A PROFESSIONAL'S GUIDE TO DECISION SCIENCE AND PROBLEM SOLVING

An Integrated Approach for Assessing Issues, Finding Solutions, and Reaching Corporate Objectives

Frank A. Tillman · Deandra T. Cassone

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We would like to dedicate this book to Dr. C. L. Hwang. Through the course of his academic career, Dr. Hwang researched and assessed an exhaustive list of Multiple Attribute, Multiple Objective, and Group Decision-Making techniques in both the crisp and fuzzy environments, which are published in six of his books. Dr. Hwang was an early pioneer in the field of Decision Science and his contributions to this field are still realized today in academia and at the heart of this book. He introduced this area of study to the authors who worked together with him for a number of years.

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-Frank A. Tillman, Ph.D. and Deandra Tillman Cassone, Ph.D.

About the Authors

Frank A. Tillman has had a varied and full career teaching and doing research in academia for more than 30 years, starting and managing two consulting firms, IBES, Inc. (government agencies) and HTX International, Inc. (private firms), and developing commercial and residential real estate. He served as department head at Kansas State University for more than 20 years where he published 50+ professional articles, published two books, and advised a number of M.S. and Ph.D. theses candidates. This book is a compilation of his consulting experiences noting which approach works best to solve real problems that result in solutions that can be implemented.

Deandra T. Cassone currently teaches as an adjunct professor at Missouri University of Science and Technology in its graduate systems engineering program and is in management at a Fortune 100 company. She has spent more than 25 year in the industry, serving in consulting, technical, and management roles. Her interests lie in building structured decision-making models that encompass the application of the concepts in this book. She has also submitted and been awarded a number of business process patents.

Preface

Executives must know how well their company operates compared to others in the industry. By looking at industry benchmarks, you can learn where companies excel and where improvement is needed. The approach in this book can help you pinpoint specific areas that show the most promise for improvement and how they can ultimately impact upstream and downstream functions. It is vital that lower-level decisions support the overall corporate goals. You can evaluate the product line in regard to which product should be put into the product line and which should be dropped. You can access the supply chain to determine areas in which performance improvements should be focused. You can weight mergers for their impact on current operations and whether the merger is the right move. This book presents a unique approach for the first time and the included case studies provide insights into how you can apply the steps of the approach.

This book integrates new and existing methods to provide a comprehensive and holistic approach for assessing company performance and identifying areas for corporate improvement efforts. Many times, you look at the problem in a stove pipe manner and try to solve what appear to be key issues from a singular perspective. You must take a global, holistic approach to understand the overall impact a problem has on the entire organization. All organizations have multiple interactions, so you must look at the upstream interactions and the impact on the downstream functions before any decisions are made.

This process is geared toward all levels of an organization. The goal is to get people to think of the big picture and understand the tools and techniques that they can use to solve corporate-wide problems. The difficulty is to know when and where you should use these concepts. Understanding the problem and the environment, and analyzing the information and quantifying results involve putting the conceptual and analytical pieces together to solve the presented problem. You can use this basic process from the production floor to the board room. It is based on applying the right solution approach to the problem and generating a sound, implementable solution. In general, corporate planning approaches are based on establishing a vision, doing a situation analysis, setting objectives, and developing strategies. This new approach incorporates some of these characteristics; however, it focuses on structured analysis processes that you can use to quantify, explore, and solve problems from a crossfunctional perspective. Depending on the executive, a traditional strategic planning approach may be conducted by a vice president for a given functional area. The traditional approach would focus on optimizing this particular area. It is crucial, however, to ensure that the optimization of one functional area does not negatively impact another. This is why the integrated, cross-functional approach to problem solving is critical to benefit the company as a whole.

If organizations approach problem solving from a corporate perspective, the organization will undoubtedly become an effective and more efficient operation. The solution then is based on an overall objective approach, and not on individual agendas, and a well-operating environment such as this is a true measure of the future success of a company.

The breadth of problems that this approach can address is large, including new product development, inventory level optimization, logistics modeling, manpower planning, budget allocation, and many other applications. *Knowing where to begin, what to assess, how to look for workable solutions, and what to measure provides effective solutions that can be implemented by the entire organization and is the key objective of this book.*

It is easy to get mired into details, overlook key elements of the problem, and not know what techniques are most appropriate. Time is always of the essence, so solutions must be quickly developed to solve problems in an ever changing environment.

Experienced employees are important to any organization. The knowledge they possess provides valuable insight into the operation of the organization. Individuals with different educational backgrounds and experiences have a variety of ideas and perspectives in how the organization should operate. Experience must be part of the decision process along with the available data to make sound business decisions. Different opinions can lead to a wide variety of approaches in solving problems and accomplishing the company's strategic goals. Quantifiable measures, however, should be used to support and justify decisions whenever available.

Data can show the condition of the organization and the efficiency of the operating environment. Making decisions without supporting facts and information can lead to less than optimal decisions that may not be justified when looking at the company's bottom line. It is critical to support experience, expert opinion, and judgment with factual data. It is much easier to justify a course of action with "the data shows" instead of "I think or believe." Unfounded opinions can more easily be dispelled with facts rather than succumbing to the power of strong-willed individuals arguing for their solution.

This book presents an upper-level management perspective of how to analyze problems. The intent is to show what information is needed, the approach, and useful methods that you should use. Observing the problem and its political environment is equally as important as knowing how to analyze the problem and arrive at a sound, acceptable solution.

A clear understanding of organizational objectives provides direction and focus for the corporation. Typically, there are many different areas of opportunity to pursue with limited resources. A clear picture and evaluation of the organization environment and the interaction between functions provides a framework to understand and evaluate the issues facing the corporation. Sound assessment of the issues within the company is critical to pinpointing key issues and opportunity areas. Measuring these key issues provides an understanding of the progress and success in improvement efforts.

Steps and methods are presented in this book to walk you through the process to identify corporate issues and develop solutions that can direct the corporation to achieve its goals. The structured thought process and solid evaluation of corporate functions and issues used in this book can drive a corporation to improvement as measured by key performance metrics. This provides a roadmap to identify the key areas in which improvements are required that can best impact the bottom line. The following sections of the book explain this process, and case studies are presented in the last three chapters of the book. The first case study describes how you can apply this integrated process to supply chain management. The second case study addresses the assessment and decision making surrounding new product development decisions. The last case study addresses key areas that should be assessed and analyzed in a corporate merger. The goal is for you to not only read the book, but also to apply these concepts to your own organization.

Following is a summary of the chapters:

- Chapter 1, "Define the Objectives and Identify Metrics" —You need to clearly articulate and document the objectives of a corporation. Each of the multiple functions within a company has different objectives with varying importance, and many of the high-level objectives of the corporation may conflict. It is vital for senior management to articulate these objectives and reach an overall consensus of the weighted importance so that these objectives can be included into the corporate decision process at all levels.
- Chapter 2, "Explore the Environment"—This chapter presents a new approach to integrated corporate planning. Assessments are made with key corporate functions to determine the closeness or dependence of the functional relationships that you can use as a guide to identify the scope of functional areas for improvement. Additionally, benchmarking, variability analysis, and budget contributions are assessed to expand beyond the relationships to evaluate how well these functions perform against industry competitors.
- Chapter 3, "Explore the Scope of the Problem and Its Importance"—Critical in this analysis is not only identifying the corporate issues, but also determining the upstream and downstream process and operational impact associated with improving these processes. High-level business process modeling is discussed. Often fixing one problem can cause an issue in another area, and this step ensures that you address the various operational impacts in the analysis.
- Chapter 4, "Data Mining and Statistical Analysis"—This chapter highlights the importance of data analysis. Recognizing the problems and determining where improvements should be made is critical. Understanding the information that can quantify and support improvements provides a factual basis for justifying changes to operations and processes. This chapter presents a number of methods to analyze data with further detail of the methods provided in the appendices.

- Chapter 5, "Solve the Problem and Measure the Results"—After the analysis is performed, as shown in Chapters 1 through 4, the approach to solving the problem is developed. Often, assessing the environment and performing the data analysis can lead to a clear solution. In other cases, you might require computer-based solutions or more sophisticated methods. *The best solution is one that the decision maker understands and uses.* This chapter focuses on determining the best methods that the data and environment can support.
- Chapter 6, "Evaluate the Results and Do Sensitivity Analysis"—This chapter discusses how to use the decision model to explore the results and determine their economic viability. A well-defined model has the functional capability to change key parameters and constraints and determine the impact of those changes on the final solution. "What-if" analysis is a key ingredient in the decision process. The sensitivity of the variables in the solution must be tested to ensure that the best solution is reached.
- Chapter 7, "Summary of Part I"—This chapter brings together the approach and highlights the key points from the analyses.
- Chapter 8, "Logistics Service Provider"—This chapter applies the process described in this book to a full-service supply chain provider. The step-by-step analysis is performed to show how to implement this approach in the logistics environment.
- Chapter 9, "New Product Development"—This chapter applies the process to a company with its core competencies and how new products can be developed. A structured approach to decision making is developed based on the interrelationships and performance of the company.
- **Chapter 10, "Airline Merger"**—This chapter addresses some of the key considerations to analyze and assess when merging two companies. Performance and functional interactions of the companies are assessed, which is key to evaluating the activities for the airlines.
- Appendix A, "Overview of Methodologies"—This appendix provides a high level overview of various analytical and decision science methodologies which can be used to evaluate and formulate problem solutions.
- Appendix B, "Detailed Methodologies"—This appendix provides the mathematical background for methods that are useful in model development.

Define the Objectives and Identify Metrics

1.1 Chapter Topic

This chapter discusses the importance of clearly articulating and documenting the objectives of a corporation. Each of the multiple functions within a company has different objectives with differing importance. Many of the high-level objectives of the corporation may be conflicting. Senior management must articulate these objectives and reach an overall consensus of the weight of importance of these objectives if the corporation is to improve and measure the success of meeting them. This chapter also discusses the development of decision criteria and metrics. This involves defining specific quantifiable measures to determine whether the objectives are met. You need to capture the weights or importance of these decision criteria and metrics to appropriately measure improvement.

1.2 Key Corporate Participants

Senior executives identify the problem and establish the task force to work on the problem with an executive-level cross-functional team of representatives. Executive management articulates the corporate objectives and communicates these objectives to the organization so that it can form a workforce team for the cross-functional problem solving. The executive-level task force representatives then update the management by progress reports and findings.

1.3 Management Steps Required to Execute the Approach

You need to follow some basic steps to solve difficult cross-functional problems, as shown in Figure 1.1. Throughout this book, you can see the details surrounding this approach. You need to establish upfront that this approach requires executive-level commitment and buy-in to be successful. A primary goal of the process is to drive the corporate objectives into a cross-functional analysis that best solves problems for the company as a whole. To accomplish this, senior executives must establish or communicate the objectives and support the overall approach so that the appropriate executives, managers, and subject matter experts also engage in the process.

Next to each of the steps listed in Figure 1.1, you can identify the management level required for the process. Each level of management serves an important part in the process. The executive levels of vice president and director must be committed to contribute so that the issues important to their organization and the interactions between the cross-functional organizations are represented in the process. Managers and subject matter experts conduct the actual analyses and assessments based on the overall organizational goals. When gathering the data used in the analysis, it requires involving those that gather and use this data at each level of the organization. Each layer of management and individual contributors play a part in driving corporate objectives into the solutions developed at each level through this process.

A project manager (with a Project Management Professional [PMP] certification) or an internal project manager should coordinate the effort. This project manager can coordinate the meetings with the task force and core team; establish time lines; ensure that the activity remains within scope, schedule, and cost; and provide status updates to executives. Additionally, the project manager must facilitate the definition of functional and system requirements and provide those requirements to the appropriate executing organization, such as IT or various operational groups. Project management techniques provide an excellent way to coordinate an activity such as this.



Figure 1.1 Overview of Integrated Corporate Planning Approach

Identifying the goals and objectives of the organization requires upper management involvement in setting goals and communicating these goals to the decision makers at all levels of the organization. Upper management is interviewed by facilitators who utilize Group Decision-Making techniques to help determine a consensus of the corporate objectives. This involves discussing the corporate and departmental objectives and goals with all the business components, such as operations, sales, marketing, and finance.

To understand the problem, you must understand the decisions that must be made at each level. This includes defining the questions so that the answers are consistent with the corporate and individual goals. The answers to the following questions should support overall corporate goals.

- How much should I produce of a product in each of the product lines?
- What research items should be funded?
- What are my warehousing requirements?
- How does my production affect my inventory requirements?
- What should I plan to produce to meet customer demand?
- How can I optimize scheduling delivery vehicles?
- And, many others.

You must also determine what you can actually change and what you cannot change within the organization. For example, if an organization wants to determine products to keep in a product line, it is not likely that the flagship items should be removed from the product line without considering their impact on all products.

Fixed operating constraints that you cannot change may also exist. This may include any number of constraints on current operations such as plant capacities, warehouse space, and the amount of resources available for spending in a given year. Usually a whole range of operating constraints exists from manufacturing, warehousing, distribution, and other areas of the company that affect the decision latitude that can be made.

You need to define the operating constraints and the variables associated with the actual decisions to be made, such as things that can be rationally changed in the normal course of business operations. This may include things such as plant throughput, funding of programs, sales commission structures, and others. The idea here is to determine what decisions can be made or changed and what cannot be changed. Understanding the decision limitations within an organization defines the operating constraints of the decision process. This part of the process involves determining the best criteria or means to measure the success of meeting the objectives and goals in the model. These criteria with their measures or metrics provide the decision maker with a quantification of the degree of success in achieving the goals of the organization. Based on the goals and objectives established previously, this part of the process involves determining the data sources and potential data elements that you can use as measures of success for the organization. You can gather these metrics from organizational data sources or from experts within the organization. First identifying those criteria that specifically measure the objectives is a key step before determining if data is available for the associated metric. Sometimes, a good metric may not have data that you can easily obtain to support it.

Maintaining metrics can be cumbersome. Keeping the number of criteria small, say around 5, should be sufficient. Decisions are usually made on only one or two key criteria, and the rest don't actually influence the decision. Perform sensitivity analysis to determine which of the metrics are the key metrics.

The result of this are the definition of the objectives and then the decisions to be made and the metrics used to measure the success of the proposed decisions.

1.4 Solving the Right Problem

The process of organizational decision making is complex because executives have their own goals independent of the corporate goals. The challenge is to balance the individual objectives and goals with the corporate objectives and goals both in the short and long term.

Traditionally, decisions are made in a stovepipe fashion. That is, each functional area makes decisions that are best for it without regard to the needs of the other functions; for example, manufacturing is not concerned with marketing or distribution or finance. The reason for this is the reward system for each functional area focuses only on the efficiency for that system. That is, the plant manager or operations manager is rewarded for such things as utilization of assets, return on assets, throughput, quality, minimum labor cost, and scrap for the units produced. None of these factors measure marketing efficiencies or any other functions. Marketing, for example, is basically measured and rewarded for total sales and not on specific products or product mix. When each function goes its separate way and decisions are made that improve that single function, who is looking out for the company as a whole? It begs the question, "Who is running the company?" Is it running by default where the strongest personality drives the company from their functional perspective? How, then, can you develop an overall plan for the good of the company where individual functions are sacrificed a little for the overall good? This may result in manufacturing making products that don't fully utilize the production assets; where marketing doesn't maximize the total volume sales but sells an optimum mix of products that maximize customer service and maximize profitability. You can then see it would be much better overall if there were a combined reward system so that the overall good of the organization is achieved in place of individual goals in the short and long term.

This leads to the issue of how best to manage the many objectives and how to trade off between them so that the entire organization prospers now and in the future. To do this you must first state the organization's goals and objectives. You must first specifically determine what these goals are in the short term and for the future and then set up metrics to measure how well you accomplish them. One way to do this is to ask some difficult questions. What are you trying to accomplish within the company? What are you trying to accomplish at each organizational level? Unfortunately, most firms do not spend time asking these questions, or if they do, they don't implement the answers into their everyday operations. Why does this happen in nearly all the corporations, large and small and at every level? Although everyone's intentions are good in setting corporate objectives, the major problem is that with today's approach to management, the objectives are ill-defined and consequently impossible to implement. How then can you ensure the corporate objectives are implemented throughout the organization, and how can you measure their success? The primary reason corporate objectives are not implemented at the operations level (which is the only place they can make an impact) is that they usually are subservient to individual managers' objectives.

Thus you must ask, "How can we get there if we don't know where we are going?" More specifically, what are you trying to accomplish at the corporate level, at the functional level, and most important at the individual or action level? A great deal of effort goes into establishing a 3-year plan and identifying a number of corporate objectives with everyone pretending to agree, knowing full well the plan will be put on the shelf and promptly forgotten after the exercise is over.

1.5 Developing an Understanding of the Problem

This phase of the process is focused on developing an understanding of what the organization wants to accomplish. In this process you ask the difficult questions and correctly interpret the answers that reveal the correct problems.

Answering these questions requires getting key individuals to look closely at what they each want to accomplish individually and companywide. This process takes thought and reflection by management. Starting this type of thought process makes management focus on its individual needs and then integrate them into the overall needs of the organization. Many times, individuals are not overtly aware of how solving their problems impacts the other divisions within their company. Bringing these individuals together and addressing the problems forces them to look at their problems as total organizational problems.

1.6 Defining Goals and Objectives of a Company or Organization

You can use a number of different methods and approaches to define corporate goals and objectives, using formal and informal procedures. Doing this can provide the organization with a definition of its goals and objectives that represent its current thinking. These goals and objectives can then be integrated into the decision-making process so that decisions made with the decision model are structured to impact all levels of the organization and are quantifiable and defensible. In establishing corporate goals and objectives, consider using management to get a group consensus. Available group decision-making techniques vary in degrees of formality and you can use them to facilitate this process. Techniques range from simple brainstorming to more sophisticated methods. The end result should be a clear definition of what a corporation views as its goals and objectives. When defined, these goals and objectives can then be built into the decision process. Following is a sequence of steps that you can use to establish the goals and objectives of an organization.

1.6.1 Establish Goals and Objectives

The first step involves establishing the objectives for the organization. Primary decision makers should meet together to ensure that all the components of the organization are represented in the decision process and are represented in the objectives. One approach is to provide to the group a "straw man" list of corporate objectives as a starting point in the development of the final list of objectives. The straw man list is based on the objectives that have historically been deemed important to the group and may include objectives such as maximizing profitability, minimizing risk, minimizing cost, or maximizing growth. The executive group can then use these as a starting point and brainstorm to add or delete from the list. As part of this process, the group should also provide a high-level definition of the objectives so that all involved understand what is meant by them.

Another method, the Nominal Group Technique (NGT), which utilizes a written form for the generation of ideas, is a more formalized method that you can use to develop corporate objectives. This method attempts to minimize conforming influences and maintain social-emotional relationships in the process. It provides for equality of participation and for all members to influence the group decision through voting and ordering of priorities. Appendix A, "Overview of Methodologies," provides a description of this method, along with several others that can be used in this process.

Managers may not have the authority to affect high-level decisions; however, the establishment of these objectives and the development of the subsequent decision criteria and metrics give managers a defensible position in their decisions. The objectives established in this manner can provide the building blocks for establishing the decision criteria and metrics used within the decision model.

It is also beneficial to establish a mission statement for the organization. A mission statement is a succinct statement, typically one sentence that summarizes the purpose of the organization. A mission statement describes why the organization is in business and what it wants to accomplish.

When any group of individuals meets to conduct activities such as this, it is difficult to arrive at complete agreement. You need to understand upfront that this may be the case. In this process, you must leave the latitude to "agree to disagree." That is, it is okay if there is not complete agreement on all the objectives. Not all objectives may have the same importance to each function of an organization. Weighting the objectives, as described in the next section, provides a means to address that not all individuals may feel the same about the importance of each objective, which can be handled in the modeling process.

Examples of corporate objectives by different industries are shown here.

- Service companies
 - Improve contract performance.
 - Minimize operating costs.
 - Improve customer management.
- Manufacturing companies
 - Minimize manufacturing costs.
 - Maximize customer service.
 - Minimize distribution costs.
- Distribution companies
 - Minimize operating costs.
 - Reduce inventory levels.
 - Improve operating cycle time.

- Insurance companies
 - Maximize customer service.
 - Streamline information technology.
 - Improve service delivery margin.
- Food Industry companies
 - Improve profitability.
 - Increase market share.
 - Increase sales.
 - Reduce manufacturing costs.
 - Reduce distribution costs.

These objectives are broad in nature and can focus management on organizational-level goals. Objectives are weighted to further focus corporate management on key operating areas within the company. Specific decision criteria and metrics further refine the key attributes that constitute the corporate measurement of the objectives. The objectives provide the starting point for the decomposition of strategic goals into actionable activities and problem solving.

1.6.1.1 Expert Judgment/Group Participation

The problem of group decision making can be broadly classified into two categories in this field: expert judgment and group consensus. The expert judgment process entails making a decision by using expertise gained through experience. Specifically, it is concerned with making judgments and constructing new solutions to the problem. On the other hand, the group consensus process involves groups that have common interests, such as executive boards and organizations, making a decision.

Expert judgment and group consensus methods involve methods commonly utilized in the group decision-making process. Creative methods used to extract, generate, and stimulate new ideas may include brainstorming, brainwriting, or Nominal Group technique. Techniques that are used to explore and clarify existing issues might include surveys, conferences, and the Successive Proportional Additive Numeration (SPAN) technique. For planning and execution, you can use techniques such as Gantt charts, PERT, and CPM. (Refer to Appendix B, "Detailed Methodologies," for a detailed description of methods.)

1.6.1.2 Weight the Objectives to Determine Their Importance

Many times goals and objectives can be stated as being important to an organization but the relative importance of them is not quantified. In addition, there are typically conflicting objectives in which the improvement in one area may adversely impact another area. For example, improvements in information technology may also lead to increases in capital costs. This step is to generate an overall importance for each of the established goals and objectives. This is accomplished by having each of the team members weigh the objectives established in the previous step for their view of overall importance in decisions. You can use the Normalized Direct Weighting scheme described next to weigh the objectives. You can also use a more complex weighing scheme such as SPAN or Borda, but they require automation to be practical. (Refer to Appendix B for a detailed description of methods.)

A weighting scheme for the example objectives of Maximize Customer Satisfaction, Minimize Logistics Costs, Maximize Growth, and Maximize Sales is shown in Table 1.1. This weighting scheme was generated by the Normalized Direct Weighting scheme. A set of weights should be generated by each of the team members. These can then be averaged to determine a group weighting of the objectives. In this example, each of the four individuals weighted the objectives on a scale of 1 to 10, where 10 was the most important. These then are totaled and normalized for the individuals and the group overall.

Objective weighting can come from senior management's view of corporate strategic direction. Another approach to weighting objectives is to determine the percent of budget that falls within a given corporate functional area. Weighting objectives using the number of dollars quantifies the magnitude of financial importance associated with a functional area. This provides a view of the potential impacts of improvement opportunities for a given functional area.

									Total	
	Expert #1	Expert #1	Expert #2	Expert #2	Expert #3	Expert #3	Expert #4	Expert #4	Input	Overall
OBJECTIVE	Input	Weights	Input	Weights	Input	Weights	Input	Weights	Values	Weight
Maximize Customer Satisfaction	6	28.10%	10	30.30%	10	33.30%	6	30.00%	38	30.40%
Minimize Logistics Costs	9	18.80%	7	21.20%	3	10.00%	4	13.30%	20	16.00%
Maximize Growth	6	28.10%	4	21.20%	7	23.30%	6	30.00%	32	25.60%
Maximize Sales	8	25.00%	6	27.30%	10	33.30%	8	26.70%	35	28.00%
TOTAL	32		33		30		30		125	

Table 1.1 Group Consensus Weighting of Objectives

Assigning an overall importance weighting to the objectives gives the decision makers an idea of what the group as a whole views as the importance of the objectives for the organization. These objectives and their importance also provide the necessary direction and focus in the decision modeling process. You now have a better idea of what you can accomplish as an organization.

1.7 Defining the Framework for the Decisions Being Made

You need to know what the organization wants to accomplish, the purpose of the decisions being made, and the operating environment of the organization. You can then develop the decision model to reflect the conditions and characteristics of the organization. Use the following questions to aid in defining the framework for the model.

- What specific decisions need to be made?
- What are the business environment and constraints in which decisions are made?
- What are the firm constraints within which to achieve the goals and objectives?
- What is the flexibility of the decision to be made to achieve the goals?

Use various fact-finding efforts to answer these questions. Depending on the breadth of the model, this may require that you conduct interviews with individuals in various departments and levels within the organization. Individuals currently responsible for the decisions and individuals that have been previously responsible for the decisions are good starting points to gain information. At this point in the development, this should still only be general information that you can use to outline the model being developed.

Decisions to be made with the model would dictate the structure of the model. Some examples of decisions might include the following:

- Establish budgets for the divisions and corporation as a whole.
- Determine which products should be in the product line.
- List the warehouse requirements.

- Compile the least-cost production scheduling options.
- Assess the facility conditions.
- Examine the personnel management and number and skill mix of employees.

Part of answering these questions and the nature of the information gathered in the modeling process may provide additional information that you can use to make decisions. For example, use a decision model to allocate resources. However, this can also provide an opportunity to standardize the submission format of budget requests and potentially do various database queries on the submitted budget data to determine how well you make the budget.

The business environment in which the decisions are made is also important in the decision process. In an organizational environment that is dictatorial, no matter what the justification for the decision, the model may be of no use. If it is a group consensus organization, the model should reflect that type of decision-making process so that it is representative of the organization. The model should be focused forward and adaptable to changes. For example, if a division combines with another division in the next 3 months, this should be accounted for in the model structure. These types of events should be investigated in the model development process.

To determine the framework for the model, you need to identify what elements of the operating environment are fixed and what elements of the environment can change. Fixed constraints would include those elements that have permanent limitations or restrictions in the decision process. In a production environment, it could be limitations on quantities that can be produced, steps in the manufacturing process required to create an item, warehouse limitations, and others. In budget decisions, this could involve the resource limits, limits on certain types of projects or programs funded, and others. In manpower planning, there may be limitations on the mix of skills required to perform certain activities or restrictions based on union requirements. A general overall understanding of what cannot change is as important as understanding what can be changed in the model.

Understanding the decision variables that represent the decisions to be made by the organization is equally important. Again, these variables are dependent upon the business environment of an organization and impact the type of model being built. With a model in a production environment, variables might include the amount of safety stock that is kept in-house or at remote locations or quantities of various products produced. With a model used for resource allocation, the decision may be which research and development projects you should fund.

The accuracy of the model is also an important consideration in the model development process. If a model must be accurate to a high level, such as 99 percent, the level of detail required will be much greater than for a model that must be accurate to 95 percent or 90 percent. The type of data and information processing will be different for these two modeling scenarios.

Overall, Group Decision-Making techniques can be useful in many consensus-building situations within the organizational environment. These techniques are used (as shown in the next chapter) to facilitate the establishment of corporate goals and objectives and in building decision models. Your goal here is to determine what is important to the organization and what is your future direction.

1.8 Metrics for Measuring Success

When an organization has defined and agreed upon its goals and objectives, decision makers should then develop a means to track and measure the accomplishment of these objectives. Often within an organization, a strategic plan, short-range plan, or long-range plan is developed and published as an edict to the organization. These plans may, however, end up on a shelf with no real meaning in the day-today operation of the organization. To drive these goals into the operating decision levels within the organization, these goals and objectives must be translated to meaningful measures of success that are used within the decision process and tracked within the organization. This is key to ensuring that the organizational goals are met. In the last section you saw how to integrate these organizational goals and weight their importance for all to follow. You now need to track their success.

Because so much data is currently available, you need to determine those measures (metrics) that provide a meaningful measure in achieving success within the organization. This process involves identifying criteria that are important to the organization. Typically decisions are made based on one or two criteria, so the metrics to support the decision process should be kept to a minimum. An approach is described in this chapter for identifying decision criteria and determining their overall importance in the decision process and measuring their success.

Based on identifying the important criteria, then data sources are assessed to determine whether this information can be relatively easily obtained, processed, and maintained. Data should be assessed to determine what level of detail should be maintained for it to be used as a metric to measure success. It may be tracked, for example, on a plant-by-plant basis or rolled up across the organization as a whole. Data can come from both automated sources or from assessments made by experienced executives or experts in the field. The process to establish, track, and maintain metrics and measures of success for an organization provides meaningful information in achieving success and understanding the organization's operations at every level.

1.9 Definition of a Metric

A metric is a standard measure to assess performance in a particular activity. A metric is a composite of measures that yield systematic insight into the state of the process or products and drives appropriate action. Metrics can be composed of both objective data such as historical data reported in a database and subjective data such as expert opinions by senior management or experts in the business.

Metrics are important for a number of reasons. You can use them to defend and justify decisions, to provide objective assessment of progress toward goals, and for problem solving and to validate process improvement. Successful enterprises constantly assess themselves and improve in all dimensions of their enterprise. Metrics provide a foundation for the assessment of success of an activity or enterprise.

A good metric is built upon an organization's missions, goals, and objectives. A metric must be meaningful and understandable for management and workers alike. The best metrics derive naturally from the process in which the data is relevant to the process and its collection becomes part of the process. The metric itself must be easily measurable. The requirement for new systems and data to implement a metric should be minimal because if not, data will not be gathered to support it.

Suppose you have established a corporate objective to improve the company's financial position. Following are metrics you can use to support that objective.

Improve the Company's Financial Position

- **EBIT/EBITDA**—Earnings before interest and taxes, and earnings before interest, taxes, depreciation, and amortization
- **FCF**—Free cash flow; the sum of operating cash flow, financing cash flow, and investment cash flow
- **EPS**—Earning per share; net earnings or profit divided by the total number of shares issued
- **P/E Ratio**—Price to earnings ratio; the price of one share of a company divided by its earnings per share
- Net Working Capital—Current assets minus current liabilities
- Debt Ratio—Total debt divided by total assets
- Debt/Equity Ratio—Total debt divided by shareholder equity
- Return on Assets (ROA)—Net earnings divided by total assets
- Return on Equity (ROE)—Net earnings divided by shareholders' equity
- **Operating Margin**—Operating earnings divided by total revenue
- **EV/EBITDA**—Enterprise value (price of the share times total shares issued) divided by EBITDA

A number of these are related; that is, Debt Ratio (Total debt divided by total assets) and Return on Assets (Net earnings divided by total assets). Key decision criteria and metrics should be limited to the critical metrics so that they are manageable and definitive goals that specific problem solving and improvement activities can be measured against. A resulting subset of metrics that may be used to measure the improvement of a company's financial position could be EBIT/ EBITDA, FCF, EPS, or Debt Ratio.

A company may choose any number of decision criteria and metrics to measure project success and evaluate the achievement of its goals. It is better, however, to measure against a few critical criteria rather than try to measure against interrelated criteria or less critical measures.

1.10 Developing Decision Criteria and Metrics

Numerous private sector and government applications provide us an approach to developing decision criteria and metrics. This approach to metrics development is to relate metrics directly to the accomplishment of the goals and objectives of the organization. This process requires the management team to critically examine goals and objectives to ensure the decisions directly relate to these objectives. Decision makers must first establish the goals and objectives and their relative importance in the final decision process. The development of goals and objectives is mentioned in the previous section.

Decision criteria and metrics are then established to support these established goals and objectives. Group decision-making techniques are also utilized to provide a means for developing the decision criteria and weighting their importance. All the decision makers should have a say in the final selection of decision criteria to ensure objectivity and avoid having dominant personalities overly control the process. The steps involved in this time-tested approach follows:

- Step 1. Establish overall objectives and goals.
- **Step 2.** Weight the objectives to determine their importance.
- Step 3. Select the decision criteria.
- **Step 4.** Weight the criteria to determine their importance.
- Step 5. Develop metrics.

Overall, this approach provides a consistent, traceable, and defensible basis for making decisions. This avoids the "I feel this is what should be done" without any justification. The following is an example of the five steps of this process for developing goals, criteria, and metrics.

1.10.1 Step 1: Establish Overall Objectives and Goals

The first step is establishing objectives and goals for an organization. Goals and objectives are established, noting their common basis and required common theme to represent these objectives. These objectives are then used in the development of the preliminary metrics schema. The initial cut is continued to be refined until a final set of goals and objectives are established that satisfies the group. Group decision-making techniques are used to gain this consensus (see Section 1.6.1).

Through a series of meetings and the use of the Nominal Group Technique, a corporation has arrived at the following senior executive corporate objectives.

- Improve customer management.
- Improve financial soundness.
- Improve market position.
- Enhance technology development.

These objectives may be consistent on a year-to-year basis, or may shift on a yearly basis based on corporate strategy.

1.10.2 Step 2: Weight the Objectives to Determine Their Importance

The goals and objectives are then weighted to assess the relative importance of the selected goals and objectives. Group decision-making techniques are also utilized to facilitate this process. A resulting importance weighting scheme is then developed and reviewed with the decision makers. In each step of the process, the decision makers must understand and agree to the methodologies used in the process.

Table 1.2 is an example of input importance weighting and overall corporate weighting for the four objectives previously identified.

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					VP	VP		
	VP	VP	VP Sales/	VP Sales/	Customer	Customer	Total	
	Operations	Operations	Marketing	Marketing	Management	Management	Input	Overall
OBJECTIVE	Input	Weights	Input	Weights	Input	Weight	Values	Weight
Max/Improve Cus- tomer Management	6	28.10%	10	30.30%	10	33.30%	29	31%
Max/Improve Finan- cial Soundness	6	18.80%	1	21.20%	3	10.00%	16	17%
Max/Improve Market Position	6	28.10%	1	21.20%	4	23.30%	23	24%
Max/Enhance Tech- nology Development	×	25.00%	6	27.30%	10	33.30%	27	28%
TOTAL	32		33		30		95	

1.10.3 Step 3: Select the Decision Criteria

For each of the objectives established in step 1, the group must establish a hierarchy of decision criteria to represent the various objectives. Define the decision criteria so that there is a clear understanding of the criteria used and what metrics will be used to measure the criteria. This definition phase provides the framework for establishing the metrics associated with each of the decision criteria. A "first cut" of the overall decision criteria will be developed, reviewed, and revised as necessary by the decision makers and senior management. Table 1.3 shows an example of the corporate goals with their associated decision criteria and metrics.

Corporate Objectives	Decision Criteria and Metrics
	Customer Calls
	Customer Turn Over
Improve Customer Management	Customer Satisfaction
	OBIDA
	Free Cash Flow
Improve Financial Soundness	Debt
	Market Share
	Brand Loyalty
Improve Market Position	Ability to Attract New Customers
	First to Market
	Technology Development
Enhance Technology Development	Innovation

Table 1.3 Develop the Decision Criteria

1.10.4 Step 4: Weight the Criteria to Determine Their Importance

Team members then weight the criteria established in step 3 for their relative importance in the decision process. Again, use group decision-making techniques to facilitate this process. The team must develop a "first cut" of the decision criteria weights and review and revise their findings to ensure reasonableness. Table 1.4 shows an example of a criteria weighting scheme based on corporate objectives and decision criteria importance.

			Decision	Resulting
Corporate	Objective	Decision Criteria	Criteria	Criteria
Objectives	Weights	and Metrics	Weights	Weights
		Customer Calls	20%	6%
		Customer Turn Over	40%	12%
Improve Customer Management	31%	Customer Satisfaction	40%	12%
		OBIDA	50%	9%
Improve Financial		Free Cash Flow	30%	5%
Soundness	17%	Debt	20%	3%
		Market Share	50%	12%
		Brand Loyalty	25%	6%
Improve Market Position	24%	Ability to Attract New Customers	25%	6%
		First to Market	30%	8%
Enhance Technology		Technology Development	50%	14%
Development	28%	Innovation	20%	6%

Table 1.4 Decision Criteria Weighting

1.10.5 Step 5: Develop Decision Criteria Metrics

From the decision criteria established in step 3, you can identify the metrics. This involves determining what data to use to measure and quantify the decision criteria. The criteria can be either subjective or quantitative in nature. You can measure criteria using "hard," quantitative data or a subjective scale of the decision makers. Expert opinion can be subjectively used when objective data is not available or when objective data is too costly or time-consuming to obtain. Again, the group must develop a "first cut" of the decision criteria metrics and review and revise its findings as needed to satisfy the decision makers. Table 1.5 shows an example of decision criteria and whether these criteria will be quantified with objective or subjective measures.

Cornorate			Metrics (Objective or Subjective
Objectives	Decision Criteria and Metrics	Definition	Criteria)
	Customer Calls	Total Monthly Calls to Customer Service Organization	Objective
	Customer Turn Over	Percent of all customers that leave the company	Objective
Improve Customer Management	Customer Satisfaction	Measure of Customer Satisfaction	Subjective
	OBIDA	Operating income before depreciation and amoritization	Objective
	Free Cash Flow	The sum of operating cash flow, financing cash flow and investment Cash Flow	Objective
Improve Financial Soundness	Debt	Debt Ratio - Total assets divided by total liabilities	Objective
	Market Share	Percent of total market held by the company	Objective
	Brand Loyalty	Customers who are repeat buyers	Subjective
Improve Market Position	Ability to Attract New Customers	Assessment of ability to attract new customers	Subjective
	First to Market	Assessment of the number of new tech- nologies that are first to market	Subjective
	Technology Development	Assessment of proficiency of technology development processes	Subjective
Enhance Technology Development	Innovation	Assessment of the ability to innovate	Subjective

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1.11 Data Used to Support Metrics

You can use either objective or subjective data to represent metrics used in the decision process. Objective data usually can be described as data that can be quantified by some measure of known commonality. This may be data such as the number of items produced, number of trucks in a location, population of a city, and so on. This data is usually available in some form in company databases and information systems. Typically, statistics such as averages and trends are generated based on a record of this objective data over some period in time. Objective or quantitative data represents a history of activities of a company that has been operating during a given time period.

Qualitative or subjective data can be easily used in a number of different situations. Surveys are good examples of subjective data used to represent a rating of a product or service. Use scales from 1 to 5 or 1 to 10 to represent high, medium, and low assessments for given metrics. Use assessments such as red, yellow, and green in other situations in which individuals (such as military personnel) might find more meaning in rating conditions. Numerical values with their verbal description provide the type of information that can be captured and utilized in a decision model when other information is not available.

Subjective data is data based on someone's opinion or best guess of a condition or a future event. Subjective data is more qualitative in nature in that it defines a situation or condition without specific data points. Subjective data can be generated by individuals within or outside of a company or experts within a given field of operation.

Typically, subjective data or opinions provide insights into a subjective assessment of a metric. Subjective data and expert opinions are typically forward looking in nature trying to predict what will happen in the future. Individuals make assessments based on what has happened in the past and what may happen in the future. Objective data, especially in the form of statistics, however, is based on historical data, thus projecting the future, what has happened in the past, which assumes that the future will behave much like the past. The entire business environment may have changed; thus, what has happened in the past may be a poor representation of the future; thus, a new source of data is required. Following is a simple scale example that you can use to represent the assessment of the future development potential of a given market.

Future Market Potential

Definition: The projection that this market will become a substantial market in future corporate activities.

Highly Probable	5
	4
Moderately Probable	3
	2
Unlikely	1

This type of information is good information to capture from the experts and decision makers. Utilizing this type of information along with statistics fills gaps that exist to get a better representation of factors that influence future activities.

In developing goals, decision criteria, and constraints, consider a number of parameters in the development process to ensure a set of well-structured, well-represented goals and decision criteria. These development parameters are as follows:

- Goals and decision criteria must represent actual and important considerations in making decisions. Examples would include reducing logistics costs, improving call center response times, and so on.
- Decision criteria must differentiate one project from another in terms of higher or lower priority. This would involve capturing key project characteristics that differ among projects, such as impacts to different functional areas, costs, completion time, and so on.
- Decision criteria must be independent, not overlapping in content or intent, to avoid accounting for the same thought or idea more than once. This tends to overweight the importance of certain criteria. Instances may occur in which both a component cost and a total cost are considered. The component cost would overlap with the total cost value.
- Decision criteria must be defined as clearly as possible to ensure that the decision criteria in the evaluation process are viewed in

the same context. Individuals have different perspectives associated with various terms and definitions. The definitions must be clear.

- Measures and scales developed for the decision criteria must be meaningful in the evaluation process and the data to perform the evaluation easily accessible. Objective data provides a basis for a relatively clear scale or measure. The use of subjective criteria requires that the scale components are clearly defined and represent a natural language intention and meaning.
- Constraints that represent types of mixes, qualifiers, and conditions that would be applied to a prioritized list of items must be identified and differentiated from the evaluation decision criteria. You must define the operating parameters. This may be total budget, capacity constraints, and manpower availability. All of these components put bounds around the issue addressed.

1.12 Structure and Definition of the Problem

The steps and analysis described provide a basis for the definition of the problem and structure of the information. The information gathered as part of the analysis performed in the process provides the basis for further development of the example model. This framework is used to illustrate the process and for assessing and developing the required data to be used for the study and selecting the best methodologies to use in the model.

1.13 Key Concepts in Defining the Objectives

Following are the key points of this chapter:

• Groundwork in understanding and defining the problems facing a corporation is essential to bring to light functional areas requiring improvement. They need to determine the scope of functional areas that may be impacted.

- It is necessary to establish corporate objectives to strategically define the direction of a company. This requires consensus among decision makers.
- A corporation has multiple conflicting objectives that require the balancing of cross-function activities.
- Decision criteria and metrics provide quantifiable measures that can be driven down into the corporate decisions so that activities meet the corporate objectives.
- Understanding the data required and data available to support corporate metrics facilitates the measurement of the key metrics and contribution to accomplishing corporate objectives.
- Subjective data or opinions provide insights into a subjective assessment of a metric. Subjective data and expert opinions are typically forward looking in nature, trying to predict what will happen in the future as opposed to statistical analysis that deals with historical data.
- It is important to weight the objectives and metrics across all executives to gain a consensus in the direction of the company.
- Senior executives must be involved in this initial step of the process to establish the corporate objectives that can drive the cross-functional problem solving effort.

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