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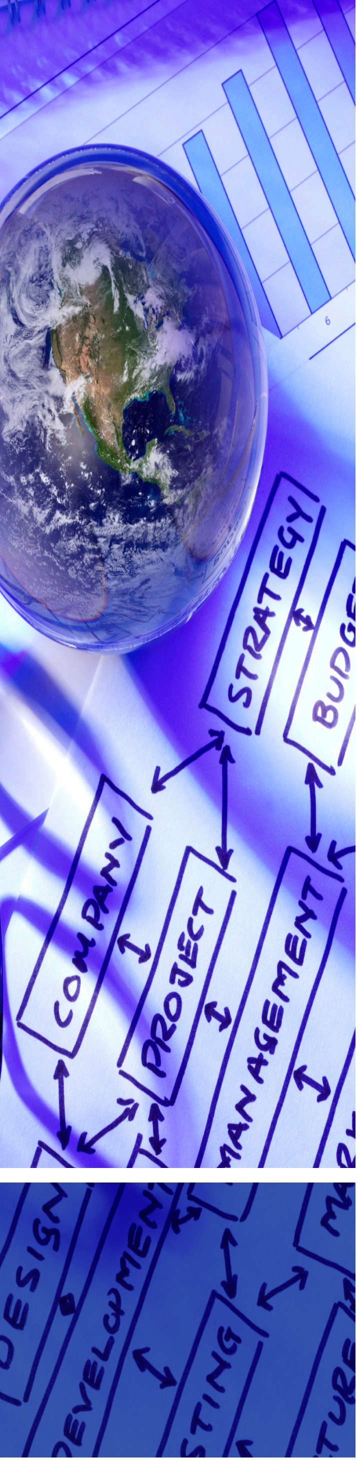

Project Portfolio Management

A Model for Improved Decision Making

Clive N. Enoch

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Abstract

Project portfolio management (PfM) is a critically important discipline, which organizations must embrace in order to extract the maximum value from their project investments. Essentially, PfM can be defined as the translation of strategy and organizational objectives into projects, programs, and operations (portfolio components); the allocation of resources to portfolio components according to organizational priorities; alignment of components to one or more organizational objectives; and the management and control of these components in order to achieve organizational objectives and benefits.

The interest and contribution to the body of knowledge in PfM has been growing significantly in recent years, however, a particular area of concern is the decision making, during the management of the portfolio, regarding which portfolio components to accelerate, suspend, or terminate. A lack of determining the individual and cumulative contribution of portfolio components to strategic objectives leads to poorly informed decisions that negate the positive effect that PfM could have in an organization. The focus of this book is aimed at providing a mechanism to determine the individual and cumulative contribution of portfolio components to strategic objectives so that the right decisions can be made regarding those components.

Having the ability to determine the contributions of portfolio components to strategic objectives affords decision makers the opportunity to conduct what-if scenarios, enabled through the use of dashboards as a visualization technique, in order to test the impact of their decisions before committing them. This ensures that the right decisions regarding the project portfolio are made and that the maximum benefit regarding the strategic objectives is achieved.

This book is intended for executives, project and program directors, project portfolio managers, project office managers, and training providers in project, program, and PfM.

Keywords

complexity, decision making, multicriteria utility, organizational, project portfolio management, systems

Contents

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I would like to take this opportunity to thank:

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CHAPTER 1
Introduction

Introduction

Project portfolio management is concerned with managing groups of projects, programs, and operational activities (hereafter referred to as portfolio components) that compete for scarce resources and that are conducted to achieve strategic business objectives. Earlier literature related to project portfolio management focused attention on the selection and prioritization of projects and programs; however, merely choosing the right portfolio components is not enough as decisions made during the management of the portfolio could negate the very effort in setting up the portfolio. Instead, the focus needs to shift toward finding ways to ensure that the right decisions are made with regard to terminating, accelerating, or delaying portfolio components. This leads to portfolio and, ultimately, business success.

Project portfolio management is by no means a solution to all an organization's problems; however, it is intended to enable organizations to do more with less. As the world deals with the current financial crisis, it is more important now than in the past few decades for organizations to ensure they are spending their money on the right project investments. This is reliant on influential stakeholders playing a crucial role in the choices made when managing the portfolio.

This chapter outlines the remainder of this book and includes the positioning of project portfolio management in terms of its (i) role in the management of project-related investments, as well as (ii) its role in contributing toward organizational success.

Project Portfolio Management—Overview

Many authors are of the view that while project and program management is traditionally focused on doing projects right, portfolio management is focused on doing the right projects. The term *portfolio* is also associated with a collection of financial investment instruments, that is, stocks and bonds; however, this book does not attempt to address such types of portfolios. Instead, the area of concern encompasses project portfolio management and is hereafter referred to as PfM.

PfM comprises a set of managed technology assets, process investments, human capital assets, and project investments that are allocated to business strategies according to an optimal mix based on assumptions about future performance. The Project Management Institute (PMI) defines PfM in *The Standard for Portfolio Management* as "the coordinated management of one or more portfolios to achieve organizational strategies and objectives" and "includes interrelated organizational processes by which an organization evaluates, selects, prioritizes, and allocates its limited internal resources to best accomplish organizational strategies consistent with its vision, mission, and values." They further state that, "Portfolio management produces valuable information to support or alter organizational strategies and investment decisions."[1]

The Office of Government Commerce (OGC) in the United Kingdom define PfM as "a co-ordinated collection of strategic processes and decisions that together enable the most effective balance of organizational change and business as usual."[2]

A goal of PfM is to guide investment decisions to maximize value and minimize risk or uncertainty thus optimizing the organization's return on investment. PfM is an effective way to communicate value in business language. Value is achieved from balancing risk and reward and making the right decisions in this regard. The approach of the remainder of this book is based on this understanding of PfM.

Project Portfolio Management The Decision-Making Challenge

Early approaches to PfM emphasized the categorizing of the landscape of existing projects in organizations without paying much attention to portfolio management decision making. Ward and Peppard, for example, illustrated that categories such as strategic, operational, high potential, and support could be used as a means for facilitating agreement between senior management on the available and required portfolio of projects.[3] Individual projects could then be categorized according to their business contribution. This is an important step forward in the developing discipline of PfM; however, selecting the right projects upfront is meaningless if the wrong decisions are taken later on in the PfM process.

PfM improves organization success if the right decisions are made when managing the portfolio. Further, successful organizations have a shared reporting approach to channel information flows from component level to portfolio level. Such organizations share responsibility for decisions at the portfolio level. The decision making at the portfolio level is the key focus of this book, since enabling decision making is becoming increasingly important given the economic downturn and renewed focus on corporate governance mentioned earlier. The selection of the right portfolio components only goes part of the way to achieve success, but making the right decisions during the course of managing the portfolio will contribute further to the success of the portfolio and, by extension, the success of the organization. Specifically, this book focuses on the process or approach that enables decision making with regard to determining which portfolio components to delay, accelerate, or terminate.

When making decisions, consideration must be given to the contribution of portfolio components (strategic fit) to organizational objectives. An assessment of the contribution that portfolio components make to organizational objectives will depend on an evaluation of multiple criteria. Therefore, the problem statement that this book is focused on addresses the following issue.

When managing a project portfolio, an understanding of both the individual and cumulative contribution of portfolio components to organizational objectives and the likely impact of such decisions on the achievement of these objectives is important in decision making. Without this understanding, the decisions regarding whether to delay, accelerate, or terminate portfolio components will be poor.

Structure of the Book

The book consists of five chapters. Figure 1.1 provides a diagrammatic layout of the book followed by a more detailed overview of each chapter.

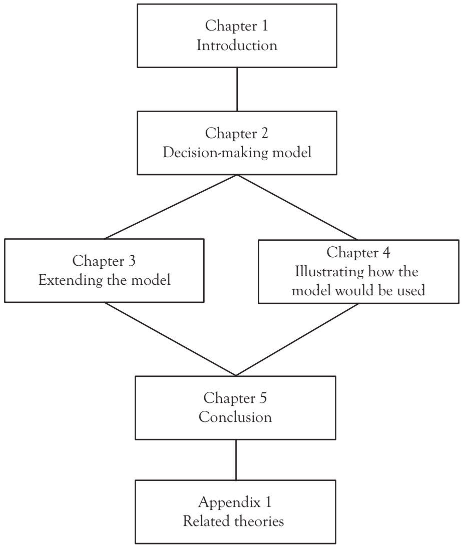


Figure 1.1 Chapter layout

Chapter 1 provides the introduction, motivation for the book, problem statement, and layout of the book.

Chapter 2 discusses the complex relationship between portfolio components and organizational objectives and presents the model, which is developed to address the problem of determining the cumulative contribution of portfolio components to organizational objectives. This is done by taking as input the qualitative evaluations of multiple criteria for each portfolio component and producing a single quantitative value representing the cumulative contribution.

Chapter 3 extends the conceptual model presented in Chapter 2. The fundamental principles presented in Chapter 2 are used in this chapter, but instead of viewing the problem from the perspective of the contribution of multiple components to individual objectives, Chapter 3 looks at the contribution of a single component to multiple objectives. This chapter illustrates how the concepts presented in Chapter 2 can be used in a different way.

Chapter 4 looks at illustrating how the model could be used using actual portfolio components and organizational objectives from a participating organization. The illustration of the model in this chapter shows the mechanics of the model and confirms how the impact of decisions regarding portfolio components can be quantified.

Chapter 5 provides a summary and makes final recommendations for the application of the model presented in this book.

Appendix 1 presents a review of the literature on PfM and discusses the definition for PfM. It also describes five theories that provide a theoretical foundation for PfM. The theories described are Modern Portfolio Theory, Multi-Criteria Utility Theory, Organization Theory, Systems Theory, and Complexity Theory.

Conclusion

This chapter provides an overview of PfM and describes the decision-making challenge, which is addressed by the model presented later in this book. This chapter further outlines the structure for the rest of the book.

PfM is intended to guide investment decisions such that value is maximized, risk or uncertainty is minimized, and organizational success is achieved. The global economic crisis, prevalent at the time of conducting the research that lead to this book, forced organizations to carefully consider their spending in terms of project-related investments. PfM is a mechanism that can address this issue provided the decision makers have a means to evaluate component contribution to strategy. The requirement for organizations to comply with legislative, regulatory, and governance requirements—as well as the factors listed earlier—means that the decisions taken during the management of the portfolio must be well informed so that the objectives of PfM can be achieved.

To ensure that decisions are well informed, or to put it differently, to improve PfM decision making, it is necessary to show how decisions will impact the success of the portfolio and ultimately the success of the organization. Organizational success is measured by the achievement of objectives, and portfolio components are executed to deliver organizational objectives. It can be deduced that finding a way to show the contribution of portfolio components to the organizational objectives will enable decision makers to test the impact of their decisions regarding portfolio components on the portfolio before committing them. This will enable decisions to have a minimum impact on the portfolio and organization while achieving maximum effect.

CHAPTER 2

A Model for Decision Making

Introduction

This chapter discusses a decision-making model for portfolio management (PfM) and is based on a response to findings from an investigation into the practice of PfM in various organizations. The key finding that motivated this chapter and the need for a model for decision making in PfM was the fact that many organizations lacked a clear approach when deciding which portfolio components to terminate, fast track, or put on hold during the course of managing the portfolio. Some organizations take the easy route and trim budgets across all portfolio components by a specified percentage in order to make the affordability constraints. Other organizations cancel portfolio components on the basis that they have not commenced yet. Most, if not all, reasons are related to short-term affordability rather than an understanding on the longer-term strategic consequence of these decisions.

In order to understand the implications of decision making in PfM, we need to (a) establish the relationship between organizational objectives and portfolio components, (b) describe the process for evaluating the individual and cumulative contribution of portfolio components to organizational objectives, and (c) describe the value and utility of the model in improving PfM decision making.

Later, motivating the need for a model, describing the objectives of the model, and the considerations that gave rise to the development of the model are discussed. This is followed by an exploration into the relationship between organizational objectives and portfolio components and a description of the complex nature of this relationship. A discussion on the model itself is then presented. The inputs, processes, and outputs of the model are explained, showing how the qualitative evaluation of components can be converted into a quantitative value that represents the contribution to organizational objectives. The chapter concludes with a discussion on the value and utility of the model with regard to PfM decision making in organizations.

Motivation for a Model

Earlier approaches to PfM focused on the selection and categorization of projects and had less to do with the management and decision-making processes involved in managing the portfolio. The focus in the literature began to shift later, however, toward aligning IT and business strategy,[1] managing IT projects like an investment portfolio,[2] and using IT PfM to unlock the business value of technology.[3]

Subsequently, authors have given increasing focus to the role of single project management in achieving portfolio efficiency;[4] alignment of the project portfolio to corporate strategy, vertical integration, and value creation through PfM;[5] the translation of strategy into programs and projects, organization performance, and the role of the project/program management office;[6] project portfolio control and performance;[7] and the influence of business strategy on PfM and its success.[8] Most recently, the third edition of *The Standard for Portfolio Management*[9] introduced three new knowledge areas (portfolio strategic management, portfolio performance management, and portfolio communication management) that expand on the previous edition significantly. This illustrates the increased emphasis on strategic alignment and portfolio performance specifically.

An understanding of the purpose or objective of PfM is important: "The objective of portfolio management is to determine the optimal mix and sequencing of proposed projects to best achieve the organizational strategy and objectives."[10] They add that managing the performance of a portfolio is critical in closing the gap between organizational strategy and the fulfillment of that strategy. This implies that successfully managed portfolios (and hence successful projects, programs, and operational activities) are measured by the achievement of organizational strategy and objectives (hereafter referred to collectively as organizational objectives). A key consideration, therefore, is the contribution made by projects, programs, and operational activities (portfolio components) toward achieving the organizational objectives. The author had to consider the quantitative and qualitative measures of assessment of portfolio components to determine the contribution of portfolio components to organizational objectives. This enabled a form of reasoning that would be suitable to model such a system.

The factors that served as input toward the development of the model were:

1. The observation from an earlier investigation into the practice of PfM that decision making regarding the management of portfolios was poor.
2. The objective of PfM, which is the determination and management of the optimal mix of portfolio components toward achieving the organizational objectives.
3. The need to understand the relationship between portfolio components and organizational objectives in order to understand the impact of decisions regarding portfolio components on organizational objectives.
4. The consideration of qualitative and quantitative ways of determining portfolio component contributions to organizational objectives.
5. The application of the theories related to PfM (refer to Appendix 1).

The objective of the decision-making model presented in this chapter is to qualitatively evaluate portfolio components using multiple criteria to determine the individual and cumulative contribution of these components to organizational objectives so that the right PfM decisions regarding which components to stop, progress, or terminate can be made.

Relationship Between Portfolio Components and Organizational Objectives

Having a well-defined strategy and organizational objectives without the ability to execute them, or having efficient and effective operations without a strategy or organizational objectives limits the success organizations could have. This notion is supported by Drs Kaplan and Norton who state the following:

> A visionary strategy that is not linked to excellent operational and governance processes cannot be implemented. Conversely, operational excellence may lower costs, improve quality, and reduce process and lead times; but without a strategy's vision and guidance, a company is not likely to enjoy sustainable success.[11]

This emphasizes the need not only to *link* strategy and execution, but also to be able to assess the *degree of contribution* the components make toward achieving the strategy.

According to the Project Management Institute (PMI), organizations build strategy to define how their vision will be achieved. The vision is enabled by the mission, which directs the execution of the strategy. The organizational strategy is a result of the strategic planning cycle, where the vision and mission are translated into a strategic plan. The strategic plan is subdivided into a set of initiatives that are influenced by market dynamics, customer and partner requests, shareholders, government regulations, and competitor plans and actions. These initiatives establish portfolio components that, through their execution, ultimately achieve the organizational objectives. Linking the organization's objectives directly to the portfolio components reveals that there is a many-to-many relationship between objectives and components.

This relationship can be illustrated as in Figure 2.1. Each portfolio component (PC) contributes to one or more objectives. For example, PC1 could contribute to partly achieving objectives 1, 3, and (n), while the remainder of objective 1 is achieved through the execution of PC3. PC2 could contribute to fully achieving objective 2, and objective (n) could be achieved by components 1 and (m). The degree of contribution of each component varies one from the other.

An alternate depiction of this relationship is given in Table 2.1.

In addition to mapping the components to their related objectives, it is also important to understand the relationships between portfolio components. For example, while PC1 and PC3 contribute to the achievement of objective 1, they do not necessarily have to be related to each other in

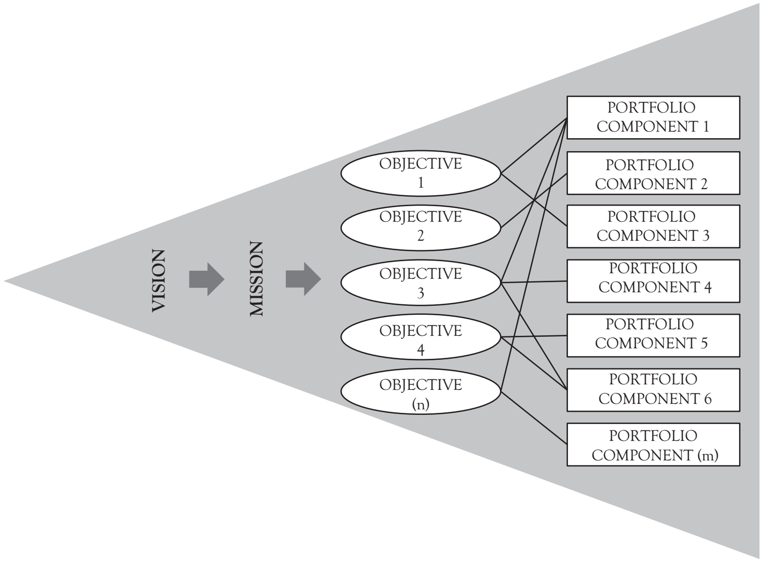


Figure 2.1 Many-to-many relationship between organizational objectives and portfolio components

Source: Adapted from Enoch and Labuschagne.[12]

Table 2.1 Relationship between organizational objectives and portfolio components

		Vision				
		Objective 1	**Objective 2**	**Objective 3**	**Objective 4**	**Objective (n)**
Portfolio	Portfolio Component 1	a		d		i
	Portfolio Component 2		c			
	Portfolio Component 3	b				
	Portfolio Component 4			e		
	Portfolio Component 5				g	
	Portfolio Component 6			f	h	
	Portfolio Component (m)					j

Source: Enoch and Labuschagne.[13]

any other way. They could be singular, independent projects managed by different teams and not dependent on each other through deliverables or resources. On the other hand, for objective 3, PC1, PC4, and PC6 could be run as a program where all components are related to each other and have interdependency through, for instance, deliverables and/or resources. Each component contributes to objectives to varying degrees. For example, the degree of contribution of PC1 to objective 1 is represented by (a), and the degree of contribution of PC3 to objective 1 is represented by (b). The degree of contribution of these two components to objective 1 is not equal. Additionally, PC1 also contributes to objectives 3 and (n) and the degree of contribution to each of these objectives (including objective 1) is represented by (a), (d), and (i). The degree of contribution of a single component (PC1) to each of the three objectives is not equal. The degrees of contribution, represented by the letters (a) to (j) in Table 2.1, vary for each component-to-objective relationship. The challenge is in understanding the degree of contribution of each component to each objective, as well as the collective contribution of many components to a single objective.

Understanding the degrees of contribution of portfolio components to the achievement of organizational objectives also aids the organization in understanding the impact of decisions made in relation to those components. When certain constraints are applied to the portfolio, such as a reduction in budget or a change in strategy, the organization needs a mechanism to aid management in decision making regarding rebalancing the portfolio. For example, if there is a reduction in the available funds for portfolio components, the organization can choose to stop or slow down components that make a *low* contribution to organizational objectives. Alternatively, a change in strategy may reprioritize certain objectives, resulting in the fast tracking of associated components that make a *medium* or *high* contribution. *Low*, *medium*, and *high* refer to the qualitative assessment of the degree of contribution of components.

In addition to the preceding, assessing the degree of contribution of portfolio components to objectives will also achieve the benefit of determining gaps in the portfolio. If the combined contribution of components 5 and 6 to objective 4 is determined to be less than 1, it may be necessary for the organization to consider additional portfolio components to close the gap and achieve the objective fully.

The evaluation of portfolio component contribution is done subjectively. Linguistic values such as low, medium, or high are used to describe the degree of contribution. In order to effectively compare components, however, quantitative values would need to be used. The challenge is in converting the qualitative assessments into quantitative values. In addition, a mechanism for dealing with the *cumulative* contribution of portfolio components is required. To address these requirements, a technique is required for the model that can deal with converting qualitative values into quantitative values while simultaneously computing the cumulative contribution of multiple components to single objectives. Following a review of various techniques, it was determined that Fuzzy Logic would be a suitable technique to use in the model as it addresses the challenge of converting qualitative assessments into quantitative values. The use of Fuzzy Logic when developing the model is discussed in more detail in the upcoming paragraphs.

Model

The following discussion gets slightly technical as it goes into how the model uses Fuzzy Logic to achieve its outcomes. However, the author briefly describes the Fuzzy Logic process and its applicability to the model to avoid distracting from the real purpose of the model. Fuzzy Logic is an extensive topic and its application is varied across many disciplines. Various publications are listed in the Reference section that provides more detail to the Fuzzy Logic process.

Fuzzy Logic is a technique that can deal with qualitative and quantitative information. It is a technique that can take subjective information and make it more objective and has proved to be very successful in a wide range of applications. The various disciplines in which Fuzzy Logic has been used successfully include, but are not limited to, decision support, control theory, artificial intelligence, genetic algorithms, and mechanical engineering.

The use of Fuzzy Logic in the decision-making model follows a combination of the systems approach, multicriteria utility theory (MCUT), and complexity theory. These theories and their relatedness to PfM are discussed in Appendix 1. Qualitative evaluations of portfolio components using MCUT are taken as INPUT, PROCESSED through the application of rules in the fuzzy system, and an OUTPUT is produced (systems approach). The relationships between organizational objectives and portfolio components make up a complex system—(complexity theory).

A complex system comprises numerous interacting parts, each of which behave according to some rule(s) or force(s).

In order to represent a complex business system, such as a portfolio of projects and their cumulative contribution to strategic objectives, a combination of multiple fuzzy models is required.[14] The reason is to allow for the variability in the number of portfolio components contributing to the organizational objectives. For each portfolio component, values for the input variables are obtained, rules are applied to the input values, and a qualitative output value is derived. The fuzzification and application of fuzzy rules is done for each portfolio component and the contribution is determined by aggregating the qualitative outputs of the related components and only then applying defuzzification to produce a crisp (numeric) value that represents the cumulative quantitative contribution of portfolio components to objectives. This process is illustrated in Figure 2.2 and a detailed description of the model and its processes follows.

The stages and phases of the model will now be described.

Stage A

Before we get into the description of the model in detail, it is important to outline the responsibilities of the executive management team and the PfM team. Table 2.2 describes the responsibilities while Figure 2.3 illustrates the interaction between both teams.

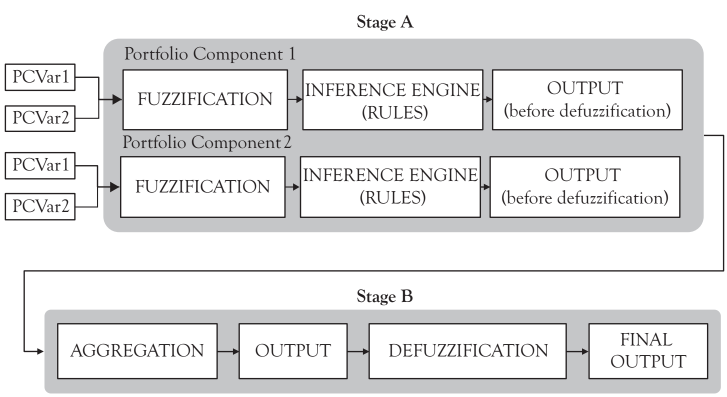


Figure 2.2 Combined Fuzzy Logic model

Table 2.2 Responsibilities of the executive management and PfM teams

Team	Responsibilities
Executive Management (Investment management Committee)	• Provide criteria for portfolio component evaluation. • Evaluate portfolio components in terms of the selected criteria. • Makes decisions regarding the project portfolio.
PfM (Enterprise PfM Office)	• Facilitates a meeting with the executive to agree to the criteria to be used for evaluating portfolio components. Criteria should remain constant but may change to a limited extent when circumstances in the organization change. • Sets up the model for evaluating portfolio components. This should only need to be done once and updated when evaluation criteria change. • Apply the model. This entails facilitating the evaluation of portfolio components based on the selected criteria and determining the individual and cumulative contributions of the portfolio components to the objectives. • Present the portfolio component as an objective matrix to the investment committee. The matrix indicates the portfolio component contributions to objectives and is used to determine which components can be terminated or fast tracked when such a decision is required. • Facilitate scenario planning and record the decisions made at the investment committee meetings.

The process for stage A of the fuzzy model is illustrated in Figure 2.4, followed by an explanation of the steps involved.

For each portfolio component that contributes to an organizational objective (in this case portfolio components 1 and 2), the model considers input values for the input linguistic variables PCVar1 and PCVar2. The input values are passed through a fuzzification process, after which the rules in the inference engine are applied to determine a qualitative value of contribution for each portfolio component. Linguistic variables are variables of the system whose values are words from a natural language, instead of numerical values. Each input variable is qualified by values, such as *poor*, *average*, and *good* for PCVAR1 and *low*, *medium*, and *high* for PCVAR2. Different linguistic terms are used for PCVAR1 and PCVAR2 here to show that different terms can be used—provided they describe the evaluation of the relevant criteria appropriately. In other

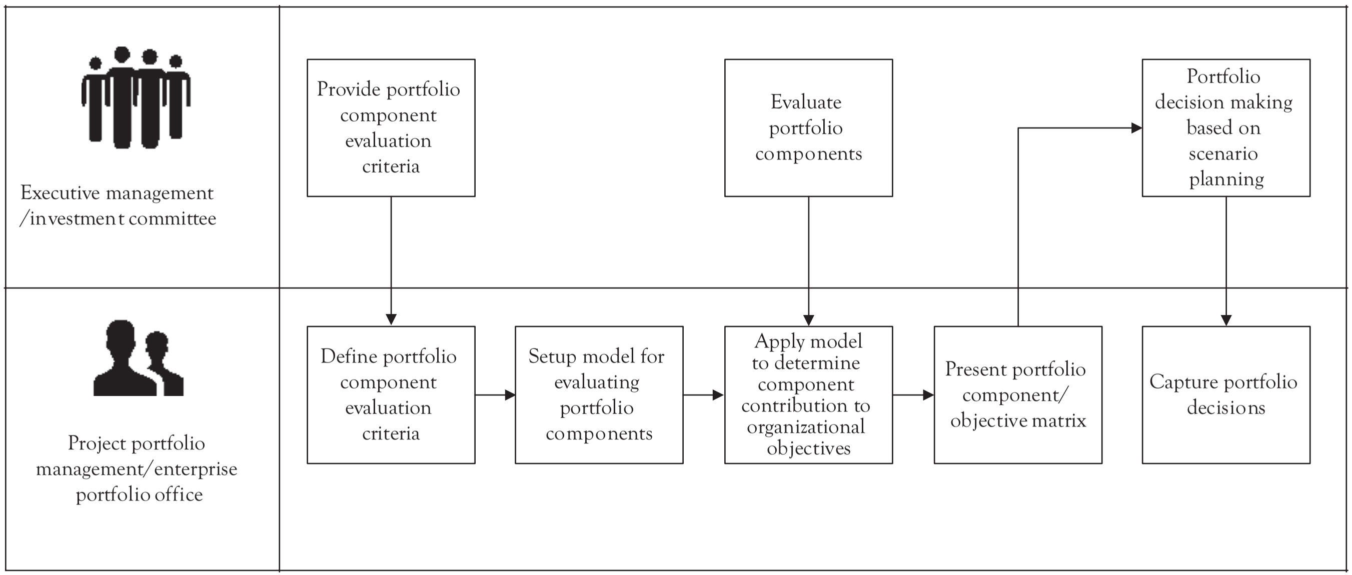


Figure 2.3 Interaction between the executive and PfM teams

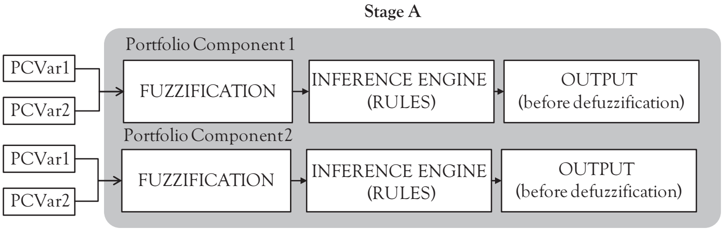
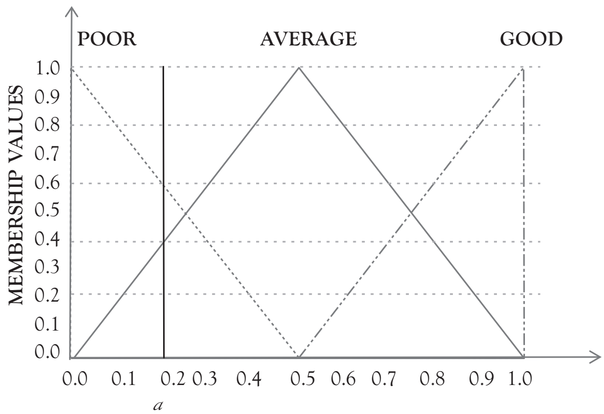


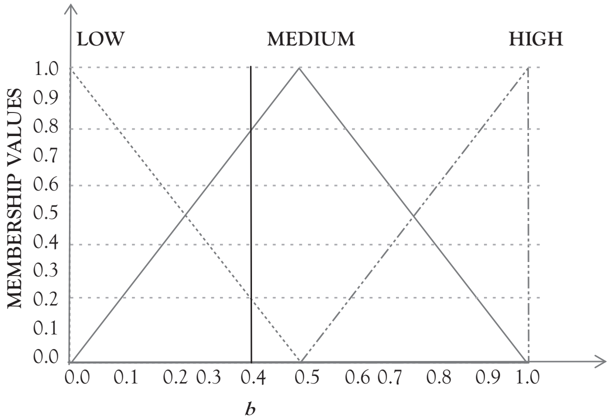
Figure 2.4 Stage A of the combined fuzzy model



μ (PCVar1 = POOR) = 0.6 μ (PCVar1 = AVERAGE) = 0.4 μ (PCVar1 = GOOD) = 0.0

Figure 2.5 PCVar1—Value

words, *poor* may be a better term than *low* for a particular criterion. Alternatively, the PfM team may choose to use *low*, *medium*, and *high* for all criteria evaluations. The output variable (contribution) is qualified by the values *very low*, *low*, *moderate*, *high*, and *very high*. Five values were chosen for the output variable to facilitate a clearer distinction when determining the contribution values. However, it is not recommended to exceed seven values for the output variable. Membership functions are used in the fuzzification process to quantify a linguistic variable value. A membership function is a curve (triangular in this case) that defines how each point in the input space (domain) is mapped to a membership value (or degree of membership) between 0 and 1 (y-axis). Refer to Figures 2.5 and 2.6 for a depiction of membership functions.



μ (PCVar2 = LOW) = 0.2 μ (PCVar2 = MEDIUM) = 0.8 μ (PCVar2 = HIGH) = 0.0

Figure 2.6 PCVar2—Durability of competitive advantage

An important characteristic of Fuzzy Logic is that a numerical value does not have to be fuzzified using only one membership function. In other words, a value can belong to multiple sets at the same time.

Phase 1—Input Variables

For the purpose of illustrating the model, only two input variables are used. In a typical organization, a group of PfM experts could decide on a number of input variables to be used for evaluating the contribution of portfolio components to organizational objectives. The model is designed to cater for more than two input variables but for illustrative purposes, only two are used. The two input variables are described in the following text.

Portfolio Component Variable 1 (PCVar1)

To give some meaning to the following example, PCVar1 represents *value*. The value that a portfolio component is expected to deliver is an important criterion when determining the portfolio component's contribution. Value considers the strategic alignment of the portfolio component—in particular, the decision maker's perception of how the component serves the organization's objectives in the long term—as well as the financial attractiveness of the component—that is, the economic feasibility, which is measured by the component's cost, contribution to profitability, and the component's growth rate.

Portfolio Component Variable 2 (PCVar2)

In this example, PCVar2 represents the durability of competitive advantage. If the portfolio component is delivering a product for which a competitor already exists, then the portfolio component will be rated *low*. If the product can be copied within a specified period, let us say two years, then the portfolio component will be rated as *medium*. If the likelihood of copying the product extends beyond two years, then the portfolio component is rated as *high*, as the contribution of the portfolio component to an objective related to market share is high.

Phase 2—Fuzzification

Fuzzy Logic starts with the concept of a fuzzy set. A fuzzy *set* is a set without a clearly defined boundary. It can contain elements with only a partial degree of membership. For each input variable in this example, three membership functions are defined. The qualitative categories for the membership functions for PCVar1 are *poor*, *average*, and *good*, while the qualitative categories for the membership functions for PCVar2 are *low*, *medium*, and *high.*

The membership functions for PCVar1 and PCVar2 are illustrated in Figures 2.5 and 2.6, respectively.

In Figures 2.5 and 2.6, the x-axis represents the domain and the y-axis represents the membership values.

As mentioned earlier, a membership function is a curve (triangular in this case) that defines how each point in the input space (domain) is mapped to a membership value (or degree of membership) between 0 and 1 (y-axis). The PfM experts in the organization in accordance with their knowledge and experience in PfM and the organization would do the definition of the membership functions. This will be done before the model is used for the first time. The membership functions will vary from one organization to the next.

The domain is not numeric since the input values are qualitative. Subjective information can now be modeled mathematically as the qualitative inputs can be converted into quantitative values.

The next step in the fuzzification process is to take the qualitative inputs, PCVar1 (represented by *a* in Figure 2.5) and PCVar2 (represented by *b* in Figure 2.6), and determine the degree to which these inputs belong to each of the respective membership functions. In an organization, the PfM experts would evaluate the input variables of a portfolio component and determine to what degree it is *poor*, *average*, or *good* or *low*, *medium*, *or high*—as the case may be.

As an example, in Figure 2.5, this is represented by the dark bold vertical line that intersects POOR at a membership value of 0.6 and AVERAGE at a membership value of 0.4. In other words, PCVar1 is assessed as being poor to a degree of 0.6 as well as average to a degree of 0.4 simultaneously.

Similarly, the PfM experts would evaluate PCVar2 of the same portfolio component and determine to what degree it is *low*, *medium*, or *high*. In Figure 2.6, the dark bold vertical line intersects LOW at a membership value of 0.2 and MEDIUM at a membership value of 0.8. In this example, the input variable PCVar2 is assessed as being low (to a degree of 0.2) as well as medium (to a degree of 0.8) simultaneously.

Phase 3—Inference Engine

A number of rules are determined by a knowledgeable group of individuals in the organization who can determine the outputs based on specific conditions within the inference engine. This would also be done before using the model for the first time. An example of a rule would be:

IF PCVar1 is *Poor* AND PCVar2 is *Low*, *THEN* Contribution is *VeryLow*.

The rules in Table 2.3 were applied to the input variables in the inference engine.

Rule Evaluation

The next step in the Fuzzy Logic process is to take the fuzzified inputs (for the preceding example these would be: $\mu_{(PCVar1 = poor)} = 0.6$,

Table 2.3 Fuzzy rules

Rule 1	If PCVar1 is *Poor* AND PCVar2 is *Low*, THEN Contribution is *Very Low*.
Rule 2	If PCVar1 is *Good* AND PCVar2 is *High*, THEN Contribution is *Very High*.
Rule 3	If PCVar1 is *Poor* AND PCVar2 is *Medium*, THEN Contribution is *Low*.
Rule 4	If PCVar1 is *Poor* AND PCVar2 is *High*, THEN Contribution is *Moderate*.
Rule 5	If PCVar1 is *Average* AND PCVar2 is *Low*, THEN Contribution is *Low*.
Rule 6	If PCVar1 is *Average* AND PCVar2 is *Medium*, THEN Contribution is *Moderate*.
Rule 7	If PCVar1 is *Average* AND PCVar2 is *High*, THEN Contribution is *High*.
Rule 8	If PCVar1 is *Good* AND PCVar2 is *Low*, THEN Contribution is *Moderate*.
Rule 9	If PCVar1 is *Good* AND PCVar2 is *Medium*, THEN Contribution is *High*.

$\mu_{(\text{PCVar1 = average})} = 0.4$, $\mu_{(\text{PCVar2 = low})} = 0.2$, and $\mu_{(\text{PCVar2 = medium})} = 0.8$) and apply them to the antecedents of the fuzzy rules. If a given fuzzy rule has multiple antecedents, the fuzzy operator (AND or OR) is used to obtain a single value that represents the result of the antecedent evaluation. The rules used here have been developed for illustration purposes. In an organization, a group of PfM experts would need to design the rules and agree on the consequent values for the respective input value combinations before using the model for the first time.

The rules transform the input variables into an output that will indicate the degree of contribution of the portfolio component. This output variable is defined with membership functions (very low, low, medium, high, very high). Once the rules have been defined according to expert knowledge, they become the knowledge base of the model. Table 2.4 represents the knowledge base associated with the rules described in Table 2.3.

How the Rule Base Works

The next step is to compute the degree of membership to the membership functions (Very Low, Low, Moderate, High, or Very High) of the output variable (contribution). Once a variable is fuzzified (refer to the section on fuzzification described earlier), it takes a value between 0 and 1 indicating the degree of membership to a given membership function of that specific variable. The degrees of membership of the input variables have

Table 2.4 Knowledge base associated with fuzzy rules

		PCVar2		
		Low	**Medium**	**High**
PCVar1	Poor	Very low	Low	Moderate
	Average	Low	Moderate	High
	Good	Moderate	High	Very high

to be combined to get the degree of membership of the output variable. In this instance where there is more than one input variable, the degree of membership for the output value will be the *minimum* value of the degree of membership for the different inputs. Referring back to Figures 2.5 and 2.6 as well as Tables 2.3 and 2.4, input (a) for PCVar1 has a membership degree of 0.6 to the membership function POOR, which applies to rules 1, 3, and 4 (Table 2.3), and a membership degree of 0.4 to the membership function AVERAGE, which applies to rules 5, 6, and 7. Similarly, input (b) for PCVar2 has a membership degree of 0.2 to the membership function LOW, which applies to rules 1, 5, and 8, and a membership degree of 0.8 to the membership function MEDIUM, which applies to rules 3, 6, and 9. When a rule is totally satisfied (indicated by ✓ in Figure 2.7), it will have an output with a membership degree to an output membership function equal to the lower degree among the inputs. The rules satisfied in this example are given in Table 2.5.

Figure 2.7 shows the graphical representation (rule view) of the rules in the system. The MATLAB® tool from MathWorks® was used to build the simple fuzzy system and generate the rule view using the Fuzzy Logic Toolbox®. In Figure 2.7, each row, numbered 1 to 9, represents a rule in the system. The two input variables are shown alongside each other and the output variable is to the right of the figure. The extended vertical lines indicate the points of intersection on the relevant membership functions associated with the membership values for each input variable.

The next section describes how the output values are derived.

Phase 4—Outputs

The output is the aggregation or sum of the membership functions from the satisfied rules. Aggregation is the process of unification of the outputs

Table 2.5 The satisfied rules

Rule 1	**IF** PCVar1 is *Poor* (degree of 0.6) **AND** PCVar2 is *Low* (degree of 0.2), **THEN** Contribution is *Very Low* (degree of 0.2), the lowest degree among the inputs.
Rule 3	**IF** PCVar1 is *Poor* (degree of 0.6) **AND** PCVar2 is *Medium* (degree of 0.8), **THEN** Contribution is *Low* (degree of 0.6).
Rule 5	**IF** PCVar1 is *Average* (degree of 0.4) **AND** PCVar2 is *Low* (degree of 0.2), **THEN** Contribution is *Low* (degree of 0.2).
Rule 6	**IF** PCVar1 is *Average* (degree of 0.4) **AND** PCVar2 is *Medium* (degree of 0.8), **THEN** Contribution is *Moderate* (degree of 0.4).

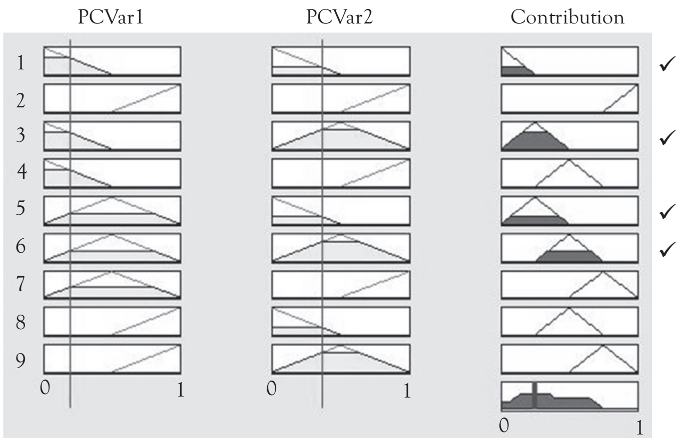


Figure 2.7 Rule View

of all rules. We take the membership functions of all rule consequents and combine them into a single fuzzy set. The input of the aggregation process is the list of consequent membership functions, and the output is one fuzzy set for each output variable. Among the satisfied rules, the membership degree of each output membership function will be the *higher* among the rules that have as a result that membership function.

In Figure 2.8, the shading of the triangles indicates the degree of membership.

- For the membership function *Very Low* the degree of membership is 0.2 (based on the result of rule 1 in Table 2.5).
- For the membership function *Low* the degree of membership is 0.6 (based on the higher result of rules 3 and 5 in Table 2.5).

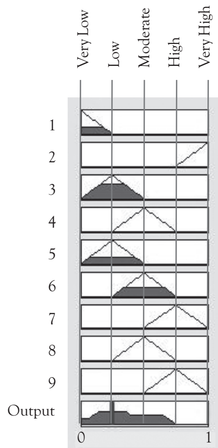


Figure 2.8 Output of rules

- For the membership function *Moderate* the degree of membership is 0.4 (based on the result of rule 6).
- For the membership function *High* the degree of membership is 0.
- For the membership function *Very High* the degree of membership is 0.

To calculate the quantitative contribution of a single portfolio component with two input variables, the aggregated output must be defuzzified to get a single output value. While the most popular defuzzification method is the centroid method, the method used here is the MOM (mean of maximum) defuzzification method.

In this example, the output value 0.25 represents the contribution of the portfolio component to an objective. An output value of 1 would imply that the objective is fully achieved; hence, the output value in this example (0.25) indicates that the portfolio component contributes to the objective to a degree of 0.25. This implies that if this were the only portfolio components selected to achieve an organizational objective, then only a low degree of the objective would be achieved. The organization would need to select other portfolio components or amend the scope of the component such that more of, or the entire, objective, is achieved.

However, we want to determine the cumulative contribution of two or more components and so, before we defuzzify the qualitative output of a single component, we move to stage B where the contribution of multiple components is considered.

Stage B

Phase 5—Additive Aggregation

The aggregation in stage A earlier is the unification of the outputs of all rules per portfolio component. The aggregation in stage B is the aggregation (sum) of the outputs of all portfolio components before defuzzification.

To maintain the information in the complete system, the fuzzy regions (outputs of portfolio components in stage A) are combined using the additive aggregation method before defuzzification.[15] The process adds the truth membership values of the consequent fuzzy set and the solution fuzzy set at each point along their mutual membership functions. The bounded sum method is applied so that the composite membership value can never exceed 1.0. Figures 2.10 through 2.13 illustrate the aggregation of the portfolio component outputs into a single aggregated output before defuzzification.

The additive technique adds the consequent fuzzy sets (stage A outputs) to the solution variable's output fuzzy region. The process adds the truth membership value of the consequent fuzzy sets and the solution fuzzy set at each point along their mutual membership functions.

Using the output of the example used earlier for one portfolio component, Figure 2.10 shows the first step in the aggregation process.

For the second portfolio component, let us assume the stage A process is followed as was done for the first portfolio component, and an output for the second portfolio component is derived, such that

- For the membership function *Very Low* the degree of membership is 0.0.
- For the membership function *Low* the degree of membership is 0.2.

- For the membership function *Moderate* the degree of membership is 0.4.
- For the membership function *High* the degree of membership is 0.2.
- For the membership function *Very High* the degree of membership is 0.

Figure 2.11 shows how the second output is added to the final output (solution fuzzy region).

The combined output of both portfolio components is illustrated in Figure 2.12.

To summarize, Figure 2.10 showed the addition of the consequent fuzzy set for portfolio component 1 being added to the final output region (cumulative contribution).

Figure 2.11 showed the addition of the consequent fuzzy set for portfolio component 2 being added to the final output region. Figure 2.12 showed the combined view of Figures 2.10 and 2.11.

Phase 6—Aggregated Output

The aggregated output, also known as the solution fuzzy region, is illustrated in Figure 2.13.

The solution fuzzy region (cumulative contribution) is described as satisfying the membership functions Very Low to Very High such that:

The membership function Very Low has a membership value of 0.2.
The membership function Low has a membership value of 0.6.
The membership function Moderate has a membership value of 0.4.
The membership function High has a membership value of 0.2.
The membership function Very High has a membership value of 0.0.

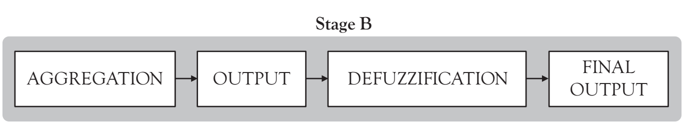


Figure 2.9 Stage B of the combined fuzzy model

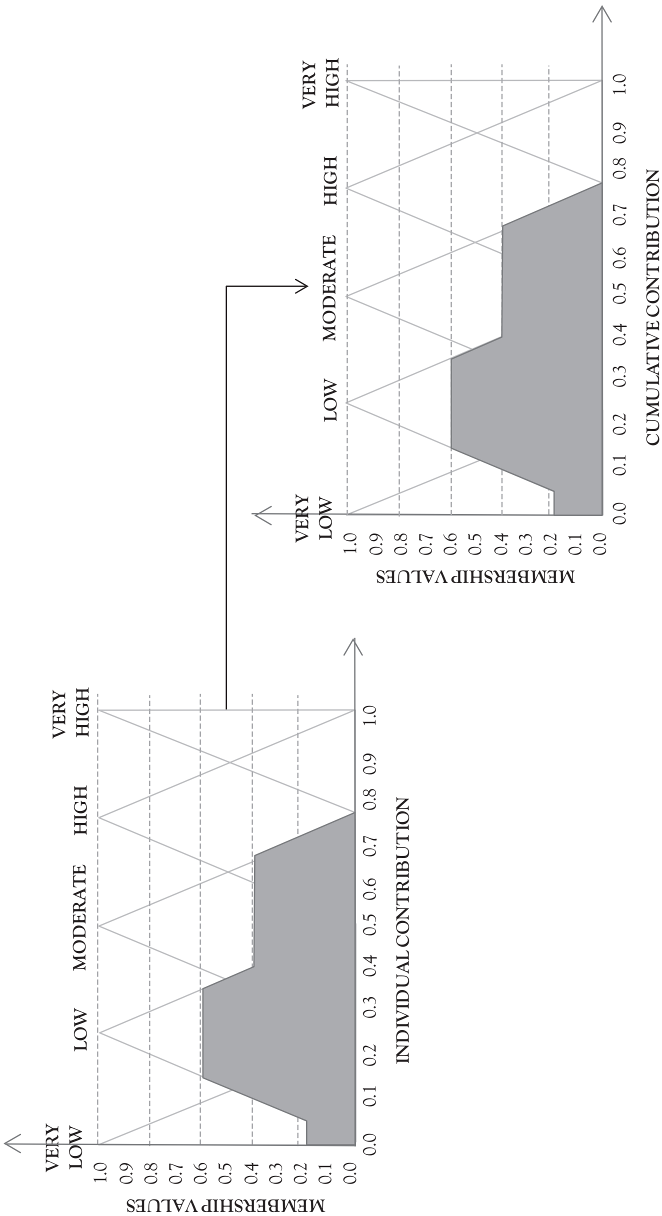


Figure 2.10 Additive aggregation—first portfolio component

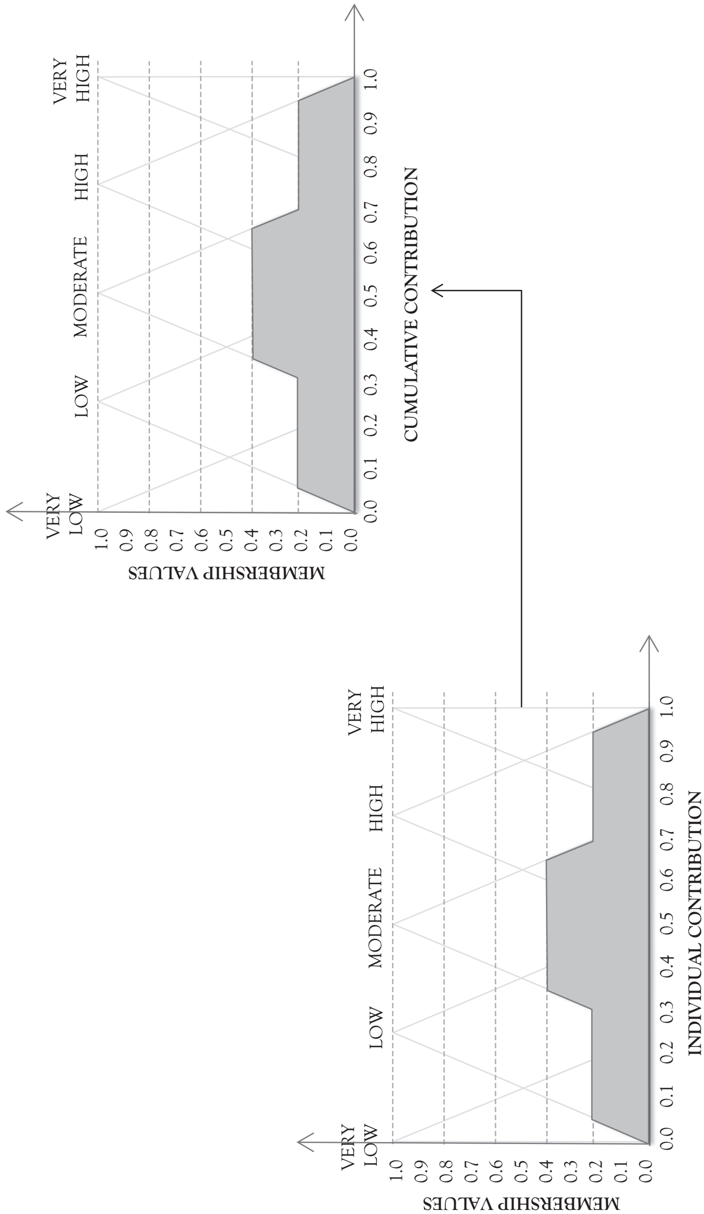


Figure 2.11 Additive aggregation—second portfolio component

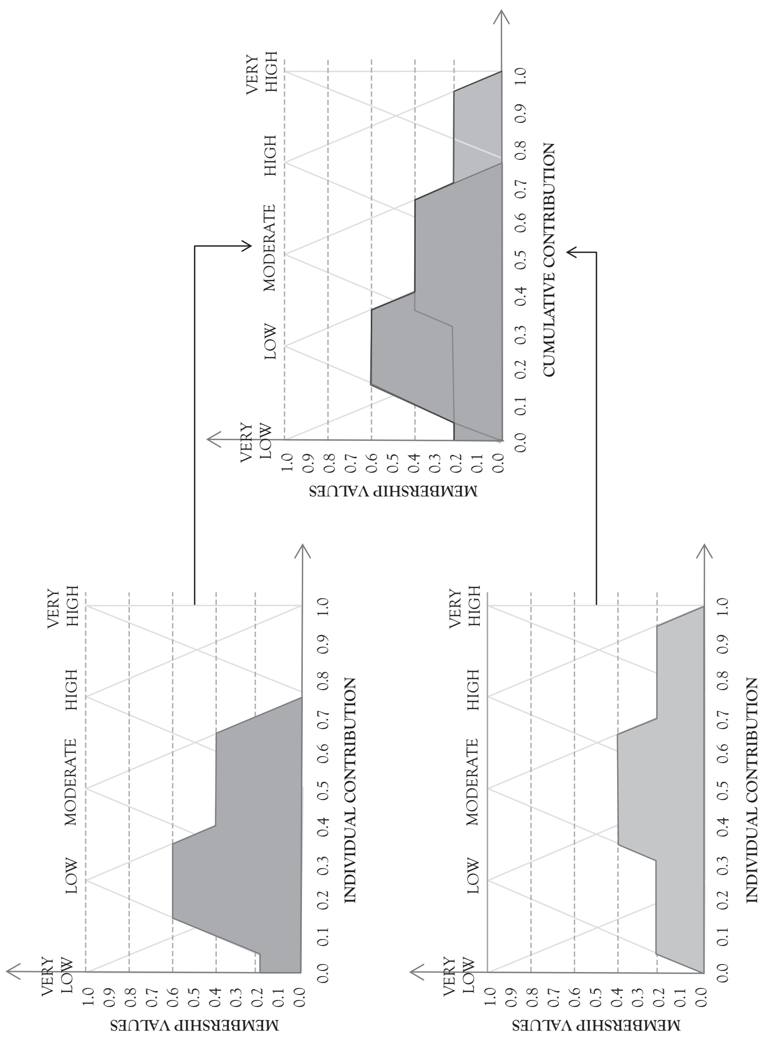


Figure 2.12 Additive aggregation—combining both portfolio components

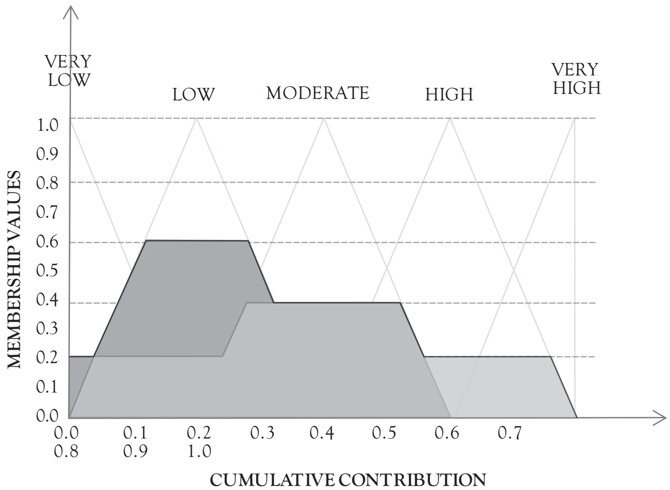


Figure 2.13 Aggregated output

Now that the aggregated output (solution fuzzy region) has been determined, the quantitative value representing cumulative contribution must be determined through the process of defuzzification.

Phase 7—Defuzzification

The last step in the Fuzzy Logic process is defuzzification. Fuzzification helps us to evaluate the rules, but the final output of a fuzzy system has to be a crisp number. The input for the defuzzification process is the aggregate output fuzzy set and the final output is a single number. For this model, the MOM defuzzification method[16] proved to be more predictable and accurate than other defuzzification methods.

Phase 8—Final Output

As indicated earlier, the application of the MOM defuzzification method results in a quantitative value. In this instance, the defuzzification method is applied to the aggregated fuzzy output to produce a quantitative value. The quantitative value (result) represents the combined contribution of the portfolio components. In this example, the combined contribution is less than one, implying that the objective is partially achieved. This would mean that if these were the only portfolio components considered for achieving this objective, the organization would fail in achieving the objective completely.

Interpretation and Utility of the Model

From the preceding discussion, while the portfolio components make a contribution to the organizational objective, it can be seen that there is still a gap in fulfilling the objective completely. This is indicated by the fact that the degree of contribution is not equal to one. There is still potential for additional portfolio components to be added to achieve the objective fully. Alternatively, the scope of the selected portfolio components could be amended such that their contribution can be improved toward meeting the objective. The results obtained from the model can assist in decision making regarding the composition of the portfolio.

Value of the Model

The ability to quantitatively determine the cumulative contribution of portfolio components in achieving objectives after making qualitative assessments of those components using multiple criteria improves the decision-making capability of decision makers when considering the portfolio mix and the potential to achieve organizational objectives. Decisions regarding the portfolio composition still lie with people but the model acts as a tool for enabling better-informed decisions. For example, if the organization, due to budget constraints, wants to determine which portfolio component can be terminated, it would use the model to test the effect on the whole system by removing individual components and, based on the results, make the decision as to which components can be terminated.

Many current approaches focus on assessing only individual portfolio components and lack the ability to determine the *cumulative contribution* of portfolio components to organizational objectives. The assessment of components is usually based on decision makers offering a subjective score in order to rank components in the portfolio, whereas this model uses Fuzzy Logic—a tried and tested technique—for taking linguistic evaluations of components based on multiple criteria, and converting them into quantitative values, based on predefined rules, to determine the individual and cumulative contribution of portfolio components to organizational objectives.

This model considers the complex relationship between portfolio components and organizational objectives and it is illustrated in a subsequent chapter, how the model can be used to improve decision making when managing the project portfolio. Instead of simply applying a percentage reduction in budget across all portfolio components when the organization is faced with budget constraints, for example, the model shows the contributions of portfolio components and the impact on the achievement of organizational objects if any of the components are terminated.

Conclusion

During the investigation into the practice of PfM, it was observed that decision making regarding portfolio components were being made with little knowledge of the contribution of these components to organizational objectives. This led to a lack of understanding of the impact of the decisions to stop or terminate the components. The focus of this chapter, therefore, was to present a model that would address the problem.

This chapter began with a motivation for a conceptual model by firstly describing the factors that led to the need for a model and, secondly, describing the objective of the conceptual model. The relationship between portfolio components and organizational objectives was then discussed, illustrating that components have varying degrees of contribution to objectives and that one or more objectives can contribute to one or more objectives. This results in a complex relationship between components and objectives. The model, using Fuzzy Logic as a technique, considers the qualitative evaluation of portfolio components, applies a set of rules to convert the input values into qualitative outputs, aggregates the outputs, and defuzzifies the aggregated outputs to produce a quantitative value that represents the cumulative contribution of portfolio components to organizational objectives.

The ability to determine the contribution of portfolio components using this model implies that decision makers now have a mechanism to enable them to determine the impact of their decisions on the achievement of organizational objectives, as they now understand the degree of contribution the components make to organizational objectives.

This model is significant for a number of reasons. First, it provides a mechanism for taking qualitative evaluations and converting them to quantitative values for comparison. Second, multiple criteria can be used when evaluating portfolio components. This allows flexibility as any organization can choose whichever criteria and any number of criteria to apply in this process. Third, while other models evaluate individual portfolio components, this model allows the simultaneous evaluation of multiple components and is able to determine a cumulative contribution value. Fourth, the approach or thinking of a number of theories discussed in Appendix 1 was applied in the development of the model. Lastly, by being able to also determine the individual contribution values, decision makers can view the component—objective relationship from an alternative perspective—that is, the contribution of individual components to multiple objectives.

Chapter 3 uses the fundamental concepts presented in this chapter and discusses the alternate perspective mentioned earlier. This implies that the concepts presented here could be applied in other ways and would be useful in dealing with various aspects that influence PfM decision making.

CHAPTER 3

Extending the Model

Introduction

The previous chapter presented the relationship between portfolio components and organizational objectives. Figure 2.1 illustrated the many-to-many relationships between organizational objectives and portfolio components while Table 2.1 showed that more than one portfolio component could contribute to a single objective. In Table 2.1, it could also be seen that a single component could contribute to multiple objectives—as in the case of Component 1 contributing to Objectives 1, 3, and (n). The model presented in the previous chapter showed how the qualitative assessment of multiple components, based on multiple criteria, could be taken as input, processed through the application of fuzzification, rules, aggregation, and defuzzification. This provided a quantitative output that represented the cumulative contribution of portfolio components to organizational objectives. This chapter extends the discussion on the use of the model presented earlier.

The goal of this chapter is to illustrate how the model could be re-used to present an alternate perspective on the component-to-objective relationship. Demonstrating how the total contribution of individual components to multiple objectives can be computed and discussing how this information can be used in the decision-making process achieves this.

The perspective presented in this chapter on the portfolio component contribution to strategic objectives is aimed at determining which components make the highest individual contribution to the objectives in the system. Once the cumulative contributions of the individual components are determined, the components will then be ranked in order of their individual contribution to multiple objectives. Finally, a weighting is applied to the organizational objectives based on which objectives the organization considers as more important than others. The weighting acts as a factor that influences the outcome of the rank order of the portfolio components. Components that contribute to more important objectives will receive a higher contribution score. Decision makers can use this information when deciding on which components to accelerate, suspend, or terminate.

Determining the Contribution of Single Portfolio Components to Multiple Objectives

In the previous chapter, it was determined that portfolio components could contribute to multiple objectives. Table 2.1 showed that portfolio component (PC) 1 contributes to multiple objectives (OBJ) 1, 3, and n. The data is repeated in Table 3.1 for ease of reference. The degree of contribution to each objective varies from one to the other. The degree of contribution of PC1 to OBJ1 could be 0.35 while its degree of contribution to OBJ3 could be 0.17, and its contribution to OBJ(n) could be 0.25. The total contribution that a component makes to multiple objectives does not need to be equal to 1. The fact that PC1 contributes to three objectives, rather than just one, intuitively suggests that it is an important component. However, it needs to be determined how

Table 3.1 Relationship between organizational objectives and portfolio components

		Vision				
		Objective 1	Objective 2	Objective 3	Objective 4	Objective (n)
Portfolio	Portfolio Component 1	a		d		i
	Portfolio Component 2		c			
	Portfolio Component 3	b				
	Portfolio Component 4			e		
	Portfolio Component 5				g	
	Portfolio Component 6			f	h	
	Portfolio Component (m)					j

Source: Enoch and Labuschagne.[1]

important it is in relation to PC2, for example, which contributes to only one objective.

Let us assume that PC2 contributes to OBJ2 to a degree of 0.88. The contribution of PC2 is greater in terms of degree than PC1, which has a total contribution of 0.77 (0.35 + 0.17 + 0.25) but PC1 contributes to three objectives instead of just 1. The impact of decisions regarding PC1 in terms of the portfolio mix is likely to be greater. If the investment committee decides to cancel PC1, for example, it would imply that three objectives would be impacted. These three objectives will not be fully achieved as a result of PC1 being cancelled.

The model described previously can be reused to address the aspect of a single component contributing to multiple objectives. The following discussion describes how the model can be applied.

Figure 3.1 shows that input variables (PCVar1 and PCVar2) for portfolio component (PC) 1 are evaluated for each instance that PC1 makes a contribution to an objective. In this example, it is indicated that PC1 contributes to three objectives, and hence the figure shows three instances of the Stage-A process (fuzzification, inference engine, and output) for PC1.

The process of fuzzification, rule evaluation (inference engine), and determination of a qualitative output is described in the previous chapter. To avoid repetition, the process will not be re-explained here but will be used to illustrate the degrees of contribution of PC1 to each of the three objectives.

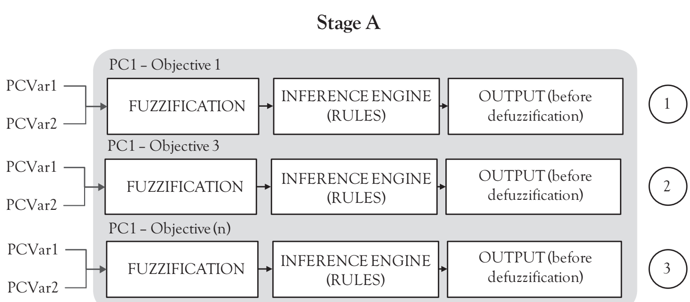


Figure 3.1 Stage A process—single portfolio component contribution to multiple objectives

Degree of Contribution of a Single Component (PC1) to Multiple Objectives

The following section briefly describes the process of determining the individual contribution of a single component (PC1) to multiple objectives (OBJ1, 3, and [n]). For each contribution relationship, the process is followed:

1. The fuzzified membership value following the evaluation of each input variable in terms of the components contribution to a specific objective
2. The rule view from the MATLAB® tool following the evaluation of the input variables
3. A table listing the satisfied rules associated with the evaluation of the input variables
4. The output membership functions once the membership functions of the two input variables have been aggregated
5. The output fuzzy region that equates the aggregation of the output membership functions
6. The defuzzified value representing the degree of contribution to the specific objective

Degree of Contribution of PC1 to Objective 1

Let us assume that the input variables are evaluated as follows:

PCVar1 = Good (with a membership degree of 0.784)
PCVar2 = High (with a membership degree of 0.812)

Figure 3.2 illustrates the membership degrees for each of the variables through the shading of the membership functions.

Applying the rules in the inference engine will result in the rules given in Table 3.2 being satisfied.

Figure 3.3 shows the rule view of the output membership functions. The shaded triangles illustrate the degree of membership following the aggregation of the membership functions from the satisfied rules in Table 3.2. Among the satisfied rules, the membership degree of each

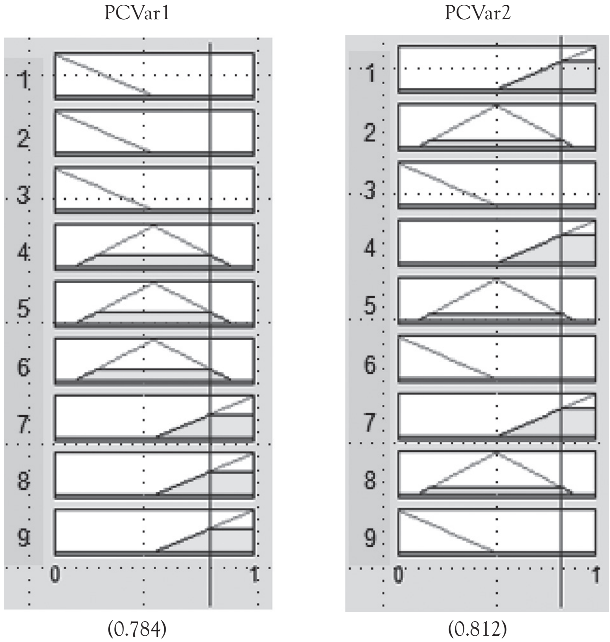


Figure 3.2 Rule view of the input variables for PC1 contribution to Objective 1

Table 3.2 Satisfied rules for PC1 contribution to Objective 1

Rule 4	If PCVar1 is *Average* AND PCVar2 is *High*, THEN Contribution is *High*.
Rule 5	If PCVar1 is *Average* AND PCVar2 is *Medium*, THEN Contribution is *Moderate*.
Rule 7	If PCVar1 is *Good* AND PCVar2 is *High*, THEN Contribution is *Very High*.
Rule 8	If PCVar1 is *Good* AND PCVar2 is *Medium*, THEN Contribution is *High*.

output membership function will be the *higher* among the rules that have as a result that membership function.

The output fuzzy region for the degree of contribution of PC1 to Objective 1 is illustrated in Figure 3.4.

The defuzzified value, using MoM, resulting from this output fuzzy region = 0.935.

The dark solid vertical line in the figure indicates this.

Degree of contribution of PC1 to Objective 3

Let us assume that the input variables are evaluated (see Figure 3.5) as:

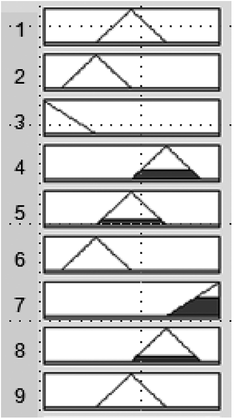


Figure 3.3 Rule view of the output membership function

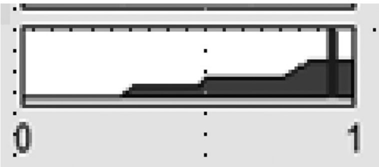


Figure 3.4 Output fuzzy region

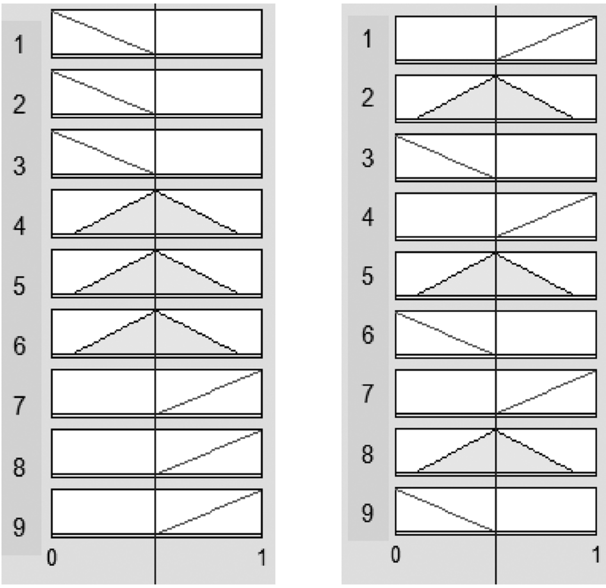


Figure 3.5 Rule view of the input variables for PC1 contribution to Objective 3

PCVar1 = Average (with a membership degree of 1.0)
PCVar2 = Medium (with a membership degree of 1.0)

Applying the rules in the inference engine, the rules given in Table 3.3 will be satisfied.

The output membership function based on the satisfied rule is illustrated in Figure 3.6 while the output fuzzy region for the degree of contribution of PC1 to Objective 3 is illustrated in Figure 3.7.

The defuzzified value resulting from this output fuzzy region = 0.5.

The dark solid vertical line in the figure indicates this.

Table 3.3 Satisfied rules for PC1 contribution to Objective 3

Rule 5	If PCVar1 is *Average* AND PCVar2 is *Medium*, THEN Contribution is *Moderate*.

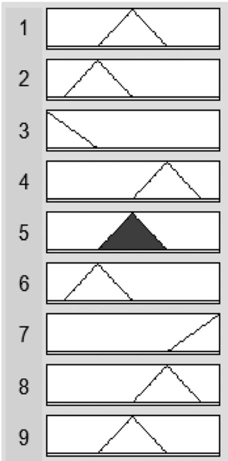


Figure 3.6 Rule view of the output membership function

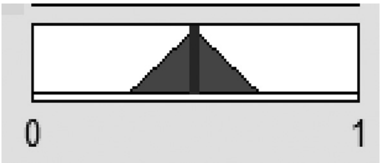


Figure 3.7 Output fuzzy region

Degree of contribution of PC1 to Objective (n)

Let us assume, as illustrated in Figure 3.8, that the input variables are evaluated as:

PCVar1 = Poor
PCVar2 = Medium

Applying the rules in the inference engine will result in the rules given in Table 3.4 being satisfied.

The output membership function based on the satisfied rules is illustrated in Figure 3.9 while the output fuzzy region for the degree of contribution of PC1 to Objective (n) is illustrated in Figure 3.10.

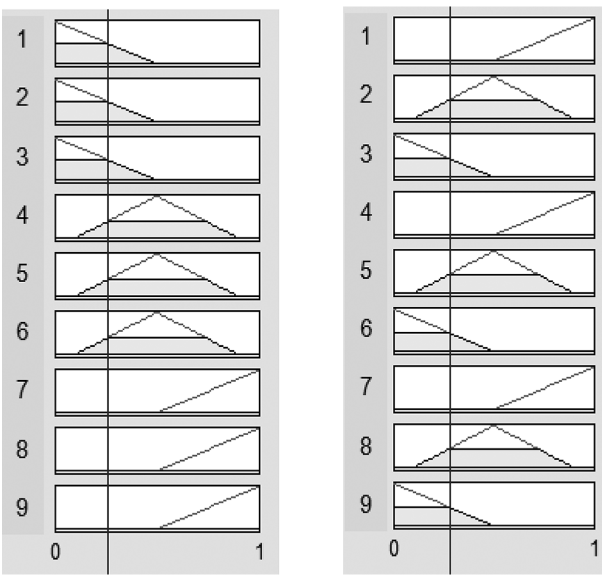


Figure 3.8 Rule view of the input variables for PC1 contribution to Objective (n)

Table 3.4 Satisfied rules for the contribution of PC1 to Objective (n)

Rule 2	If PCVar1 is *Poor* AND PCVar2 is *Medium*, THEN Contribution is *Low*.
Rule 3	If PCVar1 is *Poor* AND PCVar2 is *Low*, THEN Contribution is *Very Low*.
Rule 5	If PCVar1 is *Average* AND PCVar2 is *Medium*, THEN Contribution is *Moderate*.
Rule 6	If PCVar1 is *Average* AND PCVar2 is *Low*, THEN Contribution is *Low*.

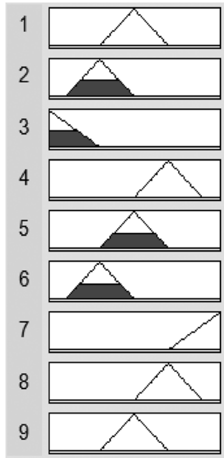


Figure 3.9 Rule view of the output membership function

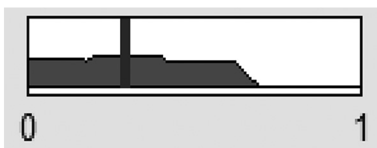


Figure 3.10 Output fuzzy region

The defuzzified value resulting from this output fuzzy region = 0.295.

The dark solid vertical line in the figure indicates this.

Calculate the Cumulative Contribution of a Single Component to Multiple Objectives

The quantitative outputs of all PC1 contributions determined in the previous section must be aggregated to work out the total contribution of PC1 to the three objectives. Based on the preceding discussion, the defuzzified degrees of contribution for PC1 to the three objectives are:

- Degree of contribution to Objective 1 = 0.935
- Degree of contribution to Objective 3 = 0.5
- Degree of contribution to Objective (n) = 0.295

Table 3.5 Cumulative contribution of PC1

	Objective 1	Objective 3	Objective (n)	Total
PC1	0.935	0.5	0.295	1.73

The total contribution of PC1 to the objectives in this system of portfolio components and objectives is equal to the sum of the individual contributions. Table 3.5 shows the quantitative contribution of PC1 to each of the three objectives, as well as the sum of the contributions, based on the preceding discussion.

Similarly, to determine a rank order of component contributions to the organizational objectives, the total contribution of the remaining portfolio components to multiple objectives can be calculated and the total contributions compared.

Determine the Relative Contribution of Single Portfolio Components to Multiple Objectives

The previous section assumed that each objective is equally weighted. In reality, objectives can be prioritized and a weighting applied to each objective to distinguish their importance in the system. This is essential to consider when looking at the individual component contributions to multiple objectives as it influences the importance of the individual components to each other in the system.

Let us assume that the objective in Table 3.5, cumulative contribution of PC1, is weighted as follows:

Objective 1 = 1.0
Objective 3 = 0.7
Objective (n) = 0.5

The higher the weighting, the more important a particular objective is compared to other objectives. In the example, Objective 1 has the highest weighting (1.0) while Objective (n) has the lowest weighting (0.5) implying that Objective 1 is considered by the organization to be most important while Objective (n) is considered to be least important.

The product of the objective weighting and the portfolio component contribution results in a new portfolio contribution value per objective and, by implication, a new total contribution value for PC1. This is illustrated in Table 3.6.

By applying the weighting assigned to each objective to the portfolio component contribution, the contributions are normalized and components can be more realistically compared. The same process is applied to the remaining components in the system after which the components can be ranked from highest to lowest.

Table 3.7 shows the rank order of portfolio components based on their total individual contribution to objectives.

The ranked order of components indicates to decision makers the importance of components in terms of the impact of decisions made. If the decision makers decide to cancel PC1, for example, and PC1 is the highest ranked component, it would mean that a significant portion of the objectives would not be achieved. Knowledge of the ranked order of components enables decision makers to understand where to allocate

Table 3.6 Cumulative contribution of PC1 after objective weighting is applied

	Objective 1 (w = 1.0)	Objective 3 (w = 0.7)	Objective (n) (w = 0.5)	Total
PC1	0.935	0.35	0.148	1.433

Table 3.7 Rank order of portfolio components after weighting is applied to objectives

		Vision						
		OBJ 1	OBJ 2	OBJ 3	OBJ 4	OBJ (n)	Total	Rank
Portfolio	PC 1	0.935		0.350		0.148	1.433	1
	PC 2		0.655				0.655	4
	PC 3	0.700					0.700	3
	PC 4			0.455			0.455	7
	PC 5				0.550		0.550	6
	PC 6			0.375	0.675		1.050	2
	PC (m)					0.650	0.650	5

resources. The ranked order also helps to focus attention appropriately on the relevant components.

Conclusion

This chapter provided an alternate perspective of the contribution of portfolio components to organizational objectives. Here, the contribution of individual components to multiple objectives was considered.

The conceptual model from the previous chapter was re-used to determine the individual component contribution to multiple objectives. The individual component contributions were then aggregated. This allowed for the ranking of portfolio components, with those components contributing to more objectives being ranked highly. In addition, by applying a higher weighting to organizational objectives that had a higher priority, their respective components contribution value was adjusted to a higher contribution value. This influenced their position in the rank order of components. The rank order of components provides additional information to decision makers and ensures better understanding of individual components and so enables better-informed decisions regarding those components.

CHAPTER 4

Using the Model

Introduction

In the previous two chapters, the model for determining portfolio component contribution has been described from two perspectives. Chapter 2 introduced the core concepts of the model using fuzzy logic as the chosen approach and described how the combined contribution of portfolio components (PCs) to organizational objectives could be determined. The focus was on many components contributing to individual objectives. Chapter 3 demonstrated how the model could be extended to consider the total contribution of single components to multiple objectives. The model, as described in Chapters 2 and 3, therefore, addresses the many-to-many relationship between components and objectives and provides a mechanism for assessing or evaluating the contribution of components to organizational objectives. Now we are in a position to use the model in a real-life example.

In order to use real data, the author requested the participation of a large financial services organization in South Africa that he was familiar with. The participant organization provided data and information regarding a subset of their organizational objectives and the portfolio components initiated to address their strategy. The objective of this chapter is to demonstrate how the model can be applied using the information from the participant organization.

The chapter begins with a brief description of the organizational context of the participating organization. The portfolio components and organizational objectives used are also described and a scenario of how the model would be used is presented, observations from the scenario are listed, and the benefit of using the model is discussed.

Organizational Context

The organization chosen for the verification was a large financial services organization in South Africa. Permission to use the strategy definition and initiatives (projects and programs) in this process was granted by the Global CIO (Chief Information Officer). It is necessary to describe the context or business environment in which it operates to appreciate the nature of the organization's operations, projects, and programs (portfolio components). The business environment within which any organization operates involves its internal environment and external environment. The external environment is divided into the macro and microenvironments. This is illustrated in Figure 4.1 and described in the following text.

Macro Environment

The macro environment involves the local, political, economic, and social aspects, which impact the organization. The case study organization (hereafter referred to as Company A) is a multinational organization based in South Africa. As a result, it has to operate in the various geographic locations in compliance with the relevant country's political and legal

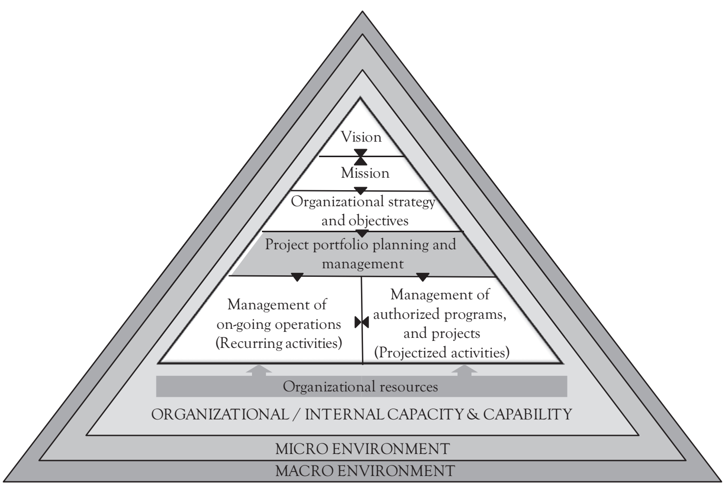


Figure 4.1 Organizational context

Source: Adapted from Project Management Institute.[1]

requirements. The global financial environment at the time of writing this book had an impact on the available funds for portfolio component investments and as a result, the portfolio(s) had to be managed in terms of component termination in response to financial pressure.

Micro Environment

The micro environment relates to the company's customers and clients, competitors, and industry regulator. Company A competes with other financial services institutions for market share within South Africa, Africa, and beyond Africa. Customers have more choice in terms of products and services as well as new channels for interacting with financial services organizations, such as mobile phone and online banking through the use of personal computers and tablet PCs. Application forms for bank accounts and insurance policies can be done electronically in a distributed fashion. Signatures on forms can be electronic using digital signatures, signature tablets, or finger print verification. The organization has to optimize its portfolio of projects and programs in a way that enables it to respond adequately and appropriately to market demands.

The micro environment exists within the organizational capacity, capability, and components that are executed to deliver value to the organization.

Organizational Capacity and Capability

The organizational environment involves the organizational capacity (available human and financial resources) and capability (human skills and technology). These factors play a role in determining the mix of portfolio components and the organization's ability to deliver them. Other factors playing a role in the portfolio component investment choices in Company A's recent realignment of strategy are the realignment of its performance management systems and the influence of major shareholders on its performance and operational focus. These factors must be considered during the financial period (or subsequent periods) and the portfolio mix of portfolio components must be adjusted in response to the preceding.

Portfolio Components and Organizational Objectives

Information gathering of the portfolio components and organizational objectives required for this process was undertaken by direct contact with the Enterprise Portfolio Management Office (EPMO) Operations Manager. This person was able to provide the author with the information related to the projects, programs, and organizational objectives. For the purpose of illustration, it was decided to keep the sample data to a manageable set. Three criteria or input variables, six components, and five objectives were used in this illustration of how the model would work.

Portfolio Components

The portfolio of projects and programs (portfolio components) at Company A extended from mega IT (information technology) and business projects and programs to small enhancements called *work requests*. Portfolio components are categorized, firstly, as signature programs, if they exceed a certain budget threshold, run over multiple years, or are implemented across multiple geographies. Large projects or programs that are under the scrutiny of the executive management due to persistent issues such as budget overrun, missed deliverable dates, and so on are also included in this category. Secondly, portfolio components are categorized as strategic initiatives. These components are under the purview of the Group Information Technology executive committee as strategic initiatives due to the fact that they were specifically identified as part of the Group IT strategy definition. The remainder of the portfolio consists of components that are (a) a mix of small, medium, and large projects and programs; (b) address a variety of objectives, such as innovation (new products); (c) regulatory and compliance requirements; (d) normal product, process, and systems enhancements; and (e) development and implementation of internal enablement systems (human resources, marketing, finance, risk, etc.).

Organizational Objectives Selected for This Exercise

The objectives identified for this exercise were defined in the Group IT division of Company A. The company followed the balanced score card methodology[2] when articulating the strategic objectives and identifying the components required in achieving those objectives. The objectives were identified in response to key issues that the executive management felt needed to be addressed in the short term to move the organization forward.

Table 4.1 describes the objectives, measures, and targets. Table 4.2 lists the components that contribute toward the achievement of the objectives.

Portfolio components are associated with the selected organizational objectives as outlined in Table 4.2. The portfolio components are henceforth to be indicated by their abbreviations.

Mapping of Components to Objectives

Table 4.3 illustrates the mapping of portfolio components (PCs) to organizational objectives. The labels (A to H) in the cells (intersection of rows and columns) indicate which components contribute to what objectives.

While Table 4.3 describes the mapping of components to objectives, it should be noted that where a component contributes to more than one objective, not all of its deliverables are necessarily applicable to all objectives. The following list describes how each component contributes to each relevant objective.

Cell A: Component PC1 contributes to Objective 1 by establishing an electronic trading platform that will facilitate business growth.

Cell B: Component PC2 contributes to Objective 2 by implementing streamlined business processes and supporting technology that will reduce the cost of operations in the retail banking division.

Cell C: Component PC2 contributes to Objective 4 by delivering improved business processes and software applications that will enable the sales force to offer clients value-added services and products thereby improving revenue.

Cell D: Component PC3 contributes to Objective 2 by implementing a system for the electronic recording—(using scanning and e-mail, storage, and retrieval)—of client documents such as application forms and copies of identity and proof of residence documents.

Table 4.1 IT organizational strategic objectives

#	Objective	Description	Measure	Target	Definition and Comment
1	Business Growth	The bank's vision includes the expansion of its operations (presence) into new global markets.	Growth	550 branches, 2.6 million Customers and 3.1 million active accounts across the rest of Africa in the next financial year.	The local market is fairly saturated with limited movement of customers and clients between existing banks in South Africa. Banks need to seek growth in new markets beyond the country's borders.
2	Reduce the cost of operations in retail banking	Owing to declining profits and a global financial crisis, it is necessary to focus on reducing costs over the short to medium term to maintain shareholder value.	Cost	Reduce costs by 20% over three years	The cost and risk associated with maintaining aging systems and processes is increasing year on year. It has, therefore, become necessary to replace the core banking systems and processes.
3	Adhere to compliance and regulatory requirements	The banking sector authority introduces or amends regulation periodically. The bank needs to comply to maintain its banking license.	Adherence/ regulatory requirement	Fulfil regulatory requirement 100% and within the specified timeframe	The executive has taken the decision to fulfil regulatory requirements 100% to avoid incurring fines or attracting negative publicity.
4	Improve the revenue generation capability	Revenue has been declining over the past three years due to the pressure of the global *credit crunch* phenomenon as well as new product and service offerings from competitors attracting clients away from the bank.	Revenue	Increase revenue by 10% per annum	The selected portfolio components will focus on new and enhanced product offerings that will generate new revenue.
5	Regain market leadership in the corporate investment banking segment	Increase EQD's competitive advantage and achieve market share growth.	Market share	Increase market share by 10% in year 1 following technology platform replacement	The current year market share figures will be used as the baseline against which the target will be measured.

Table 4.2 Portfolio component descriptions

Portfolio Component	Abbreviation	Portfolio Component Description
Global Markets e-Commerce	PC1:GMC	The aim of this program is to build an electronic trading platform for Global Markets, which provides clients with research, pre-trade services, cross asset trading, pricing, risk management, liquidity distribution, and post-trade services. The rationale of the programme is for the bank to improve the global distribution of strategic products, facilitate business growth in less established markets, enhance cross-sell opportunities, and defend its existing franchise business.
Core Banking Transformation	PC2:CBT	The Core Banking Transformation Program (CBT) is a vital enabler of the company's vision. Supported by a *burning platform* (declining profitability, ageing systems), the CBT program will assist in the transformation of the company by building the next generation bank. This will be achieved through defining and implementing a new business and operating model while rolling out a new core banking application and retiring numerous legacy systems.
Enterprise Content Management	PC3:ECM	This component is focused on the electronic recording, storage, retrieval, and disposal of unstructured data and provision of workflow capability. Deliverables include: Retention Management, Imaging at Source, Document Workflow, Online Finger Print Verification, and Electronic Formal Statements.
Consumer Protection Act	PC4:CPA	The component's objective is to adjust policies, processes, procedures, and systems to comply with the CPA legislation, while at the same time ensuring the most positive outcomes for the business.
International Trade and Payments Solutions	PC5:ITAPS	The objective of this program is to provide a single integrated solution for Payments, International Trade Services, and non-structured Trade Finance. This solution will enable Global Transactional Products Services (GTPS) to provide clients with a global online channel to process payment and trade requests with straight through processing.
EQD Technology Platform Replacement	PC6:EQD	EQD is currently constrained from achieving its strategic objectives due to limitations in its technology platform. The unique software platform that has been deployed for EQD does not enable EQD to launch new products efficiently and in a cost effective manner. This platform constrains EQD from managing growing trade volumes, minimizing the cost of over borrowing for Stock Borrow facilities and reducing operational risk. From a technology perspective, the software system is unable to evolve and cannot be supported by the vendor. The proposed solution to these challenges is a technology platform replacement.

Table 4.3 Mapping of components to objectives

		Organizational Objectives				
		1	2	3	4	5
		Business Growth	Reduce the Cost of Operations in Retail Banking	Adhere to Compliance and Regulatory Requirements	Improve the Revenue Generation Capability	Regain Market Leadership in the Corporate Investment Banking Segment
Portfolio Components	PC1: GMC	A				
	PC2: CBT		B		C	
	PC3: ECM		D	E		
	PC4: CPA			F		
	PC5: ITAPS				G	
	PC6: EQD					H

Keeping client data and information electronically reduces the cost of operations by eliminating the cost associated with printing, storing, and retrieving paper-based client documentation.

Cell E: Component PC3 contributes to Objective 3 by addressing the requirements of the POPI (Protection of Personal Information) act with regard to the management of client information.

Cell F: Component PC4 contributes to Objective 3 by addressing the requirements of the Consumer Protection Act.

Cell G: Component PC5 contributes to Objective 4 by enabling increased volume of transactions thereby increasing revenue.

Cell H: Component PC6 contributes to Objective 5 by implementing a new software platform that will enable the business to offer new products efficiently and cost effectively, growing trade volumes, reducing risk, and minimizing cost of over borrowing for Stock Borrow facilities. This will lead to a gain in market share.

Now that the objectives and components have been described and a mapping of the relationships between components and objectives has been done, we can proceed with illustrating how the model would work.

Applying the Model

Application of the model is achieved through the following phases:

1. Set up.
2. Define the membership functions for the input and output variables.
3. Define the rules to be used in the rule engine.
4. Describe the evaluation criteria (input variables).
5. Evaluate each component's contribution to organizational objectives in terms of the chosen criteria.
6. Determine the individual contribution value for each portfolio component.
7. Determine the combined contribution of those components that jointly contribute to an objective.
8. Determine the total contribution of individual components to multiple objectives by aggregating the individual contributions.

Phase 1: Set up

The set up phase consists of two sub-phases. In the first sub-phase, the membership functions for the input and output variables are defined, while in the second sub-phase, the rules to be used in the rule engine are defined. This step is done once by the portfolio management team for the portfolio and was described in Chapter 2.

In preparation for using the model, the portfolio management team needs to define the rules in the rule engine. This team of people will have an understanding of the macro and micro environments, that is, (a) the organization, (b) its competitive, regulatory, and operational environment, and (c) the nature of its organizational objectives and projects and programs. These factors will enable them to define the rules in a way that will be appropriate for their organization. The variables that will be used to evaluate each component and the specific combinations of these variables and how they interact will influence the way in which the rules are defined. The portfolio management team will need to think carefully about how each variable relates to each other.

Phase 2—Describe the Evaluation Criteria (Input Variables)

For the purpose of illustration, the author has chosen to look at three input variables or criteria for evaluating portfolio components. The three criteria used are described as follows. At the end of each description, a table is provided that lists the possible evaluations and provides a guideline description for each evaluation.

PCVAR1: Input Variable 1 (Labeled as PCVar1 to Remain Consistent with the Description in Earlier Chapters)

PCVar1 represents *Value*. The value that a portfolio component is expected to deliver is an important criterion when determining the portfolio component's contribution. *Value* considers the decision maker's perception of how the component serves the organization's objectives in the long term with respect to its financial attractiveness, that is, the economic feasibility that is measured by the component cost, contribution to profitability, and contribution to growth. Table 4.4 describes the linguistic values—poor, average, and good—which are used in evaluating PCVAR1.

Table 4.4 Linguistic value descriptions for Value (PCVAR1)

Evaluation	Description
POOR	The expected contribution to profitability is less than 1% of total profit in a given year
AVERAGE	The expected contribution to profitability is from 1% to 2.5% of total profit in a given year
GOOD	The expected contribution to profitability is more than 2.5% of total profit in a given year

PCVAR2: Input Variable 2

PCVar2 represents longevity. Longevity refers to the length of time before the product (delivered by the component) needs to be enhanced. This is relevant for all types of products whether it has to do with innovation or compliance and regulation. The longer a product is expected to last without needing enhancements, the higher the component evaluation. Table 4.5 describes the linguistic values: low, medium, and high, which are used in evaluating PCVAR2.

Table 4.5 Linguistic value descriptions for Longevity (PCVAR2)

Evaluation	Description
LOW	The product has a lifespan less than 2 years
MEDIUM	The product has a lifespan from 2 to 4 years
HIGH	The product has a lifespan of more than 4 years

PCVAR3: Input Variable 3

PCVAR3 represents the probability of successfully implementing the portfolio component. This refers to the likelihood of success in delivering the product of the component fully. The contribution toward organizational objective achievement is higher if the probability of implementation success is high. This variable will take into account the ability of the component to respond positively in uncertain environments. Factors that could influence the probability of implementation success include dependency on other portfolio components, resource availability, organizational restructuring, changes in agreements with third parties, and changes in technology. Table 4.6 describes the linguistic values—low, medium, and high—that are used in evaluating PCVAR3.

Now that we have described the three input variables and how they would be evaluated, we can perform the qualitative evaluation of each input variable per component.

Table 4.6 Linguistic value descriptions for Probability of successful implementation (PCVAR3)

Evaluation	Description
LOW	The probability for successful implementation is less than 30%
MEDIUM	The probability for successful implementation is from 30% to 70%
HIGH	The probability for successful implementation is greater than 70%

Phase 3—Component Evaluation

The first step in this process is to evaluate each component in terms of the three variables. The portfolio management team will be accountable for evaluating each component. They may do this with the help of the business heads or the investment committee. Essentially, a committee will need to assess the components in the portfolio. Then with an understanding of the organizational objectives as well as the portfolio components and the overall strategy of the organization, they can make a consensus decision regarding the evaluation of each component.

Table 4.7 illustrates evaluations that have already been done for each component contributing to the various objectives in the system. In the figure, the input variables described earlier are represented as follows:

V = Value   L = Longevity   P = Probability of implementation success

When applying the model, these evaluations will form the input to the model. The next step would trigger the fuzzification process, which takes these qualitative inputs and determines the degree to which these

Table 4.7 Qualitative evaluations of portfolio components

	Business Growth			**Reduce the Cost of Operations in Retail Banking**			**Adhere to Compliance and Regulatory Requirements**			**Improve the Revenue Generation Capability**			**Regain Market Leadership in the Corporate Investment Banking Segment**		
Input variables	V	L	P	V	L	P	V	L	P	V	L	P	V	L	P
PC1: GMC	G	M	M												
PC2: CBT				A	H	H				G	M	H			
PC3: ECM				G	H	H	A	H	M						
PC4: CPA							P	M	H						
PC5: ITAPS										A	L	L			
PC6: EQD													P	M	M

Values used for evaluating each variable:
Value (PCVAR1): P = Poor; A = Average; G = Good.
Longevity (PCVAR2) and Probability for successful implementation (PCVAR3): L = Low; M = Medium; H = High.

inputs belong to each of the respective membership functions. In an organization, the portfolio management team would evaluate the input variables of a portfolio component and determine to what degree it is *poor*, *average*, or *good* (in the case of PCVar1) or *low*, *medium*, or *high* (in the case of PCVar2 and PCVar3).

Phase 4—Determine the Individual Contribution Value of Each Portfolio Component

In order to determine the individual contribution of each portfolio component to specific organizational objectives, the fuzzification process described earlier is followed by the application of rules defined in step 1, and the result (or output) is defuzzified to obtain a value (number) that represents the individual component contribution.

The crisp contribution values for each of the components in this illustration are shown in Table 4.8.

Phase 5—Determine Combined Contribution

To determine the combined contribution of components that jointly contribute to specific objectives, it is necessary to enter the criteria evaluations

Table 4.8 Individual contribution values

	Business Growth	Reduce the Cost of Operations in Retail Banking	Adhere to Compliance and Regulatory Requirements	Improve the Revenue Generation Capability	Regain Market Leadership in the Corporate Investment Banking Segment
PC1: GMC	0.500				
PC2: CBT		0.750		0.750	
PC3: ECM		0.815	0.500		
PC4: CPA			0.245		
PC5: ITAPS				0.375	
PC6: EQD					0.500

for the relevant components into the rule engine simultaneously. For example, to determine the combined contribution of components PC2 and PC3 to Objective 2, their evaluations are entered into the rule engine at the same time. As described in Chapter 2, this is to ensure no loss of information in the fuzzy logic system. The rules described earlier apply when determining the combined contribution of two components to the same objective.

The combined contribution of PC2 and PC3 to Objective 2, PC3 and PC4 to Objective 3, and PC2 and PC5 to Objective 4 are shown in Table 4.9.

Phase 6—Determine the Total Contribution of Individual Components to Multiple Objectives

The preceding phases illustrated the determination of individual and combined contributions of portfolio components to single objectives. In this section, we determine the total contribution of a single component to multiple objectives by adding the component's individual

Table 4.9 Combined contributions—all PCs and objectives

	Business Growth	Reduce the Cost of Operations in Retail Banking	Adhere to Compliance and Regulatory Requirements	Improve the Revenue Generation Capability	Regain Market Leadership in the Corporate Investment Banking Segment
PC1: GMC	0.500				
PC2: CBT		0.750		0.750	
PC3: ECM		0.815	0.500		
PC4: CPA			0.245		
PC5: ITAPS				0.375	
PC6: EQD					0.500
Combined Contribution	0.500	0.940	0.600	0.800	0.500

contributions to multiple objectives. For example, PC2 contributes to Objectives 2 and 4. The total contribution of PC2 to multiple objectives is equal to its contribution to Objective 2 (0.750) plus its contribution to Objective 4 (0.750), which is equal to 1.500. Similarly, the total contribution of PC3 to Objectives 2 and 3 is equal to its contribution to Objective 2 (0.815) plus its contribution to Objective 3 (0.500), which is equal to 1.315. The remaining portfolio components each contribute only to single objectives. This view of the total contribution of portfolio components to objectives is illustrated in Table 4.10.

There are now two perspectives to viewing the data in Table 4.10. Firstly, for each objective we have determined the combined contributions of the contributing components using additive aggregation and the bounded sum method described in Chapter 2. Secondly, for each component, we have determined individual contributions per objective and added these to give the total contributions of individual components to multiple objectives. The total individual component contributions allow us to determine a rank order of components. The ranking informs decision makers that the higher the rank of a component, the more significant

Table 4.10 Total contribution per component

	Business Growth	Reduce the Cost of Operations in Retail Banking	Adhere to Compliance and Regulatory Requirements	Improve the Revenue Generation Capability	Regain Market Leadership in the Corporate Investment Banking Segment	Total Individual Contribution
PC1: GMC	0.500					0.500
PC2: CBT		0.750		0.750		1. 500
PC3: ECM		0.815	0.500			1.315
PC4: CPA			0.245			0.245
PC5: ITAPS				0.375		0.375
PC6: EQD					0.500	0.500
Combined Contribution	0.500	0.940	0.600	0.800	0.500	

it is in terms of its contribution to the objectives. Whether a component contributes to one or many objectives, understanding its total contribution will prevent a scenario where a decision to terminate the component is made based on limited knowledge of its contribution.

The rank order of the components in Table 4.10 based on their total individual contributions is as follows:

1. PC2 with a contribution value = 1.500
2. PC3 with a contribution value = 1.315
3. PC1 with a contribution value = 0.500
4. PC6 with a contribution value = 0.500
5. PC5 with a contribution value = 0.375
6. PC4 with a contribution value = 0.245

The next section discusses a scenario illustrating the impact of terminating a portfolio component.

Scenario—What if a Portfolio Component Is Terminated?

The management of a portfolio entails decision making about the portfolio components. Managing the portfolio involves deciding on which components to stop, delay, or fast track. The model presented in this book is designed to enable better decision making with regard to the portfolio. The researcher illustrates this through means of a scenario.

To begin, let us establish the context for managing the portfolio. Managing the portfolio, in this context, is not concerned with the process of selecting components that an organization would exercise when setting up the portfolio. Instead, it is the management response to a change in the organization's environment that requires a change in the investment being made in portfolio components. The validity of the portfolio components is not questioned. It is assumed that the components in the portfolio have been selected based on criteria the organization uses for selecting components. It is also based on an investment management process that ensures each component is supported by a business case that has been validated in terms of the alignment to organizational objectives and achievement of financial and other measures.

The recent global economic crisis has caused many organizations to critically evaluate their investment in projects and programs (portfolio components). As a result, budget constraint has become a key environmental factor that has caused investment committees to re-evaluate their portfolios with a view to optimizing them. This leads to the consideration of portfolio components as participants for termination to free up resources (human and financial) for use on components that make a higher contribution toward the achievement of organizational objectives.

When considering portfolio components for termination, stopping, or delaying, investment committees in Company A ask the following questions:

- How much have we invested in the component thus far and is the cost justified? This refers to the concept of *sunk cost* and the organization must evaluate whether continuing the project will help the organization regain the sunk cost, or whether it should walk away from the incomplete component (project or program).
- What percentage of the total cost of the portfolio component is required to complete the component?
- If the portfolio component has not commenced, can it be delayed to the next financial year?
- If the portfolio component is in progress but the actual rate of spend (burn rate) is lower than planned due to insufficient resources, can the component be stopped or delayed until resources are available?
- What has the portfolio component delivered to date and can the remaining deliverables be deferred to the new financial year?

An analysis of the preceding questions reveals that the focus is on what portfolio components can be salvaged rather than on which components should be completed to get the highest contribution toward achieving the organizational objectives.

Let us assume that due to budget cuts, the portfolio investment committee chooses to terminate one of the portfolio components. Table 4.11

Table 4.11 Components identified for possible termination

#	Portfolio Component	Reason for terminating the portfolio component
1	PC1 (GMC)	The portfolio component has been identified for termination due to the continuous technical problems experienced by the project
2	PC3 (ECM)	The portfolio component has a low probability of success and should therefore be considered for termination
3	PC5 (ITAPS)	The portfolio component can be terminated as the cost to implementation exceeds planned budget significantly

shows three possible components for termination as well as the plausible reasons for terminating each component. The portfolio investment committee will consider these reasons, and through a process of discussion and consensus, decide on one of the components to terminate.

None of the reasons given in Table 4.11 consider the degree of contribution toward achieving organizational objectives. Making a decision based purely on the preceding considerations will affect the level of success the organization has in achieving its objectives. The impact of terminating any of the three portfolio components will be illustrated in the following diagrams using the results from applying the model presented in this book. Table 4.12 shows the contribution of the portfolio components before the decision is made while Table 4.13 shows the contributions of the portfolio components after the decision to terminate the portfolio components.

Terminating PC1 would mean that no contribution is made toward the achievement of Objective 1 (business growth), as PC1 is the only component identified toward achieving Objective 1.

Terminating PC3 would result in the rules for determining the contribution to Objective 2 (reduce the cost of operations in retail banking) *only* being applied to PC2 (CBT Program). The rules for determining the contribution of PC3 will not be considered.

Removing PC3 also impacts Objective 3 (adhere to compliance and regulatory requirements). For Objective 3, only PC4 is considered when determining the contribution toward achieving the objective. The result of removing PC3 is that Objective 3 is achieved to a degree of 0.245 and Objective 2 is achieved to a degree of 0.750.

Table 4.12 Combined contributions before PCs are terminated

	Business Growth	Reduce the Cost of Operations in Retail Banking	Adhere to Compliance and Regulatory Requirements	Improve the Revenue Generation Capability	Regain Market Leadership in the Corporate Investment Banking Segment
PC1: GMC	0.500				
PC2: CBT		0.750		0.750	
PC3: ECM		0.815	0.500		
PC4: CPA			0.245		
PC5: ITAPS				0.375	
PC6: EDQ					0.500
Combined Contribution	0.500	0.940	0.600	0.800	0.500

Similarly, terminating PC5 will result in the rules being applied to PC2 in terms of its contribution to Objective 4 (improve the revenue generation capability).

The impacts of terminating PC1, PC3, or PC5 are illustrated in Table 4.13, which shows the comparative contribution before and after the components have been terminated.

Observations

Terminating PC1 results in no advancement toward achieving Objective 1 as PC1 was the only component identified to achieve Objective 1. The degree of change as a result of terminating PC1 is equal to (0.500 – 0.000 = 0.500), that is, the *original contribution* minus the *resultant contribution* after the component has been terminated is equal to the *degree of change*.

The degree of change in the combined contribution of PC2 and PC3, as a result of terminating PC3, to *Objective 2* is equal to (0.940 – 0.750 = 0.190), while the degree of change in the combined contribution

Table 4.13 Comparative contributions before and after components have been terminated

	Business Growth		Reduce the Cost of Operations in Retail Banking		Adhere to Compliance and Regulatory Requirements		Improve the Revenue Generation Capability		Regain Market Leadership in the Corporate Investment Banking Segment	
	Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
PC1: GMC	0.500									
PC2: CBT			0.750	0.750			0.750	0.750		
PC3: ECM			0.815		0.500					
PC4: CPA					0.245	0.245				
PC5: ITAPS							0.375			
PC6: EQD									0.500	0.500
Combined Contribution	0.500	0.000	0.940	0.750	0.600	0.245	0.800	0.750	0.500	0.500

of PC3 and PC4 to *Objective 3* is equal to (0.600 – 0.245 = 0.355). By terminating PC3, the combined degree of change in the contribution of PC3 to this set of objectives is equal to (0.190 + 0.355 = 0.545).

With regard to PC5, terminating this component results in a change in total contribution to Objective 4 (improve the revenue generation capability) of 0.050 (i.e., 0.800 – 0.750 = 0.050). Terminating this component has a significantly lower impact to the achievement of the objectives than terminating PC1 or PC3.

The portfolio investment committee would want to terminate the component that would result in the smallest impact to the achievement of the objectives. Based on the observations noted earlier, and the expectation that only one of the three components needs to be terminated, PC5 would be the naturally selected component for termination as terminating this component results in the smallest impact (0.05) to the achievement of the organizational objectives.

Representing the Data Using Dashboards

Executive management in organizations make performance management decisions based on critical data and information presented in the form of dashboards, also referred to as scorecards or report cards. Management decisions often consider multiple criteria and large amounts of data. PfM decision making is especially challenging due to its complex and dynamic nature. Due to cognitive limitations of human decision makers, visual techniques can be used to compensate and improve the decision making capability.[3] Dashboards present information regarding key performance indicators that management analyzes and makes decisions based on their analysis. The dashboard used here is an aid to show the results from running multiple scenarios providing information to the portfolio investment committee that enables better informed decision making regarding the management of the portfolio. By illustrating the scenarios and the results graphically, it adds to the understanding of what is going on in the portfolio. A graphic illustration makes comparisons clearer as it considers a number of dimensions simultaneously. The graphical representation of data is also easier and faster to process than textually based representation of data.

For the purpose of this illustration, the gauge chart was chosen as a way of representing the degree of achievement of organizational objectives. Gauge charts are well suited to showing the degree to which an objective is achieved as the point at which the needle rests illustrates how much of the objective is achieved. On a gauge chart, the value for each needle is read against the shaded data range or chart axis. (Note: In a color diagram, the shaded regions will likely be red, amber, and green). Gauge charts are useful for comparing values between a small number of variables either by using multiple needles on the same gauge or by using multiple gauges. The shaded data range resembles the fuzzy logic concept of looking at the data in terms of ranges rather than purely static values. Figure 4.2 illustrates how the degree of achievement of Objective 2 (which has a value of 0.940) is represented with the needle pointing close to the end of the white region.

The black, gray, and white regions that appear in the gauge partition the range of values into three segments. These regions provide further information to decision makers. If the needle points anywhere in the *white* segment, it means that the achievement of the objective is in a positive range. In other words, even though the objective is not being fully achieved, the degree of achievement is more than satisfactory.

If the needle points anywhere in the *gray* segment, it means that the achievement of the objective is in a warning range. The objective is only moderately achieved and the portfolio investment committee would want to consider enhancing the scope of the component(s) or identifying additional components that would contribute to the objective.

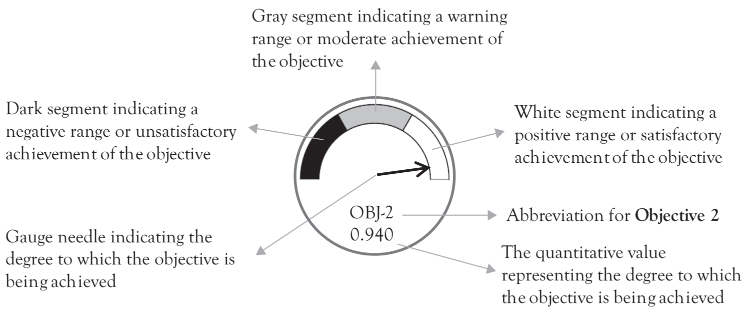


Figure 4.2 Sample gauge diagram

If the needle points anywhere in the *black* segment, it means that the achievement of the objective is in a negative range. The achievement of the objective is unsatisfactory and much more focus needs to be given to identify additional components that would contribute to the objective. A sample dashboard is illustrated in Figure 4.3, which shows the gauge charts for each of the objectives as well as supporting information. Each section is described as follows:

Section A: In this section, the organizational objectives including the measures and targets are described.

Section B: Here the portfolio components contributing to the organizational objectives are described.

Section C: The mapping of portfolio components to objectives is illustrated in this section. The individual component contributions, as well as the combined component contributions per objective, are listed.

Section D: The gauge charts represent the degree to which each objective is achieved. Each gauge represents a different objective and the needle (arrow) indicates the degree to which the objective is achieved.

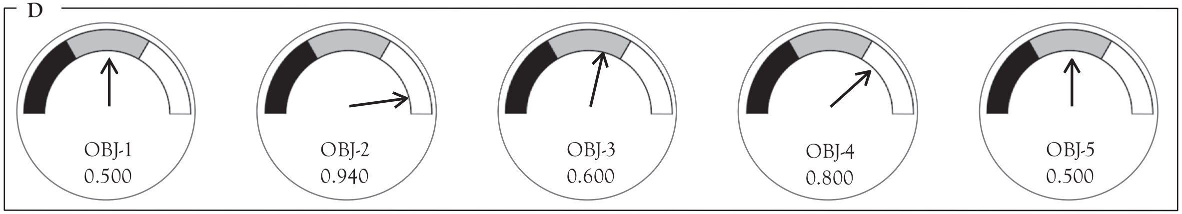
With reference to the *What-If* scenarios in the previous section, we can use gauge charts to illustrate the scenarios. Figures 4.4 through 4.6 show the original position of the degree of achievement of each of the objectives before terminating any component. This is represented by the black arrows (needles) in each of the gauge charts in these figures. The same gauge charts also show what the position would be if any of the selected components were terminated. This is shown such that the needle (arrow) in the gauge chart of the impacted objective appears as a dotted arrow and in a different color. By illustrating both positions on the same gauge chart, it is possible to show what the difference would be after an associated component is terminated.

Figures 4.4 through 4.6 show that:

The black arrows represent the original position before any of the three components are considered for termination.

PORTFOLIO COMPONENT CONTRIBUTION TO OBJECTIVES

D



C

Mapping of components to objectives

	Business growth	Reduce the cost of operations in retail banking	Adhere to compliance and regulatory requirements	Improve the revenue generation capability	Regain market leadership in the corporate investment banking segment
PC1: GMC	0.500				
PC2: CBT		0.750		0.750	
PC3: ECM		0.815	0.500		
PC4: CPA			0.245		
PC5: ITAPS				0.375	
PC6: EQD					0.500
COMBINED CONTRIBUTION	0.500	0.940	0.600	0.800	0.500

A

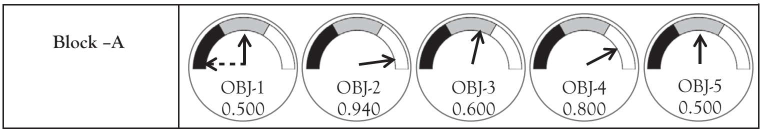
#	Objective	Description	Measure	Target
1	Business growth	The bank's vision includes the expansion of its operations (presence) into new global markets	Growth	550 branches, 2.6 million Customers and 3.1 million active accounts across the rest of Africa in the next financial year.
2	Reduce the cost of operations in retail banking	Owing to declining profits and a global financial crisis, it is necessary to focus on reducing costs over the short to medium term to maintain shareholder value.	Cost	Reduce costs by 20% over 3 years

B

Portfolio component	Abbreviation	Portfolio component description
Global markets e-commerce	PC1:GMC	The aim of this programme is to... The rationale of the programme is for the bank to improve global distribution of strategic products, ...
Core banking transformation	PC2:CBT	The Core Banking Transformation Programme (CBT) is a vital enabler of the company's vision. Supported by a "burning platform", the CBT programme will assist in the transformation of the company by building the next generation bank. This will be achieved through defining and implementing a new business and operating model while rolling out a new core banking application, and retiring numerous legacy systems

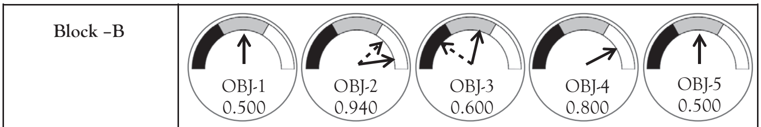
Figure 4.3 Sample dashboard

Note: The sample dashboard is for illustrative purposes only.



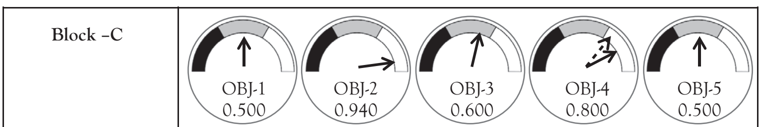
Original contribution	0.500	0.940	0.600	0.800	0.500
After terminating PC1	*0.000*	0.940	0.600	0.800	0.500

Figure 4.4 Gauge chart showing the original and new objective achievement positions after terminating PC1



Original contribution	0.500	0.940	0.600	0.800	0.500
After terminating PC3	0.500	*0.750*	*0.250*	0.800	0.500

Figure 4.5 Gauge chart showing the original and new objective achievement positions after terminating PC3



Original contribution	0.500	0.940	0.600	0.800	0.500
After terminating PC5	0.500	0.940	0.600	*0.750*	0.500

Figure 4.6 Gauge chart showing the original and new objective achievement positions after terminating PC5

The dotted arrow indicates the position if PC1 is terminated (Figure 4.4). The difference between the solid and dotted arrow visually illustrates the impact on the achievement of Objective 1.

The dotted arrow in Figure 4.5 indicates the impact of terminating PC3 on Objectives 2 and 3.

The dotted arrow in Figure 4.6 indicates the impact of terminating PC5 on Objective 4.

Furthermore, the new projected contribution values are presented against each scenario below the gauge charts to show quantitatively the expected impact on each objective of terminating the different portfolio components.

It can be seen in the preceding Figures 4.4 through 4.6 that Objectives 1, 2, 3, or 4 would be impacted if the selected components were terminated. The secondary arrow in each of the respective gauge charts as well as the new contribution values in italic font in the rows below the gauge charts illustrate this. For Objective 1, the dotted arrow (needle) points to the zero position to indicate that terminating the component (PC1) contributing to this objective will result in zero contribution to Objective 1 (Figure 4.4). Terminating PC3 would impact Objectives 2 and 3. It can be seen from Figure 4.5 that the degree of change in achieving Objective 3 is bigger than the degree of change in achieving Objective 2. Importantly, however, the termination of PC3 impacts two objectives and the cumulative impact would be greater than terminating PC1. The termination of PC5 will result in a small impact to Objective 4. The dotted arrow in the gauge chart illustrates this for Objective 4 in Figure 4.6.

The portfolio investment committee can now monitor the achievement of the objectives and establish the impact a change in circumstances has on the achievement of the objectives. The model enables the portfolio investment committee to make better decisions about the termination of components such that their impact is minimized on organizational objectives.

Scenario—What If a Portfolio Component Is Fast-Tracked?

The previous section focused attention to the impact of terminating portfolio components on the achievement of organizational objectives. Portfolio decision making, however, must also consider the possibility of fast-tracking (expediting or speeding up delivery of) a portfolio component. In this scenario, the extent to which an objective is achieved does not change, as we are not removing or adding portfolio components. The decision to fast-track portfolio components is driven by the ranked importance of the organizational objectives. If the organization wants to place emphasis on achieving a specific objective due to changes in the market or competition, knowing which components contribute to the objective and the extent to which they contribute will enable decision makers to fast-track the relevant portfolio components and, where necessary, initiate new components to close any gaps in achieving the strategy. By means of an illustration, if we refer to Figure 4.3 and nominate Objective 4 as an objective that must be achieved early, then the components that must be fast-tracked are PC2 and PC5. The gauge chart also indicates that there is still a gap in achieving the objective fully, implying that one or more components can be initiated to close this gap.

Benefit of Using This Model

The scenarios illustrate that without a way of determining portfolio component contributions to organizational objectives, it would be quite easy for the portfolio investment committee to terminate a component that makes a significant contribution to organizational objectives while other components, which make a smaller contribution, survive. Similarly, without a clear understanding of the rank order or weighting of objectives, the wrong components can be fast-tracked, drawing resources and attention away from those that do need to be fast-tracked. The model provides decision makers quantitative information, based on their qualitative evaluation of portfolio component contribution to organizational objectives that enable them to make decisions related to managing the portfolio. The portfolio investment committee can now decide with confidence as to which components to terminate or fast-track. This action would ensure that the organization makes the right decisions regarding its investments in portfolio components as they relate to achieving the organization's objectives.

The model aids decision making by focusing on component contribution. This enables decision makers to choose components for termination with the lowest contribution to organizational objectives, thereby minimizing the impact on the achievement of those objectives. It is acknowledged that this is one of the few considerations that decision makers would take into account when optimizing the portfolio.

Conclusion

This chapter looked at the illustration of the model described earlier in Chapter 2. A participant organization was used to provide information regarding their organizational objectives and portfolio components, which were used in this process. The organizational context was described to provide background for the objectives and portfolio components chosen.

The objective of this chapter was to demonstrate consistency and accuracy in the model by using the information from the participant organization. The illustration of how the model would work included (a) evaluating each component, (b) determining the individual contribution of each component to the relevant objectives, (c) determining the combined contribution of those components that jointly contribute to specific objectives, and also (d) determining the total contribution of individual components to multiple objectives.

In addition, *what-if* scenarios, including the use of gauge charts to graphically represent the data, were presented. The scenarios illustrated how the impact of decisions regarding portfolio components can be quantified, thereby enabling decision makers to get an insight into their decisions before committing them and thus ensuring better informed decision making.

CHAPTER 5
Conclusion

Introduction

While the concept of PfM (project portfolio management) is understandable due to its association with, and application of, concepts in the financial portfolio management discipline, as well as its relatedness to theories such as Modern Portfolio, Multi-Criteria Utility, Organizational, Systems, and Complexity (refer to Appendix 1), the practical application of PfM still had gaps and lacked consistency. This was evident from an investigation into the practice of PfM, which lead to the development of the model presented in Chapter 2, an extension of the model in Chapter 3, and an illustration of how the model would work.

In managing a project portfolio, an understanding of both the individual and cumulative contribution of portfolio components to organizational objectives and the likely impact of such decisions on the achievement of these objectives is important in decision making. Without this understanding the decisions regarding whether to stop, progress, or terminate portfolio components will be poor.

Such decisions tend to be based on the subjective defense of a few decision makers. This means that even if the right components are chosen upfront, there is a lack of confidence that these components remain closely aligned to organizational objectives and continues to offer the best return in benefits. Nevertheless, these components tend to be continued and supported during the PfM process. This is a fundamental issue to the success of PfM in an organization. Subjective decision making with a lack of understanding the extent to which portfolio components contribute to organizational objectives could result in the wrong components being progressed and negates the fundamental philosophy of PfM, which is to obtain the maximum return on investment. This inspired the idea to develop a model that would minimize the subjectivity in decision making so that (a) the components that have a higher contribution to organizational objectives could be progressed, (b) the cumulative contribution of components to organizational objectives is understood, (c) the degree to which objectives are being achieved is understood, and that (d) the maximum benefits of the portfolio can be achieved.

The model presented in Chapter 2 allows for the qualitative evaluation of components at any stage during the course of managing the portfolio and converts the qualitative evaluations into quantitative values for comparison. The model caters for the fact that there will always be some element of subjectivity involved as long as the human element is part of the evaluation. This cannot be removed completely. Further, while other approaches look at the individual component, this model considers the reality of multiple components contributing to one or more organizational objectives.

Chapter 3 introduced an extension (an additional perspective) to the model. While Chapter 2 focused on the contribution of *multiple components* to individual objectives, Chapter 3 discussed the contribution of *individual portfolio components* to multiple organizational objectives. This was to cater for the fact that decision makers may want to consider the alternative perspective of the component-to-objective relationship—namely, the number of additional objectives to which a single portfolio component contributes. The idea of assigning a weighting to objectives was also introduced in this chapter. Weighting objectives affect the relative importance of portfolio components. Components contributing to more highly weighted objectives imply that the impact of the contribution of those components—and the decisions related to those components—becomes more significant. This information influences the decision making regarding which components to accelerate, suspend, or terminate. This chapter also illustrated that the fundamental concepts used in developing the conceptual model could be used in alternate ways.

Chapter 4 looked at the illustration of how the model would work using actual portfolio components and organizational objectives from a participating organization. The chapter began by providing an organizational context related to the participating organization, as well as information regarding the organizational objectives and portfolio components selected for illustrative purposes. The illustration of the model in this chapter showed the mechanics of the model and confirmed how the impact of decisions regarding portfolio components can be quantified. A *what-if* scenario regarding the termination of a portfolio component was described, observations from the scenario were outlined, the use of a dashboard and gauge charts as a visualization technique for decision making was illustrated, and the benefit of using the model was discussed. The scenario illustrated that without a way of determining portfolio component contributions to organizational objectives, the potential for poor portfolio decision making exists.

Contribution to the Body of Knowledge

This book contributes to the body of knowledge of PfM and is beneficial to organizations in the following ways.

Firstly, the model provides a benefit for good governance when it comes to the decision making around portfolio components and their alignment to objectives. It reduces the subjective, gut-feel decision making that presently exists in organizations and offers an objective view on organizationally aligned components. This is important for compliance with a country's corporate governance requirements.

Secondly, this book provides a better understanding of the complex relationship between portfolio components and organizational objectives. It clarifies that we need to move beyond the common phrase in the project management discipline of "aligning projects to strategy," which at present is ambiguous. Rather, *portfolio components* (which comprise projects, programs, and operational activities) must be aligned to *organizational objectives* of the organization. Understanding this relationship will improve the operation of PfM in organizations.

Thirdly, existing knowledge (in the form of Fuzzy Logic) is used in a new way. A combined fuzzy model was developed and applied to PfM decision making. A number of studies have previously focused on project selection strategies when setting up the portfolio. Methods such as Analytical Hierarchy Process (AHP),[1] scoring models, matrices, and pairwise comparison are among the approaches used. These are quantitative in nature and the drawback of using such approaches is that decision makers tend to have vague perceptions, rather than clear knowledge expressed as exact numerical values when evaluating portfolio components. Fuzzy logic, however, is able to deal with the vague and qualitative nature of evaluating portfolio components using multiple criteria.

Fourthly, a mechanism for improving decision making in PfM is presented. Decision makers are now able to determine the individual and cumulative contribution of portfolio components to organizational objectives and, through the use of dashboards, can run alternative scenarios to test the impact of their decisions before committing them.

Fifthly, it is illustrated how established theories can be related to PfM (Appendix 1). At the time of writing this book, evidence of scientific research describing the relationship between established theories and PfM, to the extent of what was described here, did not exist.

This book thus makes important contributions to the PfM body of knowledge, Fuzzy Logic application in new domains, organizational governance, and management decision making.

Personal Reflection

The body of knowledge around PfM is growing rapidly. During the course of developing this book (from conception to completion), the Project Management Institute (PMI) alone delivered three editions of *The Standard for Portfolio Management*—the third edition being a substantial improvement on the second (Project Management Institute 2013). Worldwide, research in this discipline is increasing. This can be seen from the increase in papers presented at the PMI research and education conferences, for example.

The implementation of PfM in an organization is a major change initiative in its own right and as such will require a concerted effort over an extended period of time to embed in an organization. PfM must be seen as a means to address compliance and governance requirements and not just a *nice-to-have* idea. The level of understanding of PfM at an executive level needs to be improved by offering PfM as a module in postgraduate studies such as MBAs and executive management development programs.

The ability to make the right decisions in the PfM process remains a challenge. The model provides important information to decision makers, but the responsibility for decisions still lies with management (portfolio investment committee). This is still problematic because different people have different approaches on to how they make decisions. In addition, the vision, mission, and values of an organization further influence the decision-making process.

The model presented in this book assumes that the strategy definition and translation processes have been conducted correctly. The strategy definition process identifies the organizational objectives that must be achieved over a period of time to move the organization forward. The strategy translation process identifies the portfolio components that must be executed to deliver the organizational objectives. The model presented here takes the outputs of these processes as inputs into the model. The model will not address any flaws in the strategy definition or translation process.

For portfolio management to be effective, a proper decision-making process aligned to organizational objectives needs to be in place. This model empowers decision makers to make the right decisions, thereby ensuring the organization achieves the maximum benefit from its investment in their portfolio of projects.

APPENDIX 1

Related Theories

Introduction

Part of this appendix was presented as a paper at the Project Management Institute (PMI) Research Conference in Portland, USA.[1]

Portfolio management (PfM) is an allied discipline of project management and can be contextualized through an understanding of the following established theories: (a) Modern Portfolio Theory (MPT), (b) Organizational Theory, (c) Systems Theory, (d) Multicriteria Utility Theory (MCUT), and (e) Complexity Theory. The relationship between these theories and PfM are discussed in this appendix.

PfM is not a self-standing theory but is a relatively young discipline compared to project management. The concepts and definition of PfM need to be fully understood and considered in light of these various established theories referred to earlier.

The goal of this appendix is to provide the context for PfM based on research and is achieved by confirming the definition for PfM and by discussing the theories identified, as part of the research, and illustrating their relevance to PfM. The literature pertaining to PfM as well as the related theories is reviewed and the theoretical background and analysis of the theories are presented.

The remainder of this chapter explores a definition for PfM and reviews the literature on the theories identified earlier. The appendix concludes with a summary and illustration of the interrelationship of the theories with PfM.

PfM Definition

In this section, a definition of PfM from various sources is presented. Key phrases that provide commonality among the definitions have been italicized. A diagram, which encapsulates the key ideas from the definition of

PfM, is then presented at the end of this section, followed by an elaboration of the key elements.

Jiang and Klein identified PfM as a discipline under the broader categorization of IS (Information Systems) planning, which assists organizations in executing business plans and *realizing business goals.*[2]

Cooper, Edgett, and Kleinschmidt defined PfM as

> a dynamic decision making process whereby, a *business's list of active new products and projects is constantly updated and revised*; *new projects are evaluated, selected, and prioritized*; *existing projects are accelerated, terminated, or de-prioritized*; and *resources are allocated and re-allocated to the active projects*.[3]

The META Group defined the management of the IT (information technology) portfolio as the management of a

> set of assets (hardware, software, human capital, processes, and projects), *mapped to investment strategies* (based on risk tolerance and business goals), according to an optimal mix (the percentage or range of investment made in each business area), based on assumptions about future performance (strategic and tactical growth expectations of the business), to maximize the value/risk trade-offs (ensuring that the selected IT investments provide the desired level of business value for the cost and risk involved) in *optimizing the organization's return on IT investment.* (emphasis added)[4]

The META Group's definition considered the broader aspects of IT beyond just projects, but the essence of PfM was maintained in the definition.

Leliveld and Jeffery defined PfM as "the combination of tools and methods used to measure, control and increase the *return on both individual IT investments* and aggregate enterprise level." They also defined a portfolio as "including all direct and indirect IT projects and assets, including components such as infrastructure, outsourcing contracts and software licenses."[5]

Maizlish and Handler defined PfM as a combination of people, processes, and corresponding information and technology that sensed and responded to change by: (a) *reprioritizing and rebalancing* investments and assets, (b) *cataloguing* a value-based risk assessment of existing assets, (c) *eliminating redundancies* while maximizing reuse, (d) *scheduling resources* optimally, and (e) *monitoring and measuring* project plans from development through post-implementation and disposal.[6]

Levine stated that PfM was "the bridge between traditional operations management and project management." He defined PfM as "the management of the project portfolio so as to maximize the *contribution of projects* to the overall welfare and *success of the enterprise.*"[7]

The PMI defined PfM as the centralized or coordinated management of one or more portfolios, which included *identifying, prioritizing, authorizing, managing, and controlling* projects, programs, and other related work, to *achieve specific strategic business objectives*. They recognized that "portfolio management produces valuable information to support or alter organizational strategies and investment decisions"[8] and allowed decision making that controlled the direction of portfolio components as they achieved specific outcomes. They added that *resources are allocated* according to organizational priorities and are managed to *achieve the identified benefits*. They further elaborated that: "the organizational strategy is a result of the strategic planning cycle, where the vision and mission are *translated* into a strategic plan"[9] and that:

> Portfolio Management, through the alignment of the strategic planning establishes the portfolios required to achieve organizational strategy and objectives and performance goals. Management of authorized programs and projects and management of ongoing operations are required to execute portfolios consisting of programs, projects and operations activities to *realize the organizational strategy and objectives*.[10]

The management of the portfolio requires that the *alignment between objectives and portfolio components be maintained*. A change in circumstances (external or internal) could result in a change in the portfolio mix. *The Standard* (3rd edition) describes this process as *optimize portfolio* and describes this process as "evaluating the portfolio based on the organization's selection criteria, … creating the portfolio component mix with the greatest potential to support the organizational strategy."

The key phrases from the preceding definitions that describe PfM and its impact are summarized as follows:

- *The* translation *of strategy and objectives (organizational objectives) into projects, programs, and operations (identification, prioritization, authorization of portfolio components).*
- *The* allocation of resources *to portfolio components according to organizational priorities.*
- *Maintaining the portfolio alignment requires each component being* aligned to one or more organizational objectives *and the* extent to which the components support the achievement of the objectives *(i.e., the degree of contribution) must be understood.*
- *The portfolio components are managed and controlled in order to* achieve organizational objectives and benefits.

Figure A.1 is an adaptation of the organizational context for PfM from the 3rd edition of *The Standard for Portfolio Management*. It illustrates the key aspects from the PfM definitions described earlier.

From the diagram, the arrows numbered 1–4 illustrate key aspects from the definition of PfM presented earlier. They refer to the following:

- *Arrow* (🡻) *refers to the translation of organizational objectives into portfolio components. This entails an evaluation of the organizational objectives with the intention of identifying, prioritizing, and authorizing portfolio components that will contribute to the achievement of the organizational objectives.*
- *Arrow* (⇧) *refers to the allocation of resources to prioritized components. Once a prioritized list of components has been determined, resources can be allocated to these components to ensure they are not allocated to less or unimportant components.*
- *Arrow* (⇕) *refers to the evaluation of portfolio components in terms of their individual and cumulative contribution to organizational objectives. An understanding of the individual*

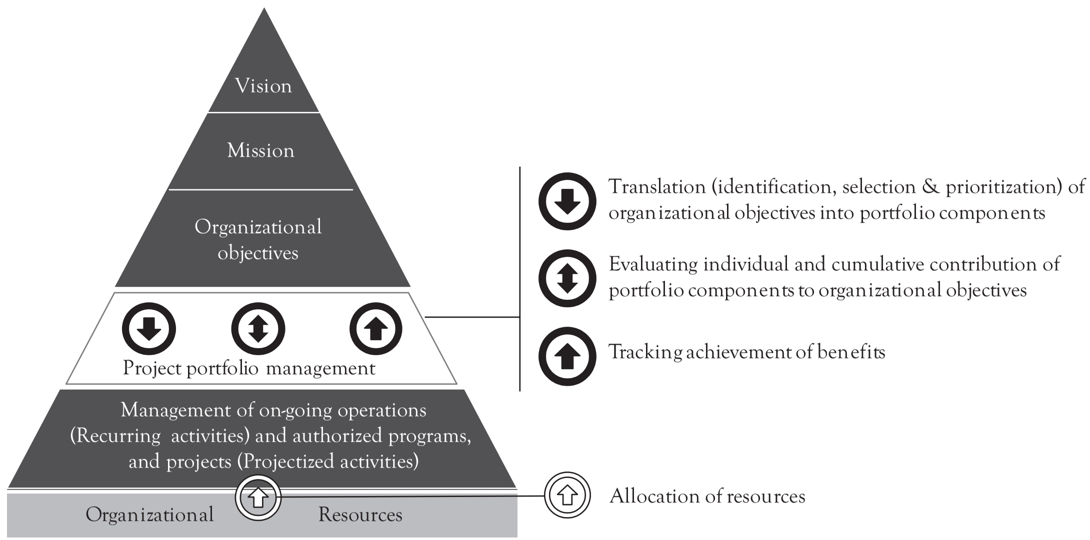


Figure A.1 PfM Depiction

Source: Adapted from Enoch and Labuschagne.[11]

and cumulative contribution of portfolio components to organizational objectives will ensure that the right decisions are made about which components to accelerate, suspend, or terminate. The process to determine the individual and cumulative contribution *of portfolio components was addressed in Chapter 2.*

- *Arrow* (🡅) *refers to tracking the achievement of benefits. This is a key aspect of PfM as it confirms the return on the investment made in executing the selected portfolio components.*

Now that the definition has been expounded, the following sections examine the relevance of various theories that relate to PfM and the representation of the PfM definition in Figure A.1 will be extended to incorporate these theories.

Modern Portfolio Theory

Background

In the early 1950s, Harry Markowitz began developing his theories on modern portfolio theory (MPT).[12] In "applying the concepts of variance and co-variance, Markowitz showed that a diversified portfolio of financial assets could be optimized to deliver the maximum return for a given level of risk."[13] In 1990, Markowitz was awarded the Nobel Prize in economics for his work in portfolio theory and he is now referred to as the *father of modern portfolio theory*.

Markowitz gives credit to A.D. Roy for his contribution to MPT.

> Roy also proposed making choices on the basis of mean and variance of the portfolio as a whole. He proposed choosing the portfolio that maximized a portfolio $(E - d)/\sigma$, where d is a fixed disastrous return and σ is standard deviation of return. Roy's formula for the variance of the portfolio included the co-variances of returns among securities.[14]

The main differences between Roy's analysis and Markowitz' analysis are that Markowitz required nonnegative investments whereas Roy's allowed the amount invested in any security to be positive or negative.

Markowitz also proposed allowing the investor to choose a desired portfolio from the efficient mean-variance combinations whereas Roy recommended choice of a specific portfolio.

In essence, the work by Markowitz provided the concepts and foundation for subsequent studies—even in non-financial fields. For example, in 1981, the *Harvard Business Review* published an article by McFarlan, which argued that the fundamentals of MPT could be applied to corporate technology assets. He identified deficiencies with IS projects from personal experience in the 10 years prior to his article. These he summarized as having to do with "a failure to assess individual project risk and the failure to consider the aggregate risk of the portfolio of projects."[15] He pointed out that the systematic analysis of risks at the portfolio level reduces the number of failures and helps in communication between IS managers and senior executives toward reaching agreement on risks to be taken in line with corporate goals.

Further, McFarlan suggested that the selection of projects based on the risk profile of the portfolio could reduce the risk exposure to the organization. However, McFarlan does not go into any detail regarding the PfM methodology, approach, or definition but merely introduces the concept of PfM from a perspective of risk management. Nevertheless, the application of portfolio theory in a new field, specifically IT, has resulted in further study toward developing methods and standards for applying portfolio theory to PfM.

Verhoef, however, felt that MPT does not work for IT. According to Verhoef, IT investments are illiquid, that is, they cannot be readily converted into cash.[16] Liquidity is a necessary assumption for applying MPT. Nevertheless, trade articles such as that by Berinato[17] and Ross[18] recognized that the process of managing IT projects using a financial investment portfolio metaphor has attracted much interest from CIOs (Chief Information Officers) in Fortune 1000 companies. Goff and Teach referred to a Meta Group survey done that year which found that more than half of the 219 IT professionals surveyed had either implemented or planned to implement some aspect of portfolio theory by the end of 2004.[19]

Subsequently, Kersten and Ozdemir presented results of the application of Markowitz's MPT on a product portfolio of an IT company. They concluded that "with the mean variance theory constructed by

Markowitz, the management of a product portfolio can be improved."[20] Their results showed "a considerable decrease in risk, while maintaining the same return. Even with constraints applied on the portfolio and its products, the optimal portfolios performed far better." They added that "the mean variance theory has proved its worthiness for an IT-product portfolio" and that "by evaluating returns achieved in the past, portfolio selection is possible." While they acknowledged that their model was not predictive as it only diversified the portfolio by looking at the results of the past, the results gave insight to the executive board of their case study about which direction to adjust the portfolio. They concluded that the application of MPT to domains other than for which it was originally developed yielded interesting results and confirmed that their study introduced a quantitative approach to product portfolios and IT portfolios.

MPT is relevant as it provides a financial investment metaphor that can be applied to PfM. Projects, programs, and operational initiatives can be viewed as investments that must be aligned to organizational goals. The project portfolio mix should be balanced in terms of risk exposure and investment returns. To understand the full impact of decisions regarding individual portfolio components, the aggregate must be considered, as opposed to the singular projects, programs, and operational initiatives.

The next section discusses the Multi-Criteria Utility Theory (MCUT) and how it is used to evaluate projects for the purpose of selection.

Multi-Criteria Utility Theory

Background

According to Stewart and Mohamed, many organizations approach the management of technology in an unstructured manner throughout the system's life cycle, thus making it difficult to compare IT/IS projects of different size or organizational impact. In addition, they stated that organizations adopting limited selection criteria lack confidence that their IT/IS projects will meet the organizational goals and objectives.[21]

MCUT considers the decision maker's preferences in the form of utility function, which is defined over a set of criteria.[22] Utility is a measure of desirability or satisfaction and provides a uniform scale to compare tangible and intangible criteria.[23] A utility function quantifies the preferences of a decision maker by assigning a numerical index to varying levels of satisfaction of a criterion.[24]

Stewart and Mohamed state that decisions typically involve choosing one or a few alternatives from a list of several with each alternative assessed for desirability on a number of scored criteria. The utility function connects the criteria scores with desirability. According to Stewart and Mohamed, the most common formulation of a multi-criteria utility function was the additive model.[25] To determine the overall utility function for any alternative, a decision maker needs to determine the total number of criteria one-dimensional utility functions for that alternative. MCUT generally combines the main advantages of simple scoring techniques and optimization models.

According to Stewart and Mohamed, business unit managers typically proposed projects they wished to implement in the upcoming financial year. These projects were supported by business cases in which costs were detailed. As cost is only one criterion related to project selection, other criteria would be based on business value, risk, organization needs that the project proposes to meet, and also other benefits to the organization like product longevity and the likelihood of delivering the product. Each criterion is made up of a number of factors that contribute to the measurement of that criterion. For example, to determine the *value* that a PfM investment delivers, organizations need to go beyond the traditional NPV (net present value) and ROI (return on investment) analysis methods. *Value* can be defined as the contribution of technology to enable the success of the business unit.

Parker, Benson, and Trainor suggest the assessment of two domains—business and technology—as they state that these determine value and should include:[26]

Business Domain Factors

- ROI—the cost benefit analysis plus the benefit created by the investment on other parts of the organization.
- Strategic match—the degree to which a proposed IT project supports the strategic aims of the organization.

- Competitive advantage—the degree to which IT projects create new business opportunity or facilitate business transformation.
- Organizational risk—the degree to which a proposed IT project depends on new untested corporate skill, management capabilities, and experience.

Technology Domain Factors

- Strategic architecture alignment—the degree to which the proposed IT project fits into the overall organization structure.
- Definition uncertainty risk—the degree to which the users' requirements are known.
- Technical uncertainty risk—the readiness of the technical domain to embrace the IT project.
- Technology infrastructure risk—the degree to which extra investment (outside the project) may be necessary to undertake the project.

The business and technology domain factors, as suggested earlier, are factors that could be considered by an organization as those that contribute toward the *Value* criterion being measured. An organization may choose different factors to represent *Value.* Other criteria, such as longevity or the likelihood of delivering a product, can also be used to evaluate portfolio components.

Stewart and Mohamed discussed IT investment management process, project selection process and framework, IT investment evaluation, and multiple criteria decision making. This is relevant to PfM and the model presented in Chapter 2, as the evaluation of multiple criteria when assessing the contribution of portfolio components to organizational objectives is necessary, and MCUT contributes to the understanding of evaluating multiple criteria when determining the contribution of portfolio components to organizational objectives.

The next section discusses organization theory and its applicability to PfM.

Organization Theory

Background

Organization theory has been defined as the "study of organizational designs and organizational structures, relationship of organizations with their external environment, and the behavior of managers and technocrats within organizations. It suggests ways in which an organization can cope with rapid change."[27]

Organization theory has been developed over many decades with many authors contributing toward the body of knowledge on organization theory. Many researchers[28,29,30] attribute the foundation of organization theory to key individuals such as: Frederick W. Taylor, 1911 (Scientific Management); Henri Fayol, 1919 (Theory of Administration); Max Weber, 1922 (Bureaucracy); Mary Parker Follett, 1925 (Organizations and Management); Chester I. Barnard, 1938 (Functions of the Executive); The Hawthorne Studies, 1939; Douglas McGregor, 1960 (Theory X and Theory Y); and Peter F. Drucker, 1995 (Management). Current ideas in organization theory focused on organizational challenges such as competitive global market or globalization, demographic changes, social responsibility, diversity, and technological developments. Organizations are complex and varied and apply processes, structure, and decision making differently from each other.

Crowther and Greene stated that:

> the earliest approach to organization theory was based on the assumption that there was a single best way of organizing the factors of production, and was brought about by the increasing size and complexity of organizations. Initially it was based upon the organization of jobs within the organization but later changed to organizing functions either within the organization or within the wider environment in which the organization operates.[31]

In their research they described various approaches that have been applied in organization theory over time. These include critical approach, postmodern approach, social constructionism, and environmentalism. They observed that organizations are an integral part of society and concluded that the problems of organizing have not been solved despite the extensive development of theory as each theory only contains a partial solution.

Other authors added that numerous challenges, such as

> globalization, diversity, ethical concerns, rapid advances in technology, the rise of e-business, a shift to knowledge and information as organizations' most important form of capital and the growing expectations of workers for meaningful work and opportunities for personal and professional growth[32]

require new responses or approaches to the problems faced by organizations.

Given this explanation, it can be established that organization theory (understanding organization design, structures, relationships, and behavior of managers and technocrats within the organization) is necessary when designing solutions for problems that affect the organization. It is relevant to PfM as PfM assists organizations in executing business plans and realizing business goals. PfM is a dynamic decision-making process whereby (a) an organization's list of active components are constantly updated and revised; (b) new components are evaluated, selected, and prioritized; (c) existing components are accelerated, terminated, or de-prioritized; and (d) resources are allocated and re-allocated to the active components. PfM combines people, processes, information, and technology to respond to organization change and maximize the contribution of portfolio components to the overall welfare and success of the organization. It can be concluded from this discussion that there is a cohesive relationship between organization theory and PfM.

The next section discusses systems theory and its applicability to PfM.

Systems Theory

Background

A system is defined as "a set of interacting units or elements that form an integrated whole intended to perform some function … exhibits order, pattern and purpose … is distinguished from its parts by its organization."[33] A system can also be seen as "an object, which, in a given environment, aims at reaching some objectives by doing an activity while its internal structure evolves through time without losing its own identity."[34] They concluded that projects should be considered as systems as they exist within a specific environment and aim to achieve objectives.

Systems theory (or general systems theory—GST) has developed over a number of decades. In 1951, Ludwig von Bertalanffy described open systems using an analogy of anatomy (muscles, skeleton, circulatory system, and so on). From this was laid the foundation for systems thinking in project and PfM.

Skyttner sums up the contributions of various authors to systems theory by describing the properties that make up GST as follows:[35]

- Interrelationship and interdependence of objects and their attributes: Unrelated and independent elements can never constitute a system.
- Holism—Holistic properties impossible to detect by analysis should be possible to define in the system.
- Goal seeking—Systemic interaction must result in some goal or final state to be reached or some equilibrium point being approached.
- Transformation process—All systems, if they are to attain their goal, must transform inputs into outputs. In living systems this transformation is mainly of a cyclical nature.
- Inputs and outputs—In a closed system the inputs are determined once and for all; in an open system additional inputs are admitted from its environment.
- Entropy—This is the amount of disorder or randomness present in any system. All non-living systems tend toward disorder; left alone they will eventually lose all motion and degenerate into an inert mass. When this permanent stage is reached and no events occur, maximum entropy is attained. A living system can, for a finite time, avert this unalterable process by importing energy from its environment. It is then said to create negentropy, something which is characteristic of all kinds of life.

- Regulation—The interrelated objects constituting the system must be regulated in some fashion so that its goals can be realized. Regulation implies that necessary deviations will be detected and corrected. Feedback is therefore a requisite of effective control.
- Hierarchy—Systems are generally complex wholes made up of smaller subsystems. This nesting of systems within other systems is what hierarchy implies.
- Differentiation—In complex systems, specialized units perform specialized functions. This is a characteristic of all complex systems and may also be called specialization or division of labor.
- Equifinality and multifinality—Open systems have equally valid alternative ways of attaining the same objectives (divergence) or, from a given initial state, obtain different, and mutually exclusive, objectives (convergence).

Systems theory helps to make sense of complex situations and facilitates better management and decision making resulting in more effective organizations.

Earlier, Hendrickson[36] presented a dynamic system model to describe the fact that organizations are constantly changing due to internal and external factors, they act as open systems adapting to the broader environment, and the managers within organizations can anticipate and prepare for issues faced by their organizations. This is opposed to the traditional theory, which viewed organizations as closed systems that did not take into account environmental influences impacting the efficiency of organizations. Katz and Khan[37] expressed the view that organization theories tended to overemphasize internal functioning while failing to understand the adaptation process. In open systems theory, the system receives inputs from the environment, transforms these inputs into outputs, and then exchanges the outputs for new inputs. This input-throughput-output cycle is the process by which the firm counteracts entropy and therefore assures its survival.

As described earlier, Ludwig von Bertalanffy and others have contributed to the development of general systems theory over the past few decades. The development of the theory has guided research in several disciplines over this period. This has led to understanding systems that have evolved to the point where we incorporate the concepts in everyday language.

In systems theory, a system is a way of understanding any dynamic process, whether it is riding a bicycle, a biological process, an organization, machine, or any other entity involving a dynamic process.[38] Systems theory was therefore applied broadly across numerous disciplines.

Systems theory is classified as

> a management approach that attempts to integrate and unify scientific information across many fields of knowledge … looks at the total picture when solving problems and … implies the creation of a management technique that is able to cut across many organizational disciplines ….[39]

System thinking is vital for the success of a project, and by extension, the success of a program and portfolio.

PfM draws from systems theory, as it is a dynamic management approach that considers the total organization and cuts across many organizational disciplines. The PfM process itself follows a systems approach as it (a) considers inputs (e.g., strategy definition), (b) translates those inputs into outputs (e.g., products consumed by the organization or its customers) using various techniques or mechanisms (e.g., projects and programs), and (c) provides a feedback in terms of achievement of the strategy through performance measurement (benefit tracking).

The next section discusses complexity theory and its applicability to PfM.

Complexity Theory

Background

Complexity theory has become a broad area of investigation. Although developed in the natural sciences, it has much to offer the social sciences. Complexity theory can be defined as "the study of how order, structure, pattern and novelty arise from extremely complicated, apparently chaotic systems, and conversely, how complex behavior and structure emerge from simple underlying rules."[40]

Earlier, Baccarini proposed that "project complexity be defined as consisting of many varied interrelated parts and can be operationalized in terms of differentiation and interdependency."[41] He considers types of complexity as being organizational (vertical and horizontal differentiation as well as the degree of operational interdependencies) and technological (the transformation processes that convert inputs into outputs). He regards these as the core components of complexity. He suggests that "this definition can be applied to any project dimension relevant to the project management process, such as organization, technology, environment, information, decision making, and systems."[42]

Complexity theory research can be divided into three categories: (1) algorithmic complexity, (2) deterministic complexity, and (3) aggregate complexity.[43] Aggregate complexity is relevant for this research and relates to how individual components of a system work together to create complex behavior. The set of interrelated concepts that define a complex system include: (a) relationships between entities, (b) internal structure and surrounding environment, (c) learning and emergent behavior, and (d) the different means by which complex systems change and grow.[44]

The behavior of complex systems is affected greatly by the central organization, which exerts control over the agents of the system.[45] The amount of this control toward achieving optimal performance must be determined as this has implications for the system. Leadership in an organization must be aware of how the actions and decisions in one functional area affect the performance of other functional areas. This includes decisions regarding projects, programs, and operations that have a cross-functional dependency. In other words, the performance of a project portfolio as a complex system was impacted by the leadership or management decisions regarding the components of the project portfolio.

Project complexity can be characterized by factors classified into four families, which are all necessary but are not sufficient conditions for project complexity.[46] The first family encompasses project size factors. The second gathers factors of project variety. The third gathers those that are relative to the interdependencies and interrelations within the project system. The fourth deals with project complexity and are context-dependent.

In many organizations today, a multitude of projects, programs, and operational activities (portfolio components) are initiated, some having a direct interdependency while others have an indirect interdependency. This implies that one way or another, changes in projects within an organization have an impact on other projects within the same organization as a result of various types on interdependencies between projects. It is crucial then that the right decisions are made when managing the portfolio. Decision making here, therefore, depends on an understanding of the component contribution to objectives.

The next section summarizes the aforementioned theories as they apply to PfM.

PfM theoretical foundations

The diagram in Figure A.2 is used to illustrate the theories that support PfM.

In summary, Figure A.2 illustrates the key elements from each theory relevant to PfM. These are as follows:

- MPT—provides the investment management metaphor applied in PfM. From Figure A.2 the identification of portfolio components (↓); the allocation of organizational resources (⇧); and the realization of benefits (↑) in the diagram are aligned to the MPT philosophy.
- MCUT—offers a way to evaluate portfolio components using multiple criteria. MCUT contributes to the understanding of using multiple criteria when determining the contribution of portfolio components to organizational objectives and is aligned with the arrow labeled (↕) in the diagram.
- Organization Theory—refers to the organization designs, structures, relationship of organizations with their external environment, and the behavior of managers and technocrats within organizations. Organization theory applies to the whole organization. PfM is a capability within the

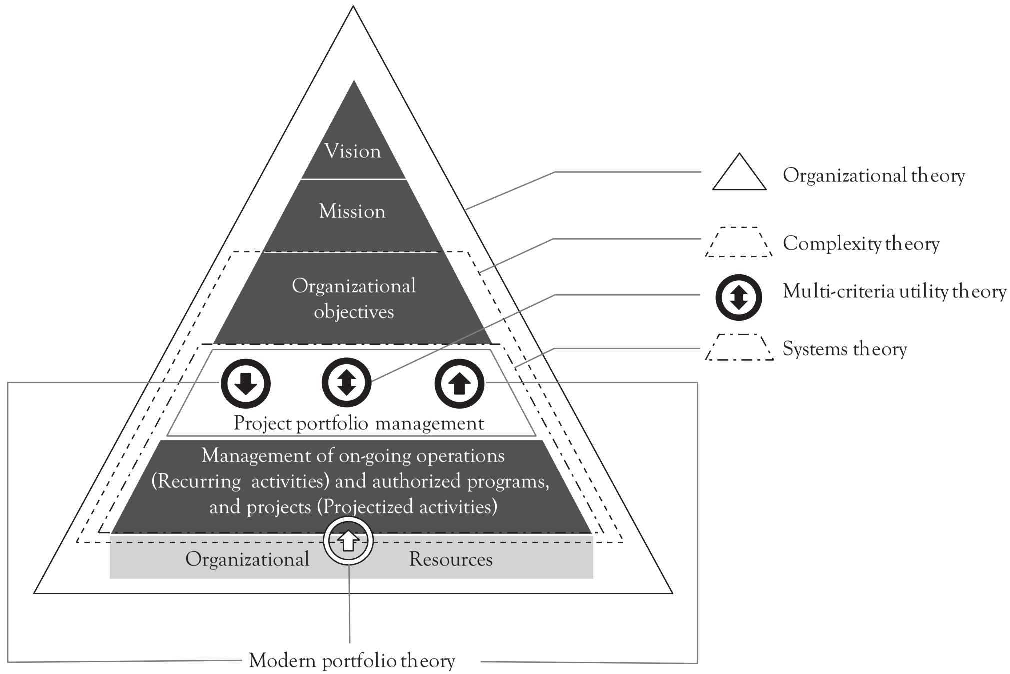


Figure A.2 Existing theories that relate to PfM

Source: Adapted from Enoch and Labuschagne.[47]

organization that enables the execution of business plans and the realization of organizational objectives. For PfM to be effective it must operate within the framework of organization design, structure, relationships, and behavior or culture of its people.

- Complexity Theory—the interdependent relationships among portfolio components and the relationships between portfolio components and organizational objectives result in a complex PfM system. The performance of a project portfolio as a complex system is impacted by the leadership or management decisions regarding the components of the project portfolio. Understanding the characteristics of complexity theory contributes to the understanding of PfM as a complex system.
- Systems Theory—a systems approach is used in the PfM process as it considers inputs (e.g., strategy and organizational objectives), converts those inputs into outputs (e.g., products consumed by the organization or its customers) using project, program, and operational techniques, and provides feedback in terms of achievement of the strategy through performance measurement.

Conclusion

The purpose of this appendix is to provide a context for PfM. To achieve this, a definition for PfM was firstly provided, followed by a presentation of five theories that relate to PfM, namely, MPT, MCUT, organization theory, systems theory, and complexity theory.

A definition for PfM was confirmed after reviewing the literature and drawing from key contributors to the PfM literature in the past 15 years. Figure A.1 representing the definition of PfM was presented and contained the key elements making up PfM. These included: (a) the translation of organizational objectives into portfolio components, (b) allocation of resources, (c) the evaluation of portfolio components to determine their contribution to organizational objectives using multiple criteria, and (d) the tracking of benefits and achievement of objectives.

The reason for exploring the five theories was due to the fact that there was no single unified theory for PfM at the time of the investigation. The five theories discussed in this chapter contribute to the theoretical background of PfM and describe characteristics that help to understand PfM better. Each of the theories mentioned were described in terms of a background to the theory and a discussion on how the theory relates to PfM. The review of the literature, definition of PfM, and exploration of the five theories provided a context for PfM.

The thrust of this book is to present a model that enables better informed decision making with regard to the portfolio and its components. Characteristics of the five theories—such as the use of multiple criteria to evaluate components, systems approach, dealing with complexity, understanding organizational relationships, and the investment management metaphor—were considered in the development of the decision-making model presented in Chapter 2.

Notes

Chapter 1

1. PMI (2013).
2. Office of Government Commerce (2010).
3. Ward and Peppard (2004).

Chapter 2

1. Cameron (2005).
2. D'Amico (2005).
3. Maizlish and Handler (2005).
4. Martinsuo and Lehtonen (2007).
5. Thiry and Deguire (2007).
6. Aubry, Hobbs, and Thuillier (2008).
7. Müller, Martinsuo, and Blomquist (2008).
8. Meskendahl (2010).
9. PMI (2013).
10. PMI (2013).
11. Kaplan and Norton (2008).
12. Enoch and Labuschagne (2012).
13. Enoch and Labuschagne (2012).
14. Cox (1995).
15. Cox (1995).
16. MathWorks (2011).

Chapter 3

1. Enoch and Labuschagne (2012).

Chapter 4

1. PMI (2013).
2. Kaplan and Norton (2008).
3. Killen (2013).

Chapter 5

1. Saaty (1980).

Appendix 1

1. Enoch and Labuschagne (2014).
2. Jiang and Klein (1999).
3. Cooper, Edgett, and Kleinschmidt (2000, 14).
4. META Group (2002).
5. Leliveld and Jeffery (2003).
6. Maizlish and Handler (2005).
7. Levine (2005, 17).
8. PMI (2013).
9. PMI (2008).
10. PMI (2008).
11. Enoch and Labuschagne (2014).
12. Markowitz (1952).
13. Goff and Teach (2003).
14. Markowitz (1999).
15. McFarlan (1981).
16. Verhoef (2002).
17. Berinato (2001).
18. Ross (2005).
19. Goff and Teach (2003).
20. Kersten and Ozdemir (2004).
21. Stewart and Mohamed (2002).
22. Goicoechea, Hansen, and Duckstein, 1982 as cited in Stewart and Mohamed (2002).
23. Ang and Tang, 1984 as cited in Stewart and Mohamed (2002, 258).
24. Mustafa and Ryan, 1990 as cited in Stewart and Mohamed (2002, 258).
25. Keeney and Raiffa (1993).
26. Parker, Benson, and Trainor (1988).
27. BusinessDictionary.com (2013).
28. Dessler (1980).
29. Champoux (2006).
30. Daft, Murphy, and Willmott (2010)
31. Crowther and Green (2004, 16).
32. Daft, Murphy, and Willmott (2010, 29).
33. Skyttner (1996, 16–17).
34. Vidal and Marle (2008, 1095).

35. Skyttner (1996, 20).
36. Hendrickson (1992).
37. Katz and Kahn (1978) as cited in Hendrickson (1992).
38. Cusins (1994).
39. Kerzner (2013, 48).
40. Cooke-Davies et al. (2007, 52).
41. Baccarini (1996, 202).
42. Baccarini (1996, 202).
43. Manson (2001).
44. Manson (2001).
45. Solow and Szmerekovsky (2006).
46. Vidal, Marle, and Bocquet (2011).
47. Enoch and Labuschagne (2014).

References

Ang, A.H.S., and W.H. Tang. 1984. "Decision, Risk and Reliability." *Probability Concepts in Engineering Planning and Design*, Vol. 1. New York: John Wiley.

Aubry, M., B. Hobbs, and D. Thuillier. 2008. "Organisational Project Management: An Historical Approach to the Study of PMOs." *International Journal of Project Management* 26, no. 1, pp. 38–43. doi:10.1016/j.ijproman.2007.08.009.

Baccarini, D. 1996. "The Concept of Project Complexity—A Review." *International Journal of Project Management* 14, no. 4, pp. 201–04. doi:10.1016/0263-7863(95)00093-3.

Berinato, S. 2001. "Do the Math." www.cio.com

BussinessDictionary.com. March 28, 2013. "What Is Organization Theory? Definition and Meaning." http://www.businessdictionary.com/definition/organization-theory.html

Cameron, B. 2005. "IT Portfolio Management: Aligning IT and Business Strategy." *The International Journal of Applied Management and Technology* 3, no. 1, pp. 205–20.

Champoux, J.E. 2006. *Organizational Behaviour. Integrating Individuals, Groups and Organizations.* 3rd ed. International: Thompson South-Western.

Cooke-Davies, T., S. Cicmil, L. Crawford, and K. Richardson. 2007. "We're Not in Kansas Anymore, Toto: Mapping the Strange Landscape of Complexity Theory, and Its Relationship to Project Management." *Project Management Journal* 38, no. 2, pp. 50–61.

Cooper, R.G., S.J. Edgett, and E.J. Kleinschmidt. 2000. "New Problems, New Solutions: Making Portfolio Management More Effective." *Research-Technology Management* 43, no. 2, pp. 18–33. http://www.scopus.com/inward/record.url?eid=2-s2.0-0034155948&partnerID=40&md5=13f5ed8d17c5dc9e7b1f5b2e51f1e953

Cox, E. 1995. *Fuzzy Logic for Business and Industry*. Rockland, MA: Charles River Media.

Crowther, D., and M. Green. 2004. *Organisational Theory*. London: The Chartered Institute of Personnel and Development.

Cusins, P. 1994. "Understanding Quality Through Systems Thinking." *The TQM Magazine* 6, no. 5, pp. 19–27.

D'Amico, V. 2005. "Manage Your IT Projects like an Investment Portfolio." *Handbook of Business Strategy* 6, no. 1, pp. 251–55.

Daft, R.L., J. Murphy, and H. Willmott. 2010. *Organization Theory and Design*. Cengage Learning EMEA. http://books.google.co.za/books?id=s6MAkpcuaZQC&printsec=frontcover&dq=organization+theory+and+design&hl=en&sa=X&ei=uyLkUOvtJ8bMhAfBkIHoBQ&ved=0CDQQ6AEwAA#v=onepage&q=organization theory and design&f=false

Dessler, G. 1980. *Organization Theory: Integrating Structure and Behavior.* NJ: Prentice-Hall.

Enoch, C.N., and L. Labuschagne. 2012. "Project Portfolio Management: Using Fuzzy Logic to Determine the Contribution of Portfolio Components to Organizational Objectives." In *PMI Research and Education Conference*. Limerick, Ireland: PMI.

Enoch, C.N., and L. Labuschagne. 2014. "Towards a Theoretical Foundation for Project Portfolio Management." In *PMI Research and Education Conference*. Limerick, Ireland: PMI.

Goff, J., and E. Teach. 2003. "The Fundamentals of Portfolio Management Are Being Applied to Corporate Technology Assets." *CFO Magazine*. www.cfo.com

Goicoechea, A., D. Hansen, and L. Duckstein. 1982. *Multiobjective Decision Analysis with Engineering and Business Applications.* New York: Wiley.

Hendrickson, L.U. 1992. "Bridging the Gap between Organization Theory and the Practice of Managing Growth: The Dynamic Systems Planning Model." *Journal of Organizational Change Management* 5, no. 3, pp. 18–37.

Jiang, J., and G. Klein. 1999. "Project Selection Criteria by Strategic Orientation." *Information and Management* 36, no. 2, pp. 63–75.

Kaplan, R.S., and D.P. Norton. 2008. *The Execution Premium: Linking Strategy to Operations for Competitive Advantage*. Boston: Harvard Business School Publishing Corporation. http://www.amazon.com/The-Execution-Premium-Operations-Competitive/dp/142212116X/ref=sr_1_1?ie=UTF8&qid=1371584871&sr=8-1&keywords=the+execution+premium

Katz, D., and R.L. Kahn. 1978. *The Social Psychology of Organizations.* 2nd ed. New York: John Wiley & Sons.

Keeney, R.L., and H. Raiffa. 1993. *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*. Cambridge: Cambridge University Press.

Kersten, H.M.P., and S. Ozdemir. 2004. "Optimising a Product Portfolio of an IT-Company." Free University Amsterdam.

Kerzner, H. 2013. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling.* 11th ed. Hoboken, NJ: John Wiley & Sons. http://www.amazon.com/Project-Management-Approach-Scheduling-Controlling/dp/1118022270/ref=sr_1_1?ie=UTF8&qid=1371581960&

sr=8-1&keywords=Project+Management:+A+Systems+Approach+to+Planning,+Scheduling,+and+Controlling

Killen, C.P. 2013. "Evaluation of Project Interdependency Visualizations through Decision Scenario Experimentation." *International Journal of Project Management* 31, no. 6, pp. 804–16.

Leliveld, I., and M. Jeffery. 2003. "IT Portfolio Management." *Research, Kellogg School of Management*. www.kellogg.northwestern.edu

Levine, H.A. 2005. *Project Portfolio Management: A Song Without Words*. Saratoga Springs, New York & San Diego, CA: The Project Knowledge Group.

Maizlish, B., and R. Handler. 2005. *IT Portfolio Management: Step-by-Step. Unlocking the Business Value of Technology*. Hoboken, NJ: John Wiley & Sons.

Manson, S.M. 2001. "Simplifying Complexity: A Review of Complexity Theory." *Geoforum* 32, no. 3, pp. 405–14. http://www1.fee.uva.nl/cendef/upload/76/2001_Manson_Simplifying_Complexity.pdf

Markowitz, H. 1952. "Portfolio Selection." *Journal of Finance* 7, no. 1, pp. 77–91.

Markowitz, H.M. 1999. "The Early History of Portfolio Theory: 1600-1960." *Financial Analysis Journal* 55, no. 4, pp. 5–16.

Martinsuo, M., and P. Lehtonen. 2007. "Role of Single-Project Management in Achieving Portfolio Management Efficiency." *International Journal of Project Management* 25, no. 1, pp. 56–65. doi:10.1016/j.ijproman.2006.04.002.

MathWorks. 2011. "Fuzzy Logic Toolbox." http://www.mathworks.com/products/fuzzy-logic/

McFarlan, F.W. 1981. "Portfolio Approach to Information Systems." *Harvard Business Review* 59, no. 5, pp. 142–50. doi:10.1225/81510.

Meskendahl, S. 2010. "The Influence of Business Strategy on Project Portfolio Management and Its Success—A Conceptual Framework." *International Journal of Project Management* 28, no. 8, pp. 807–17. doi:10.1016/j.ijproman.2010.06.007.

META Group. 2002. "IT Investment Management: Portfolio Management Lessons Learned." www.metagroup.com

Müller, R., M. Martinsuo, and T. Blomquist. 2008. "Project Portfolio Control and Portfolio Management Performance in Different Contexts." *Project Management Journal* 39, no. 3, pp. 28–42. doi:10.1002/pmj.

Mustafa, M.A., and T.C. Ryan. 1990. "Decision Support for Bid Evaluation." *International Journal of Project Management* 8, no. 4, pp. 230–35.

Office of Government Commerce. 2010. *An Executive Guide to Portfolio Management*. The Stationery Office.

Parker, M.M., R.J. Benson, and H.E. Trainor. 1988. "Information Economics: Linking Business Performance to Information Technology." *Journal of Information Technology* 5, no.1, pp. 55–58. doi:10.1057/jit.1990.13.

PMI (Project Management Institute). 2008. *The Standard for Portfolio Management.* 2nd ed. Newtown Square, PA: PMI. www.pmi.org

PMI. 2013. *The Standard for Portfolio Management*. 3rd ed. Newtown Square, PA: PMI. www.pmi.org

Ross, M. 2005. *A Holistic Approach to IT Department Wellness – Systematic Portfolio Management Planning*. www.galarath.com

Saaty, T.L. 1980. *The Analytical Hierarchy Process*. New York: McGraw-Hill.

Skyttner, L. 1996. "General Systems Theory: Origin and Hallmarks." *Kybernetes Academic Research Library* 25, no. 6, pp. 16–22.

Solow, D., and J.G. Szmerekovsky. 2006. "The Role of Leadership: What Management Science Can Give back to the Study of Complex Systems." *E:CO* 8, no. 4, pp. 52–60.

Stewart, R., and S. Mohamed. 2002. "IT/IS Projects Selection Using Multi-Criteria Utility Theory." *Logistics Information Management* 15, no. 4, pp. 254–70. doi:10.1108/09576050210436101.

Thiry, M., and M. Deguire. 2007. "Recent Developments in Project-Based Organisations." *International Journal of Project Management* 25, no. 7, pp. 649–58. doi:10.1016/j.ijproman.2007.02.001.

Verhoef, C. 2002. "Quantitative IT Portfolio Management." *Science of Computer Programming* 45, no. 1, pp. 1–96.

Vidal, L-A., and F. Marle. 2008. "Understanding Project Complexity: Implications on Project Management." *Kybernetes* 37, no. 8, pp. 1094–1110. doi:10.1108/03684920810884928.

Vidal, L-A., F. Marle, and J-C. Bocquet. 2011. "Measuring Project Complexity Using the Analytic Hierarchy Process." *International Journal of Project Management* 29, no. 6, pp. 718–27. doi:10 1016/j.

Ward, J., and J. Peppard. 2004. *Strategic Planning for Information Systems*. West Essex: Wiley Series.

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Project Portfolio Management
A Model for Improved Decision Making

Clive N. Enoch

Project portfolio management (PfM) is a critically important discipline, which organizations must embrace in order to extract the maximum value from their project investments. Essentially, PfM can be defined as the translation of strategy and organizational objectives into projects, programs, and operations (portfolio components); the allocation of resources to portfolio components according to organizational priorities; alignment of components to one or more organizational objectives; and the management and control of these components in order to achieve organizational objectives and benefits.

The focus of this book is aimed at providing a mechanism to determine the individual and cumulative contribution of portfolio components to strategic objectives so that the right decisions can be made regarding those components.

Dr. Clive N. Enoch has been a practitioner of project, program, and portfolio management, as well as a manager of project and portfolio management offices over the past 20 years and has worked across multiple industries during this time. Clive holds a master of commerce degree in information systems management from the University of the Witwatersrand (WITS) in Johannesburg and a PhD in computer science from the University of South Africa (UNISA). His PhD thesis resulted in a model for decision making in project portfolio management. Clive is passionate about project portfolio management and has contributed to the PMI's *The Standard for Portfolio Management*, third edition, as a core committee member.

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