MODULE 1

Introduction to Business Intelligence, Analytics and Decision Support

Overview of Business Intelligence, Analytics and Decision Support

- The business environment is constantly changing, and becoming more and more complex.
- Organizations, private and public, are under pressures that force them to respond quickly to changing conditions and to be innovative in the way they operate.
- Such activities require organizations to be agile and to make frequent and quick strategic, tactical, and operational decisions, some of which are very complex.
- Making such decisions may require considerable amounts of relevant data, information, and knowledge.
- Processing these must be done quickly, frequently in real time, and usually requires some computerized support.

1.1 OPENING VIGNETTE: Magpie Sensing Employs Analytics to Manage a Vaccine Supply Chain Effectively and Safely

- The cold chain in healthcare is a temperature-controlled supply chain system used to transport and store vaccines and pharmaceutical drugs. It has three main components:

  a. **Transport and Storage Equipment**: Keeps products at a stable temperature, usually between 35–46°F (2–8°C).
  b. **Trained Personnel**: Ensures that staff handle products correctly throughout the supply chain.
  c. **Efficient Management Procedures**: Monitors and maintains cold chain integrity to prevent product spoilage.

- Maintaining cold chain integrity is essential for vaccine efficacy; improper handling can lead to ineffective vaccines or adverse effects.
- The process involves real-time temperature monitoring from resource gathering to product dispensing, with location-tagged environmental data ensuring product safety.

- **Magpie Sensing** offers a solution by providing wireless, real-time monitoring of temperature and humidity for cold chain products during shipment. Its system uses three types of analytics:

  - **Descriptive Analytics**: Tracks temperature data and displays it on a dashboard.
  - **Predictive Analytics**: Anticipates potential storage issues, alerts users of configuration errors, and detects human errors like door mishandling.
  - **Prescriptive Analytics**: Offers recommendations to optimize temperature settings, reduce spoilage risks, and inform purchasing decisions based on storage unit performance.

Through this system, Magpie Sensing aids compliance with safety regulations, reduces wastage, and ensures safe healthcare product delivery. This approach exemplifies how data-driven insights can enhance business efficiency and open new entrepreneurial opportunities.

1.2 CHANGING BUSINESS ENVIRONMENTS AND COMPUTERIZED DECISION SUPPORT

(Q) *With a neat diagram, justify the significance of a model used to support changing business environment.*

- Companies are moving aggressively to computerized support of their operations.
- To understand why companies are embracing computerized support, including business intelligence, a model called the Business Pressures-Responses-Support Model is developed, which is shown in Figure 1.1.

The Business Pressures-Responses-Support Model

- The Business Pressures-Responses-Support Model has three components:
  - **business pressures** that result from today's business climate
  - **responses** (actions taken) by companies to counter the pressures (or to take advantage of the opportunities available in the environment)
  - computerized **support** that facilitates the monitoring of the environment and enhances the response actions taken by organizations.

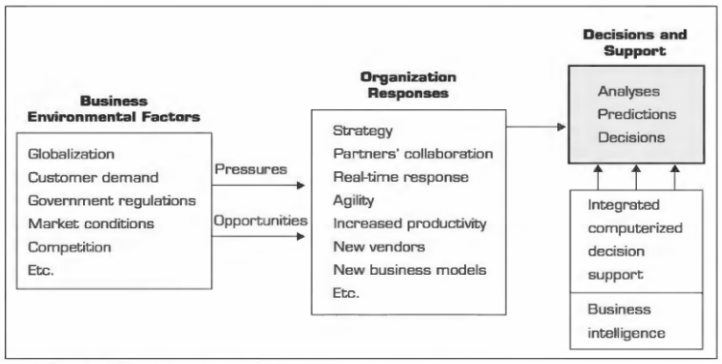

FIGURE 1.1 The Business Pressures–Responses–Support Model.

THE BUSINESS ENVIRONMENT

- The environment in which organizations operate today is becoming more and more complex which creates opportunities on the one hand and problems on the other.
- Example: Globalization. Today it is easy to find suppliers and customers in many countries, which means you can buy cheaper materials and sell more of your products and services; great opportunities exist.
- However, globalization also means more and stronger competitors.
- **(Q)** *With a neat diagram, show the implications of business environmental factors with respect to the changing business environment.*
- Business environment factors can be divided into **four** major categories: markets, consumer demands, technology, and societal. These categories are summarized in Table 1.1.

TABLE 1.1 Business Environment Factors That Create Pressures on Organizations

Factor	Description
Markets	Strong competition
	Expanding global markets
	Booming electronic markets on the Internet
	Innovative marketing methods
	Opportunities for outsourcing with IT support
	Need for real-time, on-demand transactions
Consumer demands	Desire for customization
	Desire for quality, diversity of products, and speed of delivery
	Customers getting powerful and less loyal
Technology	More innovations, new products, and new services
	Increasing obsolescence rate
	Increasing information overload
	Social networking, Web 2.0 and beyond
Societal	Growing government regulations and deregulation
	Workforce more diversified, older, and composed of more women
	Prime concerns of homeland security and terrorist attacks
	Necessity of Sarbanes-Oxley Act and other reporting-related legislation
	Increasing social responsibility of companies
	Greater emphasis on sustainability

- The intensity of most of these factors increases with time, leading to more pressures, more competition, and so on.
- In addition, organizations and departments within organizations face decreased budgets and amplified pressures from top managers to increase performance and profit. In this kind of environment, managers must respond quickly, innovate, and be agile.
- **(Q)** *What are the qualities of the manager required to provide organizational responses?*

  ORGANIZATIONAL RESPONSES: **Be Reactive, Anticipative, Adaptive, And Proactive**
- Both private and public organizations use different actions to counter the pressures.
- **(Q)** *Explain the actions taken by a manager for organizational responses to a problem.*

  Managers may take other **actions**, including the following:

  • Employ strategic planning.
  • Use new and innovative business models.
  • Restructure business processes.
  • Participate in business alliances.
  • Improve corporate information systems.
  • Improve partnership relationships.
  • Encourage innovation and creativity.
  • Encourage innovation and creativity.
  • Improve customer service and relationships.
  • Employ social media and mobile platforms for e-commerce and beyond.
  • Move to make-to-order production and on-demand manufacturing and services.
  • Use new IT to improve communication, data access (discovery of information), and collaboration.
  • Respond quickly to competitors' actions (e.g., in pricing, promotions, new products and services).
  • Automate many tasks of white-collar employees.
  • Automate certain decision processes, especially those dealing with customers.
  • Improve decision making by employing analytics.

Many of these actions require some computerized support which are facilitated by computerized decision support (DSS).

- One of the **major objectives** of computerized decision support is to facilitate **closing the gap** between the current performance of an organization and its desired performance, as expressed in its mission, objectives, and goals, and the strategy to achieve them.

1.3 MANAGERIAL DECISION MAKING

- **Management** is a process by which organizational goals are achieved by using resources.
- The **resources** are considered **inputs**, and **attainment of goals** is viewed as the **output** of the process.
- The **degree of success** of the organization and the manager is often measured by the **ratio** of outputs to inputs.
- This ratio is an indication of the organization's productivity, which is a reflection of the organizational and managerial performance.
- The **level of productivity** or the success of management depends on the performance of managerial functions, such as planning, organizing, directing, and controlling.
- To perform their functions, managers engage in a continuous process of making decisions.
- Making a decision means selecting the best alternative from two or more solutions.
- Managers perform 10 major roles that can be classified into **three major** categories: **interpersonal**, **informational**, and **decisional** (Table 1.2).
- To perform the managerial roles, managers need information that is delivered efficiently and in a timely manner to personal computers (PCs) on their desktops and to mobile devices.
- The information to managers is delivered by networks, generally via Web technologies.
- In addition to obtaining information necessary to better perform their roles, managers use computers directly to support and improve decision making, which is a key task hat is part of most of these roles.
- Many managerial activities in all roles revolve around decision making.
- Managers, especially those at **high managerial** levels, are primarily **decision makers**.
  (Q) *Analyze the various roles and their significance in the management process by a manager in the process of decision making.*

TABLE 1.2 Mintzberg's 10 Managerial Roles

Role	Description
Interpersonal	
Figurehead	Is symbolic head; obliged to perform a number of routine duties of a legal or social nature
Leader	Is responsible for the motivation and activation of subordinates; responsible for staffing, training, and associated duties
Liaison	Maintains self-developed network of outside contacts and informers who provide favors and information
Informational	
Monitor	Seeks and receives a wide variety of special information (much of it current) to develop a thorough understanding of the organization and environment; emerges as the nerve center of the organization's internal and external information
Disseminator	Transmits information received from outsiders or from subordinates to members of the organization; some of this information is factual, and some involves interpretation and integration
Spokesperson	Transmits information to outsiders about the organization's plans, policies, actions, results, and so forth; serves as an expert on the organization's industry
Decisional	
Entrepreneur	Searches the organization and its environment for opportunities and initiates improvement projects to bring about change; supervises design of certain projects
Disturbance handler	Is responsible for corrective action when the organization faces important, unexpected disturbances
Resource allocator	Is responsible for the allocation of organizational resources of all kinds; in effect, is responsible for the making or approval of all significant organizational decisions
Negotiator	Is responsible for representing the organization at major negotiations

The Decision-Making Process

- Managers usually make decisions by following a four-step process:

1. **Define** the problem (i.e., a decision situation that may deal with some difficulty or with an opportunity).

2. **Construct** a model that describes the real-world problem.

3**. Identify** possible solutions to the modeled problem and evaluate the solutions.

4. **Compare**, choose, and recommend a potential solution to the problem.

To follow this process, one must make sure that sufficient alternative solutions are being considered, that the consequences of using these alternatives can be reasonably predicted, and that comparisons are done properly.

The environmental factors make such an evaluation process difficult for the following reasons:

- Technology, information systems, advanced search engines, and globalization result in more and more alternatives from which to choose.
- Government regulations and the need for compliance, political instability and terrorism, competition, and changing consumer demands produce more uncertainty, making it more difficult to predict consequences and the future.
- Other factors are the need to make rapid decisions, the frequent and unpredictable changes that make trial-and-error learning difficult, and the potential costs of making mistakes.
- These environments are growing more complex every day. Therefore, making decisions today is indeed a complex task.

Because of these trends and changes, it is nearly impossible to rely on a trial-and error approach to management. Managers must be more sophisticated; they must use the new tools and techniques of their fields.

1.4 INFORMATION SYSTEMS SUPPORT FOR DECISION MAKING

- **{{**Computer applications have moved from transaction processing and monitoring activities to problem analysis and solution applications, and much of the activity is done with Web-based technologies.
- Analytics and BI tools such as data warehousing, data mining, online analytical processing (OLAP), dashboards, and the use of the Web for decision support are the cornerstones of today's modern management.
- Managers must have high-speed, networked information systems (wireline or wireless) to assist them with their most important task: making decisions.**}}**
- **(Q)** *Discuss the effects of information systems support in the decision making process.* Besides the obvious growth in hardware, software, and network capacities, some developments have clearly contributed to facilitating growth of decision support and analytics in a number of ways, including the following:
    - **Group communication and collaboration.** Many decisions are made today by groups whose members may be in different locations. Groups can collaborate and communicate readily by using Web-based tools as well as the ubiquitous smartphones. Collaboration is especially important along the supply chain, where partners-all the way from vendors to customers-must

share information. Assembling a group of decision makers, especially experts, in one place can be costly. Information systems can improve the collaboration process of a group and enable its members to be at different locations (saving travel costs).

- **Improved data management.** Many decisions involve complex computations. Data for these can be stored in different databases anywhere in the organization and even possibly at Web sites outside the organization. The data may include text, sound, graphics, and video, and they can be in different languages. It may be necessary to transmit data quickly from distant locations. Systems today can search, store, and transmit needed data quickly, economically, securely, and transparently.
- **Managing giant data warehouses and Big Data.** Large data warehouses, like the ones operated by Walmart, contain terabytes and even petabytes of data. Special methods, including parallel computing, are available to organize, search, and mine the data. The costs related to data warehousing are declining. Technologies that fall under the broad category of Big Data have enabled massive data coming from a variety of sources and in many different forms, which allows a very different view into organizational performance that was not possible in the past.
- **Analytical support.** With more data and analysis technologies, more alternatives can be evaluated, forecasts can be improved, risk analysis can be performed quickly, and the views of experts (some of whom may be in remote locations) can be collected quickly and at a reduced cost. Expertise can even be derived directly from analytical systems. With such tools, decision makers can perform complex simulations, check many possible scenarios, and assess diverse impacts quickly and economically.
- **Overcoming cognitive limits in processing and storing information.** Human mind has only a limited ability to process and store information. People sometimes find it difficult to recall and use information in an error-free fashion due to their cognitive limits. The term cognitive limits indicates that an individual's problem-solving capability is limited when a wide range of diverse information and knowledge is required. Computerized systems enable people to overcome their cognitive limits by quickly accessing and processing vast amounts of stored information.

- **Knowledge management.** Organizations have gathered vast stores of information about their own operations, customers, internal procedures, employee interactions, and so forth through the unstructured and structured communications taking place among the various stakeholders. Knowledge management systems have become sources of formal and informal support for decision making to managers.
- **Anywhere, anytime support.** Using wireless technology, managers can access information anytime and from any place, analyze and interpret it, and communicate with those involved. The speed at which information needs to be processed and converted into decisions has truly changed expectations for both consumers and businesses.

1.5 AN EARLY FRAMEWORK FOR COMPUTERIZED DECISION SUPPORT

(Q) *With a neat table showing early decision support framework.*

- Gorry and Scott-Morton created and used this framework in the early 1970s, and the framework then evolved into a new technology called DSS.

The Gorry and Scott-Morton Classical Framework

- Gorry and Scott-Morton 0971) proposed a framework that is a 3-by-3 matrix.
- The two dimensions are the degree of structuredness and the types of control.

	Type of Control		
Type of Decision	**Operational Control**	**Managerial Control**	**Strategic Planning**
Structured	1 Accounts receivable Accounts payable Order entry	2 Budget analysis Short-term forecasting Personnel reports Make-or-buy	3 Financial management Investment portfolio Warehouse location Distribution systems
Semistructured	4 Production scheduling Inventory control	5 Credit evaluation Budget preparation Plant layout Project scheduling Reward system design Inventory categorization	6 Building a new plant Mergers & acquisitions New product planning Compensation planning Quality assurance HR policies Inventory planning
Unstructured	7 Buying software Approving loans Operating a help desk Selecting a cover for a magazine	8 Negotiating Recruiting an executive Buying hardware Lobbying	9 R & D planning New tech development Social responsibility planning

FIGURE 1.2 Decision Support Frameworks.

(Q) *Justify the significance of computerized support for degree of structuredness in the data.*

DEGREE OF STRUCTUREDNESS

- The left side of Figure 1.2 is based on Simon's (1977) idea that decision-making processes ranges from highly structured to highly unstructured decisions.
- Structured processes are routine and typically repetitive problems for which standard solution methods exist.
- Unstructured processes are fuzzy, complex problems for which there are no cut-and-dried solution methods.
- An unstructured problem is one where the articulation of the problem or the solution approach may be unstructured in itself.
- In a structured problem, the procedures for obtaining the best (or at least a good enough) solution are known.
- Whether the problem involves finding an appropriate inventory level or choosing an optimal investment strategy, the objectives are clearly defined. Common objectives are cost minimization and profit maximization.
- Semistructured problems fall between structured and unstructured problems, having some structured elements and some unstructured elements.
- Keen and Scott-Morton 0978) mentioned trading bonds, setting marketing budgets for consumer products, and performing capital acquisition analysis as semistructured problems.

TYPES OF CONTROL

- The second half of the Gorry and Scott-Morton framework (refer to Figure 1.2) is based on Anthony's taxonomy.
- It defines three broad categories that encompass all managerial activities: **strategic planning,** which involves defining long-range goals and policies for resource allocation; **management control**, the acquisition and efficient use of resources in the accomplishment of organizational goals; and **operational control**, the efficient and effective execution of specific tasks.

THE DECISION SUPPORT MATRIX

- Anthony's and Simon's taxonomies are combined in the **nine-cell** decision support matrix shown in Figure 1.2.
- The initial purpose of this matrix was to suggest different types of computerized support to different cells in the matrix.

- Gorry and Scott-Morton suggested that for semistructured decisions and unstrnctured decisions, conventional management information systems (MIS) and management science (MS) tools are insufficient.
- Human intellect and a different approach to computer technologies are necessary.
- They proposed the use of a supportive information system, which they called a DSS.
- The more structured and operational control-oriented tasks (such as those in cells 1, 2, and 4) are usually performed by lower-level managers, whereas the tasks in cells 6, 8, and 9 are the responsibility of top executives or highly trained specialists.

Computer Support for Structured Decisions

- Computers have historically supported structured and some semistructured decisions, especially those that involve operational and managerial control, since the 1960s.
- Operational and managerial control decisions are made in all functional areas, especially in finance and production (i.e., operations) management.
- Structured problems, which are encountered repeatedly, have a high level of structure. It is therefore possible to abstract, analyze, and classify them into specific categories. Examples of categories are capital budgeting, allocation of resources, distribution, procurement, planning, and inventory control decisions.
- For each category of decision, an easy-to-apply prescribed model and solution approach have been developed, generally as quantitative formulas. Therefore, it is possible to use a scientific approach for automating portions of manage rial decision making.

Computer Support for Unstructured Decisions

- Unstructured problems can be only partially supported by standard computerized quantitative methods.
- It is usually necessary to develop customized solutions. However, such solutions may benefit from data and information generated from corporate or external data sources.
- Intuition and judgment may play a large role in these types of decisions.

Computer Support for Semistructured Problems

- Solving semistructured problems may involve a combination of standard solution procedures and human judgment.
- Management science can provide models for the portion of a decision-making problem that is structured.

- For the unstructured portion, a DSS can improve the quality of the information on which the decision is based by providing not only a single solution but also a range of alternative solutions, along with their potential impacts. These capabilities help managers to better understand the nature of problems and, thus, to make better decisions.

1.6 THE CONCEPT OF DECISION SUPPORT SYSTEMS (DSS)

- In the early 1970s, Scott-Morton first articulated the major concepts of DSS.
- He defined decision support systems (DSS) as "interactive computer-based systems, which help decision makers utilize data and models to solve unstructured problems" (Gorry and Scott-Morton, 1971).
- The following is another classic DSS definition, provided by Keen and Scott-Morton 0978): Decision support systems **couple** the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions.
- It is a **computer-based** support system for management decision makers who deal with **semistructured problems**.
- DSS can be viewed as a conceptual methodology-that is, a broad, umbrella term.

  DSS as an Umbrella Term

  - The term DSS can be used as an umbrella term to describe any computerized system that supports decision making in an organization.
  - An organization may have a knowledge management system to guide all its personnel in their problem solving. Another organization may have separate support systems for marketing, finance, and accounting; a supply chain management (SCM) system for production; and several rule-based systems for product repair diagnostics and help desks. DSS encompasses them all.

Evolution of DSS into Business Intelligence

- (In the early days of DSS, managers let their staff do some supportive analysis by using DSS tools. As PC technology advanced, a new generation of managers evolved-one that was comfortable with computing and knew that technology can directly help make intelligent business decisions faster). New tools such as OLAP, data warehousing, data mining, and intelligent systems, delivered via Web technology, added promised capabilities and easy access to tools, models, and data for computer-aided decision

making. These tools started to appear under the names BI and business analytics in the mid-1990s.

1.7 A FRAMEWORK FOR BUSINESS INTELLIGENCE (Bl)

(Q) *What is Business Intelligence?*

- Definitions of Bl Business intelligence (BI) is an umbrella term that combines architectures, tools, data bases, analytical tools, applications, and methodologies.
- It is, like DSS, a content-free expression.
- Bi's major objective is to enable interactive access (real time) to data, to enable manipulation of data, and to give business managers and analysts the ability to conduct appropriate analyses.
- By analyzing historical and current data, situations, and performances, decision makers get valuable insights that enable them to make more informed and better decisions.
- The process of BI is based on the transformation of data to information, then to decisions, and finally to actions.

A Brief History of Bl

- The term BI was coined by the Gartner Group in the mid-1990s. However, the concept is much older; it has its roots in the MIS reporting systems of the 1970s. During that period, reporting systems were static, two dimensional, and had no analytical capabilities.
- In the early 1980s, the concept of executive information systems (EIS) emerged. This concept expanded the computerized support to top-level managers and executives. Some of the capabilities introduced were dynamic multidimensional (ad hoc or on-demand) reporting, forecasting and prediction, trend analysis, drill-down to details, status access, and critical success factors. These features appeared in dozens of commercial products until the mid-1990s. Then the same capabilities and some new ones appeared under the name BI.
- Today, a good BI-based enterprise information system contains all the information executives need. So, the original concept of EIS was transformed into BI.
- By 2005, BI systems started to include artificial intelligence capabilities as well as powerful analytical capabilities.
- Figure 1.3 illustrates the various tools and techniques that may be included in a BI system. It illustrates the evolution of BI as well. The tools shown in Figure 1.3 provide

the capabilities of BI. The most sophisticated BI products include most of these capabilities; others specialize in only some of them.

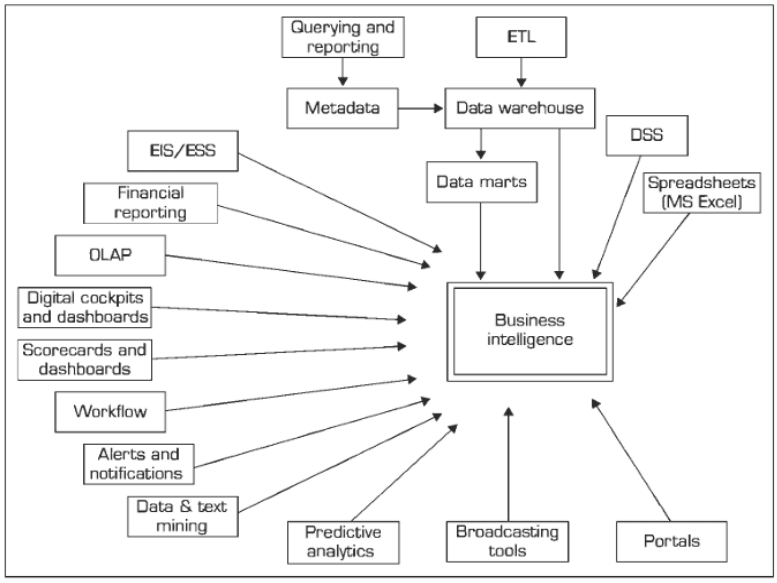

FIGURE 1.3 Evolution of Business Intelligence (BI).

(Q) *With a neat diagram, describe BI architecture and its styles.*

The Architecture of Bl

- A BI system has four major components: a **data warehouse**, with its source data; **business analytics**, a collection of tools for manipulating, mining, and analyzing the data in the data warehouse; **business performance management** {BPM) for monitoring and analyzing performance; and a **user interface** (e.g., a dashboard).
- The relationship among these components is illustrated in Figure 1.4.

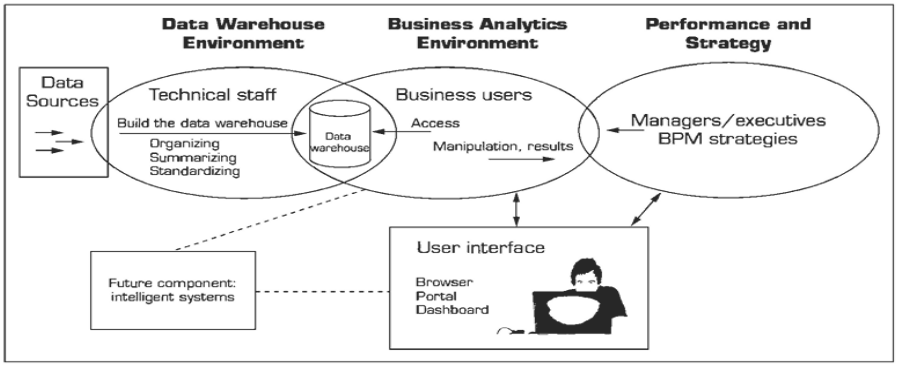

FIGURE 1.4 A High-Level Architecture of BI. *Source:* Based on W. Eckerson, *Smart Companies in the 21st Century: The Secrets of Creating Successful Business Intelligent Solutions.* The Data Warehousing Institute, Seattle, WA, 2003, p. 32, Illustration 5.

Styles of Bl

- The architecture of BI depends on its applications.
- MicroStrategy Corp. distinguishes five styles of BI and offers special tools for each.

- The five styles are **report delivery and alerting**; **enterprise reporting** (using dashboards and scorecards); **cube analysis** (also known as slice-and-dice analysis); **ad hoc queries**; and **statistics and data mining**.

The Origins and Drivers of Bl

- Organizations are being compelled to capture, understand, and harness their data to support decision making in order to improve business operations.
- Legislation and regulation now require business leaders to document their business processes and to sign off on the legitimacy of the information they rely on and report to stakeholders.
- Moreover, business cycle times are now extremely compressed; faster, more informed, and better decision making is therefore a competitive imperative.
- Managers need the right information at the right time and in the right place. This is the mantra for modern approaches to BI.
- Organizations have to work smart. Paying careful attention to the management of BI initiatives is a necessary aspect of doing business.

(Q) *Analyze the business value of BI analytic applications.*

TABLE 1.3 Business Value of BI Analytical Applications

Analytic Application	Business Question	Business Value
Customer segmentation	What market segments do my customers fall into, and what are their characteristics?	Personalize customer relationships for higher satisfaction and retention.
Propensity to buy	Which customers are most likely to respond to my promotion?	Target customers based on their need to increase their loyalty to your product line. Also, increase campaign profitability by focusing on the most likely to buy.
Customer profitability	What is the lifetime profitability of my customer?	Make individual business interaction decisions based on the overall profitability of customers.
Fraud detection	How can I tell which transactions are likely to be fraudulent?	Quickly determine fraud and take immediate action to minimize cost.
Customer attrition	Which customer is at risk of leaving?	Prevent loss of high-value customers and let go of lower-value customers.
Channel optimization	What is the best channel to reach my customer in each segment?	Interact with customers based on their preference and your need to manage cost.

The DSS-BI Connection

Some of the similarities and differences between DSS and BI.

- First, their architectures are very similar because BI evolved from DSS.

- BI implies the **use of a data warehouse**, whereas DSS *may or may not* have such a feature. BI is, therefore, more appropriate for *large* **organizations** (because data warehouses are expensive to build and maintain), but DSS can be appropriate to *any type* of organization.
- Second, most DSS are constructed to *directly* support specific decision making. BI systems, in general, are geared to provide accurate and timely information, and they support **decision support** *indirectly*. This situation is changing, however, as more and more decision support tools are being added to BI software packages.
- Third, BI has an *executive and strategy* **orientation**, especially in its BPM and dash board components. DSS, in contrast, is oriented *toward analysts*.
- Fourth, most BI systems are **constructed** with commercially *available tools* and *components* that are fitted to the needs of organizations. In building DSS, the interest may be in constructing *solutions to very unstructured problems*. In such situations, more *programming* (e.g., using tools such as Excel) may be needed to customize the solutions.
- Fifth, DSS methodologies and even some tools were **developed** mostly in the *academic world*. BI methodologies and tools were developed mostly by *software companies*.
- Sixth, many of the tools that BI uses are also considered DSS tools. For example, data mining and predictive analysis are core tools in both areas.

  (Although some people equate DSS with BI, these systems are not, at present, the same. In this book, we separate DSS from BI. However, we point to the DSS-BI connection frequently.)

  (Q) *Differentiate between DSS and Business Intelligence.*

Aspect	**Decision Support Systems (DSS)**	**Business Intelligence(BI)**
Architecture	DSS may or may not include a data warehouse.	BI typically includes a data warehouse, making it more suitable for large organizations.
Primary Purpose	Directly supports specific decision-making processes, often for unique or unstructured problems.	Provides accurate and timely information, indirectly supporting decision-making processes through data reporting and analysis.

Orientation	Analyst-oriented, focusing on detailed model-driven and custom-built solutions.	Executive and strategy-oriented, especially in components like BPM (Business Performance Management) and dashboards.
Tools and Components	Often involves customized tools and may require programming, such as Excel, to address unstructured problems.	Primarily built with commercially available tools, tailored to organizational needs.
Development Origin	DSS methodologies and tools were mostly developed in the academic world.	BI methodologies and tools were developed primarily by software companies.
Tool Overlap	Many DSS tools, such as data mining and predictive analysis, are shared with BI applications.	Uses similar tools as DSS, such as data mining and predictive analysis, but focuses more on organizational reporting.
System Relationship	DSS is sometimes considered a foundational element of BI, particularly in analytics.	BI evolved from DSS and integrates elements of DSS, but focuses more on reporting, communication, and collaboration.

1.8 BUSINESS ANALYTICS OVERVIEW

(Q) *What is business analytics? With a neat diagram, explain its types.*

- Analytics is the process of developing actionable decisions or recommendation for future actions based upon insights generated from historical data, supporting organizations in understanding what has happened, predicting future trends, and determining the best course of action.
- The Institute for Operations Research and Management Science (INFORMS) defines analytics as the combination of computer technology, management science techniques, and statistics to address and solve real-world problems.
- The goal of business analytics is to support organizations in making informed decisions by analyzing data across three levels: descriptive, predictive, and prescriptive analytics.

Types of Business Analytics

1. **Descriptive Analytics**
    - **Definition:** Descriptive or reporting analytics refers to understanding what is happening in an organization and recognizing trends and patterns from past data.
    - **Functionality:** Descriptive analytics involves consolidating data from multiple sources and making it accessible in a form suitable for reporting and analysis, often through data warehouses.
    - **Tools and Techniques:** Common tools include reporting systems, queries, alerts, trend analysis, and visualization techniques.
    - **Significance of Visualization:** Visualization tools have become crucial for gaining insights, allowing organizations to analyze operations through data-driven visuals.
    - **Example Use Cases:** Descriptive analytics can show the frequency of certain customer behaviors, summarize sales performance, or indicate areas where improvements are necessary.
2. **Predictive Analytics**
    - **Definition:** Predictive analytics aims to forecast future outcomes based on historical data.
    - **Core Techniques:** Predictive analytics uses statistical techniques and data mining methods, such as classification, clustering, and association analysis, to anticipate future behaviors.
    - **Application Areas:** Examples include predicting whether a customer is likely to leave for a competitor (churn), forecasting what products a customer is likely to buy next, assessing customer response to promotions, or evaluating creditworthiness.
    - **Specific Techniques:**
        - **Classification algorithms** categorize data based on past behavior to predict future trends.
        - **Clustering algorithms** group customers into segments for targeted promotions.
        - **Association mining techniques** analyze relationships between different purchasing behaviors. For instance, if a customer buys one product,

association mining can suggest related products they may be interested in (as seen on platforms like Amazon).

3. **Prescriptive Analytics**
    - **Definition:** Prescriptive analytics goes a step further by not only forecasting what might happen but also providing recommendations for achieving the best outcomes.
    - **Goal:** This type of analytics aims at optimizing decisions to achieve the highest possible performance by recommending specific actions.
    - **Historical Roots:** Historically, prescriptive analytics has been part of operations research or management science, focusing on system optimization.
    - **Decision Types:** Recommendations could be a specific yes/no decision, a numerical outcome like a price, or a full plan such as a production schedule.
    - **Automation Capability:** These recommendations might be provided to a decision-maker in a report or used directly in automated systems, such as airline pricing algorithms.
    - **Alternative Name:** Sometimes called decision or normative analytics, as it aims to prescribe a specific course of action.

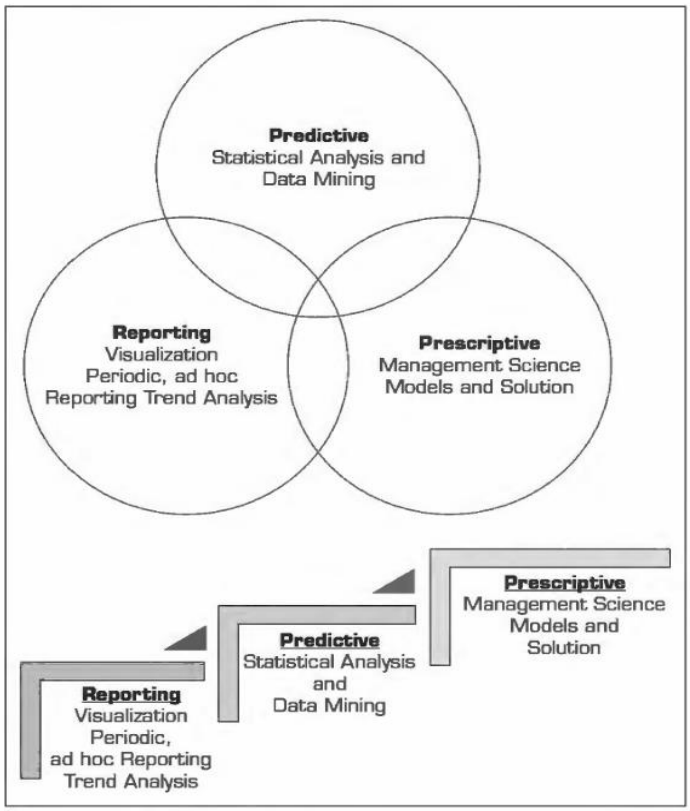

FIGURE 1.5 Three Types of Analytics.

The diagram (Figure 1.5) visually represents the types of analytics as follows:

- **Interconnected Circles View:** This view uses overlapping circles to show that while Descriptive, Predictive, and Prescriptive Analytics are distinct types, they are interconnected. Insights from one type often feed into another, creating a continuous cycle of analysis.
    - **Descriptive (Reporting)** overlaps with **Predictive** through shared tools like statistical analysis and trend recognition.
    - **Predictive** overlaps with **Prescriptive** as predictive models inform recommendations for future actions.
    - **Prescriptive** uses insights from both descriptive and predictive analytics to generate actionable recommendations.
- **Ladder or Sequential View:** This view depicts analytics types as steps in a progression:
    - **Descriptive Analytics** is the foundation, where historical data is consolidated and patterns are identified.
    - **Predictive Analytics** builds on descriptive insights to anticipate future trends.
    - **Prescriptive Analytics** uses predictions to make optimized decisions, closing the loop by informing future actions.

1.9 BRIEF INTRODUCTION TO BIG DATA ANALYTICS

(Q) *What is Big data? What are its characteristics?*

What Is Big Data?

- Big Data refers to large amounts of data that are difficult to store and process using traditional data storage systems.
- Unlike human brains, which can process various types of data—such as images, sounds, text, and videos—computers struggle to keep up with the pace at which data is generated today.
- Big Data includes data that arrives in many forms, including structured, unstructured, and streaming data.
- Major sources of Big Data include clickstreams from websites, social media posts (such as Facebook updates), and data generated by traffic sensors and weather stations.

For instance, web search engines like Google must handle billions of web pages to deliver search results quickly. To accomplish this, they use advanced Big Data analytics to process and index data at scale.

Characteristics of Big Data

Big Data is commonly defined by three main characteristics:

1. **Volume:**
    - This refers to the massive scale of data that is generated continuously. Traditional storage systems cannot handle this volume efficiently, so new storage solutions are needed.
    - A practical solution was developed where data is stored in smaller chunks distributed across multiple machines in a network. Each chunk is stored in several locations, both physically and logically, to ensure fault tolerance.
    - Google initially developed this system, called the Google File System, which was later released as an open-source project called the Hadoop Distributed File System (HDFS).
2. **Velocity:**
    - Velocity is the speed at which data is created and processed. Big Data often requires data to be processed in real-time or near-real-time.
    - A prime example is algorithmic trading in financial markets, where data needs to be processed in microseconds. This rapid processing speed enables trading platforms to respond to market changes almost instantaneously.
    - As data processing requirements have evolved, the need to manage and process data at high speeds has added velocity as a key characteristic of Big Data.
3. **Variety:**
    - Big Data includes a wide variety of data types, encompassing structured data (like databases), unstructured data (like text and images), and semi-structured data (like JSON files).
    - For example, sentiment analysis gathers and processes various forms of data from social media and customer responses to understand public opinion.
    - As more types of data sources emerged, the need to handle different kinds of data introduced variety as an essential aspect of Big Data.

Challenges and Solutions in Big Data Management

There are two major challenges in managing Big Data: storing and processing it effectively.

- **Storing Data:** Initially, storing all the data on a single, expensive storage unit was considered, but making this unit fault-tolerant was costly. An innovative solution involved breaking down data into chunks and storing them across multiple machines in a network, with copies of each chunk distributed in different locations. This approach was pioneered by Google and later adapted into the Hadoop Distributed File System (HDFS).
- **Processing Data:** Processing vast amounts of data on a single powerful computer would create a massive overhead, making it inefficient. An alternative approach, called the MapReduce programming paradigm, was developed to "push computation to the data." This means computations are processed where the data is stored rather than transferring data to a central processing node. Originally developed by Google, MapReduce was later released as an open-source project as part of Hadoop. This paradigm shift allowed for more efficient data processing on a large scale.

Examples of Big Data Applications

The growth of Big Data applications has led to an increasing focus on velocity and variety. Some prominent examples include:

- **Algorithmic Trading:** This involves using electronic platforms and algorithms for trading stocks in financial markets. With trading occurring at microsecond speeds, rapid data processing is essential, illustrating the velocity characteristic of Big Data.
- **Sentiment Analysis:** This application gathers data from social media and customer feedback to gauge public sentiment, highlighting the variety of Big Data sources.

CASE STUDIES

Application Case 1.1

Sabre Helps Its Clients Through Dashboards and Analytics

Sabre is one of the world leaders in the travel industry, providing both business-to-consumer services as well as business-to-business services. It serves travellers, travel agents, corporations, and travel suppliers through its four main companies: Travelocity, Sabre Travel Network, Sabre Airline Solutions, and Sabre Hospitality Solutions. The current volatile global eco nomic environment poses significant competitive challenges to the airline industry. To stay ahead of the competition, Sabre Airline Solutions recognized that airline executives needed enhanced tools for managing their business decisions by eliminating the traditional, manual,

time-consuming process of collect ing and aggregating financial and other information needed for actionable initiatives. This enables real-time decision support at airlines throughout the world that maximize their (and, in tum, Sabre's) return on information by driving insights, actionable intelligence, and value for customers from the growing data. Sabre developed an Enterprise Travel Data Warehouse (ETDW) using Teradata to hold its massive reservations data. ETDW is updated in near-real time with batches that run every 15 minutes, gathering data from all of Sabre's businesses. Sabre uses its ETDW to create Sabre Executive Dashboards that provide near-real-time executive insights using a Cognos 8 BI platform with Oracle Data Integrator and Oracle Goldengate technology infrastructure. The Executive Dashboards offer their client airlines' top-level managers and decision makers a timely, automated, user friendly solution, aggregating critical performance metrics in a succinct way and providing at a glance a 360-degree view of the overall health of the airline. At one airline, Sabre's Executive Dashboards provide senior management with a daily and intra-day snap shot of key performance indicators in a single application, replacing the once-a-week, &-hour process of generating the same report from various data sources. The use of dashboards is not limited to the external customers; Sabre also uses them for their assessment of internal operational performance. The dashboards help Sabre's customers to have a clear understanding of the data through the visual displays that incorporate interactive drill-down capabilities. It replaces flat presentations and allows for more focused review of the data with less effort and time. This facilitates team dialog by making the data/ metrics pertaining to sales performance, including ticketing, seats sold and flown, operational performance such as data on flight movement and tracking, customer reservations, inventory, and revenue across an airline's multiple distribution channels, available to many stakeholders. The dashboard systems provide scalable infrastructure, graphical user interface (GUI) support, data integration, and data aggregation that empower airline executives to be more proactive in taking actions that lead to positive impacts on the overall health of their airline. With its EIDW, Sabre could also develop other Web-based analytical and reporting solutions that leverage data to gain customer insights through analysis of customer profiles and their sales interactions to calculate customer value. This enables better customer segmentation and insights for value-added services.

QUESTIONS FOR DISCUSSION

1. What is traditional reporting? How is it used in organizations?

2. How can analytics be used to transform traditional reporting?

3. How can interactive reporting assist organizations in decision making?

What We Can Learn from This Application Case

This Application Case shows that organizations that earlier used reporting only for tracking their internal business activities and meeting compliance requirements set out by the government are now moving toward generating actionable intelligence from their transactional business data. Reporting has become broader as organizations are now trying to analyze archived transactional data to understand underlying hidden trends and patterns that would enable them to make better decisions by gaining insights into problematic areas and resolving them to pursue current and future market opportunities. Reporting has advanced to interactive online reports that enable users to pull and quickly build custom reports as required and even present the reports aided by visualization tools that have the ability to connect to the database, providing the capabilities of digging deep into summarized data.

Application Case 1.2

Eliminating Inefficiencies at Seattle Children's Hospital

Seattle Children's was the seventh highest ranked children's hospital in 2011, according to U.S. News & World Report. For any organization that is com mitted to saving lives, identifying and removing the inefficiencies from systems and processes so that more resources become available to cater to patient care become very important. At Seattle Children's, management is continuously looking for new ways to improve the quality, safety, and processes from the time a patient is admitted to the time they are discharged. To this end, they spend a lot of time in analyzing the data associated with the patient visits. To quickly turn patient and hospital data into insights, Seattle Children's implemented Tableau Software's business intelligence application. It provides a browser based on easy-to-use analytics to the stakeholders; this makes it intuitive for individuals to create visualizations and to understand what the data has to offer. The data analysts, business managers, and financial analysts as well as clinicians, doctors, and researchers are all using descriptive analytics to solve different problems in a much faster way. They are developing visual systems on their own, resulting in dashboards and scorecards that help in defining the standards, the current performance achieved measured against the standards, and how these systems will grow into the future. Through the use of monthly and daily dashboards, day-to-day decision making at Seattle Children's has improved significantly. Seattle Children's measures patient wait-times and analyzes them with the help of visualizations to discover the root causes and contributing factors for patient wa1tmg. They found that early delays cascaded during the day. They focused on on-time appointments of

patient services as one of the solutions to improving patient overall waiting time and increasing the availability of beds. Seattle Children's saved about $3 million from the supply chain, and with the help of tools like Tableau, they are finding new ways to increase savings while treating as many patients as possible by making the existing processes more efficient.

QUESTIONS FOR DISCUSSION

1. Who are the users of the tool?

2. What is a dashboard?

3. How does visualization help in decision making?

4. What are the significant results achieved by the use of Tableau?

What We Can Learn from This Application Case

This Application Case shows that reporting analytics involving visualizations such as dashboards can offer major insights into existing data and show how a variety of users in different domains and departments can contribute toward process and quality improvements in an organization. Furthermore, exploring the data visually can help in identifying the root causes of problems and provide a basis for working toward possible solutions.

Application Case 1.4

Moneyball: Analytics in Sports and Movies

Moneyball, a biographical, sports, drama film, was released in 2011 and directed by Bennett Miller. The film was based on Michael Lewis's book, Moneyball. The movie gave a detailed account of the Oakland Athletics baseball team during the 2002 season and the Oakland general manager's efforts to assemble a competitive team.

The Oakland Athletics suffered a big loss to the New York Yankees in 2001 postseason. As a result, Oakland lost many of its star players to free agency and ended up with a weak team with unfavorable financial prospects. The general manager's efforts to reassemble a competitive team were denied because Oakland had limited payroll. The scouts for the Oakland Athletics followed the old baseball custom of making subjective decisions when selecting the team members. The general manager then met a young, computer whiz with an economics degree from Yale. The general manager decided to appoint him as the new assistant general manager.

The assistant general manager had a deep pas sion for baseball and had the expertise to crunch the numbers for the game. His love for the game made him develop a radical way of understanding baseball statistics. He was a disciple of Bill James, a marginal figure who offered

rationalized techniques to analyze baseball. James looked at baseball statis tics in a different way, crunching the numbers purely on facts and eliminating subjectivity. James pioneered the nontraditional analysis method called the Sabermetric approach, which derived from SABR Society for American Baseball Research.

The assistant general manager followed the Sabermetric approach by building a prediction model to help the Oakland Athletics select players based on their "on-base percentage" (OBP), a statistic that measured how often a batter reached base for any reason other than fielding error, fielder's choice, dropped/ uncaught third strike, fielder's obstruction, or catcher's interference. Rather than relying on the scout's experience and intuition, the assistant general manager selected players based almost exclusively on OBP.

Spoiler Alert: The new team beat all odds, won 20 consecutive games, and set an American League record.

QUESTIONS FOR DISCUSSION

1. How is predictive analytics applied in Moneyball?

2. What is the difference between objective and subjective approaches in decision making?

What We Can Learn from This Application Case

Analytics finds its use in a variety of industries. It helps organizations rethink their traditional problem-solving abilities, which are most often subjective, relying on the same old processes to find a solution. Analytics takes the radical approach of using historical data to find fact-based solutions that will remain appropriate for making even future decisions.

Application Case 1.5

Analyzing Athletic Injuries

Any athletic activity is prone to injuries. If the injuries are not handled properly, then the team suffers. Using analytics to understand injuries can help in deriving valuable insights that would enable the coaches and team doctors to manage the team composition, understand player profiles, and ultimately aid in better decision making concerning which players might be available to play at any given time.

In an exploratory study, Oklahoma State University analyzed American football-related sport injuries by using reporting and predictive analytics. The project followed the CRISP-DM methodology to understand the problem of making recommendations on managing injuries, understanding the various data elements collected about injuries, cleaning the data, developing

visualizations to draw various inferences, building predictive models to analyze the injury healing time period, and drawing sequence rules to predict the relationship among the injuries and the various body part parts afflicted with injuries.

The injury data set consisted of more than 560 football injury records, which were categorized into injury-specific variables-body part/ site/ laterality, action taken, severity, injury type, injury start and healing dates-and player/sport-specific variables-player ID, position played, activity, onset, and game location. Healing time was calculated for each record, which was classified into different sets of time periods: 0-1 month, 1-2 months, 2-4 months, 4-6 months, and 6-24 months.

Various visualizations were built to draw inferences from injury data set information depicting the healing time period associated with players' positions, severity of injuries and the healing time period, treatment offered and the associated healing time period, major injuries afflicting body parts, and so forth.

Neural network models were built to predict each of the healing categories using IBM SPSS Modeler. Some of the predictor variables were current status of injury, severity, body part, body site, type of injury, activity, event location, action taken, and position played. The success of classifying the healing category was quite good: Accuracy was 79.6 percent. Based on the analysis, many business recommendations were suggested, including employing more specialists' input from injury onset instead of letting the training room staff screen the injured players; training players at defensive positions to avoid being injured; and holding practice to thoroughly safety-check mechanisms.

QUESTIONS FOR DISCUSSION

1. What types of analytics are applied in the injury analysis?

2. How do visualizations aid in understanding the data and delivering insights into the data?

3. What is a classification problem?

4. What can be derived by performing sequence analysis?

What We Can Learn from This Application Case

For any analytics project, it is always important to understand the business domain and the current state of the business problem through extensive analysis of the only resource-historical data. Visualizations often provide a great tool for gaining the initial insights into data, which can be further refined based on expert opinions to identify the relative importance of the data elements related to the problem. Visualizations also aid in generating ideas for obscure business

problems, which can be pursued in building predictive models that could help organizations in decision making.

Application Case 1.6

Industrial and Commercial Bank of China (ICBC) Employs Models to Reconfigure Its Branch Network

The Industrial and Commercial Bank of China (ICBC) has more than 16,000 branches and serves over 230 million individual customers and 3.6 million corporate clients. Its daily financial transactions total about $180 million. It is also the largest publicly traded bank in the world in terms of market capitalization, deposit volume, and profitability. To stay competitive and increase profitability, ICBC was faced with the challenge to quickly adapt to the fast paced economic growth, urbanization, and increase in personal wealth of the Chinese. Changes had to be implemented in over 300 cities with high variability in customer behavior and financial status. Obviously, the nature of the challenges in such a huge economy meant that a large-scale optimization solution had to be developed to locate branches in the right places, with right services, to serve the right customers.

With their existing method, ICBC used to decide where to open new branches through a scoring model in which different variables with varying weight were used as inputs. Some of the variables were customer flow, number of residential households, and number of competitors in the intended geographic region. This method was deficient in determining the customer distribution of a geographic area. The existing method was also unable to optimize the distribution of bank branches in the branch network. With support from IBM, a branch reconfiguration (BR) tool was developed. Inputs for the BR system are in three parts:

a. Geographic data with 83 different categories
b. Demographic and economic data with 22 different categories
c. Branch transactions and performance data that consisted of more than 60 million transaction records each day.

These three inputs helped generate accurate customer distribution for each area and, hence, helped the bank optimize its branch network. The BR system consisted of a market potential calculation model, a branch network optimization model, and a branch site evaluation model. In the market potential model, the customer volume and value is measured based on input data and expert knowledge. For instance, expe1t knowledge would help determine if per sonal income should be weighted more than gross domestic product (GDP). The geographic areas

are also demarcated into cells, and the preference of one cell over the other is determined. In the branch net work optimization model, mixed integer program ming is used to locate branches in candidate cells so that they cover the largest market potential areas. In the branch site evaluation model, the value for establishing bank branches at specific locations is determined.

Since 2006, the development of the BR has been improved through an iterative process. ICBC's branch reconfiguration tool has increased deposits by $21.2 billion since its inception. This increase in deposit is because the bank can now reach more customers with the right services by use of its optimization tool. In a specific example, when BR was implemented in Suzhou in 2010, deposits increased to $13.67 billion from an initial level of $7.56 billion in 2007. Hence, the BR tool assisted in an increase of deposits to the tune of $6.11 billion between 2007 and 2010. This project was selected as a finalist in the Edelman Competition 2011, which is run by INFORMS to promote actual applications of management science/operations research models.

QUESTIONS FOR DISCUSSION

1. How can analytical techniques help organizations to retain competitive advantage?
2. How can descriptive and predictive analytics help in pursuing prescriptive analytics?
3. What kinds of prescriptive analytic techniques are employed in the case study?
4. Are the prescriptive models once built good forever?

What We Can Learn from This Application Case

Many organizations in the world are now embracing analytical techniques to stay competitive and achieve growth. Many organizations provide consulting solutions to the businesses in employing prescriptive analytical solutions. It is equally important to have proactive decision makers in the organizations who are aware of the changing eco nomic environment as well as the advancements in the field of analytics to ensure that appropriate models are employed. This case shows an example of geographic market segmentation and customer behavioral segmentation techniques to isolate the profitability of customers and employ optimization techniques to locate the branches that deliver high profitability in each geographic segment.

Application Case 1.7

Gilt Groupe's Flash Sales Streamlined by Big Data Analytics

Gilt Groupe is an online destination offering flash sales for major brands by selling their clothing and accessories. It offers its members exclusive discounts on high-end clothing and other apparel. After registering with Gilt, customers are sent e-mails containing a variety of

offers. Customers are given a 36-48 hour window to make purchases using these offers. There are about 30 different sales each day. While a typical department store turns over its inventory two or three times a year, Gilt does it eight to 10 times a year. Thus, they have to manage their inventory extremely well or they could incur extremely high inventory costs. In order to do this, analytics software developed at Gilt keeps track of eve1y customer click-ranging from what brands the customers click on, what colors they choose, what styles they pick, and what they end up buying. Then Gilt tries to predict what these customers are more likely to buy and stocks inventory according to these predictions. Customers are sent customized alerts to sale offers depending on the suggestions by the analytics software.

That, however, is not the whole process. The software also monitors what offers the customers choose from the recommended offers to make more accurate predictions and to increase the effectiveness of its personalized recommendations. Some customers do not check e-mail that often. Gilt's analytics software keeps track of responses to offers and sends the same offer 3 days later to those customers who haven't responded. Gilt also keeps track of what customers are saying in general about Gilt's products by analyzing Twitter feeds to analyze sentiment. Gilt's recommendation software is based on Teradata Aster's technology solution that includes Big Data analytics technologies.

QUESTIONS FOR DISCUSSION

1. What makes this case study an example of Big Data analytics?

2. What types of decisions does Gilt Groupe have to make?

What We Can Learn From this Application Case

There is continuous growth in the amount of structured and unstructured data, and many organizations are now tapping these data to make actionable decisions. Big Data analytics is now enabled by the advancements in technologies that aid in storage and processing of vast amounts of rapidly growing data.