Chapter 12

Enhancing Decision Making

LEARNING OBJECTIVES

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

1. What are the different types of decisions and how does the decision-making process work?
2. How do information systems support the activities of managers and management decision making?
3. How do business intelligence and business analytics support decision making?
4. How do different decision-making constituencies in an organization use business intelligence?
5. What is the role of information systems in helping people working in a group make decisions more efficiently?

CHAPTER OUTLINE

Interactive Sessions:

Analytics Help the Cincinnati Zoo Know Its Customers

Colgate-Palmolive Keeps Managers Smiling with Executive Dashboards

MONEYBALL: DATA-DRIVEN BASEBALL

On September 23, 2011, the film *Moneyball* opened in theaters across the United States, starring Brad Pitt as Billy Beane, the iconoclastic general manager of the Oakland Athletics. The film was based on the bestselling book by Michael Lewis that described how Beane led the underdog A's, with one of the tiniest budgets in Major League baseball, to win 103 games in 2002. Under Beane's watch, the A's made the playoffs five times in the next eight seasons.

At the opening of the 2002 baseball season, the wealthiest team was the New York Yankees, with a payroll of $126 million; the Oakland A's and Tampa Bay Devil Rays, each with payrolls of about $41 million, were the poorest. These disparities meant that only the wealthiest teams could afford the best players. A poor team, such as the A's, could only afford what the "better" teams rejected, and thus was almost certain to fail. That is, until Billy Beane and Moneyball entered the picture.

How did Beane do it? He took a close look at the data. Conventional baseball wisdom maintained that big-name highly athletic hitters and skillful young pitchers were the main ingredients for winning. Beane and his assistant general manager Paul DePodesta used advanced statistical analysis of player and team data to prove that wrong. The prevailing metrics for predicting wins, losses, and player performance, such as batting averages, runs batted in, and stolen bases, were vestiges of the early years of baseball and the statistics that were available at that time. Baseball talent scouts used these metrics, as well as their gut intuition, to size up talent for their teams.

Beane and DePodesta found that a different set of metrics, namely, the percentage of time a hitter was on base or forced opposing pitchers to throw a high number of pitches, was more predictive of a team's chances of winning a game. So Beane sought out affordable players who met these criteria (including those who drew lots of "walks") and had been overlooked or rejected by the well-funded teams. He didn't care if a player was overweight or seemed past his prime-he only focused on the numbers. Beane was able to field a consistently winning team by using advanced analytics to gain insights into each player's value and contribution to team success that other richer teams had overlooked.

Beane and his data-driven approach to baseball had a seismic impact on the game. After observing the A's phenomenal success in 2002, the Boston Red Sox used the talents of baseball statistician Bill James and adopted Beane's strategy, only with more money. Two years later, they won the World Series.

Although many experts continue to believe that traditional methods of player evaluation, along with gut instinct, money, an

d luck, are still the key ingredients for winning teams, the major league teams acknowledge that statistical analysis has a place in baseball. To some degree, most major league teams have embraced sabermetrics, the application of statistical analysis to baseball records to evaluate the performance of individual players. The New York Yankees, New York Mets, San Diego Padres, St. Louis Cardinals, Boston Red Sox, Washington Nationals, Arizona Diamondbacks,

Cleveland Indians, and Toronto Blue Jays have all hired full-time sabermetric analysts.

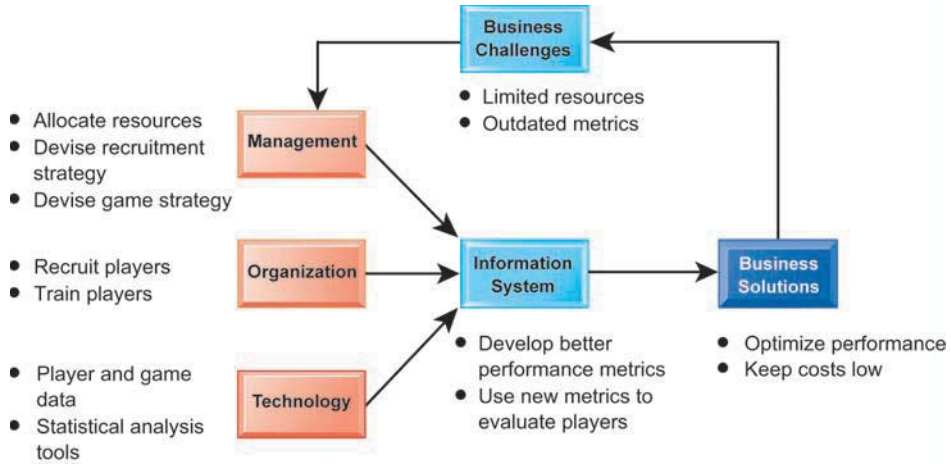
Since all the major league teams use sabermetrics in one way or another to guide their decisions, the A's no longer have the competitive edge they once enjoyed when they were the only ones with this knowledge. Even though Beane hasn't taken the A's to the playoffs since 2006, he remains a highly sought after speaker on the corporate management lecture circuit. It's easy to see why. Moneyball isn't just about baseball—it's about learning how to use data as a competitive weapon, especially in environments where resources are scarce and innovation is essential.

Sources: Don Peppers, "Baseball, Business, and Big Data," FastCompany.com, April 24, 2012; Matthew Futterman, "Baseball after Moneyball," *The Wall Street Journal*, September 22, 2011; Adam Sternberge, "Billy Beane of 'Moneyball' Has Given Up on His Own Hollywood Ending," *The New York Times*, September 21, 2011; and Michael Lewis, *Moneyball: The Art of Winning an Unfair Game*, 2003.

Baseball has been, according to the subtitle of Moneyball, an "unfair game." Given the huge disparities in MLB team budgets, wealthier teams definitely have the advantage in recruiting the best players. But by using advanced analytics to guide decisions about what players to recruit and cultivate, Billy Beane was able to turn the underdog Oakland Athletics into a winning team. Baseball is a business and this opening case has important lessons for other businesses as well: You can be more efficient and competitive if, like Moneyball, you know how to use data to drive your decisions.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. Managers at major league baseball teams were hamstrung by earlier models of decision making that used the wrong metrics to predict team performance. Teams with low budgets such as the Oakland A's were stuck in a rut because they could not afford the most highly skilled players, and the advantage went to the teams with the biggest budgets. Beane and Paul DePodesta ran sophisticated statistical analyses of player and game data to devise a better set of metrics for predicting performance. Of course, an individual player's skill is still very important, but Beane showed that a team composed of less skilled players could still win if it focused on players with high on-base percentages and pitchers with large numbers of ground-outs. Beane was able forge a team that delivered a first-rate performance much more cost effectively that competitors because he paid attention to the data.

Here are some questions to think about: Some have said Moneyball isn't really about baseball. What are the implications of this statement? What can businesses learn from Moneyball? What if all businesses were run like Moneyball?



12.1 Decision Making and Information Systems

Decision making in businesses used to be limited to management. Today, lower-level employees are responsible for some of these decisions, as information systems make information available to lower levels of the business. But what do we mean by better decision making? How does decision making take place in businesses and other organizations? Let's take a closer look.

BUSINESS VALUE OF IMPROVED DECISION MAKING

What does it mean to the business to make better decisions? What is the monetary value of improved decision making? Table 12.1 attempts to measure the monetary value of improved decision making for a small U.S. manufacturing firm with $280 million in annual revenue and 140 employees. The firm has identified a number of key decisions where new system investments might improve the quality of decision making. The table provides selected estimates of annual value (in the form of cost savings or increased revenue) from improved decision making in selected areas of the business.

We can see from Table 12.1 that decisions are made at all levels of the firm and that some of these decisions are common, routine, and numerous. Although the value of improving any single decision may be small, improving hundreds of thousands of "small" decisions adds up to a large annual value for the business.

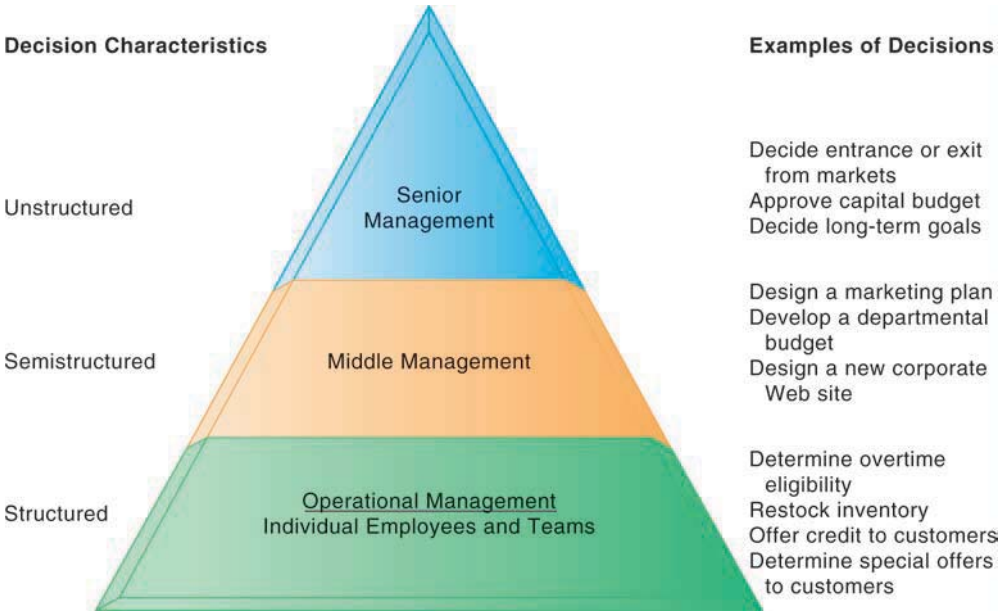
TYPES OF DECISIONS

Chapters 1 and 2 showed that there are different levels in an organization. Each of these levels has different information requirements for decision support and responsibility for different types of decisions (see Figure 12.1). Decisions are classified as structured, semistructured, and unstructured.

TABLE 12.1 BUSINESS VALUE OF ENHANCED DECISION MAKING

EXAMPLE DECISION	DECISION MAKER	NUMBER OF ANNUAL DECISIONS	ESTIMATED VALUE TO FIRM OF A SINGLE IMPROVED DECISION	ANNUAL VALUE
Allocate support to most valuable customers	Accounts manager	12	$100,000	$1,200,000
Predict call center daily demand	Call center management	4	150,000	600,000
Decide parts inventory levels daily	Inventory manager	365	5,000	1,825,000
Identify competitive bids from major suppliers	Senior management	1	2,000,000	2,000,000
Schedule production to fill orders	Manufacturing manager	150	10,000	1,500,000
Allocate labor to complete a job	Production floor manager	100	4,000	400,000

FIGURE 12.1 INFORMATION REQUIREMENTS OF KEY DECISION-MAKING GROUPS IN A FIRM



Senior managers, middle managers, operational managers, and employees have different types of decisions and information requirements.

Unstructured decisions are those in which the decision maker must provide judgment, evaluation, and insight to solve the problem. Each of these decisions is novel, important, and nonroutine, and there is no well-understood or agreed-on procedure for making them.

Structured decisions, by contrast, are repetitive and routine, and they involve a definite procedure for handling them so that they do not have to be treated each time as if they were new. Many decisions have elements of both types of decisions and are **semistructured**, where only part of the problem has a clear-cut answer provided by an accepted procedure. In general, structured decisions are more prevalent at lower organizational levels, whereas unstructured problems are more common at higher levels of the firm.

Senior executives face many unstructured decision situations, such as establishing the firm's 5- or 10-year goals or deciding new markets to enter. Answering the question "Should we enter a new market?" would require access to news, government reports, and industry views as well as high-level summaries of firm performance. However, the answer would also require senior managers to use their own best judgment and poll other managers for their opinions.

Middle management faces more structured decision scenarios but their decisions may include unstructured components. A typical middle-level management decision might be "Why is the reported order fulfillment report showing a decline over the past six months at a distribution center in Minneapolis?" This middle manager will obtain a report from the firm's enterprise system or distribution management system on order activity and operational efficiency at the Minneapolis distribution center. This is the structured part of the decision. But before arriving at an answer, this middle manager will have to interview employees and gather more unstructured information from external sources about local economic conditions or sales trends.

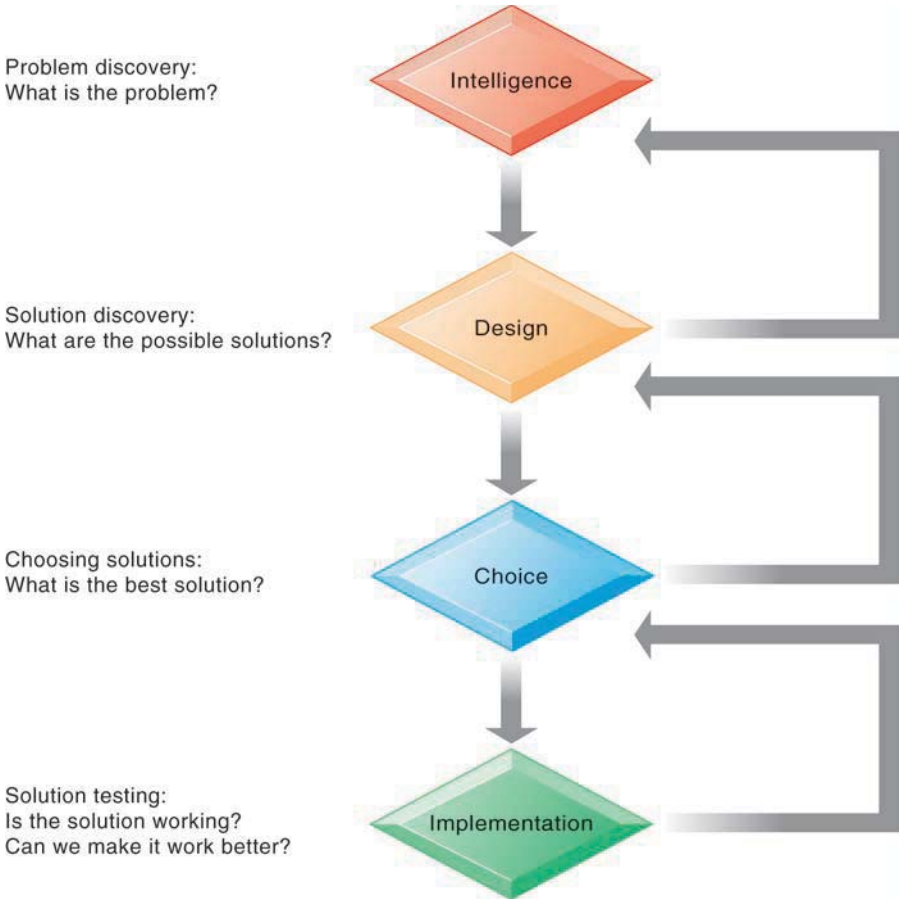
Operational management and rank-and-file employees tend to make more structured decisions. For example, a supervisor on an assembly line has to decide whether an hourly paid worker is entitled to overtime pay. If the employee worked more than eight hours on a particular day, the supervisor would routinely grant overtime pay for any time beyond eight hours that was clocked on that day.

A sales account representative often has to make decisions about extending credit to customers by consulting the firm's customer database that contains credit information. If the customer met the firm's prespecified criteria for granting credit, the account representative would grant that customer credit to make a purchase. In both instances, the decisions are highly structured and are routinely made thousands of times each day in most large firms. The answer has been preprogrammed into the firm's payroll and accounts receivable systems.

THE DECISION-MAKING PROCESS

Making a decision is a multistep process. Simon (1960) described four different stages in decision making: intelligence, design, choice, and implementation (see Figure 12.2).

FIGURE 12.2 STAGES IN DECISION MAKING



The decision-making process is broken down into four stages.

Intelligence consists of discovering, identifying, and understanding the problems occurring in the organization—why a problem exists, where, and what effects it is having on the firm.

Design involves identifying and exploring various solutions to the problem.

Choice consists of choosing among solution alternatives.

Implementation involves making the chosen alternative work and continuing to monitor how well the solution is working.

What happens if the solution you have chosen doesn't work? Figure 12.2 shows that you can return to an earlier stage in the decision-making process and repeat it if necessary. For instance, in the face of declining sales, a sales management team may decide to pay the sales force a higher commission for making more sales to spur on the sales effort. If this does not produce sales increases, managers would need to investigate whether the problem stems from poor product design, inadequate customer support, or a host of other causes that call for a different solution.

MANAGERS AND DECISION MAKING IN THE REAL WORLD

The premise of this book and this chapter is that systems to support decision making produce better decision making by managers and employees, above average returns on investment for the firm, and ultimately higher profitability. However, information systems cannot improve all the different kinds of decisions taking place in an organization. Let's examine the role of managers and decision making in organizations to see why this is so.

Managerial Roles

Managers play key roles in organizations. Their responsibilities range from making decisions, to writing reports, to attending meetings, to arranging birthday parties. We are able to better understand managerial functions and roles by examining classical and contemporary models of managerial behavior.

The **classical model of management**, which describes what managers do, was largely unquestioned for the more than 70 years since the 1920s. Henri Fayol and other early writers first described the five classical functions of managers as planning, organizing, coordinating, deciding, and controlling. This description of management activities dominated management thought for a long time, and it is still popular today.

The classical model describes formal managerial functions but does not address exactly what managers do when they plan, decide things, and control the work of others. For this, we must turn to the work of contemporary behavioral scientists who have studied managers in daily action. **Behavioral models** state that the actual behavior of managers appears to be less systematic, more informal, less reflective, more reactive, and less well organized than the classical model would have us believe.

Observers find that managerial behavior actually has five attributes that differ greatly from the classical description. First, managers perform a great deal of work at an unrelenting pace—studies have found that managers engage in more than 600 different activities each day, with no break in their pace. Second, managerial activities are fragmented; most activities last for less than nine minutes, and only 10 percent of the activities exceed one hour in duration. Third, managers prefer current, specific, and ad hoc information (printed information often will be too old). Fourth, they prefer oral forms of

communication to written forms because oral media provide greater flexibility, require less effort, and bring a faster response. Fifth, managers give high priority to maintaining a diverse and complex web of contacts that act as an informal information system and helps them execute their personal agendas and short- and long-term goals.

Analyzing managers' day-to-day behavior, Henry Mintzberg found that it could be classified into 10 managerial roles. **Managerial roles** are expectations of the activities that managers should perform in an organization. Mintzberg found that these managerial roles fell into three categories: interpersonal, informational, and decisional.

Interpersonal Roles. Managers act as figureheads for the organization when they represent their companies to the outside world and perform symbolic duties, such as giving out employee awards, in their **interpersonal role**. Managers act as leaders, attempting to motivate, counsel, and support subordinates. Managers also act as liaisons between various organizational levels; within each of these levels, they serve as liaisons among the members of the management team. Managers provide time and favors, which they expect to be returned.

Informational Roles. In their **informational role,** managers act as the nerve centers of their organizations, receiving the most concrete, up-to-date information and redistributing it to those who need to be aware of it. Managers are therefore information disseminators and spokespersons for their organizations.

Decisional Roles. Managers make decisions. In their **decisional role**, they act as entrepreneurs by initiating new kinds of activities; they handle disturbances arising in the organization; they allocate resources to staff members who need them; and they negotiate conflicts and mediate between conflicting groups.

Table 12.2, based on Mintzberg's role classifications, is one look at where systems can and cannot help managers. The table shows that information systems are now capable of supporting most, but not all, areas of managerial life.

TABLE 12.2 MANAGERIAL ROLES AND SUPPORTING INFORMATION SYSTEMS

ROLE	BEHAVIOR	SUPPORT SYSTEMS
Interpersonal Roles		
Figurehead		Telepresence systems
Leader	Interpersonal	Telepresence, social networks, Twitter
Liaison		Smartphones, social networks
Informational Roles		
Nerve center		Management information systems, executive support system
Disseminator	Information	E-mail, social networks
Spokesperson	processing	Webinars, telepresence
Decisional Roles		
Entrepreneur	Decision	None exist
Disturbance handler	making	None exist
Resource allocator		Business intelligence, decision-support system
Negotiator		None exist

Sources: Kenneth C. Laudon and Jane P. Laudon; and Mintzberg, 1971.

Real-World Decision Making

We now see that information systems are not helpful for all managerial roles. And in those managerial roles where information systems might improve decisions, investments in information technology do not always produce positive results. There are three main reasons: information quality, management filters, and organizational culture (see Chapter 3).

Information Quality. High-quality decisions require high-quality information. Table 12.3 describes information quality dimensions that affect the quality of decisions.

If the output of information systems does not meet these quality criteria, decision-making will suffer. Chapter 6 has shown that corporate databases and files have varying levels of inaccuracy and incompleteness, which in turn will degrade the quality of decision making.

Management Filters. Even with timely, accurate information, some managers make bad decisions. Managers (like all human beings) absorb information through a series of filters to make sense of the world around them. Managers have selective attention, focus on certain kinds of problems and solutions, and have a variety of biases that reject information that does not conform to their prior conceptions.

For instance, Wall Street firms such as Bear Stearns and Lehman Brothers imploded in 2008 because they underestimated the risk of their investments in complex mortgage securities, many of which were based on subprime loans that were more likely to default. The computer models they and other financial institutions used to manage risk were based on overly optimistic assumptions and overly simplistic data about what might go wrong. Management wanted to make sure that their firms' capital was not all tied up as a cushion against defaults from risky investments, preventing them from investing it to generate profits. So the designers of these risk management systems were encouraged to measure risks in a way that minimzed their importance. Some trading desks also oversimplified the information maintained about the mortgage securities to make them appear as simple bonds with higher ratings than were warranted by their underlying components.

Organizational Inertia and Politics. Organizations are bureaucracies with limited capabilities and competencies for acting decisively. When environments change and businesses need to adopt new business models to

TABLE 12.3 INFORMATION QUALITY DIMENSIONS

QUALITY DIMENSION	DESCRIPTION
Accuracy	Do the data represent reality?
Integrity	Are the structure of data and relationships among the entities and attributes consistent?
Consistency	Are data elements consistently defined?
Completeness	Are all the necessary data present?
Validity	Do data values fall within defined ranges?
Timeliness	Area data available when needed?
Accessibility	Are the data accessible, comprehensible, and usable?

survive, strong forces within organizations resist making decisions calling for major change. Decisions taken by a firm often represent a balancing of the firm's various interest groups rather than the best solution to the problem.

Studies of business restructuring find that firms tend to ignore poor performance until threatened by outside takeovers, and they systematically blame poor performance on external forces beyond their control such as economic conditions (the economy), foreign competition, and rising prices, rather than blaming senior or middle management for poor business judgment.

HIGH-VELOCITY AUTOMATED DECISION MAKING

Today, many decisions made by organizations are not made by managers, or any humans. For instance, when you enter a query into Google's search engine, Google has to decide which URLs to display in about half a second on average (500 milliseconds). Google indexes over 50 billion Web pages, although it does not search the entire index for every query it receives. The same is true of other search engines. The New York Stock Exchange spent over $450 million in 2010–2011 to build a trading platform that executes incoming orders in less than 50 milliseconds. High frequency traders at electronic stock exchanges execute their trades in under 30 milliseconds.

The class of decisions that are highly structured and automated is growing rapidly. What makes this kind of automated high-speed decision making possible are computer algorithms that precisely define the steps to be followed to produce a decision, very large databases, very high-speed processors, and software optimized to the task. In these situations, humans (including managers) are eliminated from the decision chain because they are too slow.

This also means organizations in these areas are making decisions faster than what managers can monitor or control. Inability to control automated decisions was a major factor in the "Flash Crash" experienced by U.S. stock markets on May 6, 2010, when the Dow Jones Industrial Average fell over 600 points in a matter of minutes before rebounding later that day. The stock market was overwhelmed by a huge wave of sell orders triggered primarily by high-speed computerized trading programs within a few seconds, causing shares of some companies like Procter & Gamble to sell for pennies. The past few years have seen a series of similar breakdowns in computerized trading systems, including one on August 1, 2012 when a software error caused Knight Capital to enter millions of faulty trades in less than an hour. The trading glitch created wild surges and plunges in nearly 150 stocks and left Knight with $440 million in losses.

How does the Simon framework of intelligence-design-choice-implementation work in high-velocity decision environments? Essentially, the intelligence, design, choice, and implementation parts of the decision-making process are captured by the software's algorithms. The humans who wrote the software have already identified the problem, designed a method for finding a solution, defined a range of acceptable solutions, and implemented the solution. Obviously, with humans out of the loop, great care needs to be taken to ensure the proper operation of these systems lest they do significant harm to organizations and humans. And even then additional safeguards are wise to observe the behavior of these systems, regulate their performance, and if necessary, turn them off.

12.2 Business Intelligence in the Enterprise

Chapter 2 introduced you to the different types of systems used for supporting management decision making. At the foundation of all of these decision support systems are a business intelligence and business analytics infrastructure that supplies the data and the analytic tools for supporting decision making. In this section, we want to answer the following questions:

- What are business intelligence (BI) and business analytics (BA)
- Who makes business intelligence and business analytics hardware and software?
- Who are the users of business intelligence?
- What kinds of analytical tools come with a BI/BA suite?
- How do managers use these tools?
- What are some examples of firms who have used these tools?
- What management strategies are used for developing BI/BA capabilities?

WHAT IS BUSINESS INTELLIGENCE?

When we think of humans as intelligent beings we often refer to their ability to take in data from their environment, understand the meaning and significance of the information, and then act appropriately. Can the same be said of business firms? The answer appears to be a qualified "yes." All organizations, including business firms, do indeed take in information from their environments, attempt to understand the meaning of the information, and then attempt to act on the information. Just like human beings, some business firms do this well, and others poorly.

"Business intelligence (BI)" is a term used by hardware and software vendors and information technology consultants to describe the infrastructure for warehousing, integrating, reporting, and analyzing data that comes from the business environment, including big data. The foundation infrastructure collects, stores, cleans, and makes relevant information available to managers. Think databases, data warehouses, data marts, Hadoop, and analytic platforms, which we described in Chapter 6. "Business analytics (BA)" is also a vendor-defined term that focuses more on tools and techniques for analyzing and understanding data. Think online analytical processing (OLAP), statistics, models, and data mining, which we also introduced in Chapter 6.

So, stripped to its essentials, business intelligence and analytics are about integrating all the information streams produced by a firm into a single, coherent enterprise-wide set of data, and then, using modeling, statistical analysis tools (like normal distributions, correlation and regression analysis, Chi square analysis, forecasting, and cluster analysis), and data mining tools (pattern discovery and machine learning), to make sense out of all these data so managers can make better decisions and better plans, or at least know quickly when their firms are failing to meet planned targets.

One company that uses business intelligence is Hallmark Cards. The company uses SAS Analytics software to improve its understanding of buying patterns that could lead to increased sales at more than 3,000 Hallmark Gold Crown stores in the United Sates. Hallmark wanted to strengthen its relationship with frequent buyers. Using data mining and predictive modeling, the company determined how to market to various consumer segments during holidays

and special occasions as well as adjust promotions on the fly. Hallmark is able to determine which customer segments are most influenced by direct mail, which should be approached through e-mail, and what specific messages to send each group. Business intelligence has helped boost Hallmark sales to its loyalty program members by 5 to 10 percent. Another organization that has benefited from business intelligence is the Cincinnati Zoo, as described in the Interactive Session on Organizations.

Business Intelligence Vendors

It is important to remember that business intelligence and analytics are products defined by technology vendors and consulting firms. They consist of hardware and software suites sold primarily by large system vendors to very large Fortune 500 firms. The largest five providers of these products are Oracle, SAP, IBM, Microsoft, and SAS (see Table 12.4). Microsoft's products are aimed at small to medium-sized firms, and they are based on desktop tools familiar to employees (such as Excel spreadsheet software), Microsoft SharePoint collaboration tools, and Microsoft SQL Server database software. According to the International Data Corporation, the global business intelligence and analytics market was $35.1 billion in 2012 and is expected to reach $50.7 billion by 2016 (Kern, 2012). This makes business intelligence and business analytics one of the fastest growing and largest segments in the U.S. software market.

THE BUSINESS INTELLIGENCE ENVIRONMENT

Figure 12.3 (on page 495) gives an overview of a business intelligence environment, highlighting the kinds of hardware, software, and management capabilities that the major vendors offer and that firms develop over time. There are six elements in this business intelligence environment:

- **Data from the business environment:** Businesses must deal with both structured and unstructured data from many different sources, including big data. The data need to be integrated and organized so that they can be analyzed and used by human decision makers.
- **Business intelligence infrastructure:** The underlying foundation of business intelligence is a powerful database system that captures all the relevant data to operate the business. The data may be stored in transactional databases or combined and integrated into an enterprise-data warehouse or series of interrelated data marts.

TABLE 12.4 MARKET LEADERS AND SHARE FOR THE TOP BUSINESS INTELLIGENCE VENDORS

VENDOR	MARKET SHARE	BUSINESS INTELLIGENCE SOFTWARE
Oracle	19.3%	Oracle Business Intelligence Foundation Suite
SAP	14.5%	SAP BusinessObjects BI
IBM	13.8%	IBM Cognos
Microsoft	7.4%	Microsoft Excel, PowerPivot, SQL Server 2012 Business Intelligence
SAS Institute	7.1%	SAS Enterprise Business Intelligence

INTERACTIVE SESSION: ORGANIZATIONS

ANALYTICS HELP THE CINCINNATI ZOO KNOW ITS CUSTOMERS

Founded in 1873, the Cincinnati Zoo & Botanical Garden is one of the world's top-rated zoological institutions, and the second oldest zoo in the United States. It is also one of the nation's most popular attractions, a Top 10 Zagat-rated Zoo, and a *Parents Magazine* Top Zoo for Children. The Zoo's 71-acre site is home to more than 500 animal and 3,000 plant species. About 1.3 million people visit this zoo each year.

Although the Zoo is a nonprofit organization partially subsidized by Hamilton County, more than two-thirds of its $26 million annual budget is paid from fundraising efforts, and the remainder comes from admission fees, food, and gifts. To increase revenue and improve performance, the Zoo's senior management team embarked on a comprehensive review of its operations. The review found that management had limited knowledge and understanding of what was actually happening in the Zoo on a day-to-day basis, other than how many people visited every day and the Zoo's total revenue.

Who is coming to the Zoo? How often do they come? What do they do and what do they buy? Management had no idea. Each of the Zoo's four income streams—admissions, membership, retail, and food service—had different point-of-sale platforms, and the food service business, which brings in $4 million a year, still relied on manual cash registers. Management had to sift through paper receipts just to understand daily sales totals.

The Zoo had compiled a spreadsheet that collected visitors' zip codes, hoping to use the data for geographic and demographic analysis. If the data could be combined with insight into visitor activity at the Zoo—what attractions they visited, what they ate and drank, and what they bought at the gift shops—the information would be extremely valuable for marketing.

To achieve this, however, the Zoo needed to change its information systems to focus more on an alytics and data management. The Zoo replaced its four legacy point-of-sale systems with a single platform—Galaxy POS from Gateway Ticketing Systems. It then enlisted IBM and BrightStar Partners (a consulting firm partnering with IBM) to build a centralized data warehouse and implement IBM Cognos Business Intelligence to provide real-time analytics and reporting.

Like all outdoor attractions, the Zoo's business is highly weather-dependent. On rainy days, attendance falls off sharply, often leaving the Zoo overstaffed and overstocked. If the weather is unusually hot, sales of certain items such as ice cream and bottled water are likely to rise, and the Zoo may run out of these items.

The Zoo now feeds weather forecast data from the U.S. National Oceanic and Atmospheric Administration (NOAA) Web site into its business intelligence system. By comparing current forecasts to historic attendance and sales data during similar weather conditions, the Zoo is able to make more accurate decisions about labor scheduling and inventory planning.

As visitors scan their membership cards at the Zoo's entrance, exit, attractions, restaurants, and stores, or use the Zoo's Loyalty Rewards card, the Zoo's system captures these data and analyzes them to determine usage and spending patterns down to the individual customer level. This information helps the Zoo segment visitors based on their spending and visitation behaviors and use this information to target marketing and promotions specifically for each customer segment.

One customer segment the Zoo identified consisted of people who spent nothing other than the price of admissions during their visit. If each of these people spent $20 on their next visit to the Zoo, the Zoo would take in an extra $260,000, which is almost 1 percent of its entire budget. The Zoo used its customer information to devise a direct mail marketing campaign in which this type of visitor would be offered a discount for some of the Zoo's restaurants and gift shops. Loyal customers are also rewarded with targeted marketing and recognition programs.

Instead of sending a special offer to its entire mailing list, the Zoo is able to tailor campaigns more precisely to smaller groups of people, increasing its chances of identifying the people who were most likely to respond to its mailings. More targeted marketing helped the Zoo cut $40,000 from its annual marketing budget.

Management had observed that food sales tend to trail off significantly after 3 p.m. each day, and started closing some of the Zoo's food outlets at that time. But more detailed data analysis showed that a big spike in soft-serve ice cream sales occurs during the last hour

before the Zoo closes. As a result, the Zoo's soft-serve ice cream outlets are open for the entire day.

The Zoo's Beer Hut concession features six different brands, which are typically rotated based on sales volume and the seasons. With IBM analytics, management can now instantly identify which beer is selling best, on what day, and at what time to make sure inventory meets demand. Previously, it took 7 to 14 days to get this information, which required hiring part-time staff to sift through register tapes.

The Zoo's ability to make better decisions about operations has led to dramatic improvements in sales. Six months after deploying its business intelligence solution, the Zoo achieved a 30.7 percent increase in food sales and a 5.9 percent increase in retail sales compared to the same period a year earlier.

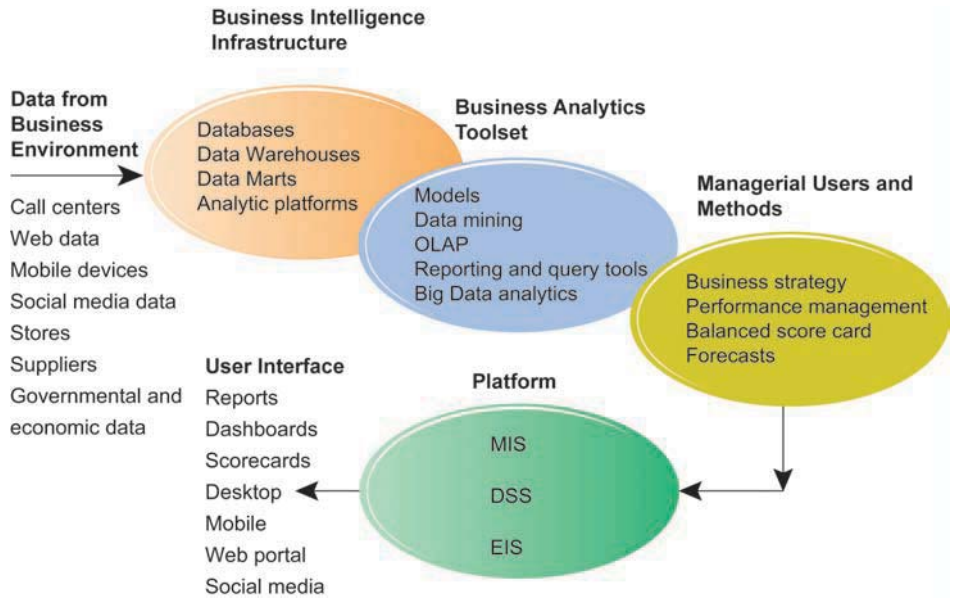
Sources: Justin Kern, "Analytics: Coming to a Zoo, Museum, or Park Near You," *Information Management*, August 28, 2012; IBM Corporation, "Cincinnati Zoo Improves Customer Experience and Enhances Performance," 2011; Nucleus Research, "IBM ROI Case Study: Cincinnati Zoo," July 2011; and www.cincinnatizoo.org, accessed May 26, 2012.

CASE STUDY QUESTIONS

1. What management, organization, and technology factors were behind the Cincinnati Zoo losing opportunities to increase revenue?
2. Why was replacing legacy point-of-sale systems and implementing a data warehouse essential to an information system solution?
3. How did the Cincinnati Zoo benefit from business intelligence? How did it enhance operational performance and decision making? What role was played by predictive analytics?
4. Visit the IBM Cognos Web site and describe the business intelligence tools that would be the most useful for the Cincinnati Zoo.

- **Business analytics toolset:** A set of software tools are used to analyze data and produce reports, respond to questions posed by managers, and track the progress of the business using key indicators of performance.

FIGURE 12.3 BUSINESS INTELLIGENCE AND ANALYTICS FOR DECISION SUPPORT



Business intelligence and analytics requires a strong database foundation, a set of analytic tools, and an involved management team that can ask intelligent questions and analyze data.

- **Managerial users and methods:** Business intelligence hardware and software are only as intelligent as the human beings who use them. Managers impose order on the analysis of data using a variety of managerial methods that define strategic business goals and specify how progress will be measured. These include business performance management and balanced scorecard approaches focusing on key performance indicators and industry strategic analyses focusing on changes in the general business environment, with special attention to competitors. Without strong senior management oversight, business analytics can produce a great deal of information, reports, and online screens that focus on the wrong matters and divert attention from the real issues. You need to remember that, so far, only humans can ask intelligent questions.

- **Delivery platform—MIS, DSS, ESS:** The results from business intelligence and analytics are delivered to managers and employees in a variety of ways, depending on what they need to know to perform their jobs. MIS, DSS, and ESS, which we introduced in Chapter 2, deliver information and knowledge to different people and levels in the firm—operational employees, middle managers, and senior executives. In the past, these systems could not share data and operated as independent systems. Today, one suite of hardware and software tools in the form of a business intelligence and analytics package is able to integrate all this information and bring it to managers' desktop or mobile platforms.

- **User interface:** Business people are no longer tied to their desks and desktops. They often learn quicker from a visual representation of data than from a dry report with columns and rows of information. Today's business analytics software suites emphasize visual techniques such as dashboards and scorecards. They also are able to deliver reports on BlackBerrys, iPhones, and other mobile handhelds as well as on the firm's Web portal. BA software is adding capabilities to post information on Twitter, Facebook, or internal social media to support decision making in an online group setting rather than in a face-to-face meeting.

BUSINESS INTELLIGENCE AND ANALYTICS CAPABILITIES

Business intelligence and analytics promise to deliver correct, nearly real-time information to decision makers, and the analytic tools help them quickly understand the information and take action. There are six analytic functionalities that BI systems deliver to achieve these ends:

- **Production reports:** These are predefined reports based on industry-specific requirements (see Table 12.5).
- **Parameterized reports:** Users enter several parameters as in a pivot table to filter data and isolate impacts of parameters. For instance, you might want to enter region and time of day to understand how sales of a product vary by region and time. If you were Starbucks, you might find that customers in the East buy most of their coffee in the morning, whereas in the Northwest customers buy coffee throughout the day. This finding might lead to different marketing and ad campaigns in each region. (See the discussion of pivot tables in Section 12.3.)
- **Dashboards/scorecards:** These are visual tools for presenting performance data defined by users.
- **Ad hoc query/search/report creation:** These allow users to create their own reports based on queries and searches.

- **Drill down:** This is the ability to move from a high-level summary to a more detailed view.
- **Forecasts, scenarios, models:** These include the ability to perform linear forecasting, what-if scenario analysis, and analyze data using standard statistical tools.

Who Uses Business Intelligence and Business Analytics?

In previous chapters, we have described the different information constituencies in business firms—from senior managers to middle managers, analysts, and operational employees. This also holds true for BI and BA systems (see Figure 12.4). Over 80 percent of the audience for BI consists of casual users who rely largely on production reports. Senior executives tend to use BI to monitor firm activities using visual interfaces like dashboards and scorecards. Middle managers and analysts are much more likely to be immersed in the data and software, entering queries and slicing and dicing the data along different dimensions. Operational employees will, along with customers and suppliers, be looking mostly at prepackaged reports.

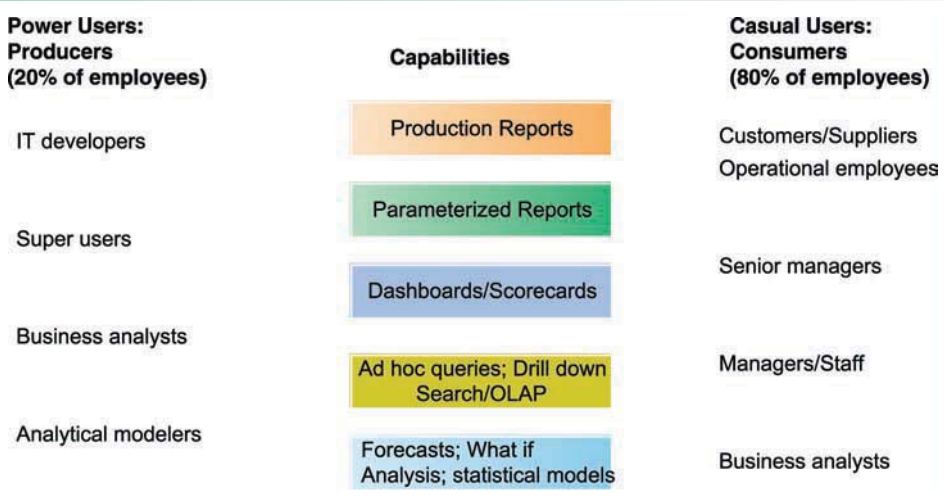
Production Reports

The most widely used output of a BI suite of tools are pre-packaged production reports. Table 12.5 illustrates some common predefined reports from Oracle's BI suite of tools.

Predictive Analytics

An important capability of business intelligence analytics is the ability to model future events and behaviors, such as the probability that a customer will respond to an offer to purchase a product. **Predictive analytics** use statistical analysis, data mining techniques, historical data, and assumptions about future conditions to predict future trends and behavior patterns. Variables that can be measured to predict future behavior are identified. For example, an insurance company might use variables such as age, gender, and driving record as

FIGURE 12.4 BUSINESS INTELLIGENCE USERS



Casual users are consumers of BI output, while intense power users are the producers of reports, new analyses, models, and forecasts.

TABLE 12.5 EXAMPLES OF BUSINESS INTELLIGENCE PREDEFINED PRODUCTION REPORTS

BUSINESS FUNCTIONAL AREA	PRODUCTION REPORTS
Sales	Forecast sales; sales team performance; cross selling; sales cycle times
Service/Call Center	Customer satisfaction; service cost; resolution rates; churn rates
Marketing	Campaign effectiveness; loyalty and attrition; market basket analysis
Procurement and Support	Direct and indirect spending; off-contract purchases; supplier performance
Supply Chain	Backlog; fulfillment status; order cycle time; bill of materials analysis
Financials	General ledger; accounts receivable and payable; cash flow; profitability
Human Resources	Employee productivity; compensation; workforce demographics; retention

predictors of driving safety when issuing auto insurance policies. A collection of such predictors is combined into a predictive model for forecasting future probabilities with an acceptable level of reliability.

FedEx has been using predictive analytics to develop models that predict how customers will respond to price changes and new services, which customers are most at risk of switching to competitors, and how much revenue will be generated by new storefront or drop-box locations. The accuracy rate of FedEx's predictive analytics system ranges from 65 to 90 percent.

Predictive analytics are being incorporated into numerous business intelligence applications for sales, marketing, finance, fraud detection, and health care. One of the most well-known applications is credit scoring, which is used throughout the financial services industry. When you apply for a new credit card, scoring models process your credit history, loan application, and purchase data to determine your likelihood of making future credit payments on time. Telecommunications companies use predictive analytics to identify which customers are most profitable, which are most likely to leave, and which new services and plans will be most likely to retain customers. Health care insurers have been analyzing data for years to identify which patients are most likely to generate high costs.

Many companies employ predictive analytics to predict response to direct marketing campaigns. By identifying customers less likely to respond, companies are able to lower their marketing and sales costs by bypassing this group and focusing their resources on customers who have been identified as more promising. For instance, the U.S. division of The Body Shop plc used predictive analytics and its database of catalog, Web, and retail store customers to identify customers who were more likely to make catalog purchases. That information helped the company build a more precise and targeted mailing list for its catalogs, improving the response rate for catalog mailings and catalog revenues.

Big Data Analytics

Many online retailers have capabilities for making personalized online product recommendations to their Web site visitors to help stimulate purchases and guide their decisions about what merchandise to stock. However, most of these product recommendations are based on the behaviors of similar groups

of customers, such as those with incomes under $50,000 or whose ages are between 18–25. Now some are starting to analyze the tremendous quantities of online and in-store customer data they collect along with social media data to make these recommendations more individualized.

Major online companies such as Walmart, Netflix, and eBay are analyzing big data from their customer transactions and social media streams to create real-time personalized shopping experiences. These efforts are translating into higher customer spending and customer retention rates.

EBay uses Hunch.com, which it acquired in 2011, to deliver customized recommendations to individual users based on their specific set of tastes. Hunch has built a massive database that includes data from customer purchases, social networks, and signals from around the Web. Hunch is able to analyze the data to create a "taste graph" that maps users with their predicted affinity for products, services, Web sites, and other people, and use this information to create customized recommendations.

The Hunch "taste graph" includes predictions on about 500 million people, 200 million objects (such as videos, gadgets, or books), and 30 billion connections between people and objects. To generate accurate predictions in near real-time, Hunch transformed each person's tastes into a more manageable "taste fingerprint" extracted from the larger taste graph.

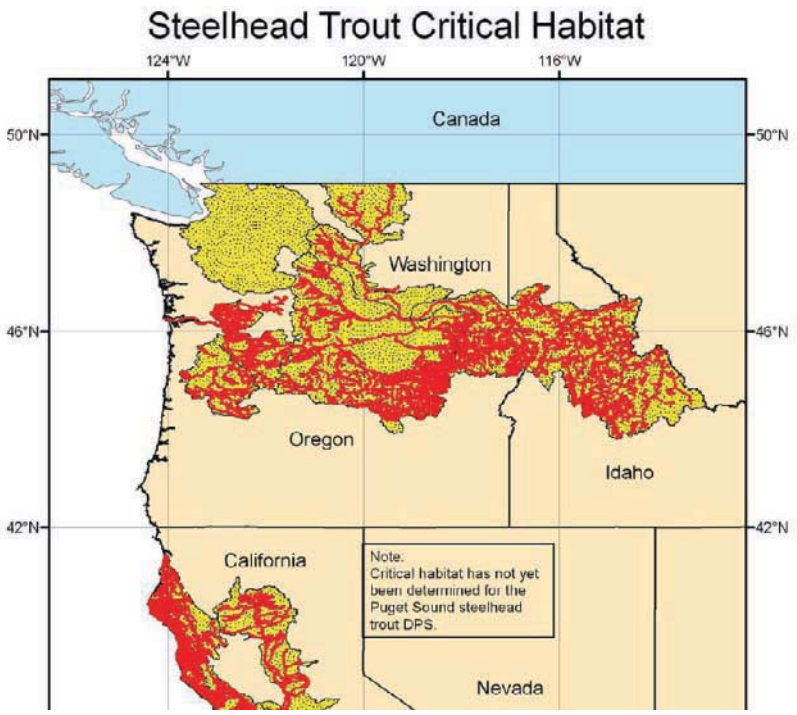
Hunch.com's prediction technology is helping eBay develop recommendations of items that might not be immediately obvious for users to purchase from its online marketplace. For example, for a coin collector purchasing on eBay, Hunch might recommend microscopes that are especially useful for coin analysis. Hunch could also become an important tool for eBay sellers if its customer profiles help them make better decisions about which items to offer, the content they use to describe their inventory, and perhaps even the advertising they use to promote their eBay listings (Grau, 2012).

Data Visualization, Visual Analytics, and Geographic Information Systems

By presenting data in visual form, **data visualization** and visual analytics tools help users see patterns and relationships in large amounts of data that would be difficult to discern if the data were presented as traditional lists of text or numbers. Data are presented in the form of rich graphs, charts, dashboards, and maps. People become more engaged when they can filter information that is presented visually and develop insights on their own.

Geographic information systems (GIS) are a special category of tools for helping decision makers visualize problems requiring knowledge about the geographic distribution of people or other resources. GIS software ties location data to points, lines, and areas on a map. Some GIS have modeling capabilities for changing the data and automatically revising business scenarios. GIS might be used to help state and local governments calculate response times to natural disasters and other emergencies or to help banks identify the best location for installing new branches or ATM terminals.

For example, Columbia, South Carolina-based First Citizens Bank uses GIS software from MapInfo to determine which markets to focus on for retaining customers and which to focus on for acquiring new customers. MapInfo also lets the bank drill down into details at the individual branch level and individualize goals for each branch. Each branch is able to see whether the greatest revenue opportunities are from mining its database of existing customers or from finding new customers.



The U.S. National Marine Fisheries Service (NMFS) created a GIS for identifying critical habitat for steelhead trout on the U.S. West Coast. Red areas show critical habitat. Pink-shaded areas indicate places where the steelhead trout are endangered, and dotted-yellow areas indicate places where the species is threatened.

MANAGEMENT STRATEGIES FOR DEVELOPING BI AND BA CAPABILITIES

There are two different strategies for adopting BI and BA capabilities for the organization: one-stop integrated solutions versus multiple best-of-breed vendor solutions. The hardware firms (IBM, HP, and now Oracle, which owns Sun Microsystems) want to sell your firm integrated hardware/software solutions that tend to run only on their hardware (the totally integrated solution). It's called "one-stop shopping." The software firms (SAP, SAS, and Microsoft) encourage firms to adopt the "best of breed" software and that runs on any machine they want. In this strategy, you adopt the best database and data warehouse solution, and select the best business intelligence and analytics package from whatever vendor you believe is best.

The first solution carries the risk that a single vendor provides your firm's total hardware and software solution, making your firm dependent on its pricing power. It also offers the advantage of dealing with a single vendor who can deliver on a global scale. The second solution offers greater flexibility and independence, but with the risk of potential difficulties integrating the software to the hardware platform, as well as to other software. Vendors always claim their software is "compatible" with other software, but the reality is that it can be very difficult to integrate software from different vendors. Microsoft in particular emphasizes building on its desktop interface and operating system (Windows), which are familiar to many users, and developing server applications that run on Microsoft local area networks. But data from hardware and software produced by different vendors will have to flow seamlessly into Microsoft workstations to make this strategy work. This may not be adequate for Fortune 500 firms needing a global networking solution.

Regardless of which strategy your firm adopts, all BI and BA systems lock the firm into a set of vendors and switching is very costly. Once you train thousands

of employees across the world on using a particular set of tools, it is extremely difficult to switch. When you adopt these systems, you are in essence taking in a new partner.

The marketplace is very competitive and given to hyperbole. One BI vendor claims "[Our tools] bring together a portfolio of services, software, hardware and partner technologies to create business intelligence solutions. By connecting intelligence across your company, you gain a competitive advantage for creating new business opportunities." As a manager, you will have to critically evaluate such claims, understand exactly how these systems could improve your business, and determine whether the expenditures are worth the benefits.

12.3 Business Intelligence Constituencies

There are many different constituencies that make up a modern business firm. Earlier in this text and in this chapter we identified three levels of management: lower supervisory (operational) management, middle management, and senior management (vice president and above, including executive or "C level" management, e.g. chief executive officer, chief financial officers, and chief operational officer.) Each of these management groups has different responsibilities and different needs for information and business intelligence, with decisions becoming less structured among higher levels of management (review Figure 12.1).

DECISION SUPPORT FOR OPERATIONAL AND MIDDLE MANAGEMENT

Operational and middle management are generally charged with monitoring the performance of key aspects of the business, ranging from the down-time of machines on a factory floor, to the daily or even hourly sales at franchise food stores, to the daily traffic at a company's Web site. Most of the decisions they make are fairly structured. Management information systems (MIS) are typically used by middle managers to support this type of decision making, and their primary output is a set of routine production reports based on data extracted and summarized from the firm's underlying transaction processing systems (TPS). Increasingly, middle managers receive these reports online on the company portal, and are able to interactively query the data to find out why events are happening. To save even more analysis time, managers turn to exception reports, which highlight only exceptional conditions, such as when the sales quotas for a specific territory fall below an anticipated level or employees have exceeded their spending limits in a dental care plan. Table 12.6 provides some examples of MIS applications.

Support for Semistructured Decisions

Some managers are "super users" and keen business analysts who want to create their own reports, and use more sophisticated analytics and models to find patterns in data, to model alternative business scenarios, or to test specific hypotheses. Decision-support systems (DSS) are the BI delivery platform for this category of users, with the ability to support semistructured decision making.

TABLE 12.6 EXAMPLES OF MIS APPLICATIONS

COMPANY	MIS APPLICATION
California Pizza Kitchen	Inventory Express application "remembers" each restaurant's ordering patterns and compares the amount of ingredients used per menu item to predefined portion measurements established by management. The system identifies restaurants with out-of-line portions and notifies their managers so that corrective actions will be taken.
PharMark	Extranet MIS identifies patients with drug-use patterns that place them at risk for adverse outcomes.
Black & Veatch	Intranet MIS tracks construction costs for various projects across the United States.
Taco Bell	Total Automation of Company Operations (TACO) system provides information on food, labor, and period-to-date costs for each restaurant.

DSS rely more heavily on modeling than MIS, using mathematical or analytical models to perform what-if or other kinds of analysis. "What-if" analysis, working forward from known or assumed conditions, allows the user to vary certain values to test results to predict outcomes if changes occur in those values. What happens if we raise product prices by 5 percent or increase the advertising budget by $1 million? **Sensitivity analysis** models ask what-if questions repeatedly to predict a range of outcomes when one or more variables are changed multiple times (see Figure 12.5). Backward sensitivity analysis helps decision makers with goal seeking: If I want to sell 1 million product units next year, how much must I reduce the price of the product?

Chapter 6 described multidimensional data analysis and OLAP as one of the key business intelligence technologies. Spreadsheets have a similar feature for multidimensional analysis called a **pivot table**, which manager "super users" and analysts employ to identify and understand patterns in business information that may be useful for semistructured decision making.

Figure 12.6 illustrates a Microsoft Excel 2010 pivot table that examines a large list of order transactions for a company selling online management training videos and books. It shows the relationship between two dimensions: the sales region and the source of contact (Web banner ad or e-mail) for each customer order. It answers the question: does the source of the customer make a difference in addition to region? The pivot table in this figure shows that most customers come from the West and that banner advertising produces most of the customers in all the regions.

One of the Hands-On MIS projects for this chapter asks you to use a pivot table to find answers to a number of other questions using the same list of transactions for the online training company as we used in this discussion. The complete Excel file for these transactions is available in MyMISLab. We have also added a Learning Track on creating pivot tables using Excel.

In the past, much of this modeling was done with spreadsheets and small stand-alone databases. Today these capabilities are incorporated into large enterprise BI systems where they are able to analyze data from large corporate databases. BI analytics include tools for intensive modeling, some of which we described earlier. Such capabilities help Progressive Insurance identify the best customers for its products. Using widely available insurance industry data,

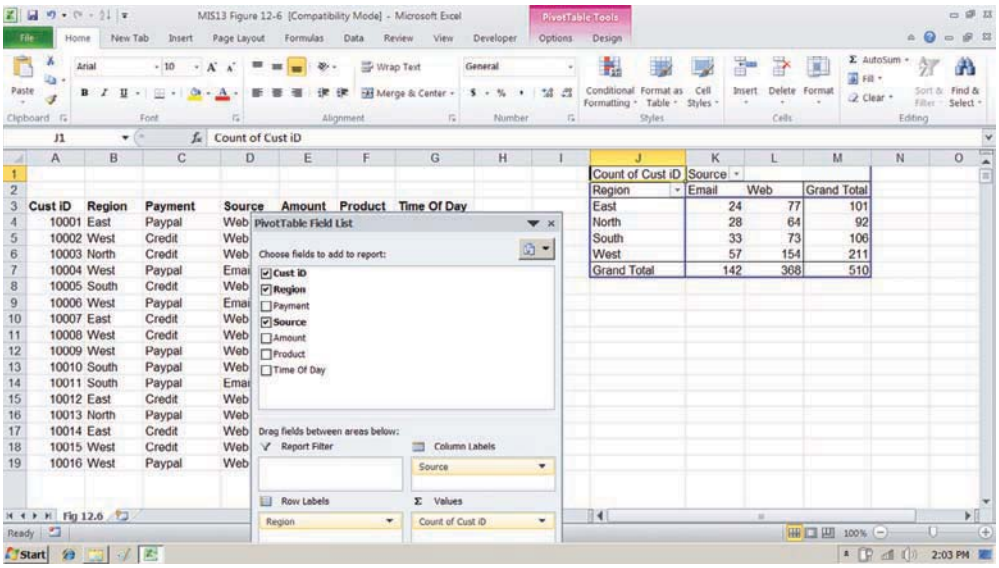
FIGURE 12.5 SENSITIVITY ANALYSIS

Total fixed costs	19000					
Variable cost per unit	3					
Average sales price	17					
Contribution margin	14					
Break-even point	1357					
		Variable Cost per Unit				
Sales	1357	2	3	4	5	6
Price	14	1583	1727	1900	2111	2375
	15	1462	1583	1727	1900	2111
	16	1357	1462	1583	1727	1900
	17	1267	1357	1462	1583	1727
	18	1188	1267	1357	1462	1583

This table displays the results of a sensitivity analysis of the effect of changing the sales price of a necktie and the cost per unit on the product's break-even point. It answers the question, "What happens to the break-even point if the sales price and the cost to make each unit increase or decrease?"

Progressive defines small groups of customers, or "cells," such as motorcycle riders aged 30 or above with college educations, credit scores over a certain level, and no accidents. For each "cell," Progressive performs a regression analysis to identify factors most closely correlated with the insurance losses that are typical for this group. It then sets prices for each cell, and uses simulation software to test whether this pricing arrangement will enable the company to make a profit. These analytic techniques, make it possible for Progressive to profitably insure customers in traditionally high-risk categories that other insurers would have rejected.

FIGURE 12.6 A PIVOT TABLE THAT EXAMINES CUSTOMER REGIONAL DISTRIBUTION AND ADVERTISING SOURCE



In this pivot table, we are able to examine where an online training company's customers come from in terms of region and advertising source.

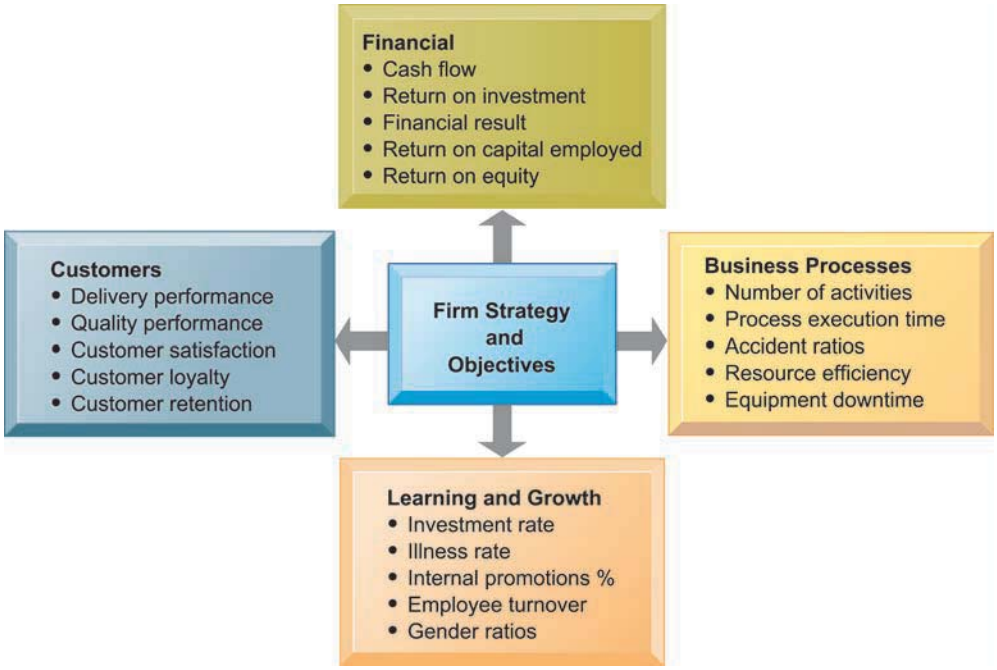
DECISION SUPPORT FOR SENIOR MANAGEMENT: BALANCED SCORECARD AND ENTERPRISE PERFORMANCE MANAGEMENT METHODS

The purpose of executive support systems (ESS), introduced in Chapter 2, is to help C-level executive managers focus on the really important performance information that affect the overall profitability and success of the firm. There are two parts to developing ESS. First, you will need a methodology for understanding exactly what is "the really important performance information" for a specific firm that executives need, and second, you will need to develop systems capable of delivering this information to the right people in a timely fashion.

Currently, the leading methodology for understanding the really important information needed by a firm's executives is called the **balanced scorecard method** (Kaplan and Norton, 2004; Kaplan and Norton, 1992). The balanced score card is a framework for operationalizing a firm's strategic plan by focusing on measurable outcomes on four dimensions of firm performance: financial, business process, customer, and learning and growth (Figure 12.7).

Performance on each dimension is measured using **key performance indicators (KPIs)**, which are the measures proposed by senior management for understanding how well the firm is performing along any given dimension. For instance, one key indicator of how well an online retail firm is meeting its customer performance objectives is the average length of time required to deliver a package to a consumer. If your firm is a bank, one KPI of business process performance is the length of time required to perform a basic function like creating a new customer account.

FIGURE 12.7 THE BALANCED SCORECARD FRAMEWORK



In the balanced scorecard framework, the firm's strategic objectives are operationalized along four dimensions: financial, business process, customer, and learning and growth. Each dimension is measured using several KPIs.

The balanced scorecard framework is thought to be "balanced" because it causes managers to focus on more than just financial performance. In this view, financial performance is past history—the result of past actions—and managers should focus on the things they are able to influence today, such as business process efficiency, customer satisfaction, and employee training. Once a scorecard is developed by consultants and senior executives, the next step is automating a flow of information to executives and other managers for each of the key performance indicators. There are literally hundreds of consulting and software firms that offer these capabilities, which are described below. Once these systems are implemented, they are often referred to as ESS.

Another closely related popular management methodology is **business performance management (BPM)**. Originally defined by an industry group in 2004 (led by the same companies that sell enterprise and database systems like Oracle, SAP, and IBM), BPM attempts to systematically translate a firm's strategies (e.g., differentiation, low-cost producer, market share growth, and scope of operation) into operational targets. Once the strategies and targets are identified, a set of KPIs are developed that measure progress towards the targets. The firm's performance is then measured with information drawn from the firm's enterprise database systems. BPM uses the same ideas as balanced scorecard but with a stronger strategy flavor (BPM Working Group, 2004).

Corporate data for contemporary ESS are supplied by the firm's existing enterprise applications (enterprise resource planning, supply chain management, and customer relationship management). ESS also provide access to news services, financial market databases, economic information, and whatever other external data senior executives require. ESS also have significant **drill-down** capabilities if managers need more detailed views of data.

Well-designed ESS help senior executives monitor organizational performance, track activities of competitors, recognize changing market conditions, and identify problems and opportunities. Employees lower down in the corporate hierarchy also use these systems to monitor and measure business performance in their areas of responsibility. For these and other business intelligence systems to be truly useful, the information must be "actionable"—it must be readily available and also easy to use when making decisions. If users have difficulty identifying critical metrics within the reports they receive, employee productivity and business performance will suffer. The Interactive Session on Management shows how Colgate-Palmolive addressed this problem and helped its managers make more data-driven, actionable decisions.

GROUP DECISION-SUPPORT SYSTEMS (GDSS)

The DSS we have just described focus primarily on individual decision making. However, so much work is accomplished in groups within firms that a special category of systems called **group decision-support systems (GDSS)** has been developed to support group and organizational decision making.

A GDSS is an interactive computer-based system for facilitating the solution of unstructured problems by a set of decision makers working together as a group in the same location or in different locations. Collaboration systems and Web-based tools for videoconferencing and electronic meetings described earlier in this text support some group decision processes, but their focus is primarily on communication. GDSS, however, provide tools and technologies geared explicitly toward group decision making.

GDSS-guided meetings take place in conference rooms with special hardware and software tools to facilitate group decision making. The hardware includes