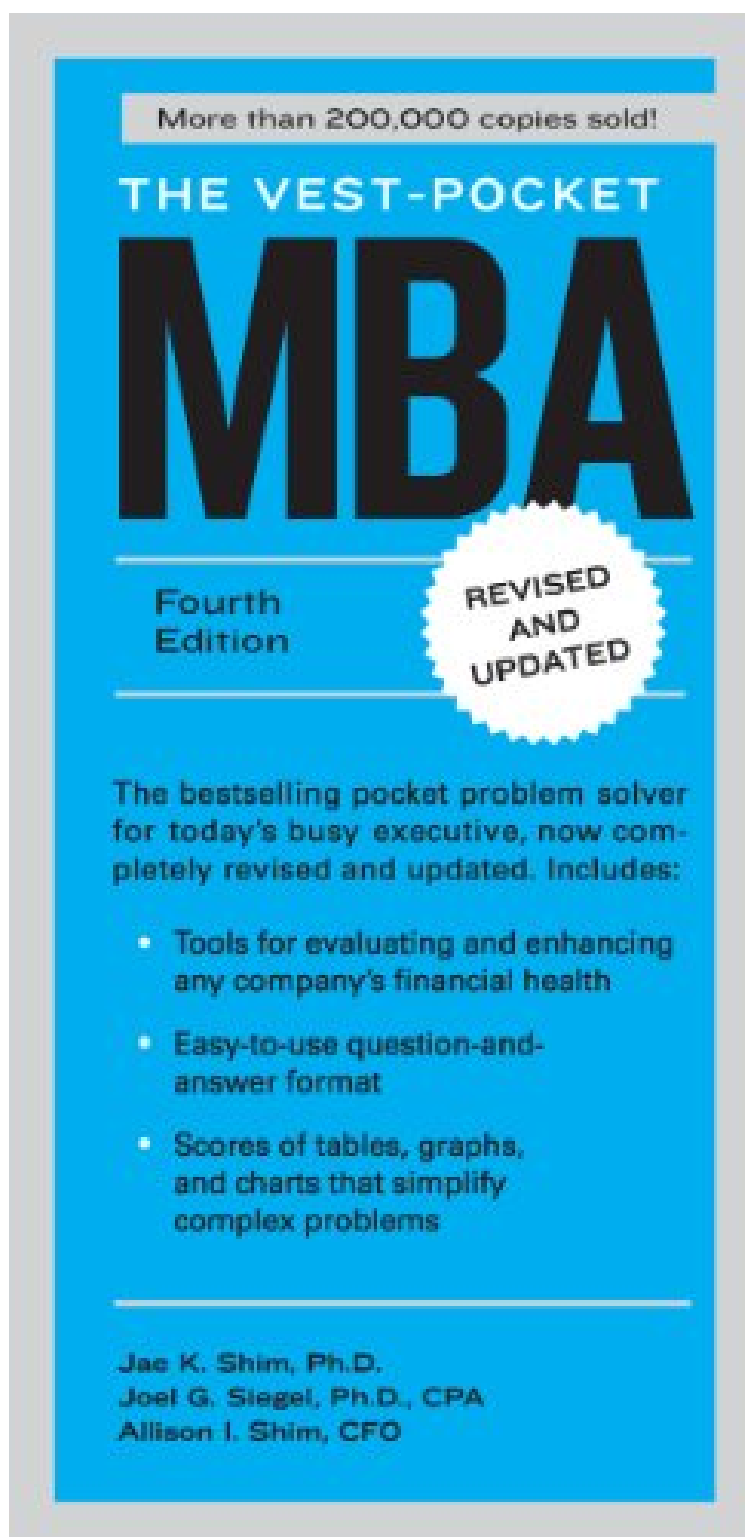


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PORTFOLIO / PENGUIN
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The scanning, uploading, and distribution of this book via the Internet or via any other means without the permission of the publisher is illegal and punishable by law. Please purchase only authorized electronic editions, and do not participate in or encourage electronic piracy of copyrighted materials. Your support of the author's rights is appreciated.

Preface Here is a handy pocket problem solver for today's busy executive. It is a working guide to help you quickly pinpoint in the complex world of business: What to look for; What to do; What to watch out for; How to do it You will find ratios, formulas, guidelines, and rules of thumb to help you analyze and evaluate any business-related problem. Throughout, you will find this book practical, quick, and useful. Uses for this book are as varied as the topics presented.

Part I (Chapters 1, 2, 3, and 4) takes you through the world of business strategy, management, marketing, and legal environments of business. You will learn strategic analysis, various management techniques, production /operations management, the marketing process of planning and distribution, and how to price and promote products. These management and marketing techniques and processes have been presented in an extremely understandable and practical format to make them as useful as possible. The statutory and case laws affecting business operations and decisions are also presented. Legal requirements must be known to protect the business entity.

Part II (Chapters 5, 6, and 7) takes you through accounting principles and guidelines for evaluating a company's financial health. You will have an increased understanding of various financial statements and their implications. You will be exposed to Corporate Responsibility Law, better known as the Sarbanes-Oxley (SOX) Act. You will learn techniques for analyzing another company's financial position should you wish to invest, extend credit, or compare. You will also learn how to improve a company's corporate profitability and shareholder value. We present internal managerial accounting applications to help you evaluate your own company's performance, profitability, marketing effectiveness, and budgeting process. You will learn how to highlight problem areas with variance analysis. You will also learn some valuable new tools, such as activity-based costing (ABC), life-cycle costing, target costing, and corporate balanced scorecard.

Part III (Chapters 8, 9, and 10) takes a look at financial analysis tools, financial metrics, and financing methods for decision making. Through break-even and sensitivity analysis, you will be able to move your company toward greater profits. For investment purposes, this part presents guidelines for evaluating proposals, whether they be short or long term, for profit potential and risk-return comparisons. You will learn management and financing techniques to ensure the best possible strategies for maximizing and acquiring cash. Also covered are basic financial tenets of portfolio theory, the capital asset pricing model (CAPM), and the arbitrage pricing model (APM).

Part IV (Chapters 11, 12, and 13) takes you through the seemingly complex world of quantitative analysis and information technology (IT). You will use statistics for forecasting and validity testing. Decision tools and techniques include linear programming, learning curve theory, project management, and queuing models; these are presented concisely and comprehensively to help you use such sophisticated techniques with relative ease. In addition, you will learn how computer applications facilitate the many complex procedures. Computer applications are heavily stressed throughout the chapters. Chapter 13 takes up the issue as to how IT assists managers in business decisions. It covers the use of information systems in all phases of business and in all functional areas to analyze and solve business problems in the "real world."

Part V (Chapters 14 and 15) covers the economic issues of interest to business managers, because they have a significant impact upon corporate success or failure. Attention should be given to the changing economic environment as well as economic indices and statistics in making financial and investment decisions. Many companies are multinational, so business managers must understand the opportunities and difficulties associated with international business and multinational finance. Some relevant issues of concern to businesspeople are foreign exchange rates, currency risk management, political risk, and international sources of financing.

This book has been designed in question-and-answer format in order to address the pertinent issues that come up during the course of business. The questions are typical of those

asked by persons like you. The answers are clear, concise, and to the point. In short, this is a veritable cookbook of guidelines, illustrations, and "how-to's" for you, the modern decision maker. Keep it handy for easy reference throughout your busy day.

Jae K. Shim
 Joel G. Siegel
 Allison I. Shim

PART ONE Business Strategy, Management, Marketing, and Legal Strategies

CHAPTER 1 Strategic Management and Operations Management (OM)

This chapter provides a discussion of strategic management and production and operations management (P/OM), including Mission statement Strategic management Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis Management decision making Simulation Capacity management Location analysis Time-study procedures Aggregate planning schedules Inventory management Scheduling, including project scheduling

Strategy can be defined as a course of action or a plan, including the specification of resources required, to achieve a specific objective. All business organizations have objectives, but because of the dynamic nature of the organizations' environments, overall plans or strategies are needed to specify in broad terms just how the objectives of the organizations can be achieved, given the uncertainty of the environments. Strategic management is therefore concerned with deciding on a strategy and planning how that strategy is to be effected. As such, strategic management has general relevance in that it is relevant for managers in all types of organizations—profit-seeking and nonprofit organizations, state and private sector.

Production and operations management (P/OM) is a vital management activity in both manufacturing and service organizations. It is primarily concerned with the process of transforming organizational resource inputs into final organizational outputs. It is a comprehensive process that treats the organization as a system of interconnected functions. The major functions of P/OM incorporate design, planning, decision making, operations, and system controls.

1.1 THE ORGANIZATIONAL MISSION STATEMENT

What is the purpose of a mission statement? A mission statement describes the basic operational intent of an organization. It takes a long-term perspective and states the reason for a firm's existence. Its function is to provide guidance for the firm's shareholders, customers, and employees about the organization's overall direction and rationale.

How is a mission statement developed? A mission statement should be consistent with the organization's history, including past achievements, organizational culture, attributes, and basic policies. A new organization will take into consideration the history of the industry it is joining as well as the purpose it wishes to serve. Successful mission statements emphasize areas in which an organization has its greatest strengths and resources.

What are the key elements of a mission statement? A mission statement must be:

- Meaningful for the organization's client or customer base. Organizations must be constantly aware of who their clientele is, and of its requisite needs.
- Realistic and attainable. Unrealistic mission statements will cause an organization to fail.
- Stimulating and inspiring. A motivational mission statement will enhance employee creativity and commitment.
- Definitive and explicit. Unclear mission statements result in dispersed and unsuccessful organizational strategies.

Example 1.1 An independent power producer states that its mission consists of four central values:

- Integrity: To act with integrity and honor commitments.
- Fairness: To treat fairly employees, customers, suppliers, and the governments and communities in which the organization operates.
- Fun: To create and maintain an atmosphere in which employees can advance in their skills while enjoying their time at work.
- Social Responsibility: To undertake projects that provide social benefits, such as lower costs to customers, a high degree of safety and reliability, increased employment, and a cleaner environment.

Example 1.2 A rapidly growing petroleum company states that its mission is to create value by adding substantial oil and gas reserves while minimizing geological risk and leveraging staff expertise.

Example 1.3 A company that introduced the first independent electronic product information database that uses the industry standard Universal Product Code (UPC) numbering system states that its mission is to provide quality electronic merchandise management services and technologies to the retail industry.

1.2 STRATEGY MANAGEMENT PROCESS

Basically, strategic management can be broken down into three phrases: strategy planning and strategy formulation, strategy implementation, and strategy evaluation.

Strategy planning and strategy formulation involves the following steps:

1. Defining the organization's guiding philosophy, purpose, and mission.
2. Establishing long-range objectives to achieve the mission.
3. Selecting the strategy to achieve the long-range objectives.

Strategic implementation is concerned with aligning the organizational structure, systems, and processes with the chosen strategy. It involves making decisions with regard to:

1. Developing an organizational structure, selecting leadership, and providing motivational systems to achieve the strategy.
2. Establishing short-range objectives, developing budgets, and developing functional strategies to achieve the strategy.

Strategy evaluation, sometimes referred to as strategic evaluation and control, involves the following activities:

1. Establishing standards of performance for the overall organization and its different units or functional areas.
2. Monitoring progress in the execution of the organization's strategy. This requires assessing and measuring the implementation of the strategies pursued by different units throughout the organization.
3. Initiating corrective actions to ensure continued commitment to the implementation of the strategy. Taking corrective actions requires the timely dissemination of feedback data to the managers of the organization's different units, its top executives, and members of its board of directors.

What is the purpose of an organizational strategy? The purpose of an organizational strategy is to achieve the goals of the mission statement. This is done by developing a logical plan for utilizing the organization's strengths and resources. An organizational strategy provides direction for the organization's activities and its

human resources within the context of its mission statement's objectives. What strategy must an organization develop to achieve its mission? An organizational strategy must be developed for each functional area within an organization's mission statement. The resulting strategies contain:

1. A clear purpose
2. Measurable expected outcomes
3. Fall-back plans in the event the primary strategy cannot be implemented
4. Costs and benefits

Developing an organizational strategy using the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. To use SWOT analysis is to combine the assessment of the environment with the analysis of the organization's internal resources and capabilities. The key objective is to arrive at a strategic fit—the matching of strength to opportunities, the elimination or avoidance of threats, and the strengthening or avoidance of weaknesses. Elements analyzed within the organization's environment consist of the following variables:

1. culture
2. demographics
3. economic technology
4. organizational publicsa. capital originators including shareholders, creditors, bankers, and underwritersb. raw material and component providersc. customersd. human resourcese. competitive rivalsf. governmental and legal entities, including regulatorsg. special-interest lobbying groups

The SWOT analysis allows managers to develop a strategic plan by examining organizational strengths and weaknesses in terms of the opportunities and threats presented by the organization's environmental elements. Subsequent strategies and tactical decisions can produce a competitive advantage.

What does strategic analysis seek? Strategic analysis seeks to understand the strategic position of the organization. The analysis should encompass the environment, resources, objectives, expectations, and behaviors of the organization. Strategic choice concerns the formulation of possible courses of action, the evaluation of the courses of action, and the choice between them. Strategic implementation is the planning of how the strategy can be put into effect. Implementation affects all aspects of the organizational system. More specifically, strategic analysis is concerned with the understanding of the strategic position of the organization, and will thus seek to analyze:

- The mission—What business are we in? Why does the business exist at all? What is the value system of the business?
- The goals—The goals reflect the specific relevance of the mission to the various stakeholders.
- The objectives—Embodying the mission, objectives are quantifiable and are used to measure actual performance.
- The external environment—This analysis involves the scanning of the environment for factors relevant to the organization's current and future activities.
- The internal appraisal or position audit—This is an assessment of the current state of an organization in terms of resources, assets, facilities, and performance values.
- The corporate appraisal—This is the evaluation of the strengths, weaknesses, opportunities, and threats (SWOT) in relation to the environmental factors.
- The gap analysis—This involves identifying the gap between where we are now, where we will be when extrapolated, and where we desire to be.

Selection of appropriate strategies and creation of strategic business units (SBUs)—Businesses should be defined in market terms, that is, in terms of needs and customer groups. Moreover, a distinction should be made between a target market definition and a strategic market definition. For example, a target market for a railroad might be freight hauling, but a strategic market might be transportation of any goods and people. A business also may be defined with respect to customer groups, their needs, and the technology required to satisfy those needs. A large firm has multiple businesses. Thus, the concept of the strategic business unit (SBU) is useful for strategic planning by large firms. An SBU is a business (or a group) for which separate planning is possible. An SBU also has its own competitors and a manager who engages in strategic planning and is responsible for the major determinants of profit. Determining the strength of each SBU with respect to its potential markets and the position of businesses in those markets is called business portfolio management.

Implementation of the chosen strategies—Strategic plans must be filtered down the organizational structure through development of plans at each lower level that are congruent with higher-level plans. This process is most likely to succeed if the structure is compatible with strategic planning, personnel have the necessary abilities, the organizational culture is favorable or can be changed, and controls exist to facilitate implementation.

What are the three levels of planning? How are they related? There are, in general, three levels of strategy: corporate strategy, business strategy, and functional strategy. Corporate strategies define what business or businesses the firm is in or should be in, and how integrated these businesses should be with one another. Business strategies define how each business attempts to achieve its mission within its chosen area of activity. Functional strategies govern how the different functions of the business (marketing, production, sales, finance, HRM, IT, etc.) support the corporate and business strategies. These levels of strategies are matched by the three levels of planning: strategic planning, tactical planning, and operational planning. Strategic planning defines the objectives of the organization, changes in these objectives, the resources needed to attain these objectives, and the policies that are to govern the acquisition, use, and disposition of said resources. Tactical planning ensures that the resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives. Operational planning ensures that specific tasks are carried out effectively and efficiently.

1.3 MANAGERIAL DECISION MAKING

All managers suffer from a shortage of knowledge, resources, and time. Working within these parameters, the management process culminates in decisions to implement various actions. Decision making is the focal point of all organizational dynamics, and management effectiveness is judged on the basis of the quality of these decisions.

What is managerial decision making? Managerial decisions are deliberate choices made from a range of alternatives. Before making a decision, a manager must evaluate each choice according to its projected outcomes in terms of the organization's resources as well as the amount of

information and time available. Thus, every managerial decision is a best-effort compromise made in an environment of uncertainty. What are the types of management decisions? From a management perspective, there are three types of decisions: 1. Long-term strategic decisions concerning the external environment of the organization. 2. Administrative decisions intended to order the functions of the organization in the most cost-effective way. 3. Operational decisions designed to maximize a firm's profitability through productive procedures.

What are the types of strategic decisions? There are many types of strategic decisions in production and operations management (P/OM):

1. Product or service strategy. Management decisions regarding product-line market strategies (including design, quality, and cost) determine production cost parameters.
2. Process strategy. Management decisions regarding process methods are critical in determining technological and organizational production requirements. The process strategy decision is also crucial in determining capital and financial requirements.
3. Research and development (RD) strategy. RD is critical for organizational survival in today's rapidly changing marketplace. The RD strategy includes total resources being devoted to an effort and the type of research to be performed, including pure vs. applied research, manufacturing vs. market research, and product vs. process development.
4. Location strategy. Often the success or failure of a business, production, or service is determined by a location decision.
5. Inventory management strategy. It is essential to develop a strategy for coordinating production needs with raw material and component inventories. However, the inventory strategy is determined by whether the demand is dependent on or independent of the demand for other components. If the demand for one product, such as air conditioners, is independent of that for another product, such as kitchen chairs, an independent inventory management strategy is required. However, if the overall component demand is dependent on the demand for the product, a material requirements planning (MRP) strategy is needed. MRP is a component-manufacturing planning method in which items required for a manufacturing process are indexed to overall product demand. With MRP it is not essential that all inventory items be available at all times, but that they be available only when they are required in the production process. Thus, under MRP, inventory needs are coordinated with production needs. (See Chapter 12, on inventory management, for a more complete discussion.)
6. Human resource planning and management strategy. As a rule of thumb, more than 75 percent of a firm's operating expense is for human resources. Therefore, adequate hiring, training, and utilization of human resources is a critical operational strategy for achieving success.

Example 1.4 The management of an organization makes a strategic decision to develop a five-year marketing plan to achieve a competitive advantage through the introduction of a new service.

Example 1.5 An automobile manufacturer makes a process strategy decision to offer a standard group of options on its automobiles in order to reduce the variation in its production needs and lower unit costs.

Example 1.6 A computer-chip manufacturer makes a strategy decision to increase RD expenditures on an advanced CPU chip design, enabling compatibility with multiple computer operating systems.

Example 1.7 A firm makes a location strategy decision to conduct a nationwide survey of state industrial development agencies to evaluate in which locations the company would receive the greatest financial and environmental benefits.

Example 1.8 A lawn-mower and snow-blower manufacturer makes an inventory management decision to use an MRP system to coordinate the need for lawn-mower and snow-blower components with seasonal manufacturing schedules.

Example 1.9 A manufacturer makes a human resource strategy decision to give more responsibility to its employees by creating work teams to assemble entire products rather than components in the belief that it will obtain greater productivity as a result of job enrichment.

What are the types of administrative decisions?

1. Programmed decisions. Decisions typically made regarding highly routine situations, in which little discretion is required.
2. Nonprogrammed decisions. Decisions made in unstructured situations, in which problem conceptualization and original thinking are required.

Example 1.10 Management makes a programmed administrative decision to establish a vehicle maintenance schedule.

Example 1.11 Management makes a nonprogrammed administrative decision to implement an organizational downsizing plan to reduce duplication of services, decrease costs, and increase profitability.

What are the types of operational decisions?

1. Quality. Decision making regarding product and service quality is a vital operations responsibility necessitating comprehensive organizational support. Quality decisions are made in the design stage of the product or service plan and require the creation and maintenance of standards.
2. Process. Operational decisions are made regarding the design of the process used in the manufacturing or servicing of a final product. Process decisions are normally long-range and cannot be easily reversed.
3. Capacity. Operational capacity decisions are concerned with the long-term capability of an organization to produce the required amount of output over time. Capacity planning determines not only the size of an organization's physical productive capability, but also its human resource needs.
4. Inventory. Inventory decisions are crucial in fulfilling management's inventory management strategy. The challenge for operations management is to create a balance in inventory between product demand, cost, and supply needs.
5. Human Resources. Human resources are an extremely important operational management responsibility. Organizations pay a major portion of their revenues to employees. Therefore, effective selection, hiring, training, termination, and general management of human resources are critical for the future of the organization.

Example 1.12 The franchise management of a fast-food retail chain makes a determination concerning quality standards in terms of the content and temperature of the food when it is served to the customer. It implements a program to ensure that individual franchises meet the quality standards.

Example 1.13 The management of a car-washing company makes a process decision to utilize a

brushless car-washing facility that requires fewer workers, results in less damage to car finish, and is more productive. Example 1.14 A seasonal manufacturer of lawn equipment makes a capacity operational decision to hire and train a second shift of employees during peak demand periods rather than increase overall plant capacity. This makes more productive use of existing capacity without increasing long-term overhead costs, including plant maintenance and capital financing costs. Example 1.15 The franchise manager of a chain of job printers makes an operational decision to allow the individual store managers to buy their own printing supply inventory as long as they use the franchiser's equipment. Example 1.16 A franchise manager makes a human resource operational decision to allow individual franchisees to hire, train, and supervise their own employees. Thus, the individual franchisee has the entire human resource operational responsibility.

What are the steps in the decision-making process? Making good decisions is essential to the management process. As discussed, decisions are made based on rational choices from among a group of alternatives. Good decisions are the result of a sequential series of analytical steps.

1. Identify and delineate the problem. No management action can occur unless there is a need to resolve an issue. Additionally, when identifying a problem, management must assess the seriousness of the issue. Highly critical issues require more immediate attention and place a greater demand on existing resources. Difficulties in identifying problems include:
 - Perceptual errors. Often problems are not identified because of personal biases, which do not allow an individual to perceive that there is a problem that needs attention. Preconceived notions of how something should be (as well as personal preferences) will interfere with the ability to identify a problem.
 - Insufficient information. Insufficient research about a specific problem can result in misleading and unwarranted conclusions regarding the true nature of the problem and its possible solution.
 - Mistaking a symptom as the cause of the problem. An apparent cause of a problem may just mask a systemic cause. Again, further research is essential to find the cause and nature of a problem.
2. Establish decision priorities and goals. Managers constantly deal with problems. However, all organizations have limited resources. They must assign priorities to problems in terms of their importance relative to the organization's goals. This process results in a matching of organizational resources with priorities, and creates a management methodology for administering solutions to problems.
3. Ascertain the cause of the problem. In order to develop a solution to a problem, management must understand the problem's cause. This requires a systemic understanding of the dynamics of the situation that has caused the problem.
4. Develop realistic alternatives. It is important for the manager to develop a range of alternative, realistic solutions. This means doing extensive research into the nature of the problem and discovering what alternatives would provide a good solution.
5. Weigh the best alternative. This requires extensive evaluation and comparison using a cost-benefit analysis. Alternative solutions are developed within the constraints of limited time and resources, and with a degree of uncertainty.
6. Choose a solution. After conducting extensive research, a decision will have to be made regarding an optimal solution. Managers operate within an environment of incomplete information, time deadlines, and limited resources. All solutions represent choices with limited outcome predictability. Therefore, managers must make decisions within a range of known alternatives having unknown outcomes.
7. Implement the decision. This requires developing human resources to carry out the decision. This mandates a high communication level between the manager and the human resource team.
8. Follow up. All decisions require constant monitoring. Changes will have to be made over time to ensure optimum results. This requires an effective organizational control and evaluation system for future organizational decisions.

Example 1.17 A word-processing software manufacturer that has been very successful in the text-based operating system market faces a crucial decision when the industry standard operating system is changed to a graphical user interface (GUI) system. The company's text-based word processor is extremely successful and has a large following. The commands used in the text-based word processor are difficult to learn, but once learned, it is a very versatile word processor. If the word processor is converted to a graphical user interface, a portion of the installed user base may be lost, and its competitive advantage, based on powerful nonintuitive commands, may also be compromised. However, failure to convert the word processor to a graphical user interface will mean losing market share since the major competitors have already released GUI word processors. After deciding to develop a GUI word processor, the company has to decide whether to do a fundamental rewrite of the program, which could take at least two years, or to simply update it and make it GUI compatible. The company decides to release a GUI update to its word processing program, with a fundamental GUI rewrite scheduled for a future date.

What is decision making under certainty and conflict? Decision making involves managing three major elements:

- Decision strategy. A decision maker develops a plan affecting long-term organizational outcomes, utilizing existing organizational resources.
- States of nature. These are elements of the environment over which the manager has little or no control. States of nature include weather, political environment, the economy, technological developments, etc. These can dramatically affect the outcomes of any decision strategy.
- Outcome. This is the result of the interaction of the implementation of a decision strategy with the states of nature. Because of the many variables within the states of nature, outcomes can be extremely difficult to forecast. Thus, outcomes of a decision strategy, O (the dependent variable), is a function of the interaction of the two independent variables D (decision strategies) and S (the states of nature). Figure 1.1 shows a decision matrix. The rows are strategic choices a manager can make, while the columns represent decision outcomes. An outcome O_{ij} is a function of a decision strategy D_i and a state of nature S_j .

Figure 1.1 Decision

Matrix Mathematically, this relationship can be expressed as follows: $O_{ij} = f(D_i, S_j)$

What are decision trees and decision tables? Developing a graphical display is an effective way of mapping the alternatives and probable events that can occur in a complex decision-making environment. Decision trees use symbols consisting of squares and circles. Branches of the decision tree that extend from a square depict an area in which several choices can be made, while a circle connotes a unique state of nature having certain outcomes. A decision tree is analyzed in reverse order, from right to left, going back chronologically. Decision trees are normally accompanied by a payoff or decision table, where all the alternatives are listed down the left side of the table, with states of nature listed across the top of the table, and payoffs stated in the main part of the table.

Example 1.18 The Jackson Lawn Products Corporation is studying the possibility of manufacturing a new line of lawn mowers. Since the market for the new mowers is uncertain, the corporation must decide whether to construct a large or small plant, or do nothing. Figure 1.2 presents a decision tree depicting the Jackson Lawn Products decision choices.

Figure 1.2 Jackson Lawn Products Corporation Decision Tree

A payoff or decision table can be developed to assist Jackson Lawn Products in determining what type of lawn-mower plant they should build. There is an outcome for each decision and state of nature that can be described in units of monetary value. The units of monetary value are also described as conditional values.

Exhibit 1.1 describes all of Jackson's decision alternatives in the left column of the exhibit, the states of nature across the top, and the payoffs (conditional values) in the main part of the exhibit. In the case of building a large plant, a strong market will produce a \$250,000 net profit, whereas a weak market will result in a \$125,000 net loss. If a small plant is built, a strong market will produce a \$125,000 net profit, with a \$60,000 net loss in a weak market.

Exhibit 1.1 Decision Table with Conditional Values for Jackson Lawn Products Corporation

What is decision making in a total quality environment? Total quality management (TQM) evolved from W. Edwards Deming's fourteen points, which were termed total quality control. Decision making in a total quality environment essentially involves the elements of a continuous process, focusing on three essential components: continuous improvement, assessment management, and teamwork. Implementing decision making in a total quality environment requires making quality improvement a central organizational focus.

- Extensive and continuous employee training
- Total involvement of the employees and management concerning the organization's mission, goals, and operational objectives
- Continual improvement of organizational processes rather than focusing on employees as the source of quality failures
- Team decision making
- The recognition that the customer defines quality, and that a total quality decision objective is to meet or exceed customer satisfaction standards.

Decision making in a TQM environment is a shared experience for all employees throughout an organization. Information is an organizational resource essential for making quality decisions. Increased quality leads to increased productivity, lower unit costs, and higher customer satisfaction.

Example 1.19 A transmission manufacturing company was machining highly exacting parts to be used in automatic transmissions. The parts consisted of gears, bearings, and assorted spacers and shafts. The parts were engineered to be within the industry standard of + or - .003 of specifications. However, other manufacturers were able to produce the same transmissions at two-thirds of the price and achieve higher productivity and quality. Management decided to make a 300 percent improvement in the tolerances of the parts by reducing them to + or - .001 tolerance. The net results were fewer returns, lower unit costs, and higher overall customer satisfaction. Consequently, productivity and profits grew substantially.

1.4 SIMULATION MODELS Management uses simulation techniques to replicate the characteristics and dynamics of a real system. Simulations enable management to test models of performance when it is too expensive, risky, or time consuming to use the real materials, workers, and equipment. Using simulation, a manager can test the effects of a decision in a wide variety of situations, including time compression scenarios, without disrupting an operational system. It allows the manager to evaluate alternative system designs when implementing a given operational strategy. Additionally, simulation permits the manager to evaluate the effects of interactions between individual system components and various when/if tactics.

The weaknesses of simulations are that they are syllogistic in that they can evaluate only the information built into the model. Therefore, variables not included or not capable of being included in the model cannot be evaluated. Another limitation of simulation is that it is typically designed for unique situations, thus restricting transferability to other scenarios.

How is simulation implemented by management? When implementing a simulation model, management is required to:

1. Delineate the problem.
2. Categorize the factors associated with the problem.
3. Develop an analytical model.
4. Construct strategic alternatives for testing.
5. Implement the simulation.
6. Analyze the outcomes of the simulation.
7. Apply the analysis to an operational system.

What is the Monte Carlo simulation? When a scenario contains elements of chance, the Monte Carlo simulation can be used to estimate outcomes. The Monte Carlo simulation analyzes the probability distribution of variables in a problem and uses random sampling of the data. Using random sampling, these probabilities are calculated to estimate a problem's solution. The Monte Carlo simulation is developed through the following procedures:

1. Probability distributions for major elements of the problem are established. (A critical feature of the Monte Carlo simulation is the generation of probability distributions. The probability distribution must correspond to the actual data as closely as possible in order for the simulation to be valid and reliable. A commonly accepted method for doing this is historical frequency.)
2. Cumulative probability distributions are developed for each variable. After establishing a probability distribution for each variable in the model, the probabilities are sequentially totaled.
3. Random samples are established

using the cumulative probability distributions to obtain specific element values for each observation. A random-number table is often used to generate numbers for the sampling distribution.⁴ Several simulation trials are performed. The actual number of trials needed is determined by statistical tests of significance. Monte Carlo simulations have a wide number of applications, including estimating inventory demand on a time-interval basis, times between machine failures, project scheduling times, and servicing schedules. Exhibit 1.2 presents a Random Number Table. Example 1.20A computer memory-chip manufacturer's records show the following failure rates of a particular memory chip when tested individually:

Memory Chip Failures	Frequency of Failure	Failure Probability	Cumulative Probability	Monte Carlo Numbers
0	1	0.05	0.05	01-05
1	3	0.15	0.20	06-20
2	5	0.25	0.45	21-45
3	7	0.35	0.80	46-80
4	4	0.10	0.90	81-90
5	1	0.05	0.95	91-95

Random numbers are then assigned, using a computer-generated table of random numbers: Exhibit 1.2 Random-Number Table. The next step is to simulate the memory-chip failures. In this example, twenty simulations are run using random numbers from the first column of the random-number table. The number of memory-chip failures is derived from where the random number coincides with the Monte Carlo interval, as shown in Exhibit 1.3. Exhibit 1.3 Failure Rates. A frequency distribution for the hours and failures of the simulation can now be tabulated, as shown in Exhibit 1.4. Exhibit 1.4 Simulation Frequency Distribution. In this simulation, the average failure rate for the memory chips is 3; however, the greatest number of failures occurs between 40 and 50 hours of operation. Assuming enough simulated iterations occurred, the simulated outcomes will represent real operations. In this example, running more simulations could have changed the average failure rate for the memory chips. The expected failure rate for the memory chips can be calculated from the failure rates and their probabilities: The expected failure rate for the memory chips is higher than the average for the sample simulation. Assuming more simulations were run, the average failure rate would more closely approximate the expected failure rate.

1.5 CAPACITY MANAGEMENT

Capacity is the total productive capability of a system during a unit of time. For a manufacturing facility, capacity is simply the maximum output that can be attained with the existing capital equipment during a certain period of time. Thus, an automobile manufacturer may define its capacity as the number of cars that can be assembled in an hour, day, week, or month. Capacity is critically important for a productive organization because:

- It provides the output required to meet product demand.
- It directly impacts the cost and efficiency of productive capability.
- It is a major organizational investment.

What is design capacity? Design capacity is the total achievable capacity under perfect conditions. Normally, perfect conditions are not achievable, and few organizations operate for any period of time at design capacity. Furthermore, operating at design capacity can cause rapid wear and breakdowns. Operating at design capacity essentially means operating at the organization's productive limits.

What is effective capacity or utilization? Effective capacity or utilization is a ratio between the expected capacity of a firm and its design capacity. It can be computed using following formula: Effective capacity is affected by an organization's product mix, production scheduling, equipment age, and maintenance standards.

Example 1.21A television manufacturing company has a design capacity of fifty televisions per hour, but due to intensive quality control standards, it normally produces only forty televisions per hour. The effective capacity or utilization of the television manufacturing company is calculated in the following manner: What is capacity efficiency? Capacity efficiency is the ratio of production output to effective capacity. It is a measure of effective management in utilizing effective capacity. It is calculated using the following formula: Example 1.22The effective capacity of a candy manufacturing company is 1,000 units of candy per hour; however, it actually produces only 850 units per hour. The efficiency of the candy manufacturing company can be computed in the following manner: What is rated capacity? Rated capacity is a determination of the maximum usable capacity of manufacturing capability. Rated capacity can never exceed design capacity. It is a product of design capacity times effective capacity times efficiency. The formula used to calculate rated capacity follows: Rated capacity = Design capacity times; Effective capacity times; Efficiency

Example 1.23A computer-printer manufacturer has a manufacturing facility operating at an effective capacity of 80 percent with 85 percent efficiency. It has two assembly lines operating five days a week, with two shifts a day. Each assembly line has a design capacity of forty printers per hour. The rated capacity of the computer-printer manufacturer is calculated by multiplying the design capacity by the effective capacity by the efficiency of the plant. To determine the design capacity, the two production lines have to be multiplied by the number of printers times the combined number of hours of production: What factors affect capacity? Many factors affect an organization's productive capacity. Some are within management's control, others are not. Factors that are within management's control include the acquisition and supervision of land, physical resources, and the utilization of labor. Management challenges affecting organizational capacity include personnel issues, technological maximization, and issues that are not directly controllable, such as the impact of weather events, political issues, or war.

1.6 LOCATION ANALYSIS

Few decisions have more long-lasting and critical-cost implications than plant location. Costs affected by location decisions include:

- Transportation. The geographic location will determine how far products must be transported to markets.
- Energy. Utility geographic service areas determine the respective energy costs for any particular location. These costs vary widely.
- Taxation. Local and state tax rates vary widely. Location decisions have major taxation cost implications.
- Wages. Wage levels vary widely, depending on geographic regions. However, a location decision made solely on the basis of wage levels without considering labor productivity is counterproductive.
- Raw materials. Certain industries are extremely

dependent on the ready availability of specified raw materials, such as wood or iron ore. Location analysis, therefore, must include the availability of such raw materials. What is locational break-even and profit analysis? Locational break-even analysis is an economic comparison of locational options based on a cost-volume examination. Location decisions can be compared in graph form using alternative production/sales volumes. In order to perform locational break-even analysis, it is essential to 1. Establish the fixed and variable costs for each location. 2. Graph the costs for each location, where costs are on the y axis and production/sales volume is on the x axis of the graph. 3. Determine which location has the lowest production /sales volume.

Example 1.24A washing-machine manufacturer is analyzing three possible locations; Buffalo, New York; Toledo, Ohio; and Orlando, Florida; to build an additional manufacturing facility. Research analyses indicate the annual fixed costs for the sites are, respectively, \$45,000; \$60,000; and \$95,000. The variable unit costs, respectively, are \$235, \$205, and \$185. The anticipated selling price for the washing machines is \$350. The company is seeking the most economical location for an expected volume of five thousand units annually. The total cost for each city at the expected volume of five thousand units is calculated using the following formula: Total cost = Fixed cost + Variable cost times; Total volume

Buffalo: Total cost = \$45,000 + \$235 times; 5,000 = \$1,220,000
 Toledo: Total cost = \$60,000 + \$205 times; 5,000 = \$1,085,000
 Orlando: Total cost = \$95,000 + \$185 times; 5,000 = \$1,020,000

Expected annual profits for each location can be calculated using the following formula: Total revenue = (Selling price times; 5,000) - Total cost (Fixed cost + Variable cost times; total volume)

Buffalo: \$1,750,000 - \$1,220,000 = \$530,000
 Toledo: \$1,750,000 - \$1,085,000 = \$665,000
 Orlando: \$1,750,000 - \$1,020,000 = \$730,000

Assuming a maximum production of five thousand units, Orlando provides the lowest cost location, at \$1,020,000, and the highest annual profit, \$730,000. Figure 1.3 shows the locational break-even analysis. At five hundred units, Buffalo and Toledo are both cheaper than Orlando. At fifteen hundred units, Toledo is the cheapest location, but at two thousand units of production, Orlando becomes the cheapest. Therefore, the crossover points in the break-even analysis are five hundred and fifteen hundred units of production.

Figure 1.3 Locational Break-Even Analysis

Figure 1.4 shows the locational profit analysis. At 500 units both Buffalo and Toledo earn a profit of \$12,500. At 1,000 units Toledo earns a profit of \$85,000, while Buffalo and Orlando earn \$70,000. At 1,500 units Buffalo shows a profit of \$127,500, while Orlando shows a profit of \$152,500 and Toledo shows a profit of \$157,500. From 2,000 to 5,000 units Orlando is clearly more profitable than either Buffalo or Toledo. The crossover points are 500; 1,000; 1,500; and 2,000 units for locational profitability.

Figure 1.4 Locational Profit Analysis

Therefore, from both a cost analysis and profit analysis standpoint, Orlando at two thousand units and more is the best locational choice.

What is the center-of-gravity location method? The center-of-gravity location method relies on mathematical analysis to determine where a warehouse should be located in order to service a number of retail stores in disparate locations. The method considers three factors:

- Market location
- The volume of goods handled in these markets
- Shipping expenses to each location

In order to develop the center-of-gravity location method, each retail outlet has to be given coordinates within a map grid system where the geographical distances are correctly established. The center of gravity is determined by using the following formula:

where i Cx = x coordinate of the center of gravity
 Cy = y coordinate of the center of gravity
 d_{ix} = x coordinate of the center of gravity
 d_{iy} = y coordinate of the center of gravity
 V_i = volume of goods moved to or from location i

In order to accurately reflect the true cost of distance on shipping, the center-of-gravity method evaluates the distance as well as the total volume actually being shipped to any respective location. The ideal location for a warehouse servicing several retail outlets is that which has the lowest weighted cost of distance and volume of units actually shipped.

Example 1.25 Good Worth Hardware is a chain of six retail hardware stores being supplied by an outdated warehouse close to its first store. Stores are located in cities A, B, C, D, E, and F in Ohio, Pennsylvania, and New York. The monthly volume of goods shipped to the respective stores is shown in Exhibit 1.5.

Exhibit 1.5 Monthly Volume of Goods Shipped to Stores

The company needs to find a more centralized location in which to locate a modern warehouse to supply all the hardware stores. The data from the coordinate locations is then used in the formulas for coordinates x and y. The center-of-gravity coordinate is shown in the coordinate locations in Figure 1.5.

Figure 1.5 Coordinate Locations for Hardware Stores

1.7 TIME STUDIES

The classical approach to time studies, developed by Frederick W. Taylor in 1911, is the accepted procedure for production analysis. A time study, also termed a stopwatch time study, is an analysis of a worker's performance against a time standard. Time studies are normally performed on short, repetitive, production types of tasks.

How is a time study performed? There are several basic steps which must be followed in any time study:

1. Define the job to be analyzed.
2. Break the job into discrete tasks.
3. Measure the actual time required for each task.
4. Develop a statistically significant sample size of the task work-cycles to be measured.

Work measurement depends on sampling the work process. However, in order to counter inherent variability in the work samples, a sufficient representation of the sample universe must be selected. Therefore, it is essential to determine an adequate work-cycle sample size. In order to do this, a preliminary analysis, usually consisting of anywhere from five to twenty repetitive work cycles to determine variability, must be performed. The work-cycle sample size is dependent on three factors:

- a. Observed variance in the work-cycles.
- b. How closely the sample will conform to the average work-cycle (accuracy).
- c. The desired statistical level of confidence.

The work-cycle element having the greatest variability will determine the sample size needed to obtain an acceptable statistical

level of confidence. The typical statistical level of confidence expected is 95 percent, with a reliability of $t = 5\%$. The following formula will determine required sample sizes: where n = initial sample size X = cycle time a = accuracy Z = confidence level ($Z = 1$ for 68.3% confidence level, $Z = 2$ for 95.5% confidence level, and $Z = 3$ for 99.7% confidence level)⁵. Calculate the average time required for each job element using the following formula: Rate the performance of each worker (performance rating). Calculate the normal time required for each job element using the following formula: Here the observed time, normal time, for a particular employee is rated against the average job element time.