figure 12-1: Business Intelligence based organization

When properly constructed, an organization gains intelligence by which to make decisions by extracting information from existing systems within the organization or from data sources external to the company. This information is processed and placed in a data warehouse. From this data warehouse. Information is extracted to be processed using analytical technologies in applications to provide actionable data for decisions. All this activity should be controlled by processes for describing the data, ensure that the data is of high quality and that the process runs to meet the needs of the organization.

THE BI PROCESS

The standard methodology for doing an analytic project is given by the **Cross Industry Standard Process for Data Mining (CRISP-DM)**. This is a public standard developed in 1996 and used by over 40% of organizations surveyed by KD-Nuggets (http://www.kdnuggets.com/2014/10/crisp-dm-top-methodology-analytics-data-mining-data-science-projects.html). As such it is the most widely used process within the field. It is an industry neutral and tool neutral process for data mining.

As shown in figure 12-2, the CRISP-DM process has six iterative steps.

1. Business Understanding
2. Data Understanding
3. Data Preparation
4. Modeling
5. Evaluation
6. Deployment

In the **Business Understanding** phase, the BI analyst asks a question to be solved by analytic analysis. To properly ask the question, we must understand the business issue to be resolved and the problem domain initiated the study. This requires that the analyst understand the business or have access to domain experts who do understand the business. This is critical to properly understand the data and how it interrelates with itself and what it means in the business.

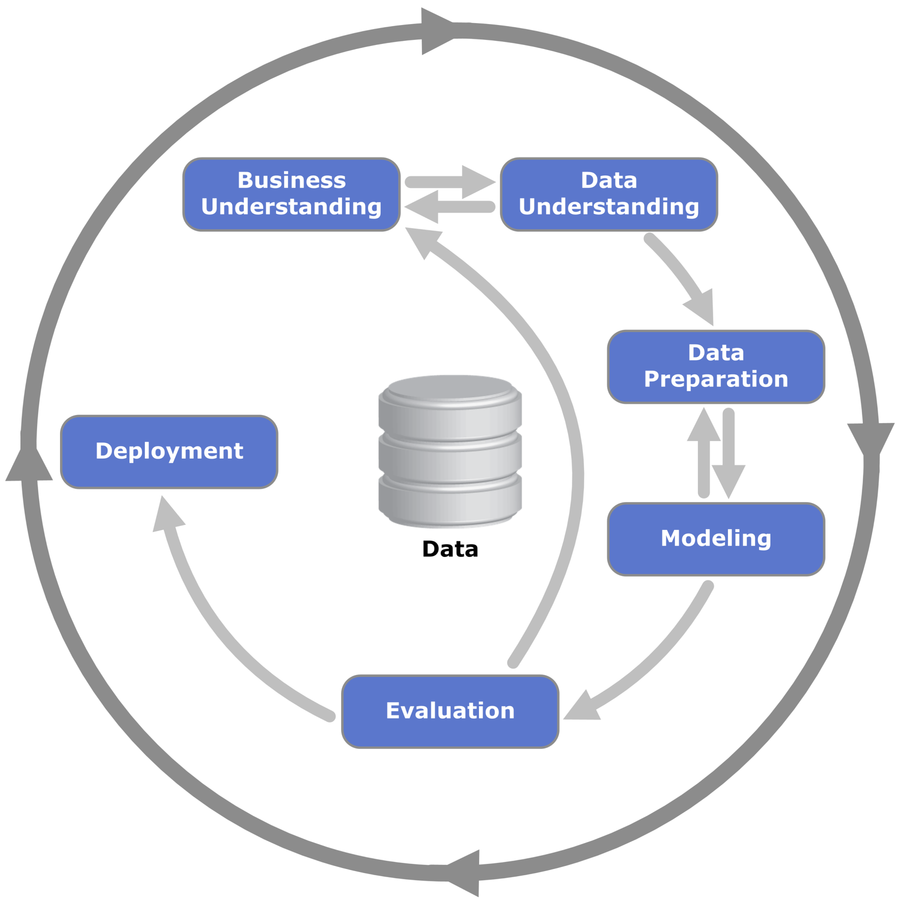

Figure 12-2: CRISP-DM process

CRISP-DM Process diagram by Kenneth Jensen (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons
From (https://itsalocke.com/crisp-dm/)

Once we understand what it is we are trying to learn, in the **Data Understanding** phase, we investigate the data that exists for us to determine an answer. In this phase, we examine data sources that are available from both within and without the organization. Then we look at each data source and determine its suitability to enable us to answer the question we have posed. Multiple data sources might be needed to arrive at an answer. To truly understand the data, we have to understand the contents of each field in the data source, its format, how often it is updated and many other characteristics. Data sources can include in-house systems such as an ERP system. They can also include sources such as governmental bodies such as Federal Government Census data, voter registration and voting records data or data purchased from others such as POS data from retail stores. It can also include non-digital data such as hand written notes. This process may account for 50 to 80% of the project cost (Sabherwal and Becerra-Fernandez, 2011).

An important consideration here is to determine the **Data Quality**, its appropriateness for use in our analysis. For BI purposes, we must understand the amount of data in each field that is missing, its validity, and its granularity. If many records in the data source have no value or invalid values in a field that is critical to our understanding of the problem, then this data source is probably not very useful for our purposes. If the data is at too coarse a granularity then we either must find a way to break it down into multiple records at the right granularity or decide that this data source is not useful. If the granularity is too fine, then we need to summarize the data into a coarser set of records.

If after examining the available data, we find that we do not have the data that we need to arrive at answer to our question, then we need to return to the Business Understanding phase and reassess our question to find one for which we have the data.

Once we have assessed the data available and found that we have the data that we need to answer our question, we then perform the **Data Preparation** stage. In this phase, we **Extract, Transform and Load (ETL)** the data. Extract means to take the data from its source. We may not need all the records or all the fields on each record in which case only those records or fields needed are extracted. Transform refers to converting the data from the source into the form needed for analysis. Missing data is populated with default values, invalid data is corrected, too fine data is summarized. If we are using data from multiple data sources, it must be combined into a single source. Once prepared, the data is loaded into a dataset to be used by the analysis routines. At this point, the total data set is partitioned into Modeling and Validation datasets. The Modeling dataset will be used in the Modeling phase to create the model, while the Validation dataset will be used in the Evaluation phase to determine if the model is accurate.

In the **Modeling** phase, depending on the question different analytical techniques are applied to arrive at a model of the data. These various techniques are discussed below. The object of data model is to provide a way to answer our questions. For example, if our question was, to ask what were the characteristics of the customers that most purchased product X, the resulting model might be a decision tree that illustrates the different characteristics and their propensity to buy product X. At this stage, it may be determined that the data is insufficient or improperly prepared in which case we return to the data preparation stage to revise the data used for the analysis.

A key aspect to the modeling phase is the presentation or **Visualization** of the model. Visualization refers to how we display to model to its users. It can be as simple as a chart showing the decision tree to answer the question described above or a simple application that allows the user to enter the characteristics of the customer and receive a number showing their propensity to buy. The visualization of the model is critical for the acceptance of the data model.

Once the model is prepared, it must be validated. In the **Evaluation** phase, we determine if the model generated provides valid answers to our questions. The evaluation takes two different approaches. The first approach evaluates if the *process* for developing the model was appropriate. We verify if sampling was done correctly and the analysis routines properly executed. The second approach validates the results. This is done through a process of using validation data sets to test the model. The objective here is to determine if the model returns similar results when processed used the validation datasets.

Once the model has been verified to operate successfully, moves into the **Deployment** phase. In this phase, the model is provided to business units to provide guidance to operations. While it is deployed, it must be monitored to ensure that it continues to provide valid advice. As will be discussed below conditions may change which invalidate the model, so it should be continually revalidated. One way to do this is to regenerate the model periodically using new data which will refresh the model with more recent information.

EXTRACTION, TRANSFORMATION AND LOADING OF DATA FOR BUSINESS INTELLIGENCE.

The BI process is all about information. That is why in the second step of the process, we say we transform the data. In this section, we discuss the nature of the data in the BI process and how it is worked with to make it ready for analysis.

Extraction

In the data understanding phase, we identify the data and its location and state to be used in the analytical processes. This is referred to as **Extraction**. Data is taken from the data sources to be prepared for analysis. This data can come from internal sources, e.g. the databases used in the transactions systems of the organization. In this case, queries can be written to go against the database and produce a file of the information desired. It can also be purchased from external sources. E.g. food manufacturers will purchase point of sale data from grocery store chains. Public databases such as voter registration rolls, U.S. Census data and property tax information which is publically available can be utilized. Once extracted, this data is usually formatted in the form of a relational database.

Relational Databases

A **relational database** can be thought of as a self-describing collection of integrated records. It is a collection of records about different entities. These entities might be inventory items, customers, transactions, facilities, etc. They store all the information we might want to know about the entity. Each of these records is composed of **fields** or **columns**, a series of bytes that contains the information about a field. **Records** or **rows**, are a series of fields that describe one particular instance of that entity. All the records for an entity together form a **file** or **table.** This relationship is shown in figure 12-3.

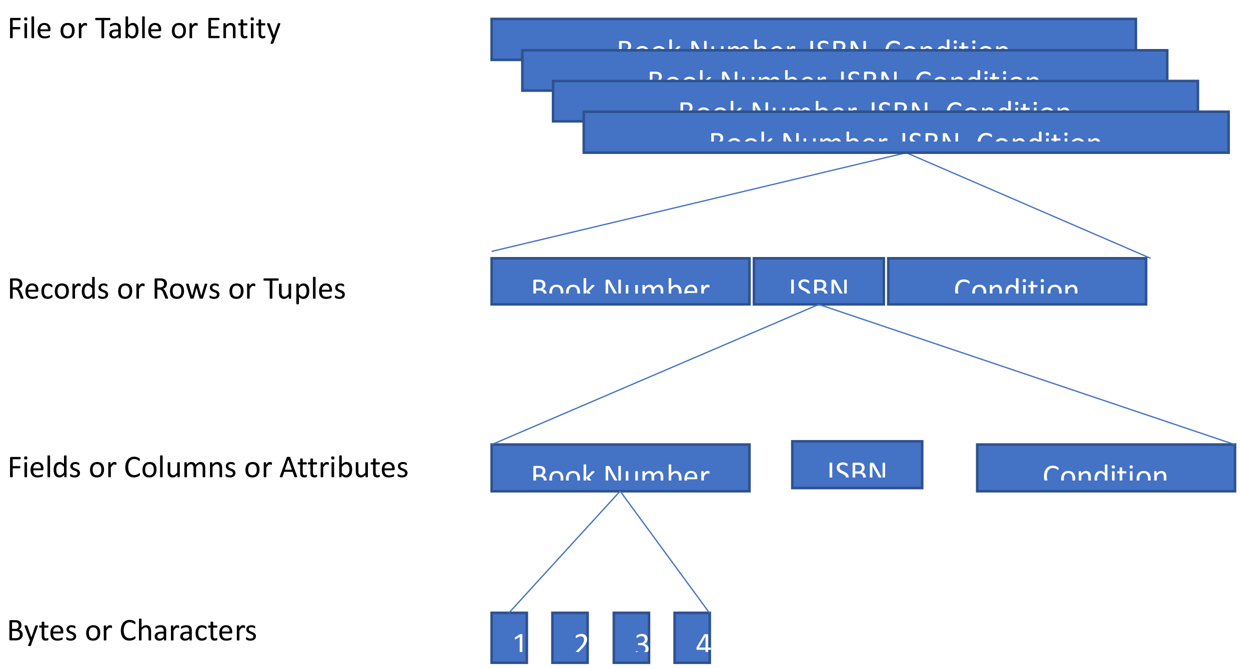

Figure 12-3: Data Elements in a Relational Database

Database tables are related to each other by means of keys. The keys indicate the relationships between the tables. A **Primary Key** is a field or set of fields in a table that make a record unique in the table. For example, in figure 12-4, Book Number is the primary key of the Book Table. In the inventory table, it is possible to have two copies of the same book so there will be duplicates of the ISBN field. Additionally, there are only a limited number of values for the Condition, so there can be duplicates of the values in Condition, so Book Number is the only field that makes the record unique. Now, ISBN is the primary key of the Book table and AuthorID is the primary key of the Author table.

Note that the ISBN field is also found in the Inventory table as well as the book table. This is how the relational database connects tables. The ISBN field acts as a **Foreign Key**, a primary key of one table found in another. By using the foreign key, if we need more information about a particular book found in inventory we can use it to access the book table and get more

Inventory Table

Book Number	ISBN	Condition
95234	978-0-07-340298-X	VG
107236	978-0-07-340298-X	Fair
110344	978-0-15-329759-0	VG

Book Table

ISBN	Author ID	Title	Date Published
978-0-07-340298-X	9123	Fields of Weeds	2014
978-0-10-892037-7	8362	Office Hours	2012
978-0-15-329759-0	7839	Simple Networks	2014

Author Table

Author ID.	Name.	City.	State	ZIP
	Bullington, Joe	Atlanta	Georgia	30305
8362	Rutner, Paige	Dallas	Texas	75062
9123	Williams, Susan	St. Simons	Georgia	31522

Figure 12-4: How Keys Integrate a Relational Database

information about that book. Similarly, the Book table has the Author ID in its records. Author ID is the primary key of the author table so that we can more information about the author of that book from the Author table. If we use all the foreign keys here we can build a record that has all the information in all three tables on it.

It is self-describing because it includes **Metadata**, data about data. In figure 12-5, we see that MS Access provides the ability to provide a description of each field. Access also allows the user to see the parameters of the data. In this example, Course ID is described as the "Number of the course in the file", it is a "double" field size, is formatted as a general number and is required when a record is created, etc. These examples of metadata provide information about each field and the file for the user's reference.

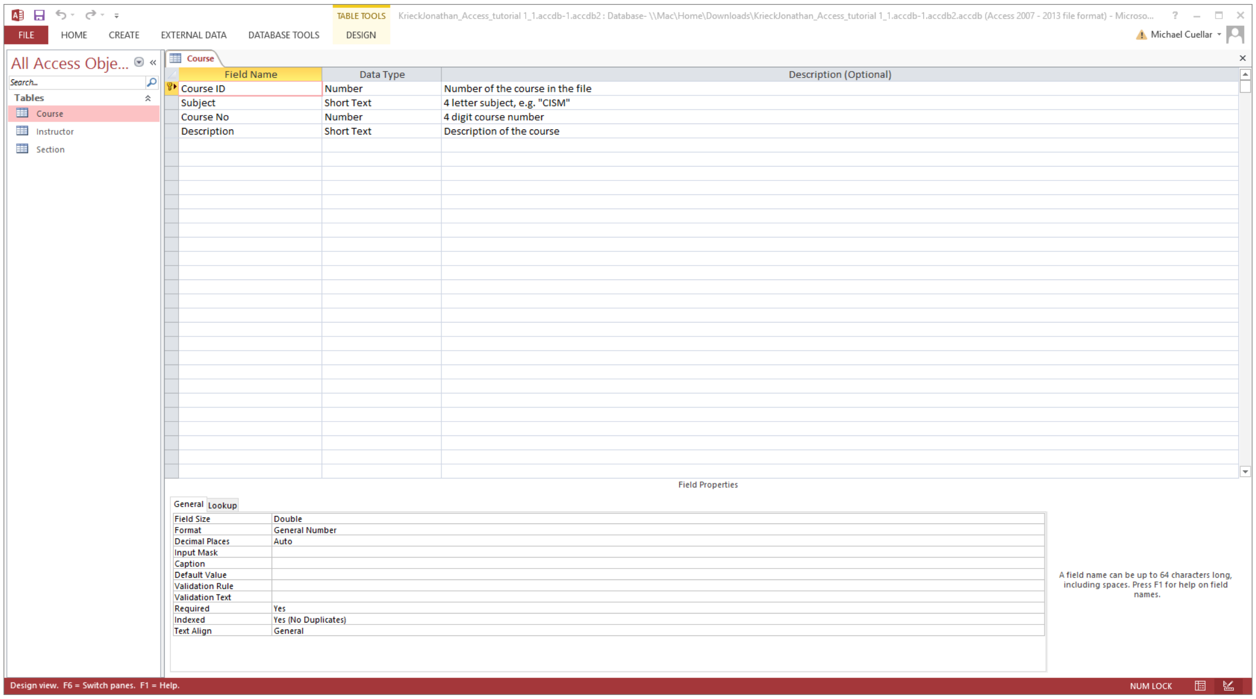

Figure 12-5: Example of Metadata from MS Access

All this information will have different contents and formats even for data that is supposed to be about the same information. When all the data is collected, we need to transform the data, that is prepare the data for analysis.

Cleansing

Once the data is extracted and stored, its quality for BI purposes must be assessed. Information quality is measured by examining several characteristics of the data for its use in this particular analytical process. When this is done, it is said we are examining its cleanliness. **Cleanliness** refers to whether the in the fields is valid. If data is missing or not incorrect for the field, the dataset is said to contain **dirty data**. Invalid data occurs when the contents of a field is wrong. E.g. if a zip code field which should be all numeric for United States addresses contains letters, then the data is invalid. Similarly if instead of zip codes stored in the field, phone numbers of bank account numbers are stored in the field, the data is invalid and therefore dirty.

Cleanliness also includes such dimensions as accuracy, relevance, and granularity. **Accuracy** refers to the correctness, completeness of the data. **Relevance** refers to the idea that the information must be needed for the analysis. **Granularity** means that the level of detail must be correct. If we a looking at sales information for the quarter and the data that we have extracted is for each individual order, the data that we have is too **fine granularity**, it is too detailed. The data must be summarized to get to a **coarse granularity.**

To cleanse the data various techniques are undertaken. Missing data may be replaced by default values ore the average of all the other values depending on what will work for this analysis. Inaccurate data must be corrected. Irrelevant data should be removed. Data at the wrong granularity must be summarized or taken to more detail.

Transformation

Once the data is cleansed, it must be transformed or put into the right form for use by the analytical program. Different programs have different format requirements. Alternately, the data could be stored in a data warehouse. A **data warehouse** is a store of data set aside for analytical purposes. Data warehouses provide a standard set of organization wide data. It provides such benefits as standardization of data e.g. standard naming conversions and coding formats (e.g. Male/Female is 1/0). This repository of data becomes the standard place to extract data for analytical purposes as it will have already been cleansed and summarized to the appropriate level. **Data Marts** are subsets of the data warehouse that are created for focused analyses. Data marts may be created to contain data relevant to a particular department within the organization or to prevent spread of sensitive information to those who do not need access to it.

TYPES OF ANALYTIC PROCESSES

In the Modeling phase of the BI process, there are a number of different analytical techniques that can be used to examine the data. The objective of using these tools is to identify patterns in the data that can be used to guide decision making. There are three broad categories of tools that can be used: descriptive analytics, Predictive Analytics and Prescriptive Analytics.

Descriptive Analytics

In **descriptive analytics**, we answer the broad question, “What has happened?” These analysis tools allow the user to look at the past activity and identify what has occurred. The techniques used here report the past results, cluster or segment data. Thus, it identified what has historically happened but does not predict what will happen in the future or prescribe what should be done. Examples of these techniques include Online Analytical Processing, Dashboards, and RFM analysis.

Online Analytical Processing

Online Analytical Processing (OLAP) tools are used to query the data and to provide a multi-dimensional picture of the data known as a **cube**. Data is viewed across a set of dimensions which categorize the data which is known as **measures**. An analyst can manipulate or **pivot** the cube to look at the data in different ways. He/she can also **rollup** to higher levels of summarization or **drill-down** to get more detail about data. A good example of an OLAP tool is the Excel Pivot table functionality. Figure 12-6 provides an example of a pivot table.

Sales by Region	**Value Sold**			
Date	**NO**	**SO**	**WE**	**Grand Total**
02/05	1,528,078.00 €	2,139,890.00 €	1,177,004.00 €	4,844,972.00 €
02/10	1,597,349.00 €	1,726,996.00 €	1,480,794.00 €	4,805,139.00 €
02/15	1,450,919.00 €	1,926,008.00 €	1,379,042.00 €	4,755,969.00 €
02/20	1,668,643.00 €	1,919,087.00 €	1,149,768.00 €	4,737,498.00 €
Grand Total	**6,244,989.00 €**	**7,711,981.00 €**	**5,186,608.00 €**	**19,143,578.00 €**

Figure 12-6 Pivot Table of Sales by Date

In this table, we can see the sales by day. We can see that sales per say were relatively consistent and that more value was sold in the South and that the West but it doesn't really tell us anything about the relative sales of the various products. So, we can pivot the table to see how the products did. We remove the days and substitute in the products. This new table is shown in figure 12-7.

Sales of Product by Region	**Column Labels**			
Row Labels	**NO**	**SO**	**WE**	**Grand Total**
1kg Blueberry Muesli	1,071,464.00 €	805,973.00 €	617,055.00 €	2,494,492.00 €
1kg Mixed Fruit Muesli	207,170.00 €	442,549.00 €	339,589.00 €	989,308.00 €
1kg Nut Muesli	814,890.00 €	1,018,810.00 €	760,692.00 €	2,594,392.00 €
1kg Original Muesli	138,060.00 €	73,726.00 €	105,791.00 €	317,577.00 €
1kg Raisin Muesli	669,301.00 €	764,271.00 €	801,202.00 €	2,234,774.00 €
1kg Strawberry Muesli	576,840.00 €	1,254,054.00 €	431,700.00 €	2,262,594.00 €
500g Blueberry Muesli	637,728.00 €	1,097,285.00 €	501,063.00 €	2,236,076.00 €
500g Mixed Fruit Muesli	127,394.00 €	267,869.00 €	136,839.00 €	532,102.00 €
500g Nut Muesli	900,877.00 €	327,065.00 €	274,082.00 €	1,502,024.00 €
500g Original Muesli	163,947.00 €		68,040.00 €	231,987.00 €
500g Raisin Muesli	309,101.00 €	723,056.00 €	474,965.00 €	1,507,122.00 €
500g Strawberry Muesli	628,217.00 €	937,323.00 €	675,590.00 €	2,241,130.00 €
Grand Total	**6,244,989.00 €**	**7,711,981.00 €**	**5,186,608.00 €**	**19,143,578.00 €**

Figure 12-7: Example OLAP Cube showing Drill down into Sales of Products by Region

In this table, sales are broken out but the dimensions of product on the rows and regions on the columns illustrating the way that sales are distributed over the regions. Thus we could say from this pivot table that the South region of Germany prefers Strawberry Muesli, followed by Blueberry and Nut Muesli while the North region prefers Blueberry Muesli followed by Nut and Strawberry. This gives us valuable information to plan inventory levels in the different regions.

Dashboards

Another form of descriptive statistics is the use of a dashboard. A **dashboard** shows on a visual basis the information needed for a function. Using tables, charts, graphs, speedometers, stoplights and other indicators it provides easily accessible data. Figure 12-8 shows an example dashboard for a social media application.

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Figure 12-8: Social Media Dashboard

This dashboard provides summary numbers for orders, earnings and sales percent. Then it provides a number of icons to illustrate progress on Maintenance, Visotrs and type of device usage. On the bottom it shows a graph of the activity on Twitter, Facebook and Behance and the progress with activity.

Recency, Frequency, Money Analysis

Recency, Frequency, Money Analysis or **RFM** is a method of analyzing and classifying customers based on their historical purchasing patterns. Based on how recently (R) a customer has purchased, how frequently they have purchased (F), and how much money they have spent (M) it allows organizations to classify their customers in terms of these three characteristics and then based on that classification to make some decision about how to relate to them.

To do an RFM analysis, the process is conceptually very simple. Say for example we wanted to know how to work with various contributors to a non-profit for an upcoming promotion. We need information on the recency of donation, frequency of donation and total dollar amount of donation. We recognize that we have this in the order management files of the ERP system. We extract Information on each donor's contributions. Then the data is prepared for analysis by identifying for each customer the date of the most recent donation, then computing the number of donations over the time period we want to consider and the sum up the total volume of donations for each customer. For example, the data might appear as in figure 12-9.

Contributor	Last Contribution Date (Recency)	Number of contributions in the last year (Frequency)	Dollar volume of contributions (Money)
1	4/7/13	10	100,000
2	7/1/12	1	10
3	9/1/12	10	50,000
4	4/1/13	1	500,000
5	7/1/13	5	20,000
6	12/1/13	7	10,000

7	1/1/14	10	5,000
8	4/1/14	1	20,000
9	4/1/14	20	500
10	9/1/13	5	75,000

Figure 12-9: Prepared data for RFM analysis.

Then each of the columns is sorted and the divided into five sections based on recency of purchase. You give the most recent 20% of donors a R score of 1 then next most recent 20% an R score of 2 down to the least recent 20% an R score of 5.
Then each of the columns is sorted and the divided into five sections based on frequency of purchasing. You give the 20% of donors with the most purchases a F score of 1 then next 20% an F score of 2 down to the least recent 20% s an F score of 5.

Finally, each of the columns is sorted again and the divided into five sections based on total volume of money donated. You give the highest volume 20% of donors a M score of 1 then the next highest volume 20% an M score of 2 down to the lowest 20% an M score of 5. After all three actions are taken, you arrive at figure 12-10.

Contributor	Last Contribution Date	Number of contributions in the last year	Dollar volume of contributions	R	F	M
4	4/1/13	1	500,000	4	5	1
1	4/7/14	10	100,000	1	2	2
10	9/1/13	5	75,000	3	3	2
3	9/1/12	10	50,000	5	2	3
5	7/1/13	5	20,000	4	3	3
8	4/1/14	1	20,000	1	5	3
6	12/1/13	7	10,000	3	3	4
7	1/1/14	10	5,000	2	2	4
9	4/1/14	20	500	1	1	5
2	7/1/12	1	10	5	5	5

Figure 12-10: Data processes and Assigned RFM scores.

With this table, you can now determine what to do with each customer during a sales promotion for example. Suppose we decided to save marketing dollars we won't contact customers who score 4 or 5 on all three of the RFM dimensions. This means that customers such as customer 2 will not be contacted. Similarly, if we have some big contributors who have not donated in a while, we want to contact them specially to ask for a donation. This means that customers who score a 1 or 2 but scored a 4 or 5 in R and F would receive this approach. Thus donor 4 would receive this approach. Finally, we want to contact frequent and recent but small contributors to try to get them to give more. We would identify them as donors with an M score of 4 or 5 but R and F of 1 or 2. Thus donors 7 and 9 would receive this treatment. All other donors would receive the standard literature.

You can see how by describing your donors in this way, you can save marketing dollars by not approaching non-responsive donors and make your effort more effective by giving special targeting to certain classes of donors.

Predictive Analytics

In this category of **predictive analytics**, we use techniques that will allow us to predict what will occur under certain situations. Predictive modelling can be used to in many different applications. In marketing, predictive analysis can be used to improve sales promotions and product loyalty, inform target marketing by finding segments of customers likely to respond to offers or appeals. It can also be used to find customers who are likely to switch brands (churn). In financial applications, credit scoring is an important application. Here predictive analytics can be used to identify which customers are likely to default on loans. Finally, fraud detection is another potential use for predictive analytics. Here we look at such transactions as insurance claims to anticipate fraudulent activity so that they can be investigated. This category includes such techniques as Regression Analysis, Decision Trees and Market Basket Analysis.

Regression Analysis

In **regression analysis**, the goal is to find an equation that best describes the effect on a dependent variable of a set of independent variables. The business object is to be able to predict the dependent variable based on the values of the independent variables. An example might be to predict sales based on the household income of the customer. Figure 12-11 shows an example visualization of this relationship.

Cluster Analysis

In **cluster analysis**, analysts attempt group together entities that have common or similar characteristics. In this analysis, we look for groups of cases that are similar based on a set of characteristics. Harrah's used cluster analysis to segment their customers into the 100+ groups of customers along with their gambling characteristics. Another example of cluster analysis is **Market Basket Analysis (MBA)**. In this type of analysis, different groups of purchases (market baskets are analyzed to determine which products a likely to be purchased together. As an example of MBA "In 1992, Thomas Blischok, manager of a retail consulting group at Teradata, and his staff prepared an analysis of 1.2 million market baskets from about 25 Osco Drug stores. Database queries were developed to identify affinities. The analysis 'did discover that between 5:00 and 7:00 p.m. that consumers bought beer and diapers'" (http://tx.liberal.ntu.edu.tw/~PurpleWoo/Literature/!DataAnalysis/What%20is%20the-true%20story-about%20data%20mining,%20beer%20and%20diapers.htm). While in this case the managers did not exploit the opportunity by adjusting store presentation to put beer and diapers together, they could have done just that and thereby bring more customers into the store.

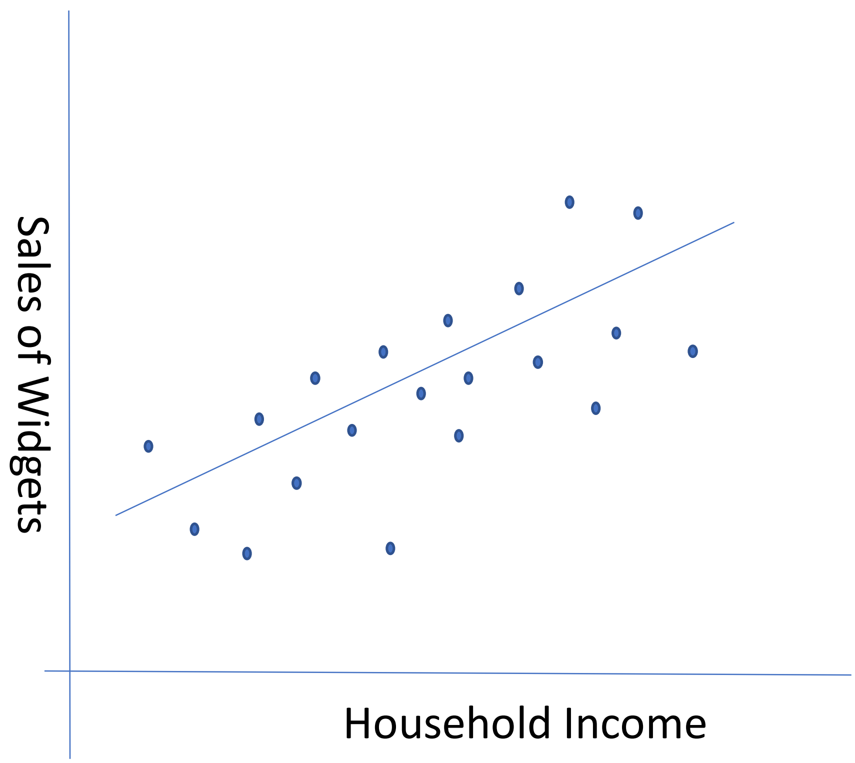

Figure 12-11: Example Regression Chart

Decision trees

A third form of predictive analytics is the use of Decision Trees. **Decision trees** are used to hierarchically describe decision rules that can be used to predict a certain characteristic or outcome. This is done by analyzing the effects of the characteristics of the data on the outcome. Today, decision trees are drawn by means of software. An analyst sets up the data for the program such as SAS Enterprise Miner and then the software creates the decision tree. An example decision tree is shown in figure 12-12.

In constructing a decision tree, the software processes the data through a series of steps at each step, it seeks to decide which of the characteristics have the strongest effect on the outcome. It then divides the data so that the results on the outcome are greatest. As an example, consider a set of data describing the giving patterns of of approximately 9700 donors to a charity. The charity is trying to understand what are the characteristics of the donors that have the highest propensity to give. When the data is entered into SAS Enterprise Miner, the software evaluates the data, it determines that the count of gifts given in the last 36 months provides the biggest effect and that the effect is most pronounced between donors who have given 2.5 times or more and those that haven't. This is known and the **split value**. Approximately 57% of the donors who have given less than 2.5 times in the last 36 months tend not to give while 57% the other donors tend to give. This creates two nodes. They are called **internal nodes**, because they are not at the end of a branch.

Then for each of those two internal nodes, the same type of analysis is carried out separately. For those who gave less than 2.5 times in the last 36 months, the software determines that Median Home Value is the most important characteristic and that a home value of $67350 is the split value. Here we see that 63% of those with a home value under $67350 tend not to give while of the others, 53% tend not to give. The software decides that at this point, any nodes that might be created from these two nodes would not be very significantly different, so it stops the process. These nodes not having any nodes below them are called **leaf nodes**.

On the other side, Enterprise Miner determines that the amount of the last gift is what is significant and that the split value is $7.50. 64% of those that gave less than $7.5 will give while only 53% of those who gave more than $7.50 will give. The less than $7.50 node is determined to be a leaf node and then the algorithm moves to last internal node. The software determines that of those, the time since last gift makes a significant difference with a split value of 17.5 months. About 59% of those who have given in the last 17.5 months will tend to give again, while only about 49% of the others will tend to give. The software then determines that there is no significant difference that can be made and both of those then become leaf nodes.

At this point, we can now use the leaf nodes to determine decision rules for those who will tend to give to the charity, the decision rules are

> If the donor has given more than 2.5 times in the last 36 months and their gift amount was less than $7.5, they will give approximately 64% of the time.
>
> If the donor has given more than 2.5 times in the last 36 moths and the gift amount was greather than or equal to $7.50 and the time since the last gift was less than 17.5 months, they will give approximately 59% of the time.
>
> All other classes of donor will give less than 50% of the time.

This then gives us some rules to follow to determine to whom to solicit donations. With these two rules we can cut down the number of solicitations to make from approximately 9700 to approximately 1550 saving a significant amount of time and money. In addition, the probability of a donation from a solicitation rises from 50% to 61.3% yielding a significant increase in efficiency.

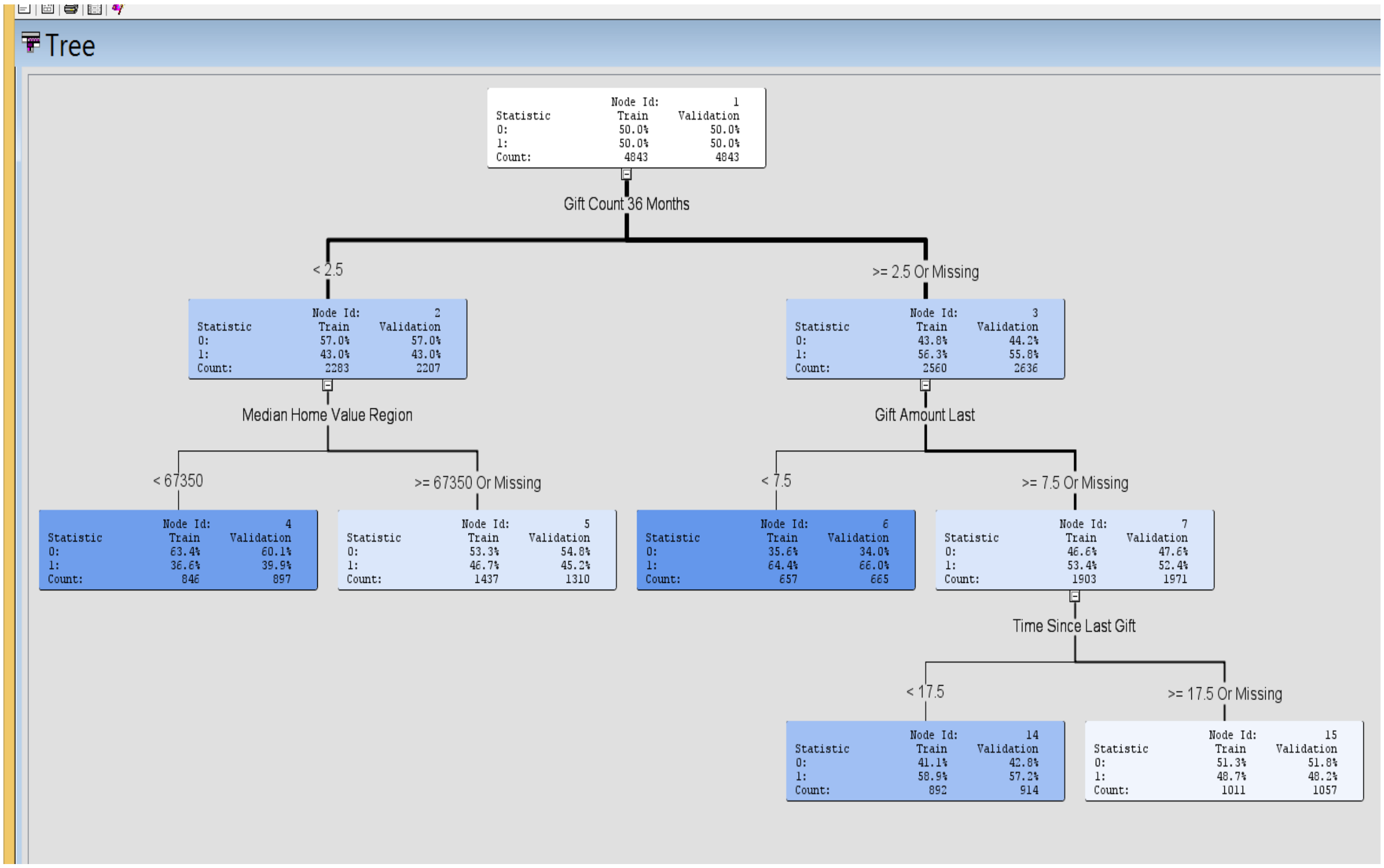

Figure 12-12: Optimal Decision Tree from SAS Enterprise Miner 12.1

Prescriptive Analytics

Prescriptive Analytics describes what should be done. They provide solutions to questions about such things as product mix or the location of warehouses. Tools such as linear programming provide support for this type of analytics.

Linear Programming (or Linear Optimization) is a technique for achieving optimal results under constraints. The objective here is to maximize or minimize a value subject to various constraints on actions. A typical example is a product mix problem.

Consider the following. XYZ corporation manufactures 4 products. The question that it faces is how much of each product should it make? They know how much time each product takes within each department on the manufacturing plant floor, how much time is available in each department and how much profit they derive from each product. They also have minimum production levels that must be maintained.

To solve this problem, they wish to maximize the amount of profit for this problem. This problem can be solved using the **Solver** add-in of Microsoft Excel. Solver is a free add-in that solves linear programming problems.

To user solver, they create a worksheet as shown in figure 12-13.

A	B	C	D	E	F	G	H	I	J
Department									
Product	Wiring	Drilling	Assembly	Inspection	Unit Profit		Number Produced		Profit
Xj201	0.5	3	2	0.5	$9		150		$15,600
XM897	1.5	1	4	1	$12		0		
TR29	1.5	2	1	0.5	$15		950		
BR788	1	3	2	0.5	$11		0		
Production Time			Production Level						
Department	Time Avail		Product	Min. Prod. Level					
Wiring	1,500		Xj201	150			Wiring Used	1500	
Drilling	2,350		XM897	100			Drilling Used	2350	
Assembly	2,600		TR29	200			Assy Used	1250	
Inspection	1,200		BR788	400			Inspection Used	550	

Figure 12-13: Worksheet setup to address a Solver problem

Then, they set up solver as show in figure 12-14. The profit computation is identified to be maximized. The numbers of each product produced are maximized. This done subject to the constraints and the time used cannot exceed the amount of time available in each department nor can it be less than the minimum production level. Once the solver program is executed, solver changes the numbers of each product produced until profit is maximized. It then produces a solution: XYZ should produce 150 of project ZJ201 and 950 of product TR29 and none of the XM897 or BR788. Profit will be maximized at $15,600.

Thus, you can see that XYZ has learned the optimum profit mix that will produce the most profit subject to production constraints.

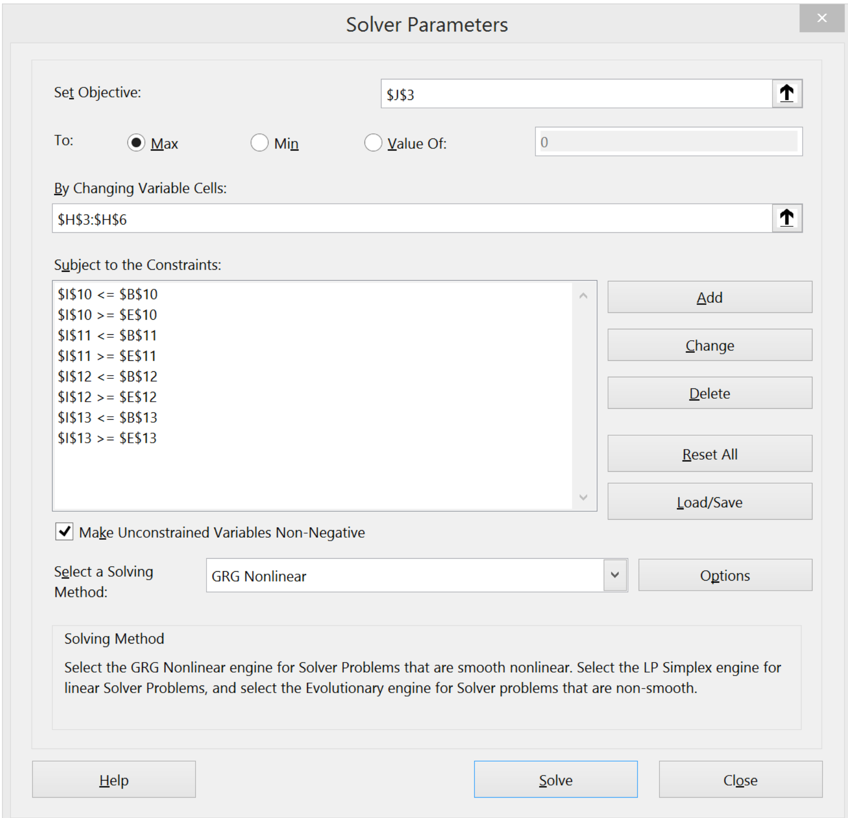

Figure 12-14: Solver setup for the XYZ manufacturing problem.

BIG DATA

Today with its increasing information flow in all aspects of lift has resulted in an increasing amount of information available for analysis. Datasets have according become much larger often increasing over a petabyte in size. These large datasets have been termed **Big Data**. Big data is determined by its *volume*, when it exceeds a petabyte in size; its *velocity*, when it is generated rapidly; and by its *variety*, when it comes in many forms: structured, free-form text, bitstream data, audio and video. These differences make the traditional forms of data management such as relational database difficult or impossible which has lead to the rise of new technologies to handle big data.

MapReduce

MapReduce is a programming model by which large datasets are broken into pieces and analyzed on multiple processors. Each processor produces keys and associated values for these keys. These multiple key results are then consolidated (reduced) into a single key/value combination.

For example, consider counting word occurrences in a large data set. A master processor is responsible for controlling the entire process (Figure 12-15). The master processor identifies the number of processors available for mapping and reduction processing and then determines how many mapping processors are required and how many reduce processors are required. It then divides the dataset into pieces for each mapping processor and determines which reduce processor will process what intermediate data. Each map processor then produces a map of each word with an associated count and writes it into a location on its local disk for each reduce processor to access. Each reduce processor accesses its area in the mapping processor for its data; combines the counts for its area which is then consolidated into a single count of all the words for the dataset. (Dean and Ghemawat, MapReduce: Simplified Data Processing on Large Clusters, http://static.googleusercontent.com/media/research.google.com/es/us/archive/mapreduce-osdi04.pdf)

Thus by harnessing the power of multiple processors and having them work simultaneously, a BigData dataset can be processed very rapid. Google processes the enormous amount of data resulting from each of its searches in under a second.

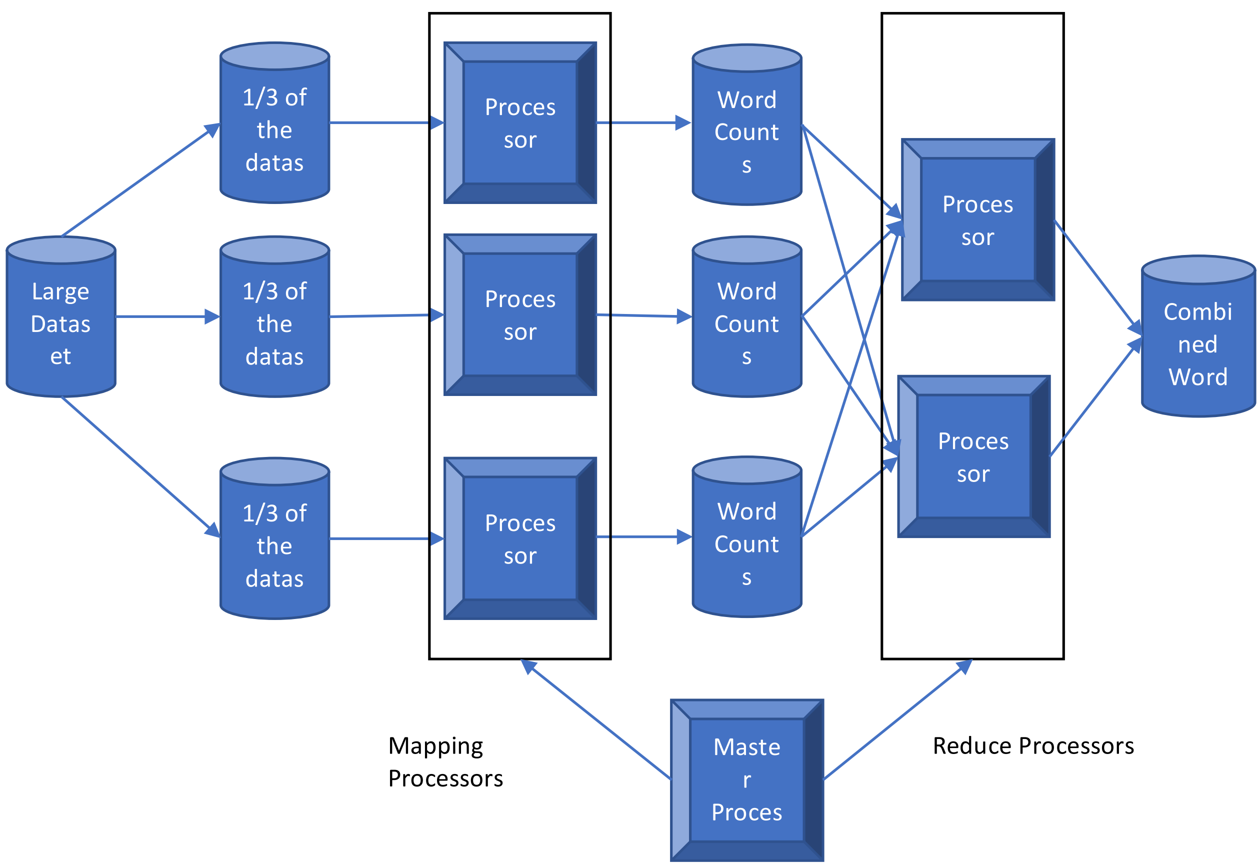

Figure 12-15: Illustration of the MapReduce Process

Hadoop

Hadoop is an open source project that implements the MapReduce process. In addition to the MapReduce process, it provides a **Hadoop file system (HDFS)** in which the dataset is stored across multiple computers. The HDFS provides the capability to replicate, balance and move data around from the different machines to ensure reliability and performance. It has been used to perform management of many types of Big Data, e.g. clickstream analysis, marketing analytics, image processing, web crawling and general archiving. It is used by half of the Fortune 50 companies, Facebook, and Yahoo!.

BI ETHICAL ISSUES

In the movie, *Spiderman*, Uncle Ben kept repeating "with great power comes great responsibility". With analytical techniques, we have great power. Take for example the case of Target and their attempt to market baby supplies. In 2002, the marketing department asked the question "How can we find out if a customer is pregnant, even if she didn't want us to know?". The idea here is to identify pregnant women before they give birth so they can market to them and get them to come to Target. Customers usually have brand preferences and they shop for one thing at this store and for another that a different store. These brand preferences all break down during times such as the birth of a child and Target wanted to get on this before their child's birth became public record so that they could have customers increase their spend at Target. The object was to send special ads to the customers prior to birth.

Target had a vast amount of data on customers. Every time you shopped at Target and used a credit card or coupon or filled out a survey or mailed in a refund, open an email or visit they website, they recorded that interaction and filed it under a "Guest ID" number. To this they added publically available information about demographics, court records, home ownership, educational status, what you talk about online, your brand preferences and more. All that was needed was to analyze it.

Target began by analyzing trends of customers on the baby registry. By identifying those customers and then analyzing their buying patterns they gained some useful insights. They switched from buying scented to unscented lotions in the second trimester. They loaded up on supplements like calcium, magnesium and zinc as well as soap and cotton balls. In total, they identified 25 products that allowed them to calculate a "pregnancy prediction score" and estimate their due date. This allowed them to provide them with targeted coupons.

After about a year, a man stormed into the local target store demanding to see the manager. Clutching a handful of these pregnancy related coupons, he ranted to the manager about how he was outraged that they would send them to his high school age daughter. The manager not nothing anything about the couponing program was profusely apologetic. A few days later he called back to apologize again. At this point the father himself indicated that he need to apologize. It seems that he was not aware of what was going on and his daughter was in fact pregnant.

What Target learned from this was that they should not send strictly pregnancy related coupons as that would be considered "creepy." "How do they know I'm pregnant?" Instead, they learned bury those coupons in a circular containing other non-related coupons to reduce the impression of stalking. The program as a whole was very effective. Between 2002 and 2010, revenue from grew over $23billion to over $67 billion. Most of this increase was attributed to a "heightened focus on … specific guest segments such as mom and baby." (http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html?_r&hp=&pagewanted=all)

The message for the rest of us is rather frightening. Companies such as Target and indeed the government possess and collect large amounts of data on us. If Target can determine from something as obscure as buying patterns a life condition such as pregnancy, what else is possible? Can the government use this to identify us engaging in behaviors of which they do not approve? To this point, we have been developing analytics and using them because we can without regard to the impact on people and their privacy. We are doing these things because we now have the ability to do so without regard to whether we should do so. This raises questions about the privacy of our information. We now turn to a discussion of privacy and organizations ethical obligations related to information.

Privacy

James Moor has defined **privacy** as

> *An individual [has] privacy in a situation with regard to others if and only if in that situation, the individual [is] protected from intrusion, interference and information access by others. (Moor, James H. 2000. "Toward a Theory of Privacy for the information Age." In R.M. Baird, R. Ramsower, and S. E. Rosenbaum, eds. Cybterethics: Moral, Social, and Legal Issues in the Computer Age. Amherst NY: Prometheous Books, pp. 200-12.)*

This definition of privacy includes several elements. Unwarranted intrusion, freedom from interference in one's decisions, one's ability to restrict access to and control the flow of one's personal information this includes freedom from surveillance, being followed, tracked, watched or intruded upon. A situation can refer to several things such as activities, relationships or storage in a computer that can be declared private.

In situations, we must distinguish between situations which are naturally private and those that are normatively private. In **naturally private** situations, we are protected from access and interference from others by natural means. For example, if you are alone in a computer lab, you are in a private location. However, if someone comes in to the lab, you have lost privacy, but your privacy has not been violated because you have no expectation of being alone. A computer lab is a public space and most of the time other people are there. **Normatively private** situations are those where there is an expectation of privacy, for example when in your home. These are often defined by laws and policies. By making this distinction, it allows us to identify conditions required for having privacy and a right to privacy and therefore a loss of privacy and a violation of privacy.

In making determinations about violation of privacy, we must determine if processes used for gathering and disseminating information (a) are appropriate for a context and (b) comply with norms of specific contexts. Appropriateness norms describes whether a type of information is acceptable to divulge in a certain situation whereas distribution norms restrict or limit flow across context. When you breach these norms, a violation has occurred.

In the Target case, we see that they used an aggregation of information to arrive at a knowledge of situations that are normatively kept private and disclosed only to selected people at selected times. In the case of the teenage girl, she probably didn't want her condition disclosed and she had a normative expectation that her condition would be disclosed on her timing and to the people she chose. Instead, Target arrived at a determination of her condition and then disclosed it publically by providing that information including her name and address to Target employees, postal service employees and her parents without her knowledge and consent.

As business professionals, we need to handle our customers' information in an ethical and responsible manner. In the next section, we articulate what we argue should be a data provider's bill of rights as related to their information.

Ethical Principles for Business Intelligence

Customers disclose personal information to organizations such as governments and companies for the purpose of facilitating transactions with them. In exchange for performing the transaction, they provide information. While they may appreciate it at times and other times not (see this clip from the movie Minority Report: https://www.youtube.com/watch?v=oBaiKsYUdvg), they do not provide the information to retailers for the purposes of facilitating their marketing to them or selling that information to others. Additionally, companies at present will not purge customer provided information on request. They view it as their information. We want to argue that it is not the company's information but rather is given to the company in trust. Thus, we argue that

I. The person or organization who provided the data owns the data and has the right to determine what is done with that data. This includes whether the data is used for any other purpose beyond facilitating a transaction.

We must remember that it is the customer's information not ours. We have the right to use the information only for the purpose that it was provided, unless we previously indicate to the customer that any information that they provide will be used for a different purpose. This implies the principle of **informed consent**. The customer must explicitly consent to any use of the information that they provide beyond the limited purpose beyond which they provide it.

By this standard, Target should have informed customers of the baby registry that their information would be used to develop information to be used to market additional products to them. Failing to do so was a misuse of the information under this principle. Similarly, governmentally collected data such as property records, tax rolls, voter registration information, census data should not be collected without disclosure that it will be released to other entities.

II. Data collected from non-private sources should be handled according to the reasonable expectation of privacy.

Surveillance cameras or pictures taken in public places create no expectation of privacy. If you are sitting on a public beach and someone takes a picture that happens to include you and posts it on Facebook, that is a proper use. However, if you are at a private party, then there is a reasonable expectation of privacy. Pictures taken at that party and posted on Facebook without the consent of people in them would be a violation of privacy unless the guests were told that such pictures would be taken and posted. Similarly, data transmitted over the internet should have no expectation of privacy. The information travels over publically accessible communications media and servers which may be privately owned but allow others not party to the transmission or transaction to access. Therefore, clickstream data and anything entered in a transaction and transmitted in cleartext should have no expectation of privacy. However, when encryption is used, that clearly signals that there is an intent to keep that information private and it should be handled as such.

III. The person or organization that holds another's data should delete any records on the request of the provider including any summarized information derived from that data.

Since the customer provides their data for the purposes of completing the transaction, they retain ownership of it. Even if they give prior informed consent for the use of their data for other purposes, if they decide to change their mind or to request deletion of the data, our organizations should delete that data on request.

IV. Companies hold data in trust for the owner and therefore must keep data secure from unauthorized disclosure

Since the company holds the data in trust for the customer, they have a responsibility to keep it safe and not allow disclosure to third parties without the permission of the customer. We have seen in recent years, stories of hacking incidents in which sensitive information was disclosed that threatened the financial well-being of millions of customers. We must take steps to ensure that no one without a proper need to access the information from employees to hackers has access to it.

V. Companies and governments cannot use the information for invasion of privacy of the data creators

This should probably go without saying based on the principles that have gone before, but uncomfortable situations such as those caused by Target should not exist. Our organizations should not infer private information from multiple sources and then use it to expose or market to them. While it is a reasonable action on the part of the US Federal government to seek to identify terrorists using analytical processes, it should consider the US citizens right to privacy and refrain from using the same techniques on its citizens.

SUMMARY

In this chapter, we have looked at the use of analytical tools to improve the decision making in the organization. We saw that the generic process by which we analyze data is defined by the CRISP-DM process. First, we determine a question to which we would like the answer. Then we determine the data that we have available to us to determine the answer. If the information is appropriate and useful, we proceed to analyze the data using descriptive, predictive or prescriptive tools to determine the answer to our question. We use appropriate methods of visualizing this data to the ultimate users of the data. Then we evaluate its effectiveness and if we determine it is useful, we deploy it to the field.

We saw that relational database technology creates a self describing collection of records that allows us to connect and relate data as needed to gain insight into reality. By merging these records through the use of keys, we can arrive at datasets that will contain the information that we can analyze to answer our questions.

Descriptive analytics tell us “what has happened” using techniques such as OLAP and RFM analysis we can “slice and dice” data to get to the answers as the state of affairs. Predictive analytics such as regression and decision trees, allow us to attempt to predict what will happen under various conditions. Finally, prescriptive analytics such as linear programming allows to make decisions as to what should happen; what will be the optimal decision under a set of constraints.

We also saw how that modern information technology and the internet create “Big Data,” massive databases that change often and are composed of wide varieties of data. These huge datasets make traditional relational database inefficient and therefore require special methods such as MapReduce and Hadoop to process them in an appropriate amount of time.

Finally, we saw that these techniques raise additional ethical issues that we need to concern ourselves with. As we saw with the Target case, by using these techniques we now have the unprecedented ability to intrude into people’s lives. We provided a set of five principles for information ethics that organizations can use to properly handle data and perform analytical analysis in an effective manner.

KEY TERMS

Accuracy 8	Analytics 2	Big Data … 18
Business Intelligence 2	Business Understanding 3	Cleanliness 8
Cluster analysis 13	Coarse Granularity 8	Columns 6

Cross Industry Standard Process for Data Mining (CRISP-DM) 2	Cube 9	Dashboard 11
Data Preparation 4	Data Quality… 4	Data Understanding … 4
Data Mart 9	Data Warehouse 9	Decision Trees 14
Deployment 5	Descriptive Analytics 5	Dirty Data 8
Drill-down 10	Evaluation 5	Extract, Transform and Load … 4
Extraction 5	Fields 6	File 6
Fine Granularity 8	Foreign Key 7	Granularity 8
Hadoop 19	Hadoop file system (HDFS) 19	Informed Consent 22
Internal Node 15	Leaf Node 15	Linear Programming 17
Market Basket Analysis 13		
Measures 9	Metadata 7	Modeling 4
Naturally Private 21	Normatively Private 21	Online Analytical Processing 9
Pivot 9	Predictive analytics 13	Primary Key 6
Privacy 21	Regression Analysis 13	Record 6
Relational Database 6	Relevance 8	RFM 11
Rollup 9	Row 6	Split Value 15
Table 6	Validation Data Sets 6	Visualization 5

REVIEW QUESTIONS

1. What is Business Intelligence and how does it help you run your business?
2. List and describe the six steps in the CRISP-DM methodology.
3. Describe the characteristics of a relational database.
4. How can relational database keys be used in transforming data for BI purposes?
5. Describe the six characteristics of data cleanliness for BI purposes.
6. What are the three types of analytical analyses?
7. What is a data warehouse? Contrast a data warehouse with a data mar.
8. Describe what kind of intelligence that OLAP processing can provide a business.

9. What does RFM analysis do and how can it help your business?
10. What is regression analysis and what can it do for your business?
11. What is cluster analysis?
12. How does Decision Tree analysis help you to make decisions?
13. What decisions does Linear Programming assist with?
14. What is Big Data?
15. How does MapReduce work?
16. What is the difference between MapReduce and Hadoop?
17. What is required to have a violation of privacy?
18. What are the five ethical principles for business intelligence?

EXERCISE 12-1: DOING AN RFM ANALYSIS IN EXCEL

According to the book, doing an RFM analysis requires us to analyze the purchasing patterns of our customers and make determinations about how to work with them.

We can do this by stratifying the customer into quintiles and then assigning them a number from 1-5 based on which quintile they are a part of. We do this for three different categories: recency of purchase, frequency of purchase and money volume of purchase. Then based on the pattern of quintiles we make determinations about what to do with them.

This is how we might do it in Excel. We follow 3 steps:

1) We take the data given and create tables to be used by VLookup to identify which quintile the of recency, frequency or money volume that the customer is in.
2) Then we create VLookup functions that use those tables to assign each customer to values of 1-5 in terms of the recency of purchase, frequency of purchases and money volume using those tables.
3) We then use the RFM values to make decisions about what action to take with each customer.

Here are the steps to follow:

Step 1: Get the file, "Ch11-RFM-InitialData" from the assignment.

Step 2: Build the lookup tables

To calculate the quintile of the last date purchased, we will build a table of cutoff values for each of the quintiles and then assign a quintile value to each of the dates of our purchasers.

a. Build a table for the Vlookup function to use for the date last purchased
    i. The spreadsheet gives you a set of tables to use for the Vlookup. The cutoff values are in the leftmost column, the cutoff value is in the middle and the quintile number is in the right most column.
    ii. In cell M2, use the percentile.inc function to compute the cutoff for the lowest value.
        1. =PERCENTILE.INC($B$2:$B$302,L2)
        2. Copy this to cells M3 – M6
        3. Set those cell formats to "date"
b. Do the same thing for the # purchases in the last quarter table in cells M9-M13, setting the value to number with no decimals. You will need to change the column setting in the Percentile.inc function to point to the # purchases column.
c. Do the same thing for the Dollar volume purchases table in cells M16-M20, setting the values to currency. You will need to change the column setting the in the percentile.inc function to point to the dollar volume purchases column.
d. The tables are now built

Step 3: Use Vlookup to compute with quintile the customer is in to calculate the quintiles values for each customer

a. To get the quintile number for the date last purchased, we will use the Vlookup function.
    i) In cell E2, use the VLOOKUP function to get the quintile number

ii) =VLOOKUP(B2,$M$2:$N$6,2)
iii) Copy this down the column

b. Do the same thing for the # of purchases column (F). You will need to change the row values in the table part of the VLOOKUP.
c. Do the same thing for the Dollar volume purchases column (G). You will need to change the row values in the table part of the VLOOKUP.
d. You now have built the RFM indices

Step 4: Now to decide what with do with this data

a. For those customers who have bought in a while and didn't buy very much and were low dollar volume, we won't do anything. We will try to upsell good regular customers of small dollar items. For those who used to be good regular customers, but haven't bought for a while we will contact them and see what's up. We will use a compound IF function to set up those conditions.
b. For those, we need not to do anything about, we need to check to see if they are in the lowest two quintiles (4 and 5) in R, F and M. If so, display the word "ignore" otherwise display a " " (blank).
   i) In cell H2, enter the following: =IF(AND($E2>3,$F2>3,$G2>3),"Ignore "," ")
   ii) In cell ch1, title this column "Yes"
c. Where there are recent, regular purchasers of small goods we want to find them to try and upsell them. These are customers with R&F<3 and M>3.
   i) Enter an IF function in column I.
   ii) If that is true display the value of "Yes"
   iii) otherwise display a blank.
d. Where we have big regular purchasers who haven't purchased in a while we want to contact them to find out what is happening.
   i) Put an IF function in column J to identify these customers.
   ii) Display "Yes" if this condition is true and a " " (blank) if it is false.

When you complete this tutorial, submit the worksheet that you have to the RFM tutorial dropbox entry.