PROJECT PORTFOLIO MANAGEMENT: A MODEL FOR IMPROVED DECISION MAKING

by

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ABSTRACT

The recent global financial crisis, regulatory and compliance requirements placed on organisations, and the need for scientific research in the project portfolio management discipline were factors that motivated this research. The interest and contribution to the body of knowledge in project portfolio management has been growing significantly in recent years, however, there still appears to be a misalignment between literature and practice. A particular area of concern is the decision-making, during the management of the portfolio, regarding which projects to accelerate, suspend, or terminate. A lack of determining the individual and cumulative contribution of projects to strategic objectives leads to poorly informed decisions that negate the positive effect that project portfolio management could have in an organisation. The focus of this research is, therefore, aimed at providing a mechanism to determine the individual and cumulative contribution of projects to strategic objectives so that the right decisions can be made regarding those projects.

This thesis begins with providing a context for project portfolio management by confirming a definition and providing a theoretical background through related theories. An investigation into the practice of project portfolio management then provides insight into the alignment between literature and practice and confirms the problem that needed to be addressed. A conceptual model provides a solution to the problem of determining the individual and cumulative contribution of projects to strategic objectives. The researcher illustrates how the model can be extended before verifying and validating the conceptual model.

Having the ability to determine the contributions of projects 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 research provides the mechanism to enable better-informed decision-making regarding the project portfolio.

Key Words: project portfolio management; fuzzy logic; multi-criteria evaluation; decision-making; complexity; strategy; organisation theory; modelling; modern portfolio theory; systems theory

Affidavit

Student number: **0841-031-3**

I declare that PROJECT PORTFOLIO MANAGEMENT: A MODEL FOR IMPROVED DECISION MAKING is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

21 June 2013

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To whom it may Concern

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1 Chapter 1 - Introduction

1.1 Introduction

Project portfolio management is concerned with managing groups of projects, programmes and operational activities that compete for scarce resources and which are conducted to achieve strategic business objectives (Jonas, 2010; Meskendahl, 2010; Voss, 2012). Until now, the primary focus in project portfolio management has been on the selection and prioritisation of projects and programmes (Petit & Hobbs, 2012); however, merely choosing the right projects and programmes 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 towards finding ways to ensure that the right decisions are made with regard to project and programmes. This leads to portfolio and, ultimately, business success (Meskendahl, 2010).

Project portfolio management is by no means a solution to all an organisation's problems; however, it is intended to enable organisations 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 organisations 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 (Beringer, Jonas, & Kock, 2013; Unger, Kock, Gemünden, & Jonas, 2012).

This chapter outlines a clear case for this scientific research into organisations. Included in this study is 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 towards organizational success.

This chapter also describes the research problem relevant to the motivation of this thesis by identifying the problem that needs to be addressed. It also presents a diagram of the chapter layout of the thesis (see Figure 1.1, section 1.5.). This is used to enable readers to assess visually where the research objectives are addressed in the thesis.

1.2 Motivation for this research

The first factor motivating this study stemmed from previous investigations by the researcher which examined the barriers to the adoption of IT (Information Technology) portfolio management and strategies to overcome them (Enoch & Addison, 2006). At the conclusion of this previous research, there was little evidence of a standard[1], or a model[2] produced through scientific analysis that described the discipline of project portfolio management in sufficient detail. The first edition of the *Project Management Institute Standard for Portfolio Management* was released in 2006 after the above-mentioned research was completed and although a number of authors have written books and articles on the topic of project portfolio management, the opportunity clearly exists for further scientific research in the discipline.

The second factor motivating this research is to do with the global economic climate. At the time of conducting the research, the global economy was in crisis over a period of five years (2007-2012) (New York Times, n.d.; United Nations, n.d.). The situation was serious enough for many Governments to get involved in minimizing the impact on their citizens. Organisations, in their turn, had to take drastic measures in order to survive.

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[1] “A document approved by a recognized body, which provides for common and repeated use, rules, guidelines, or characteristics for products, processes, or services with which compliance is not mandatory” (Project Management Institute, 2013)

[2] “A schematic description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics” (The Free Dictionary, n.d.-b)

Among the top management concerns during this time were productivity, cost reduction, IT and business alignment, and IT strategic planning (Luftman & Ben-Zvi, 2010). While these concerns are not necessarily new, the effect of poor decision-making would be more profound during a period of global economic uncertainty.

The third factor for this research was the focus on compliance to corporate governance requirements. From a South African perspective, organisations are encouraged to adopt King III, which is the collective name for the *Report on Governance for South Africa 2009' and the 'Code of Governance Principles for South Africa 2009* (PriceWaterhouseCoopers, n.d.). A relevant extract from King III for this thesis is principle 4.16, which states that,

> "IT governance is essential to the achievement of corporate objectives and information resources, such as people, funding and information. IT governance should focus on four key areas", namely: (1) "strategic alignment with the business"; (2) "optimizing expenses and improving the value of IT"; (3) "the importance of IT in driving and supporting the company's objectives"; (4) "the board should take ownership of IT governance … aligning IT initiatives with real business needs, and insisting the IT performance is measured and reported on" (The South African Institute of Chartered Accountants, n.d.).

The global economic repercussions and the accompanying focus on corporate governance meant that management in organisations has to become more responsible with their decision-making of projects, programmes and operations. (Institute of Directors Southern Africa, 2009; Marnewick & Labuschagne, 2011). In this respect, executive management generally consider that the use of portfolio management better enables decision makers to meet the organizational goals and objectives (Project Management Institute, 2013), and this thereby helps to address the challenges of the economic crisis and compliance to corporate governance requirements.

The next section provides an overview of project portfolio management while a more detailed discussion of its definition is provided in Chapter 3 where the context of project portfolio management is given.

1.3 Project Portfolio Management – Overview

Many researchers are of the view that while project and programme management are traditionally focused on doing projects right, portfolio management is focused on doing the right projects (Blomquist & Müller, 2006; R. G. Cooper, Edgett, & Kleinschmidt, 2000; Ibrahim, 2011; Rayner & Reiss, 2012). The term “portfolio” is also associated with a collection of financial investment instruments i.e. stocks, bonds, among others (Jeffrey & Leliveld, 2004); however, this thesis 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 (Solomon, 2002; Tan & Theodorou, 2009). The Project Management Institute (2013: 5) defines PfM as “the coordinated management of one or more portfolios to achieve organizational strategies and objectives” and “includes interrelated organizational processes by which an organisation evaluates, selects, prioritises, and allocates its limited internal resources to best accomplish organizational strategies consistent with its vision, mission, and values”. They further state: “Portfolio management produces valuable information to support or alter organizational strategies and investment decisions” Project Management Institute (2013:5).

A goal of PfM is to guide investment decisions to maximise value and minimise risk or uncertainty thus optimizing the organisation's return on investment (Maizlish & Handler, 2005; Project Management Institute, 2008a). 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 (Project Management Institute, 2013; Tan & Theodorou, 2009; Visitacion, 2003). The approach of the remainder of this thesis is based on this understanding of PfM.

The next section identifies the problem that needs to be solved.

1.4 Research problem

Early approaches to PfM emphasised the categorizing of the landscape of existing projects in organisations without paying much attention to portfolio management decision-making (Berinato, 2001; D'Amico, 2005; Jeffrey & Leliveld, 2004; Kersten & Verhoef, 2003; Ross, 2005). Ward and Peppard (2004), for example, illustrated that categories such as strategic, operational, high potential and support could be used as a means for obtaining agreement between senior management on the available and required portfolio of projects. Individual projects could then be categorised 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.

Despite the increasing amount of literature on PfM, the practice in itself remains incomplete. Levine (2005) notes, for example, that while the overall concept and promise of PfM is understandable, there is still a misalignment between what is perceived as appropriate application and what is practical. Maizlish and Handler (2005) add that the definition and practical aspects of PfM are not obvious or widely accepted, and that less than 20 per cent of companies maintain an active PfM framework[3]. (Kalin, 2006) also recognises that despite the promises of PfM and the associated vendor products offering graphic views of the portfolio in order to enable decision-making, many chief information officers (CIOs) say their portfolio management efforts are still works-in-progress.

Nevertheless, PfM improves organisation success if the right decisions are made when managing the portfolio. This view is supported by (Müller, Miia Martinsuo & Blomquist, 2008: 38). They concluded in their research that “first … successful organisations have an organisation-level practice of selecting and prioritizing projects in line with strategy. Second, successful organisations have a shared reporting approach to channel information flows from projects to the portfolio level. Third, such organisations share responsibility for decisions at the portfolio level”. The decision-making at the portfolio level is a key focus of this research, since enabling this decision-making is becoming increasingly important given the economic downturn and renewed focus on corporate governance mentioned earlier. The selection of the right projects, programmes and operational activities (hereafter referred to as portfolio components) to ensure one can monitor their progress only goes part of the way to achieving 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 organisation. Specifically, this research focuses on the process or approach that enables decision making with regard to determining which portfolio components to place on hold, progress or terminate.

[3] “A set of assumptions, concepts, values, and practices that constitutes a way of viewing reality.” (The Free Dictionary, n.d.-c)

When making decisions, consideration must be given to the contribution of portfolio components (strategic fit) to organizational objectives before a decision can be made about which components to stop, progress or terminate (Unger et al., 2012). 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 research is focused on addresses the following issue:

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 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.

To further understand the problem and provide a solution, the following research objectives were identified to:

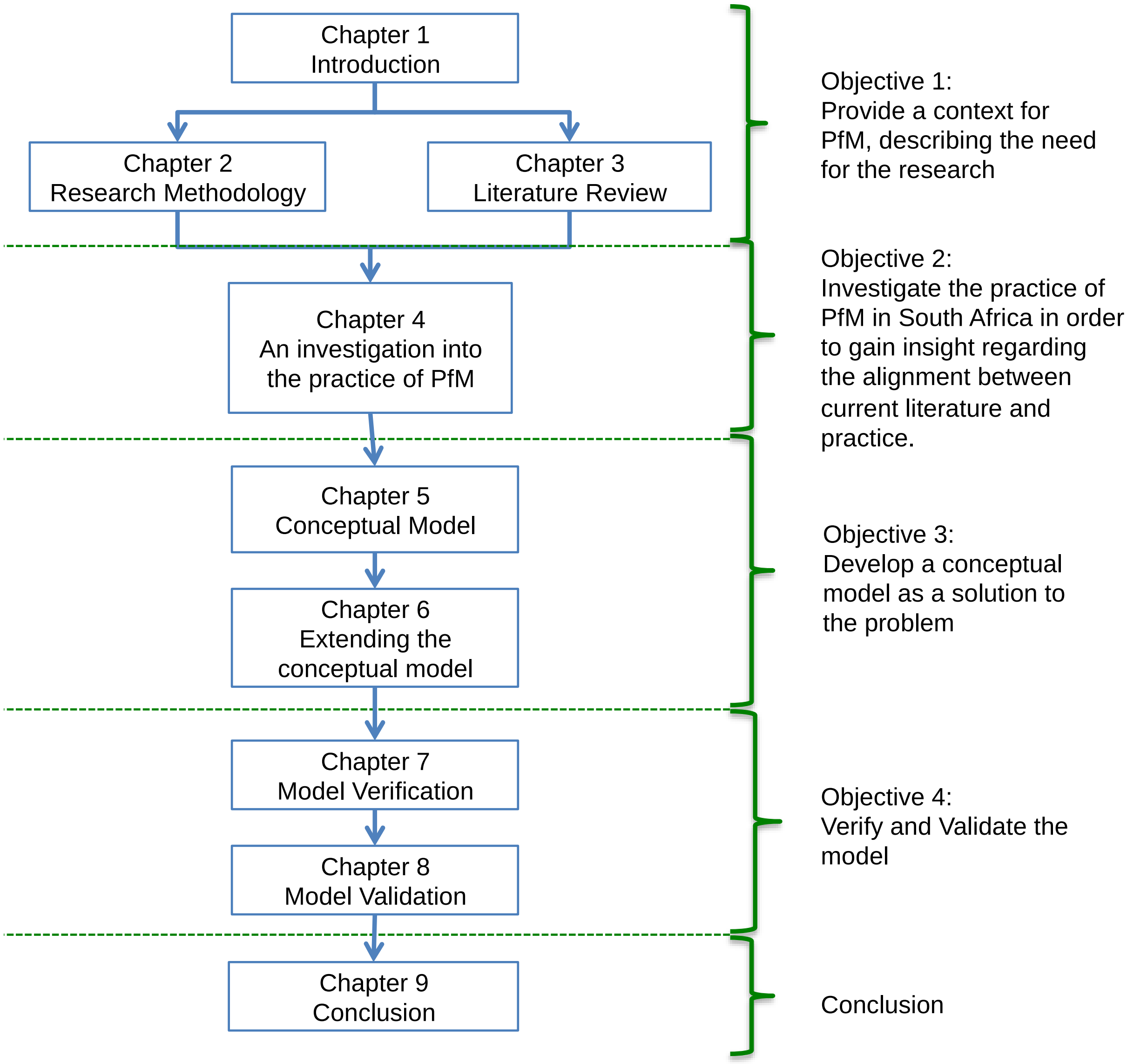
1. *Provide a context for PfM describing the need for the research.*
2. *Investigate the practice of PfM in South Africa in order to gain insight regarding the alignment between current literature and practice.*
3. *Develop a conceptual model as a solution to the problem of determining the cumulative contribution of portfolio components to organizational objectives.*
4. *Verify and validate the conceptual model to build confidence in its feasibility and describe how it would be used to improve PfM decision-making.*

The next section describes the layout of the thesis and aligns the chapters to the aforementioned research objectives.

1.5 Layout of the thesis

The thesis consists of nine chapters. **Error! Reference source not found.** below rovides a diagrammatic layout of the thesis followed by a more detailed overview of each chapter.

Figure 1.1: Thesis layout



Chapter 1 provides the introduction, motivation for the research, problem statement, research objectives, and layout of the thesis.

Chapter 2 describes the research methodology used in this thesis. A multi-method approach is used across the research objectives, whereby a literature review (method 1) is conducted in order to understand the context of PfM by confirming its definition. This is used to provide a theoretical foundation by showing how established theories support and relate to PfM. A semi structured interview (method 2) is then conducted to elicit information regarding the practice of PfM in various South African organisations. The key findings from this investigation informed the development of the conceptual model in Chapter 5. Modelling is the third method used in this research.

Conventionally, a literature review follows the introduction and precedes the research methodology (Hofstee, 2009); however, as the literature review is part of the research methodology, this thesis deviates from convention and presents the research methodology before the literature review. In addition, an extended literature review is discussed at the beginning of Chapter 4 as it relates specifically to the interview instrument used in the investigation described in that chapter. Chapter 3, then, reviews the literature on PfM and discusses the definition for PfM. It also describes five theories that are relevant to PfM and this research. The theories described are Modern Portfolio Theory, Multi Criteria Utility Theory, Organisation Theory, Complexity Theory, and Systems Theory.

Chapter 4 discusses the investigation into the practice of portfolio management in South Africa and presents a comparative analysis between the literature and practice of PfM. To avoid confusion an extended literature review is included in this chapter and not included in the literature review in Chapter 3 for the reasons given above. The extended literature review in Chapter 4 is specific to the investigation into the practice of PfM rather than the definitions of PfM and their related theories in Chapter 3, and therefore, they are not combined.

Chapter 5 discusses the complex relationship between portfolio components and organizational objectives and presents the conceptual 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, qualitative evaluations of multiple criteria for each portfolio component and producing a single quantitative value representing the cumulative contribution.

Chapter 6 extends the conceptual model presented in Chapter 5. The fundamental principles presented in Chapter 5 are used in this chapter, but instead of viewing the problem from the perspective of the contribution of multiple components to individual objectives, Chapter 6 looks at the contribution of a single component to multiple objectives. This chapter illustrates how the concepts presented in Chapter 5 can be used in a different way and opens up the possibility for future research using the conceptual model presented in this thesis.

Chapter 7 looks at the verification of the model using actual portfolio components and organizational objectives from a participating organisation. The verification of the model in this chapter illustrates the mechanics of the model and confirms how the impact of decisions regarding portfolio components can be quantified. The researcher used actual portfolio components and organizational objectives to move from concept to reality.

Chapter 8 validates the model. Three tests were chosen for model validation. The purpose of validating the model is to build confidence in the model in terms of its representation of reality and the fulfilment of its purpose. The validation confirmed that the model fulfils its purpose in that it enables decision-makers to get an insight into their decisions before committing to them, thus ensuring better informed decision-making.

Chapter 9 provides a summary of the thesis and suggests possible future research opportunities stemming from this research. This chapter makes final recommendations for the application of the model presented in this research.

1.6 Conclusion

This chapter introduces the thesis by discussing the motivating factors for this research, providing an overview of PfM, articulating the problem statement, presenting the research objectives and providing a layout for the rest of the thesis. PfM is intended to guide investment decisions such that value is maximised, risk or uncertainty is minimised, and organizational success is achieved. This chapter lays the foundation for the remainder of the thesis.

The chapter objectives were addressed by: a) providing the reasons for conducting this research, which included the need for scientific research in PfM, the recent economic climate and the focus on corporate governance; b) positioning project portfolio management in terms of its role in the management of project related investments in organisations, as well as its role in contributing towards organizational success; and
c) describing the research problem that needed to be solved.

The chapter goal is to confirm the need for the research achieved by providing the above-mentioned motivation for the research, an overview of PfM, and identifying the problem to be addressed. The chapter also discusses the need – existing at the time - for scientific research in PfM that initiated this research because at that stage, neither a standard in portfolio management, nor a scientific model similar to the one presented in this thesis, existed. The global economic crisis forced organisations to carefully consider their spending. 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 organisations to comply with legislative, regulatory and governance requirements - as well as the factors listed above - 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 organisation. Recognizing that organizational success is measured by the achievement of objectives and that 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 making them. This will enable decisions to have a minimum impact on the portfolio and organisation while achieving maximum effect.

The next chapter describes the research methodology used throughout this research. The concept of the “research onion” is introduced and this chapter describes how each layer of the onion is applied for each research objective in terms of the research method used.

2 Chapter 2 – Research Methodology

2.1 Introduction

The previous chapter introduced the thesis by a) discussing the motivating factors for this research; b) providing an overview of PfM; c) articulating the problem statement, and d) presenting the research objectives. Subsequent chapters will look at e) the theories that relate to PfM; f) investigate the practice of PfM; g) develop the conceptual model; and h) verify and validate the conceptual model.

The goal of this chapter is to describe the research methodology used throughout the thesis. It will also act as a map for the remainder of the research in terms of the research process, as follows:

- *to provide the context for PfM,*
- *to gain insight into the practice of PfM, and*
- *to develop a solution for the stated problem.*

The objectives for this chapter include: a) laying out the design for the research; b) ensuring that an approach is used that exercises control over the data collection, administration, and analysis; and c) describing the methods used in this research to address the research objectives and problem statement described in Chapter 1.

The remainder of the chapter begins with an overview of the research design. The research onion from Saunders, Lewis and Thornhill (2009) is introduced and each layer of the onion is described in the overview section. Subsequent sections in the chapter describe the research method used to address the research objectives and makes reference to how each of the six layers of the research onion were applied.

2.2 Research Design

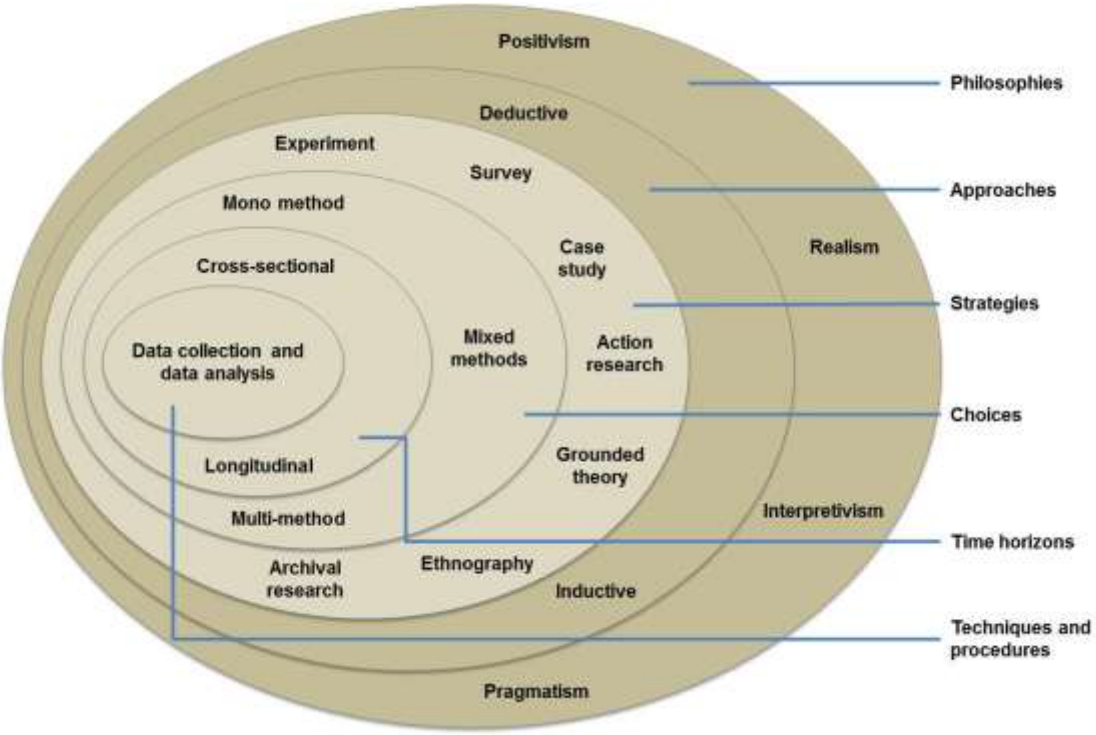
2.2.1 Overview

Polit and Hungler (1999:155) describe research design as a “blueprint, or outline, for conducting the study in such a way that maximum control will be exercised over factors that could interfere with the validity of the research results”. Burns and Grove (2001:223) state that “to design a study helps researchers to plan and implement it in a way that will achieve the intended results and increase the chances of obtaining information that could be associated with the real situation”. The research design is the overall plan for obtaining answers to the research questions guiding the design and covers the decisions from broad assumptions to detailed methods of data collection and analysis. (Creswell, 2009; Saunders, Lewis & Thornhill, 2009).

The research objectives described in Chapter 1 provide the direction for this research. The way in which these objectives were addressed, was guided by the layers of the research onion below (Figure 2.1), which describes research design considerations from the research philosophy to the data collection and analysis stages. An explanation of the research onion here is followed by a discussion on the research design for each research objective.

The research onion (Figure 2.1) illustrates the various aspects that a researcher must consider when deciding on a research design.

Figure 2.1: The research onion



Source: Saunders, Lewis, & Thornhill, 2009

A summary of the salient points of the onion regarding each layer from Saunders et al. (2009) is as follows:

- ***Philosophies:*** *The research philosophy (outer-most ring) adopted by the researcher "contains important assumptions about the way in which you view the world" (Saunders et al., 2009: 128). They caution against falling into the trap of considering any philosophy better than the others and note that research questions rarely fall into only one philosophical domain as maybe suggested in the onion. Other authors such as Ritchie and Lewis (2003); Denzin and Lincoln (2011); Rossman and Rallis (2012) use the word "paradigm" as an alternate term or concept to "philosophy" that is defined as a world-view, a shared understanding of reality, and a basic set of beliefs that guide action.*

This research is aligned with the pragmatism philosophy (paradigm) because it is centred on the problem of improving portfolio management decision-making, and it is oriented towards real-world practices, and it also uses a multi-method approach to understand the literature and practice of PfM.

- ***Approaches:*** *The next layer of the onion refers to research approaches. The research approach can follow either a deductive or inductive form. Deduction involves developing a theory or hypothesis and designing a strategy to test the hypothesis. Induction, on the other hand, involves collecting data and developing a theory from an analysis of that data.*

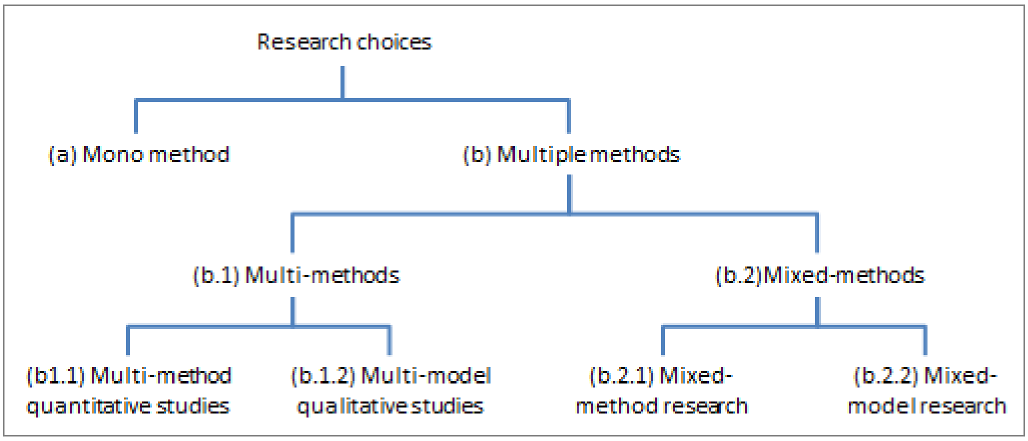
This research used a deductive and an inductive approach. To develop the interview instrument, an extended literature review was done and a framework consisting of key themes that described the phenomenon of PfM was developed. The inductive approach was used when analysing the data collected during the interview process, to develop key themes from respondents. The findings from the interviews were compared to the themes identified in the literature to test for alignment between literature on PfM and the practice of PfM.

- ***Strategies:*** *While some strategies (3rd layer) belong to the deductive form and others to the inductive form of research, strategies should not be considered as mutually exclusive. What is of importance is choosing a strategy that is appropriate for addressing the research problem and objectives.*

This research followed a grounded theory strategy of inquiry as an understanding of PfM practice was derived from the views of respondents to a semi structured interview process *(Creswell, 2009)*. A grounded theory inquiry involves constant comparison of data with emerging categories. In addition, the literature review was used for comparing and contrasting findings from the study (in this case, from the interviews).

- ***Choices:*** *Research choices (4th layer) refer to the way in which the data collection techniques and data analysis procedures are done. The various choices are described in Figure 2.2 to ensure clarity in understanding the terminology, which shows a diagrammatic representation of the research choices.*

Figure 2.2: Research choices (adapted)



Source: Saunders et *al*. (2009)

The following research choices are grouped in the figure above as follows:

Mono method (a) refers to a situation where a single data collection technique and corresponding analysis procedure is used.

Multiple methods (b) involve the use of more than one data collection technique and analysis procedures to address the research question. As illustrated in the figure above, multi-methods could be applied in a quantitative (b1.1) or qualitative (b1.2) study. A mixed methods approach (b.2) refers to the use of quantitative and qualitative data collection techniques and analysis procedures in a research design.

In mixed-method research (b.2.1) the quantitative and qualitative data collection techniques and analysis procedures are used simultaneously or sequentially but are not combined. Mixed-model research (b.2.2) on the other hand combines quantitative and qualitative data collection techniques and analysis procedures. For example, quantitative data can be converted into a narrative that can be analysed qualitatively or vice versa.

This research used a multi-method approach as, firstly, a literature review was done, from which key themes related to PfM were derived. Secondly, interviews were conducted to establish an understanding of the practice of PfM. The inductive analysis of the interview data was compared to the findings from literature.

- ***Time horizons:*** *This 5th layer refers to whether the research will be a snapshot (cross-sectional) taken at a point in time, or a sequence of events over a period of time (longitudinal).*

This research was a cross-sectional study as it was conducted at a point in time. A snapshot of the context for PfM and the practice of PfM were taken. The research was not repeated over an extended period or with different communities with the aim of assessing variations in results over the period or between communities.

- ***Data collection and data analysis:*** *The final layer refers to data collection and analysis techniques and procedures. Quantitative data collection techniques (such as questionnaires) and analysis (using graphs) generate or use numerical data. Qualitative data collection techniques (such as interviews) and analysis (such as categorizing of data) generate or use non-numerical data.*

This research made use of semi structured interviews to collect data on the practice of PfM and then applied qualitative analysis techniques to analyse the data. The literature was also reviewed to provide a context against which the findings from the interviews could be compared.

In choosing a research design, the researcher had to consider the research objectives. These objectives were to provide a context for PfM research, investigate and interpret the practice of PfM in South African companies, and develop a conceptual model to address a practical problem related to decision-making when managing project portfolios. According to the layers of the research onion, the research can be described as: a) *fundamentally interpretative, b) using a deductive and an inductive approach, c) focusing on context, d) requiring the use of multiple methods, e) occurring at a point in time, and, f) taking place in the natural world.*

A discussion will now follow on the application of the research onion (Figure 2.1) for each research objective.

2.2.2 Objective 1: Provide a context for project portfolio management describing the need for the research

To address this first objective, a review of the literature was required. A literature review is the process of finding, obtaining, reading and assessing (or evaluating) the research literature of interest (Bordens & Abbott, 2002). It is a “systematic, explicit and reproducible method for identifying, evaluating and interpreting the existing body of recorded work produced by researchers, scholars and practitioners” (Fink 2010:3). It is often conducted to provide evidence that the chosen practice is likely to be effective.

The importance of reviewing the literature is to discover the most recent theorizing about a subject, and to avoid duplicating a previous study (Mouton, 2001).

The purpose of the literature review in this research was to identify theories and ideas in the PfM literature that would be used to provide a context for PfM. This initial literature review contributed to the definition of PfM used in this thesis. It also explored five theories that related to PfM and that provided the theoretical foundation for PfM. This aspect of the literature review is discussed further in Chapter 3.

The research onion is applied in addressing this objective and is summarised in the following table:

Table 2.1: Application of research onion to objective 1

Onion layer	**Application**
Philosophy	Pragmatism was the philosophy adopted for the full research
Approach	Deduction was the approach used here as the literature was reviewed and a context for PfM was deduced.
Strategy	A grounded theory strategy was adopted for this research. The literature review provided a context for PfM against which established theories could be related to PfM.
Choice	Use of the literature to provide a context for PfM. The literature review was one of multiple methods used in this research.
Time horizon	The time horizon for the entire research is cross-sectional.
Techniques and procedures	Various books, articles, and the Standard for PfM were reviewed.

2.2.3 Objective 2: Investigate project portfolio management in South Africa to gain insight into the alignment between current literature and practice

To collect the data on the practice of PfM in South Africa, interviews were chosen instead of questionnaires or surveys to get an in-depth understanding of the practice of PfM. As "interviews are a purposeful discussion between two or more people" (Kahn & Cannell (1957) as cited in Frauendorf (2006:166), their use helps gather a rich, detailed set of data that is valid and reliable and relevant to the research objectives (Saunders, Lewis & Thornhill, 2009). However, to use a purely structured or unstructured interview method has several disadvantages, but combining structured and unstructured questions appropriately to use the strengths of both approaches enhances the process (Bordens & Abbott, 2002). Hence, a semi structured interview tool was developed using the framework made up of themes from the literature. A description of structured, unstructured, and semi structured interviews as well as the advantages and disadvantages of each of the approaches can be found in Appendix A.

An extended literature review (discussed in detail in Chapter 4) was done specifically for the purpose of preparing the interview instrument. Notable contributions to the PfM body of knowledge was reviewed, including the second edition of the *Standard for Portfolio Management* (Project Management Institute, 2008b), which was published at the time of preparing the interview questions. The *Standard* was used to develop the interview questions as it represented the most recent literature on PfM at the time of developing the interview instrument and, having reviewed other relevant literature, the *Standard* was considered to have covered the themes discussed in the literature that related to PfM.

The interview instrument was therefore developed using the themes (sections) that described the PfM context in the *Standard*. For example, based on the section on organisation strategy the question was developed regarding the process followed by the respondent organisations for translating strategic objectives into initiatives. The themes and associated questions are described in more detail in Chapter 4.

The application of the research onion in addressing this objective is summarised in the following table:

Table 2.2: Application of research onion to objective 2

Onion layer	**Application**
Philosophy	Pragmatism was the philosophy adopted for the full research.
Approach	A deductive approach was used initially to deduce the themes for the interview instrument. An inductive approach was used subsequently in the analysis of the data. Once the interviews were transcribed, the data transcripts were coded and inductively analysed to determine emerging categories from the responses received. This is discussed in more detail in section 2.2.3.6
Strategy	A grounded theory strategy was adopted for this research. The findings from the investigation into the practice of PfM could be compared to the context of PfM developed from reviewing the research.
Choice	An extended literature review and a semi structured interview were conducted for this objective. A multiple method approach was used for this objective.
Time horizon	The time horizon for the entire research is cross-sectional.
Techniques and procedures	Semi structured interviews were used to collect the data on the practice of PfM, which was analysed by coding the data and determining the categories that emerged from the data.

The remainder of this section discusses the process for: a) choosing the interview respondents, b) the procedure for administering the interviews and capturing the data, c) quality control of data, d) the storing and safeguarding of data, e) ethical considerations, f) data analysis, and g) confirming the reliability and validity of the research.

The extended literature review related to this objective as well as the preparation of the interview instrument was discussed in detail in Chapter 4. The reason for discussing these aspects in Chapter 4 instead of this chapter was about the continuity. This chapter, then (Chapter 2) discusses aspects relevant to the data handling while Chapter 4 presents the findings. It was decided to keep the latter aspects of the research together in Chapter 4 to ensure they flowed logically from the preparation of the interview instrument, the themes and questions that made up the interview instrument, and the associated findings.

2.2.3.1 Interview respondents

A database of individuals from various organisations had been developed as a result of a previous research project conducted by the researcher, as well as through invitation at a project management conference held in South Africa in 2008. Delegates at the "*PMSA 2008 – Strategy to Reality*" Conference held in Midrand in 2008 were approached individually and asked if they would be willing to participate in the research. The purpose of the research was described to the delegates and confidentiality and anonymity assured. Each delegate was provided a return card on which they could complete their contact details. The cards were either returned to the researcher directly or to the information desk at the conference. Additional cards were placed on the desks at all the conference session venues for the attention of any delegates that the researcher may have missed.

At the conference, 40 people responded affirmatively when asked if they would participate in the research. A further 60 individuals had been identified from a previous survey. Where major organisations in South Africa were not represented, the researcher attempted to contact key persons in those organisations who were likely to be willing to participate in the research. All of these individuals formed the initial group of potential participants in the interview process.

From the database of potential participants, the researcher selected an initial sample of 18 interviewees to participate in the research. Individuals who fit a particular profile comprising chief information officers (CIOs), senior IT managers, portfolio and programme managers and business division heads were invited to participate. These management levels were chosen because of their awareness and knowledge of and experience in project, programme and portfolio management. According to Glaser and Strauss (1967) as cited in Shaw (1999), the minimum number of respondents is determined by whether or not new data is being acquired. In other words, the process of conducting further interviews should stop when the researcher finds that the respondents are giving the same or similar responses. Early on in the interview process, the researcher found that the responses received were similar, but realised that this was due to most respondents being from the banking sector at that stage. The researcher then proceeded to interview respondents from other sectors such as insurance and telecommunications until it was determined that no new information was being obtained. At that point, 22 respondents representing 15 organisations and 8 sectors had participated in the interview process. The industry sectors represented included banking, insurance (short-term and medical), government, mining, telecommunication, an energy utility and a manufacturer of defence-force vehicles.

2.2.3.2 Procedure for administering Interviews and capturing the data

Face-to-face and telephonic interviews were held with respondents. Each interview was digitally recorded using a digital voice recorder and later transcribed into a text document. The transcripts were quality controlled by the researcher by reading the text transcripts while listening to the recorded interviews to ensure that all the information from the recorded interviews was captured correctly. The transcripts were then loaded into a Computer Assisted Qualitative Data Analysis (CAQDAS) software tool called ATLAS.ti – version 6[4].

2.2.3.3 Quality control of data

During the coding process, it became apparent that some of the transcripts did not load into the CAQDAS tool correctly. Some paragraphs, for example, were duplicated and in two transcripts some words were replaced with special characters. Upon investigation, it was found that there was a conversion problem when using MSWord 2007 documents. The documents were then saved in MSWord 2003 format and reloaded which then corrected the problems described above.

In the code report generation, the CAQDAS tool indicated that a certain respondent made certain comments but, the actual comment did not appear in the report. The researcher manually corrected this section in the relevant transcript and manually updated the code report. Although the researcher intervened to ensure completeness and accuracy of the output from the tool, the data was not manipulated or changed in any way. Only the sections that the report referenced were copied.

[4] ATLAS.ti is a workbench for the qualitative analysis of large bodies of textual, graphical, audio, and video data. It offers a variety of tools for accomplishing the tasks associated with any systematic approach to unstructured data, e.g., data that cannot be meaningfully analysed by formal, statistical approaches. In the course of such a qualitative analysis, ATLAS.ti helps you to explore the complex phenomena hidden in your data (Muhr & Friese, 2004).

2.2.3.4 Storing and safeguarding data

All interviews were recorded on a digital voice recorder and electronic backups were kept on a password-protected personal computer, flash disk, and an external USB hard drive. Written notes from the interviews were scanned and stored electronically.

2.2.3.5 Ethical considerations

The researcher has an obligation to respect the rights, values and desires of the informants. As such, the following safeguards were employed:

a) *The research objectives were clearly articulated in writing so that informants clearly understood the purpose and objectives of the research project.*
b) *Written approval to proceed with the interview was obtained from the informant.*
c) *The informant was informed of all data collection devices and steps in the data collection process.*
d) *Written interpretations and reports were made available to informants for verification.*
e) *Informant anonymity was practised.*
f) *At the conclusion of the interview, informants were informed of the possibility of revisiting him/her for any points of clarification required during the analysis.*

2.2.3.6 Data Analysis

The data was inductively analysed to generate a comprehensive understanding of the practice of PfM in respondent organisations (Creswell, 2009; Patton, 2002). This was achieved by organizing and structuring data according to topics that respondents identified as being important. The literature recommends that the inductive analysis of qualitative data involves:

a) The reading and re-reading of transcripts and field notes code (Ritchie & Lewis, 2003; Saunders et al., 2009);
b) The use of codes to bring order, structure and meaning to raw data (Creswell, 2009; Denzin & Lincoln, 2011; Strauss & Corbin, 1990);
c) The constant comparison of the codes and categories which emerge with subsequent data collected and also with concepts suggested by the literature ((Glaser & Strauss, 1967), in (Shaw, 1999); (Ritchie & Lewis, 2003)); and
d) The search for relationships among emerging categories of data (Marshall & Rossman, 2011; Ritchie & Lewis, 2003).

The following steps were taken:

The analysis process:

The process of analyzing the data collected for this research began as soon as the researcher started collecting data. Lofland (1971) explains that in qualitative research, researchers must begin analyzing the data obtained during the interviewing phase rather than at the end. By overlapping the phases of data collection and analysis, this researcher was able to simultaneously check and test ideas presented by the respondents (Marshall & Rossman, 2011) with the collection of further data. The emergent nature of the PfM concepts being explored suits this concurrency of data collection and analysis. Further, the volume of information expected (Patton, 2002) as a result of the qualitative methods used, required that analysis should not be delayed until the completion of the collection of primary data.

Familiarity with data:

The reading and re-reading of transcripts and field notes, served a double purpose. The first was to familiarise the researcher with the data (Easterby-Smith, 2002) and the second was to start the process of structuring and organizing the data. The familiarity created by reading and re-reading of transcripts and field notes improved the researcher's awareness of the patterns, themes and categories of meanings existing in the data (Patton, 2002; Ritchie & J. Lewis, 2003; Saunders, P. Lewis & Thornhill, 2009).

Confirming the findings:

During the process of collecting and analyzing the data, the findings were presented to informants. The purpose of presenting findings to informants was to ensure the understanding that emerged from the analysis was a valid representation of the perspectives of informants. In this way, research findings are given social validity (Adam & Schvaneveldt, 1991), that is, informants confirmed that the information presented back to them was a valid reflection of the perceptions they imparted about the practice of PfM.

Another reason was that the researcher also received feedback to re-evaluate his understanding as being necessary or not. By creating a situation in which research findings could be discussed with each informant, the researcher ensured a correct identification of meaningful and insightful themes in the data and whether the relationships between categories and the understanding which emerged was valid. A further reason for presenting findings back to informants was to exchange something in the form of information (interpretation of data). This enabled the researcher to maintain a good relationship with the informants and help them see the outcome of their contribution.

2.2.3.7 Reliability and Validity

Ritchie and Lewis (2003) describe reliability and validity as follows:

- *Reliability is generally understood to concern the replication of research findings and whether or not they would be repeated if another study, using the same or similar methods, was undertaken.*
- *Validity is traditionally understood to refer to the correctness or precision of a research reading.*

In qualitative research, the terms Confirmability, Consistency, or Dependability are preferred in place of Reliability. Also, terms such as Credibility, Plausibility, Applicability or Transferability are preferred in place of Validity (Lincoln & Guba, 1985; Ritchie & Lewis, 2003; Denzin & Lincoln, 2011)

To ensure reliability, the following procedures were undertaken: (Creswell, 2009)

- *Transcripts were checked to ensure they did not contain obvious mistakes made during transcription.*
- *The definition and meaning of codes were kept consistent by constantly checking and comparing codes.*

Validity (and the alternative terminology) is concerned with whether the findings can be applied in another situation that is sufficiently familiar to permit generalization. To ensure such transferability, the findings had to be evaluated to confirm whether they would remain applicable even if different people were involved. Given that no new data was being collected through the interview process, it can be concluded that the responses obtained from the respondents represented generally the practice of PfM in South African companies.

It can be concluded that the relevant measures were taken to ensure that the research was reliable and valid.

2.2.4 Objective 3: Develop a conceptual model as a solution to the problem of determining the cumulative contribution of portfolio components to organizational objectives.

According to (Egger & Carpi, n.d.), "modelling involves developing physical, conceptual, or computer-based representations of systems. Scientists build models to replicate systems in the real world through simplification, to perform an experiment that cannot be done in the real world, or to assemble several known ideas into a coherent whole to build and test hypotheses". They suggest that as a research method, it is necessary to define the system that is being modelled. This involves determining the boundaries for the model as well as the variables and their relationships. Once a model is built it can be tested using a given set of conditions (Egger & Carpi, n.d.).

Cooper & Schindler (2011: 67) defined a model as "a representation of a system that is constructed to study some aspect of that system or the system as a whole". They pointed out "models differ from theories in that a theory's role is explanation whereas a model's role is representation" (67). They further stated that, "a model's purpose is to increase our understanding, prediction and control of the complexities of the environment" (67). They also suggested that in business research, three types of models are typically found: a) descriptive, b) predictive and c) normative. Descriptive models are used more frequently to describe complex systems. Predictive models are used to forecast future events. Normative models are used for control – informing decision makers about the actions to be taken. The conceptual model in this research can be described as a descriptive model as it illustrates the complex relationship between portfolio components and organizational objectives and describes a process for determining the cumulative contribution of portfolio components to the respective objectives.

Models are developed through the use of inductive and deductive reasoning. “Inductive reasoning allows the modeller to draw conclusions from the facts or evidence in planning the dynamics of the model. The modeller may also use existing theory, managerial experience, judgment, or facts deduced from known laws of nature. … Deductive reasoning serves to create particular conclusions derived from general premises” (Cooper & Schindler, 2008:67). In this research, inductive and deductive reasoning were used in the development of the proposed model as it relied on existing theory, managerial experience, and judgement as well as learning from developing the model.

With regard to research model classification, the (University of Southampton, 2011) suggest that there is “no common agreement on the classification of research models” but propose the following five categories:

a) *Physical model: A physical model is a physical object shaped to look like the represented phenomenon, usually built to scale – such as small-scale versions of vehicles or buildings.*
b) *Theoretical model: This generally consists of a set of assumptions about some concept or system; is often formulated, developed and named on the basis of an analogy between the object or system that it describes and some other object or different system; and it is considered an approximation that is useful for certain purposes.*

c) *Mathematical model: A mathematical model refers to the use of mathematical equations to depict relationships between variables. It is an abstract model that uses mathematical language to describe the behaviour of a system.*

d) *Mechanical model: A mechanical (or computer) model tends to use concepts from the natural sciences, particularly physics, to provide analogues for social behaviour. It is often an extension of mathematical models.*

e) *Symbolic interactionist model: This is generally a simulation model. That is, it is based on artificial (contrived) situations, or structured concepts that correspond to real situations. It is characterised by symbols, change, interaction and empiricism, and is often used to examine human interaction in social settings.*

The model proposed in this research was aligned with the mathematical model category as it looked at the relationship between portfolio components and organizational objectives and computed the individual and cumulative contributions of portfolio components to organizational objectives. The conceptual model is described in detail in Chapter 5.

The application of the research onion for this objective is described in the following table.

Table 2.3: Application of research onion to objective 3

Onion layer	Application
Philosophy	Pragmatism was the philosophy adopted for the full research.
Approach	Developing the conceptual model involved inductive and deductive reasoning.
Strategy	A grounded theory strategy was adopted for this research.
Choice	Modelling was the third of three research methods used in this research.
Time horizon	The time horizon for the entire research is cross-sectional.
Techniques and procedures	Modelling.

2.2.5 Objective 4: Verify and validate the conceptual model

The purpose of verifying and validating a model was to prove consistency and accuracy of the model and to test the model so that confidence in the model can be attained. The model verification illustrated the mechanics of this model using actual components and objectives from a participating organisation. The verification process in Chapter 7 steps through the model presented in Chapter 5 to ensure that each step in the model is tested for accuracy and consistency. A subset of portfolio components and associated objectives from the participating organisation was chosen for the verification as the researcher wanted to test the model using actual instead of fictitious components and objectives.

When verifying the model, the impact of choices that decision-makers have when terminating one or more components, was illustrated. This was done by using the model to calculate the new combined contribution values after removing the component they wished to terminate. The verification process emphasised the benefit of the model as it improved decision making through calculating the individual and cumulative contribution of portfolio components.

The aim of the validation process was to obtain confidence that the model addressed the problem it was meant to address. The model's purpose, therefore, guided the validation process. The model presented in Chapter 5 was validated in terms of its ability to deliver predictable results under extreme conditions, its behaviour when circumstances change, and its ability - from a structural point of view - to enable decision-making. Three tests were selected to validate the model and these are discussed further in Chapter 8.

The validation process confirmed that the model fulfilled its purpose.

2.3 Conclusion

This chapter described the research design for the thesis. The research design was developed with the research objectives in mind. The research philosophy, approach, strategy, choice, time horizon, techniques and procedures applicable to the design for addressing each objective were discussed.

In this chapter, methods were explained that included a literature review to provide a context for PfM. Also explained was an extended literature review for preparing the semi structured interview instrument used to understand the practice of PfM in South Africa. The interview sources, procedure for administering the interviews and capturing the data, quality control of data, storing and safeguarding the data, ethical considerations, data analysis and ensuring the reliability and validity of the research were also presented. In addition, the concept of modelling and the verification and validation thereof was introduced in this chapter.

The goal of providing a map or guide for the remainder of the research in terms of the research process followed was achieved. This chapter's purpose was to describe the research methods used for each research objective.

Given the objectives of this research and the problem that had to be addressed, this research can be described as fundamentally interpretative: a) it used a deductive and an inductive approach, b) was cross-sectional, c) took place in the natural world, and d) required the use of multiple methods.

The next chapter addresses the first research objective by providing the context for PfM by a) reviewing the literature on PfM, b) discussing a definition for PfM, and c) presenting various theories related to PfM – all of which illustrate how these theories relate to or support PfM.

3 Chapter 3 – Literature Review

3.1 Introduction

PfM is an allied discipline of project management and can be contextualised through an understanding of the following established theories: a) modern portfolio theory, b) organizational theory, c) systems theory, d) multi-criteria utility theory and e) complexity theory. The relationship between these theories and PfM are discussed in this chapter.

The provision of a context for PfM is necessary in this chapter as the context provides a foundation for the remaining chapters in the thesis. PfM is not a self-standing theory and 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 above in the first paragraph.

The goal to provide the context for PfM is achieved by confirming its definition and by discussing the theories identified and illustrating their relevance to PfM. The literature pertaining to PfM as well as the related theories are 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 above. The chapter concludes with a summary and illustration of the inter-relationship of the theories with PfM.

3.2 Project portfolio management definition

In this section, a definition of PfM from various sources is presented. Key phrases that provide commonality among the definitions have been italicised. 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.

To place PfM in perspective, Jiang and Klein (1999) identified PfM as a discipline under the broader categorization of IS (Information Systems) planning which assists organisations in executing business plans and *realizing business goals*.

Cooper, Edgett and Kleinschmidt (2000:14) 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 prioritised*; *existing projects are accelerated, terminated, or de-prioritised*; and *resources are allocated and re-allocated to the active projects*.”

META Group (2002:3) defined the management of the IT 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 organisation’s return on IT investment*”. The META Group’s definition considered the broader aspects of IT beyond just projects, but the essence of portfolio management was maintained in the definition.

Leliveld and Jeffery (2003:3) 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 licences".

Maizlish and Handler (2005) 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.

Levine (2005:17) stated that project portfolio management was "the bridge between traditional operations management and project management". He defined project portfolio management as "the management of the project portfolio so as to maximise the *contribution of projects* to the overall welfare and *success of the enterprise*" (Levine, 2005:22).

Project Management Institute (2006, 2008b, 2013) defined PfM as the centralised or coordinated management of one or more portfolios, which included *identifying, prioritizing, authorizing, managing, and controlling* projects, programmes, and other related work, to *achieve specific strategic business objectives*. They recognised that "portfolio management produces valuable information to support or alter organizational strategies and investment decisions" (Project Management Institute, 2013:5) 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" (Project Management Institute, 2008b: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*" (Project Management Institute, 2013:9)

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, 2013:71) describes this process as "Optimize Portfolio" and describes this process as "evaluating the portfolio based on the organisation's selection criteria, … creating the portfolio component mix with the greatest potential to support the organizational strategy."

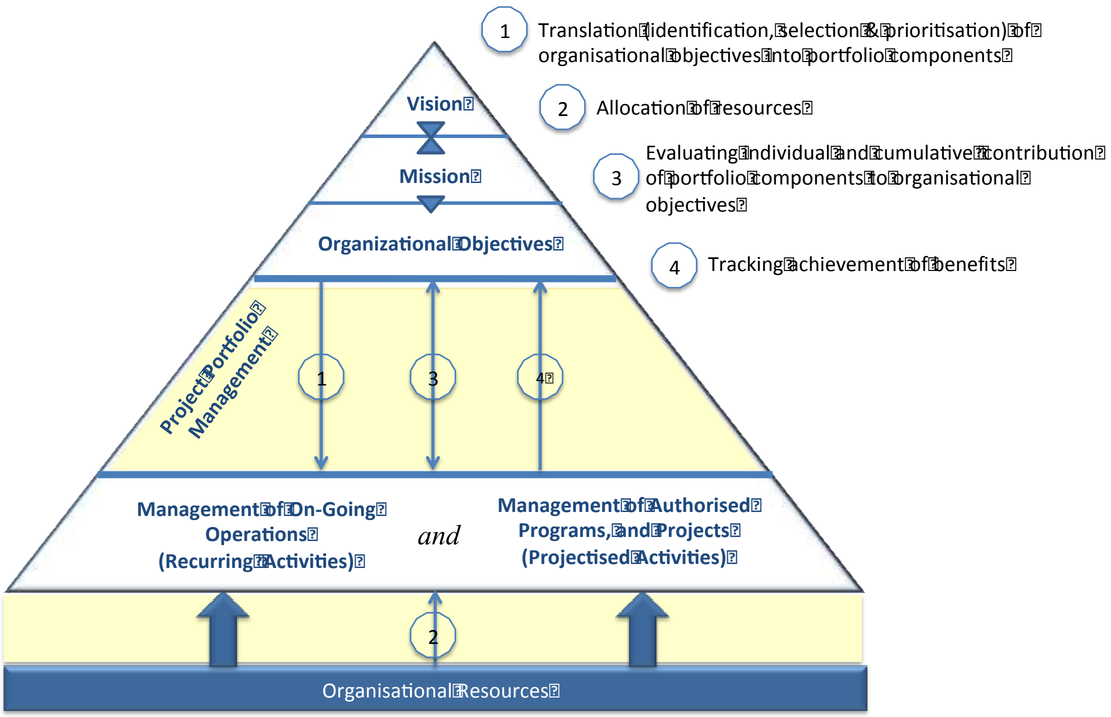
The key phrases from the preceding definitions that describe PfM and its impact are summarised as:

- *The **translation** of strategy and objectives (organizational objectives) into projects, programmes, 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.***

The following diagram is an adaptation of the organizational context for portfolio management from the 3rd edition of the *Standard for Portfolio Management* (2013:8). It illustrates the key aspects from the PfM definitions described above.

Figure 3.1: Project Portfolio Management depiction (adapted)



Source: Project Management Institute (2013)

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

- *Arrow (1) 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 (2) refers to the allocation of resources to prioritised components. Once a prioritised 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 (3) refers to the evaluation of portfolio components in terms of their individual and cumulative contribution to organizational objectives. An understanding of the individual 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 is addressed in Chapter 5.*
- *Arrow (4) 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 3.1 will be extended to incorporate these theories.

3.3 Modern Portfolio Theory (MPT)

3.3.1 Background

In the early 1950s, Harry Markowitz (Markowitz, 1952) began developing his theories on modern portfolio theory (MPT). In "applying the concepts of variance and co-variance, Markowitz showed that a diversified portfolio of financial assets could be optimised to deliver the maximum return for a given level of risk" (Goff & Teach, 2003). 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 (MPT)".

Markowitz (1999:5) 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 maximised a portfolio (E - d)/ σ, 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". 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 (Markowitz, 1999).

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 (1981), which argued that the fundamentals of modern portfolio theory could be applied to corporate technology assets. He identified deficiencies with Information Systems (IS) projects from personal experience in the 10 years prior to his article. These he summarised 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" (McFarlan, 1981:142). 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 towards reaching agreement on risks to be taken in line with corporate goals.

Further, McFarlan (1981) suggested that the selection of projects based on the risk profile of the portfolio could reduce the risk exposure to the organisation. However, McFarlan does not go into any detail regarding the portfolio management methodology, approach or definition but merely introduces the concept of portfolio management from a perspective of risk management. Nevertheless, the application of portfolio theory in a new field, specifically IT, has resulted in further study towards developing methods and standards for applying portfolio theory to PfM.

Verhoef (2002) suggested that MPT does not work for IT. According to Verhoef, IT investments are illiquid, that is they cannot be readily converted into cash. Liquidity is a necessary assumption for applying MPT. Nevertheless, trade articles such as that by Berinato (2001) and Ross (2005) recognised 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 (2003) 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.

Kersten and Ozdemir (2004) subsequently presented results of the application of Markowitz's modern portfolio theory (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" (Kersten and Ozdemir, 2004:10).

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” (Kersten and Ozdemir, 2004:10). 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.

Modern portfolio theory (MPT) is relevant for this research as it provides a financial investment metaphor that can be applied to project portfolio management. Projects, programmes 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, programmes and operational initiatives.

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

3.4 Multi Criteria Utility Theory (MCUT)

3.4.1 Background

According to Stewart and Mohamed (2002), many organisations 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 organisations adopting limited selection criteria lack confidence that their IT/IS projects will meet the organizational goals and objectives.

MCUT considers the decision-maker's preferences in the form of utility function, which is defined over a set of criteria (Goicoechea, Hansen, & Duckstein, 1982 as cited in Stewart and Mohamed (2002:258)). Utility is a measure of desirability or satisfaction and provides a uniform scale to compare tangible and intangible criteria (Ang & Tang, 1984 as cited in Stewart and Mohamed (2002:258)). A utility function quantifies the preferences of a decision maker by assigning a numerical index to varying levels of satisfaction of a criterion (Mustafa & Ryan, 1990 as cited in Stewart and Mohamed (2002:258)).

Stewart and Mohamed (2002) 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 (2002), the most common formulation of a multi-criteria utility function was the additive model (Keeney and Raiffa, 1993). 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 (2002) 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, organisation needs that the project proposes to meet, and also other benefits to the organisation 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, organisations 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 (1988) suggest the assessment of two domains - business and technology – as they state that these determine value and should include:

Business Domain Factors:

1. *Return on investment (ROI) – the cost benefit analysis plus the benefit created by the investment on other parts of the organisation.*
2. *Strategic match – the degree to which a proposed IT project supports the strategic aims of the organisation.*
3. *Competitive advantage – the degree to which IT projects create new business opportunity or facilitate business transformation.*
4. *Organizational risk – the degree to which a proposed IT project depends on new untested corporate skill, management capabilities and experience.*

Technology Domain Factors:

1. *Strategic architecture alignment – the degree to which the proposed IT project fits into the overall organisation structure.*
2. *Definition uncertainty risk – the degree to which the users' requirements are known.*
3. *Technical uncertainty risk – the readiness of the technical domain to embrace the IT project.*
4. *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 above, are factors that could be considered by an organisation as those that contribute towards the *Value* criterion being measured. An organisation 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. These criteria are further discussed in Chapter 7, which looks at the verification of the conceptual model.

Stewart and Mohamed (2002) discussed IT investment management process, project selection process and framework, IT investment evaluation, and multiple criteria decision-making. This is relevant to this research, as the research problem statement described in Chapter 1 refers to the evaluation of multiple criteria when assessing the contribution of portfolio components to organizational objectives, and MCUT contributes to the understanding of evaluating multiple criteria when determining the contribution of portfolio components to organizational objectives.

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

3.5 Organisation Theory

3.5.1 Background

Organisation theory has been defined as the “study of organizational designs and organizational structures, relationship of organisations with their external environment, and the behavior of managers and technocrats within organisations. It suggests ways in which an organisation can cope with rapid change.” (BusinessDictionary.com, n.d.)

Organisation theory has been developed over many decades with many authors contributing towards the body of knowledge on organisation theory. Many researchers (Dessler, 1980; Champoux, 2006; Daft, Murphy, & Willmott, 2010) attribute the foundation of organisation 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 (Organisations 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 organisation theory focused on organizational challenges such as competitive global market or globalization, demographic changes, social responsibility, diversity, and technological developments. Organisations are complex and varied and apply processes, structure and decision-making differently from each other.

Crowther and Green (2004: 16) stated that: “the earliest approach to organisation 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 organisations. Initially it was based upon the organisation of jobs within the organisation but later changed to organizing functions either within the organisation or within the wider environment in which the organisation operates”. In their research they described various approaches that have been applied in organisation theory over time. These include, Critical Approach, Postmodern Approach, Social Constructionism, and Environmentalism. They observed that organisations 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, (Daft, Murphy & Willmott, 2010:29) 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 organisations’ most important form of capital and the growing expectations of workers for meaningful work and opportunities for personal and professional growth”, require new responses or approaches to the problems faced by organisations.

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

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

3.6 Systems Theory

3.6.1 Background

A system was defined by Skyttner (1996:16-17) as "a set of interacting units or elements that form an integrated whole intended to perform some function … exhibits order, pattern and purpose". He further added that, "a system is distinguished from its parts by its organisation". According to Vidal and Marle (2008:1095), "a system is 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". 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 portfolio management.

Skyttner (1996:20) sums up the contributions of various authors to systems theory by describing the properties that make up GST as follows:

- *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 towards 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 labour.*
- *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 organisations.

Earlier, Hendrickson (1992) presented a dynamic system model to describe the fact that organisations are constantly changing due to internal and external factors, they act as open systems adapting to the broader environment, and the managers within organisations can anticipate and prepare for issues faced by their organisations. This is opposed to the traditional theory, which viewed organisations as closed systems that did not take into account environmental influences impacting the efficiency of organisations. Katz and Kahn (1978) as cited in Hendrickson (1992) expressed the view that organisation 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 above, 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.

Cusins (1994) stated that in systems theory, a system is a way of understanding any dynamic process, whether it is riding a bicycle, a biological process, an organisation, machine, or any other entity involving a dynamic process. Systems theory was therefore applied broadly across numerous disciplines.

Kerzner (2013:48) classified systems theory as "a management approach that attempts to integrate and unify scientific information across many fields of knowledge." He further stated that systems theory looks at the total picture when solving problems and that "it implies the creation of a management technique that is able to cut across many organizational disciplines …". He suggested that system thinking is vital for the success of a project, and by extension, the success of a programme and portfolio.

PfM draws from systems theory, as it is a dynamic management approach that considers the total organisation 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 organisation or its customers) using various techniques or mechanisms (e.g. projects and programmes) 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.

3.7 Complexity Theory

3.7.1 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 behaviour and structure emerge from simple underlying rules" (Cooke-Davies, Cicmil, Crawford, et al., 2007: 52)

Earlier, (Baccarini, 1996:202) proposed that "project complexity be defined as consisting of many varied interrelated parts and can be operationalized in terms of differentiation and interdependency". 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 which 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 organisation, technology, environment, information, decision-making, and systems” (Baccarini, 1996:202).

According to Manson (2001) complexity theory research can be divided into three categories: (1) Algorithmic complexity, (2) Deterministic complexity, and (3) Aggregate complexity. Aggregate complexity is relevant for this research and relates to how individual components of a system work together to create complex behaviour. Manson (2001) outlined the set of interrelated concepts that define a complex system. These included: a) relationships between entities, b) internal structure and surrounding environment, c) learning and emergent behaviour, and d) the different means by which complex systems change and grow.

The behaviour of complex systems, according to Solow and Szmerekovsky (2006) is affected greatly by the central organisation, which exerts control over the agents of the system. The amount of this control towards achieving optimal performance must be determined as this has implications for the system. They added that leadership in an organisation must be aware of how the actions and decisions in one functional area affect the performance of other functional areas. This included decisions regarding projects, programmes 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.

According to Vidal, Marle and Bocquet (2010), project complexity can be characterised by factors classified into four families. They suggested that all are necessary but are not sufficient conditions for project complexity. The first family encompasses project size factors. The second gathers factors of project variety. The third gathers those that are relative to the inter-dependencies and inter-relations within the project system. The fourth deals with project complexity and are context-dependent.

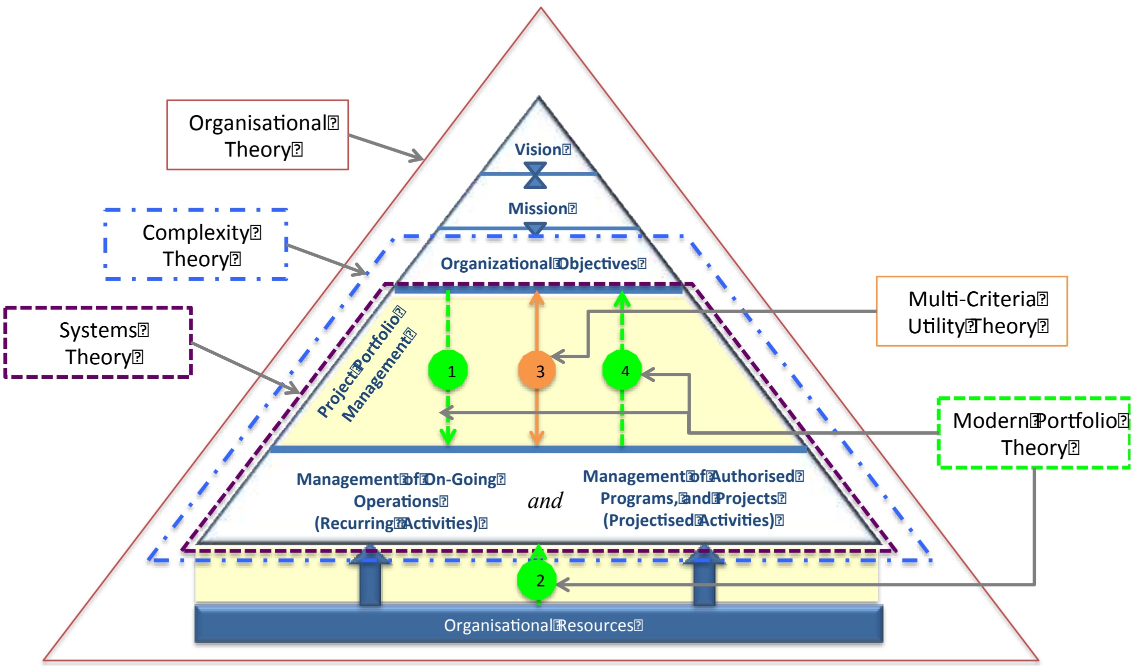
In many organisations today, a multitude of projects, programmes, and operational activities (portfolio components) are initiated, some having a direct inter-dependency while others have an indirect inter-dependency. This implies that in one way or another, changes in projects within an organisation have an impact on other projects within the same organisation as a result of various types on inter-dependencies 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 summarises the aforementioned theories as they apply to PfM.

3.8 Project portfolio management theoretical foundations

The diagram in Figure 3.2 below is used to illustrate the theories that support PfM.

Figure 3.2: Theories related to project portfolio management (adapted)



Source: Project Management Institute (2013)

In summary, Figure 3.2 illustrates the key elements from each theory relevant to PfM. These are:

- *Modern Portfolio Theory – provides the investment management metaphor applied in PfM. From Figure 3.2 the identification of portfolio components (1); the allocation of organizational resources (2); and the realization of benefits (4) in the diagram are aligned to the MPT philosophy.*
- *Multi-Criteria Utility Theory – 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 (3) in the diagram.

- *Organisation Theory refers to the organisation designs, structures, relationship of organisations with their external environment, and the behaviour of managers and technocrats within organisations. Organisation theory applies to the whole organisation. PfM is a capability within the organisation 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 organisation design, structure, relationships and behaviour or culture of its people.*
- *Complexity Theory – The inter-dependent relationships among portfolio components and the relationships between portfolio components and organizational objectives result in a complex portfolio management 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 organisation or its customers) using project, programme and operational techniques, and provides feedback in terms of achievement of the strategy through performance measurement.*

3.9 Conclusion

The purpose of this chapter was to address the first research objective, which 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 Modern Portfolio theory, Multi-Criteria Utility theory, Organisation 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. A diagram representing the definition of PfM was presented at the end of that section 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. 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 context of PfM, as presented in this chapter, provided a strong foundation for the remainder of the thesis. The thrust of this research is to develop 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, are considered in the development of the conceptual model presented in Chapter 5.

The following chapter addresses the next research objective, which is the investigation into the practice of PfM in South African organisations.

4 Chapter 4 – An investigation into the practice of project portfolio management

4.1 Introduction

The previous chapter addressed the first research objective by providing a context for PfM by the construction of a definition for PfM and an exploration of theories that relate to PfM. During the past decade, a substantial body of knowledge has been developed in the area of PfM. Books, articles and white papers - some of which have already been referenced in the first three chapters of this thesis - have been published on the topic.

The goal of this chapter is to focus on the second research objective, which is, to investigate the practice of PfM in South Africa for an insight into the alignment between current literature and practice. Drawing this comparison helps practitioners and researchers understand the practical implications of models or approaches presented in literature. Such a comparison may also reveal a good practice, which may need to be incorporated into literature through research.

To achieve the goal stated in the previous paragraph, the following objectives were needed: a) Collect data on the practice of PfM in South African organisations; b) Provide a comparative analysis between the literature and practice of PfM; and c) Identify key issues that need to be addressed by the conceptual model developed in this thesis.

The remaining sections of this chapter include an extended literature review specific to the preparation of the interview instrument in this chapter and a discussion on the findings of the investigation into the practice of PfM in South Africa.

4.2 Extended literature review

In this section, notable contributions to the body of knowledge of PfM are reviewed to identify key themes for the interview instrument. This will be followed by a discussion on the concept of practice as the focus of this chapter is on the investigation into the practice of PfM. The latter part of this section discusses the preparation of the interview instrument used in the investigation, a discussion on the responses received, a comparison between key findings in practice with literature, and finally, an explanation for the differences between literature and practice.

4.2.1 Contributing literature to the body of knowledge of PfM

The Free Dictionary (n.d.) defined literature as “the body of written work produced by scholars or researchers in a given field”. Various authors have made contributions to the body of knowledge of PfM for more than a decade. The following authors included in some of these key contributions were:

Kersten and Verhoef (2003:27) discussed IT PfM from a banking perspective. They noted, “in 1996, the US Congress passed the Clinger-Cohen Act, which compels government decision makers to adopt a portfolio approach to IT investments”. They recognised that with the rising costs of IT, the Act had the advantage of forcing decision-makers to not only take a short-term perspective, but to also develop an overall vision, taking into account the balance of the portfolio in terms of risk, technology, payback period, capital allocation, and distribution.

Jeffrey and Leliveld (2004) developed an IT portfolio management tool for assessing best practice in IT PfM which segmented a company’s IT portfolio into four stages – ad hoc, defined, managed, and synchronized. Their findings from their research were that 4.5% of companies interviewed were at the ad hoc stage, 24.5% at defined stage, 54%

at the managed stage, and 17% at the synchronized stage. To understand the significance of the findings, a brief description from the article on each stage is presented here: 1) At the Ad Hoc stage, companies are making decisions regarding the PfM investments in an uncoordinated manner resulting in similar portfolio components being authorized in different parts of the business. 2) Companies at the Defined stage have identified and documented key components of their IT portfolios, estimating each element's costs and benefits. 3) At the Managed stage, companies have a standardized IT PfM process that enables objective project selection with a clear link to business strategy. 4) Companies in the Synchronized stage have the ability to align investment portfolios with business strategy. Such companies measure project value through their life cycle, weeding out underperforming initiatives.

Pennypacker (2005) developed a Project Portfolio Management Maturity Model to help organisations improve the capability of their PfM processes. The model a) provides practices to determine the maturity of an organisation's PfM processes, b) maps out a path to improve PfM processes, c) sets priorities for short-term process improvement actions, assesses the role of a project office in PfM, d) tracks progress against PfM improvement plan, and e) builds a culture of PfM excellence across the organisation.

Maizlish and Handler (2005) noted that the practical aspects of PfM were not obvious, or widely accepted, and that few companies maintained an active PfM practice. They added, however, that there were elements of PfM that existed in all companies and that most companies utilised simple and straightforward financial models to make investment decisions.

Bonham (2005) linked modern financial portfolio theory to IT project and programme management approaches. He also introduced asset, architecture, resource, and knowledge (AARK) management as core processes to enable the IT PMO (Portfolio Management Office) to support PfM. Much of the discussion in his book is centred on the IT PMO.

Levine (2005) offered a practical guide to PfM recognizing that the project portfolio lifespan extends well beyond that of a project and includes identification of needs and opportunities and the realization of benefits.

D'Amico (2005) advocated managing IT projects like an investment portfolio. Important observations from his article include: 1) The need for a clear definition of corporate strategic goals in order for PfM to be effective, 2) the need for some type of scoring system to prioritise projects, and 3) the need to re-evaluate projects regularly as a way of actively managing the portfolio.

Martinsuo and Lehtonen (2007) discussed the role of single project management in achieving portfolio management efficiency. The results of their research imply that "an understanding of portfolio-level issues needs to be considered as part of a project manager's capabilities rather than remain only a top management concern" Martinsuo and Lehtonen (2007:56).

Blichfeldt and Eskerod (2008) found that although organisations manage project portfolios using project portfolio theory, they still experience problems such as delayed projects, resource issues, and a lack of overview of the projects. They found that a key reason was that PfM was only applied to a subset of on-going projects. Projects that were not part of the portfolio utilise the same resources as projects that were part of the portfolio, resulting in an impact on the portfolio. Their assessment was that the practice of PfM was therefore deficient.

Montibeller et al. (2009) discussed the use of multiple criteria portfolio analysis models in resource allocation and suggested that such models helped decision-makers identify options that generated greater value for the organisation. They recognized, however, that there were still several unexplored opportunities and suggested the need for further research in this area.

More recently, authors such as Killen et al. (2012) and Martinsuo (2012) discussed the application of strategic management theories to PfM research and recognised that despite good practices being implemented for PfM, companies still struggled with sub-optimal performance.

A key contribution to this research was the Standard for Portfolio Management (Project Management Institute, 2006, 2008b, 2013). The *Standard* represents generally accepted good practice in PfM and it provides a common language or vocabulary within the PfM profession for applying the PfM processes and concepts. Since the *Standard* is developed through the contribution of practitioners, it bridges the gap between a purely theoretical perspective on PfM and the practice of PfM.

To summarise, while the review of the literature indicated that various authors emphasized different aspects of - or approaches to - PfM, many recognized that despite the available literature, there still was a gap between literature and practice.

4.2.2 The concept of practice

Wenger (1999:45) describes the concept of practice as a result of collective learning that "reflects the pursuit of enterprises" - which he described earlier as being anything from ensuring physical survival to seeking lofty pleasures – "and social relations".

Using the example of claims processors, he states that “the collective construction of a local practice ... makes it possible to meet the demands of the institution” and that the “claims processors make the job possible by inventing and maintaining ways of squaring institutional demands with the shifting reality of actual situations”. He goes on to describe the concept of practice as that which “connotes doing ... in a historical and social context that gives structure and meaning to what we do” Wenger (1999:46).

In essence, the above description is the meaning of practice as it would relate to any discipline or context and, therefore, is applicable to understanding the practice of PfM by the organisations represented in this study.

The extent to which PfM is used in South African organisations was considered unknown before this research as no literature could be found on it. It was therefore necessary to conduct an investigation among organisations in South Africa to determine how PfM was practiced and compare it with the literature to determine the alignment between literature and practice. For this task, a semi structured interview was conducted with respondents from various companies and industries. The data collection procedure, quality control, and analysis were discussed in detail in Chapter 3 and will not be repeated here; however, the preparation of the interview instrument and a summary of the responses received are presented in the next two sections.

4.2.3 Preparing the interview instrument

To assess the practice of PfM, the researcher recognized the need to frame the interview questions in the context of PfM literature. It was decided to use the PMI’s second edition of the *Standard for portfolio management*, (Project Management Institute, 2008b), specifically as the topics it contained provided a documented set of processes that were recognized in the discipline of PfM. The *Standard* was also developed through contributions from more than 400 volunteers across 36 countries over a three- to five-year period. The content, therefore, is a collective consensus that extends beyond the views of select individuals such as authors mentioned already. Furthermore, this edition of the *Standard* was published at the time the interview instrument was being designed and it therefore represented the most recent publication on PfM at that time.

The *Standard for portfolio management* provides guidelines for the portfolio management processes, tools and techniques and discusses knowledge areas such as governance and risk management. The *Standard* addresses the topics that would be of interest to practitioners, such as the link between portfolio management and organizational governance, strategy, operations management, and project and programme management.

The purpose of the *Standard*, as outlined by the Project Management Institute (2008b: 3), is to “describe generally recognized good practices associated with portfolio management”. It focuses on portfolio management “as it relates to the disciplines of project and program management” and is an expansion to *A guide to the project management body of knowledge* (Project Management Institute, 2008c), which suggests that the development of the *Standard* was written from a project management perspective. This can be interpreted as a bottom-up approach. Other frameworks, such as the V2P framework, (Marnewick & Labuschagne, 2008), suggested a top-down approach. For the purpose of this investigation, however, the *Standard* provides a strong point of reference for PfM and was suitable for developing the interview instrument.

Table 4.1 describes the themes (presented in the *Standard* as section headings) used to formulate the questions in the interview instrument. While the literature was reviewed in preparation for developing the interview instrument, the *Standard* was the primary source used to develop the specific themes and questions in the interview instrument. In Table 4.1, the theme, a brief description of the theme, and the questions used in the interview instrument and related to the theme are presented.

As a point of clarification, the tables and sections that follow in this chapter, refer to the term “initiatives”. At the time of conducting this investigation, this term was used as a collective term for projects, programmes, and operational activities. Subsequently, the phrase “portfolio components” replaced the term “initiatives” to align with terminology used in more recent literature (e.g. 3rd edition of the *Standard for portfolio management*).

Table 4.1 - Interview themes

Themes (T)	**Brief Summary**	**Interview Question (Q)**
T1. Organizational 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.	Q1. What process does your organisation follow to translate its strategic objectives into initiatives? Q2. Briefly explain the process used to select initiatives.
T2. Organizational Governance	Governance establishes the limits of power, rules of conduct and protocols of work that organisations can use effectively to advance strategic goals and objectives. Here the researcher wanted to determine the existence of a governing body that took on the responsibility for selecting initiatives as well as overseeing the performance of those initiatives.	Q3. Who is responsible for the selection and overall management of these initiatives? Q4. What are the responsibilities of the individual/committee?
T3. Operations Management	Operational budget may be influenced by portfolio management decisions – including allocation of resources to support portfolio components. Distinguishing work into project and non-project activities has a bearing on how budget is allocated.	Q5. Explain the process to approve and fund initiatives. Q6. What criteria do you use to distinguish between project and non-project activities?

Themes (T)	**Brief Summary**	**Interview Question (Q)**
T4. Organizational Impacts	Portfolio management interacts with and impacts on a number of organizational functions. The achievement of portfolio objectives may impact functional groups within an organisation.	Q7. Explain how you deal with the impact of initiatives on organizational structure and culture.
T5. Planning & Maintenance	The alignment process deals with the identification, categorization, evaluation, selection, prioritization and authorization of initiatives.	Q8. What criteria are used to prioritize initiatives? Q9. Explain how resources are managed across initiatives. Q10. Explain the process to approve and fund *new* initiatives.
T6. Role of the Portfolio Manager	A senior manager responsible for prioritizing projects, measuring value to the organisation (benefits realization), communicating portfolio performance to stakeholders and reviewing project and programme progress.	Q11. What are the responsibilities of the individual who oversees a group of initiatives?
T7. Performance Measurement/ Metrics	Aggregate measures of strategic goal achievement, financial contribution, asset maintenance and development, end user satisfaction, stakeholder satisfaction, risk profile and resource capability.	Q12. Are the benefits that are to be achieved through these initiatives documented at the start of the initiatives? Q13. Does the business track or measure the benefits that are being realized through these initiatives?

The next section covers the findings based on the analysis of the transcribed interviews.

4.2.4 Key findings from the interviews

In the following paragraphs the general consensus of respondents to the questions posed is described, except where it was deemed necessary to describe the specific practice of one or more organisations.

Theme: T1. Organizational strategy

Q1. Translation of strategy

Strategic goals and objectives were generally set by the executive committee or board and reviewed annually in all organisations. The initiatives planned for the coming year were identified by business division or function heads, who attempted to address day-to-day needs such as compliance, legislation, enhancing profitability, reducing cost and improving pricing. From the strategy translation process described by the respondents, only two respondents (representing two different organisations in the same industry sector) indicated a process that closely resembled a direct translation of strategy into initiatives as opposed to identifying initiatives and then trying to justify them back to the strategic objectives.

Q2. Process to select initiatives

Business division or function heads identify the initiatives they wish to run. These initiatives are then submitted to a committee for approval. In organisations where the process is administered by a project office, a consolidated list across business divisions is collated and submitted to the committee for approval.

One organisation develops key themes and uses a ranking mechanism to select initiatives. With regard to the other organisations, however, affordability is the final determinant on which initiatives are approved. In other words, the executive management decides on how much they want to spend on projects and programmes in a given year and the wish list of projects and programmes is trimmed until it meets the affordability amount.

Theme: T2. Organizational Governance

Q3. Responsibility for selection of initiatives

The selection of initiatives that are approved for funding is done by a governance body or committee which is made up of a subset of an executive committee and which includes business division heads and executive committee representatives. The names given to these committees include "Programmes of Work", "Investment Committee", "Strategic Initiatives Investment Committee", "Change Council" and "PRIORC Committee" and will hereafter be referred to collectively as "investment committee".

Q4. Responsibilities of the initiative selection committee

The responsibilities of these committees include evaluating (initiative) options, making tradeoffs between initiatives, tracking the progress of initiatives and ensuring that the budget is utilized or apportioned appropriately.

Theme: T3. Operations Management

Q5. Funding the initiatives

In the financial services sector, a forecast is made for the following year, listing all the projects and associated budget requirements at a very low level of confidence. The overall budget (total spend for initiatives) is decided at an executive level and apportioned to the various business divisions generally based on the size of the division. Through a process of arbitrage, the investment committee (refer to Question 3) decides which projects are important enough to get funding.

One organisation relies on an allocation of funds from Treasury to cover operational expenses. After allocating funds to the operational budget of the organisation, an amount is made available for initiatives and is allocated according to the ranked order of these initiatives.

At one of the insurance companies, the total fund for initiatives is calculated as a percentage of net earned income and is split into three categories, namely strategic initiatives, other projects and maintenance/support.

Q6. Distinguishing between project and non-project initiatives

In distinguishing between project and non-project initiatives, the criteria used by the various organisations included: a) defined start and end date, b) a budget threshold, c) cross-divisional impact, and d) duration.

Theme: T4. Organizational Impacts

Q7. Managing change

Apart from one organisation, all other organisations indicated that they have a change management function that controls change in the organisation. One respondent distinguished tactical change from strategic change and acknowledged that change management at a strategic level in their organisation was non-existent.

Theme: T5. Planning and Maintenance

Q8. Criteria for prioritizing initiatives

Different organisations use different criteria for prioritizing initiatives. Below is a consolidated list of criteria used across the various organisations:

1. *Strategic enablement* – Will the initiative meet the strategic objectives of the organisation?
2. *Impact* – How will the initiative influence the efficiency and effectiveness of the organisation?
3. *Affordability* – Does the organisation have the funds to embark on the initiative?
4. *Capacity* – Does the organisation have the resources to work on the initiative?
5. *Regulatory compliance* – Does the organisation have a choice whether to implement or not?
6. *Complexity* – Is the initiative and its context well understood?
7. *Business need or benefit* – What will be the value of the completed initiative?
8. *Financial measures* – Is this a worthy investment based on the internal rate of return (IRR), return on investment (ROI) and net present value (NPV)?

It was found that only two organisations use a weighted scoring system to prioritize their initiatives.

Q9. Allocating and managing resources across initiatives

Different approaches are used across the organisations. In one organisation, resources are drawn from a centre of excellence to work on initiatives. Another organisation organizes their resources according to specific disciplines (project management, business analysis, development and testing) and resources are allocated from these centres of excellence to portfolios. The allocation of business resources, however, was considered poorly done by most interviewees.

Another organisation uses a central pool of resources that includes a secondment of business resources for use on initiatives. Only one organisation uses a portfolio management tool to manage the allocation of resources.

Other organisations allocate resources from the relevant business areas. Resource utilization is not levelled. Individuals are expected to manage their time across multiple initiatives which results in missed deadlines and delayed projects due to multi-tasking across a number of projects.

Q10. Approving and funding new initiatives

Business divisions, through their portfolio manager, submit requests for new initiatives either at the monthly progress meetings or quarterly revised estimate meetings as part of the formalised budgeting process in the financial services sector specifically.
As far as possible, the portfolio budget is not increased. This requires their portfolio managers to reprioritize initiatives within their portfolios while maintaining the affordability constraint.

In one organisation, initiatives that are underway are allowed to continue. Any new initiatives are only prioritized against those initiatives that have not started. Another organisation applies the same rigour to any new initiatives as it does in the forecasting process at the beginning of the year. It uses its scoring system to verify the importance of the new initiatives against other initiatives; then it approaches Treasury for additional funds or delays other initiatives in favour of the new, more critical initiative.

All organisations use a business case to justify the initiatives. If it is justified to run the initiative in the current financial year, the organisation attempts to use the budget allocated for initiatives for the current financial year and include the new initiative into the portfolio mix. This may require delaying other initiatives either totally or in part to reallocate funds from existing initiatives to the new one.

Theme: T6. Role of the portfolio manager

Q11. Responsibility of the person overseeing a group of initiatives

In one of the organisations, the responsibilities of the person overseeing a group of initiatives include meeting objectives, delivering benefit, managing risks and dependencies and managing stakeholders.

In organisations within the financial services sector, such a person is given the title of Portfolio Manager; however, the responsibilities are centred on a line management function within a functional competency. The business analysts, for example, report to a business analysis (BA) portfolio manager who manages the BA resources and the quality of their deliverables. The portfolio manager manages project managers and is responsible for project budgets within the portfolio.

In one organisation, the responsibility of overseeing initiatives lies with the CIO and the head of the project office. Programme managers sometimes play a role in overseeing a group of initiatives depending on the scope of the initiatives. The remaining organisations use a programme manager to fulfill this function. The role of a portfolio manager does not exist in these organisations.

Theme: T7. Performance measurement / metrics

Q12. Benefit specification and **Q13. Benefit realization tracking**

All of the organisations interviewed said that the benefits associated with an initiative are specified in the business case; however, benefit realization tracking is done in only two of the 15 organisations.

One of the respondents from a financial services organisation suggested that benefits are postulated and based on many assumptions. In his 20 years of experience, he had never come across an initiative where the calculated benefit was realized. He suggested that the only value that could be derived is the learning experience gained about which areas in the organisation estimate the benefits more accurately.

One of the C-level executives did not see the need for tracking benefit realization. He felt that the achievement of benefits, or the lack thereof, does not change the fact that money has already been spent. He viewed benefit tracking as a means for punitive action rather than a part of organizational learning.

4.2.5 Responses to additional questions

Interviewees were also asked whether or not they used a portfolio management model for the purposes of PfM. Some organisations developed a portfolio management approach internally but none of the respondents were aware of the *Standard for portfolio management* or any other formal model or approach from literature. All respondents were aware of and most used a formal *project* management standard or methodology – either the PMBoK® guide or the Prince 2® methodology. At least three respondents confused a project management methodology for a portfolio management methodology.

With regard to the effectiveness of the approach being used in the respective organisations, most respondents indicated that their approach worked for them and was “fit for purpose”. One respondent felt, however, that the use of a model and appropriate tools would improve the strategic alignment and determination of spend. Another respondent indicated that while the current approach provided some structure, more could be done towards optimizing the execution of strategic objectives.

In the next section a comparison is drawn between the literature and practice (as determined from the interview responses) by tabulating the literature and practice codes used in the preceding sections as well as observations from the preliminary findings. The third column indicates whether a gap exists.

4.3 Project Portfolio Management Literature versus Practice

In Table 4.2 (pages 80-82), the comparison between the themes deduced from the *Standard* and the practice in organisations is illustrated. From the table it can be determined that there are indeed gaps between PfM literature and practice. In summary, the following observations were made from the interviews and analysis of the transcripts:

1. *While PfM is being considered and tried in some form in organisations, none of the organisations interviewed recognised any formal approach, model or methodology that they could adopt. The role of the portfolio manager appears to be merely a line function (next level of reporting) for project and programme managers. Although some organisations exercise some rigour around their*

budgeting process, their mechanism for ensuring the creation and identification of initiatives following strategy definition is weak, if not lacking completely.

2. *The selection, prioritization and authorization of initiatives are left to the subjective defense of business area executives. There is a lack of forced ranking of initiatives across business areas to ensure that only the most strategically aligned initiatives are run. It was illustrated by an executive in one of the banks during the interview that projects (initiatives) address tactical problems and, as a result, more resources are allocated to tactical endeavours rather than addressing the strategic objectives.*

3. *It can be argued that despite the focus of investment on tactical problems as opposed to achieving strategic objectives, organisations are still successful. However, organisations may be successful for other reasons, such as a unique product offering, service or presence in the market. One respondent reported, however, that their organisation achieved increasing success since adopting a portfolio management approach and getting better alignment of initiatives with strategic objectives.*

4. *The literature of PfM has developed substantially over the past decade and while there is still a need for scientific contribution to the theory, the existing body of knowledge provides a useful reference for practitioners. Despite the available literature, however, the practice of PfM is limited in its implementation and, therefore, requires further investigation.*

5. *A notable observation was the fact that poor decision-making regarding the management of the portfolio was being made due to a lack of understanding of*

the contribution that portfolio components made towards the achievement of organizational objectives.

It can be concluded from this investigation that there are gaps between literature and practice in PfM and these gaps need to be addressed. These include the translation of strategy into executable initiatives, the categorization of initiatives using a common set of decision filters and criteria, identification and management of portfolio risks, prioritization of initiatives across portfolios as opposed to only within portfolios, balancing portfolios and monitoring and responding to business strategy changes.

Table 4.2 – A Comparison of Theory versus Practice

Literature (Themes)	Practice (Questions)	Existence of Gap (Y/N)	Comment/Observation
T1 Organizational Strategy	Q1. What process does your organisation follow to translate its strategic objectives into initiatives?	Y	Except for one organisation, the direct translation of strategy into initiatives is not practiced.
	Q2. Briefly explain the process used to select initiatives.	Y	The process for selecting initiatives in practice is flawed as focus is given to addressing the tactical needs of the organisation rather than the strategic needs.
T2 Organizational Governance	Q3. Who is responsible for the selection and overall management of these initiatives?	N	Governance bodies in the form of committees exist to make decisions regarding the selection of and budget approval for initiatives.
	Q4. What are the responsibilities of the individual/committee?	N	The committees set up to perform the governance regarding budget approval for initiatives carry out their mandate as required by the respective organisations.
T3 Operations Management	Q5. Explain the process to approve and fund initiatives.	Y	In practice, the amount to be spent on initiatives in any given year is decided at a higher level than the designated portfolio management. Finances are apportioned to different business divisions, which then fund the initiatives as they see fit. As a result, owing to a lack of forced ranking of initiatives across divisions, some initiatives in one division enjoy funding while other more important initiatives in another division are overlooked.

Literature (Themes)	Practice (Questions)	Existence of Gap (Y/N)	Comment/Observation
T3 Operations Management	Q6. What criteria do you use to distinguish between project and non-project activities?	Y	The *Standard*[5] defines a portfolio to include programs, projects and other work (including the management of ongoing, recurring operational activities); in practice, ongoing operational activities are not included in portfolios.
T4 Organizational Impacts	Q7. Explain how you deal with the impact of initiatives on organizational structure and culture.	N	The *Standard* does not explicitly include change management processes but acknowledges that the achievement of the portfolio objectives will impact the business divisions within an organisation. With the exception of one organisation, the change management capability for individual projects and programs exists in organisations.
T5 Planning & Maintenance	Q8. What criteria are used to prioritize initiatives?	Y	The *Standard* states that the criteria used must be defined by the organisation and that the prioritization activities include classification of components according to strategic categories, assignment of weighted scores for ranking components and the determination of priority within the portfolio. This is achieved partially in practice. Organisations do use criteria but from the lists provided, strategic categories are not obvious.
	Q9. Explain how resources are managed across initiatives.	N	Every organisation attempts to manage resource allocation to initiatives but is constrained by the adequate availability of sufficiently skilled resources. While different approaches are followed for allocating and managing resources, no gap between theory and practice is evident.

[5] This reference refers to the second edition of the Standard for Portfolio Management

Literature (Themes)	**Practice (Questions)**	**Existence of Gap (Y/N)**	**Comment/Observation**
T5 Planning & Maintenance	Q10. Explain the process to approve and fund *new* initiatives.	Y	Under the Monitor Business Strategy Changes process step in the *Standard*, only a significant change in strategic direction will impact component categorization or prioritization, which will require rebalancing the portfolio. In practice, a significant change in strategic direction is not required for new initiatives to be considered. As long as the initiative can be justified through a business case and the funds can be made available, the initiative is approved.
T6 Role of the Portfolio Manager	Q11. What are the responsibilities of the individual who oversees a group of initiatives?	Y	The role of the portfolio manager is outlined in the *Standard*. In organisations with a portfolio management role, the responsibilities are limited to fulfilling a line function role within a project management competency.
T7 Performance Measurement / Metrics	Q12. Are the benefits that are to be achieved through these initiatives documented at the start of the initiatives? Q13. Does the business track or measure the benefits that are being realized through these initiatives?	Y	According to the *Standard*, the portfolio manager is responsible for measuring and monitoring the value to the organisation through key performance indicators. In practice, while benefits are specified in the business case, there is a lack of effort in tracking the achievement of the stated benefits.

In addition to the above, the following are some explanations derived from comments made during interviews for the existence of these gaps:

1. In some organisations the need for PfM often originated from senior management as a mechanism to collectively manage several initiatives in order to achieve a specific result. This constitutes a top-down approach to the development of an organizational PfM framework. In other organisations PfM originated from middle management as a mechanism to conveniently group together initiatives to have better control over resources and to track their progress. This constitutes a bottom-up development of an organizational PfM framework. These two divergent points of origin would lead to different frameworks being developed.

2. Some participants were of the opinion that all initiatives collectively form a single portfolio as it is the collective interaction between the components that leads to organizational results. Others supported multiple portfolios based on the range of products (e.g. home loans, vehicle finance and credit cards in a retail bank). Still others viewed portfolios according to strategic goals or drivers having each goal represented by a portfolio with all related initiatives across business functions being managed within that portfolio. The underlying view of a singular versus multiple portfolios would influence the resulting PfM framework.

3. Several participants indicated that the development and incorporation of PfM into their organisations were exacerbated by factors such as constantly changing organisation structures, immature project management practices and internal politics. Many also commented on senior management's lack of

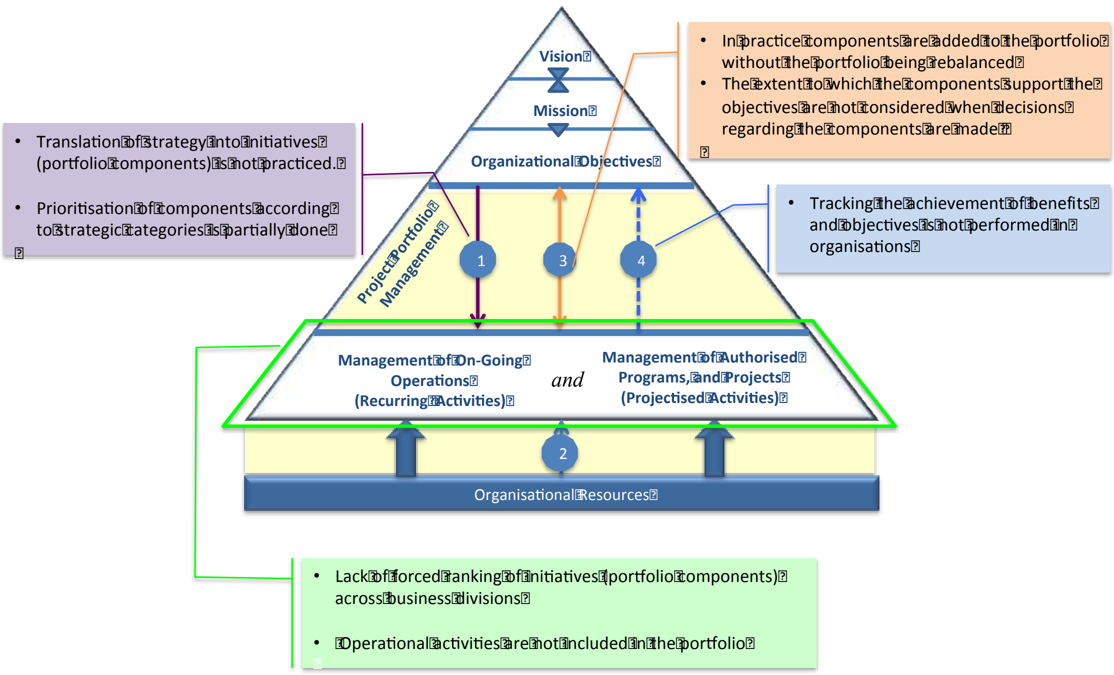
understanding of what PfM was. This indicates that both project management maturity and organizational maturity impact the practice of PfM.

4. None of the respondents interviewed acknowledged awareness of the portfolio management standard or any other formal model or approach. In organisations where PfM was actively being pursued, the approach was developed in-house. Practice was therefore based on need rather than on theory or existing literature. This suggests that there is still a lack of awareness of PfM in allied disciplines.

5. Even though PfM has a relatively substantial body of knowledge (journal and conference papers, White Papers, standards and books), a comprehensive awareness and understanding (knowledge) of what PfM entails is lacking. This is evident from the absence of:
    a. a competency development framework for portfolio managers
    b. formal certification of portfolio managers
    c. empirical evidence on the value of portfolio management

Following on from the definition of PfM in Chapter 3, the diagram that represented the context for PfM is used here to illustrate the gaps between literature and practice (Figure 4.1). A fundamental aspect that is required to address these gaps is an understanding of the relationship between portfolio components and organizational objectives. For example, a) in translating strategy to portfolio components requires a mapping of the organizational objectives and the components that support or contribute to the objectives; b) tracking or monitoring the achievement of objectives is possible when the organisation monitors the delivery of contributing components to the relevant objectives; c) decisions related to rebalancing the portfolio, specifically regarding which components to accelerate, suspend, or terminate is possible when the degree of contribution of portfolio components to organizational objectives is understood.

Figure 4.1: Gaps between literature and practice



The relationships between portfolio components and organizational objectives are further explored in Chapter 5 of this thesis.

4.4 Conclusion

This chapter focused on the second research objective, which was, to investigate the practice of PfM in South African organisations. The purpose of this investigation was to understand how organisations practiced PfM, their use or alignment to literature and to identify any key issues that needed to be resolved through scientific research.

The investigation into the practice of PfM was done by interviewing a number of respondents from various organisations in South Africa. A semi structured interview tool was used to gather the data and the data was qualitatively analysed using a computer assisted qualitative data analysis software (CAQDAS) tool. This involved transcribing the digitally recorded interviews, confirming the correctness of the transcripts, checking items with respondents for clarification, and coding the transcripts. Once the data analysis was complete, the researcher proceeded to do a comparative analysis between the literature and the findings from the investigation into the practice of PfM.

The purpose of this chapter was achieved as the interview process revealed how PfM is practised. The comparative analysis showed that gaps between literature and practice exist. Further analysis of the data and observations from the interviews revealed reasons for the gaps and an opportunity to solve a problem related to portfolio management decision-making. The chapter objectives and goal were thus achieved.

The key learning from the investigation into the practice on PfM was that decision-making in organisations is flawed due to executive management making decisions regarding portfolio components without understanding the contribution these portfolio components make to achieving organizational objectives. As a result, they are unaware of the impact of those decisions on the achievement of organizational objectives and, subsequently, the impact of portfolio and organizational success.

The next chapter looks at the relationship between portfolio components and organizational objectives and develops a conceptual model to determine the individual and cumulative contribution of portfolio components to organizational objectives. The chapter also discusses the utility and value of the conceptual model.

5 Chapter 5 – Conceptual Model

5.1 Introduction

Chapter 4 addressed the second research objective by investigating the practice of PfM to understand how organisations practiced PfM, their alignment to approaches presented in literature and by determining key issues that needed to be resolved through scientific research. This chapter focuses on addressing the third research objective, which was the development of a conceptual model to resolve a key issue identified during the investigation.

In the previous chapter, a notable observation from the investigation was the fact that poor decision-making regarding the management of the portfolio was being made due to a lack of understanding of what portfolio components contribute in the achievement of organizational objectives. The goal of this chapter, therefore, is to develop the conceptual model as a solution to this problem.

The goal is achieved by: a) establishing the relationship between organizational objectives and portfolio components; b) developing the conceptual model that will describe the process for evaluating the individual and cumulative contribution of portfolio components to organizational objectives; and c) describing the value and utility of the model in improving portfolio management decision making.

The remainder of the chapter begins with motivating the need for a conceptual model, describing the objectives of the model, and the considerations that gave rise to the development of the model. This is followed by an exploration into the relationship between organizational objectives and portfolio components and describes the complex nature of this relationship. A discussion on the conceptual 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 portfolio management decision-making in organisations.

5.2 Motivation for a conceptual model

Earlier approaches to PfM were briefly described in section 1.4. Focus was given to 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, towards aligning IT and business strategy (Cameron, 2005), managing IT projects like an investment portfolio (D'Amico, 2005) and using IT portfolio management to unlock the business value of technology (Maizlish & Handler, 2005).

Subsequently, authors have given increasing focus to the role of single project management in achieving portfolio efficiency (Martinsuo & Lehtonen, 2007); alignment of the project portfolio to corporate strategy, vertical integration and value creation through portfolio management (Thiry & Deguire, 2007); the translation of strategy into programmes and projects, organisation performance and the role of the project/programme management office (Aubry, Hobbs, & Thuillier, 2008); project portfolio control and performance (Müller et al., 2008), and the influence of business strategy on PfM and its success (Meskendahl, 2010). Most recently, the third edition of the *Standard for portfolio management* (Project Management Institute, 2013) 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.

Important for this research is an understanding of the purpose or objective of PfM. The Project Management Institute (2013:85) stated: "The objective of portfolio management is to determine the optimal mix and sequencing of proposed projects to best achieve the organizational strategy and objectives." They add that managing the performance of a portfolio is critical in closing the gap between organizational strategy and the fulfilment of that strategy. This implies that successfully managed portfolios (and hence successful projects, programmes 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, programmes, and operational activities (portfolio components) towards achieving the organizational objectives. The researcher had to consider the quantitative and qualitative measures of assessment of portfolio components to determine the contribution of portfolio components to organizational objectives (Project Management Institute, 2013). This enabled a form of reasoning that would be suitable to model such a system.

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

1. *The observation from the 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 towards 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 that were presented in chapter 3.*

The objective of the conceptual 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 portfolio management decisions regarding which components to stop, progress, or terminate, can be made.

To achieve this objective, the relationship between portfolio components and organizational objectives must be understood. This is discussed in the next section.

5.3 The relationship between portfolio components and organizational objectives.

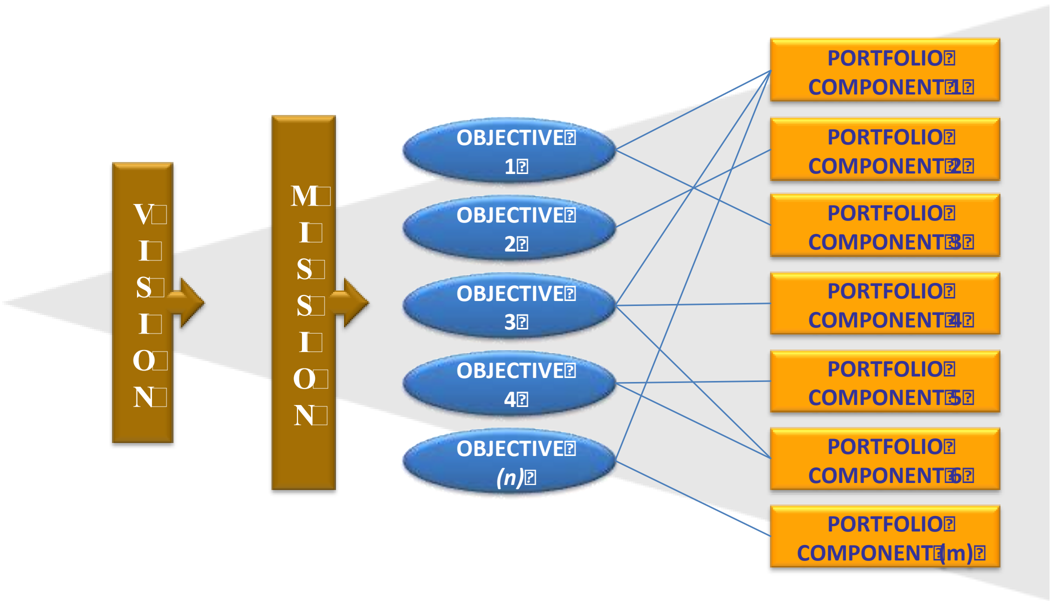
Having a well-defined strategy and organizational objectives without the ability to execute them, or having efficient and effective operations without a strategy or organizational objectives limits the success organisations could have. This notion is supported by Kaplan and Norton (2008:1), who state: “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.” 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 towards achieving the strategy.

In Chapter 3 it was established that organisation theory (the study of organisation design, structures, relationships, and behaviour of managers and technocrats within the organisation) is necessary when designing solutions for problems that affect the organisation. This is applicable in establishing an understanding of the relationship between portfolio components and organizational objectives.

According to Project Management Institute (2008b:8-9), "organisations 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 organisation'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 in the following way:

Figure 5.1: Many-to-many relationship between organizational objectives and portfolio components (adapted)



Source: Enoch and Labuschagne (2012)

In (Figure 5.1), 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 2, 3 and (m). The degree of contribution of each component varies one from the other.

An alternate depiction of this relationship is given in Table 5.1.

Table 5.1: Relationship between organizational objectives and portfolio components (adapted)

VISION

PORTFOLIO

	OBJECTIVE 1	OBJECTIVE 2	OBJECTIVE 3	OBJECTIVE 4	OBJECTIVE (n)
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 (2012)

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 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 programme 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 5.1, therefore 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 components to a single objective.

Understanding the degrees of contribution of portfolio components to the achievement of organizational objectives also aids the organisation 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 organisation 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 organisation 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 above, 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 organisation 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 conceptual 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.

5.4 Conceptual Model

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 (Lin & Hsieh, 2004; Sowell, 2005; Othman & Ku-Mahamud, 2010). 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 (Sowell, 2005).

The use of Fuzzy Logic in research related to PfM is also gaining popularity. At the time of writing this chapter, a number of articles on its use had been written in the area of project selection (Laarhoven & Pedrycz, 1983; K. Chen & Gorla, 1998; Machacha & Bhattacharya, 2000; Huang, Chu, & Chiang, 2006; Wang & Hwang, 2007 C.-T. Chen &

Cheng, 2009).[6] In addition, authors such as Earl Cox have written numerous books on the application of Fuzzy Logic in which he provides easy to understand illustrations of how fuzzy logic is used in different applications (Cox, 1995, 2005).

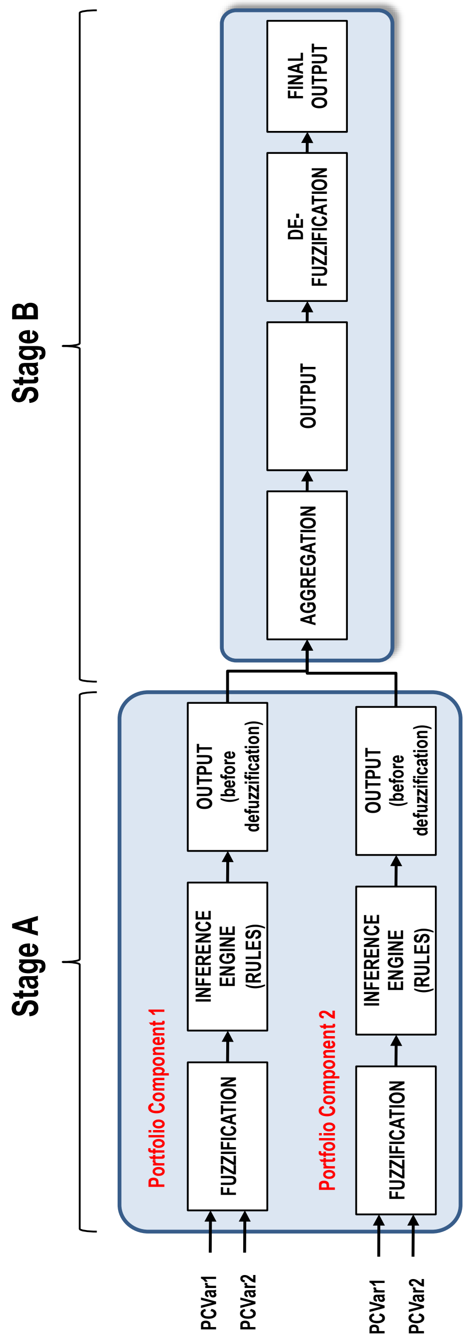
The use of Fuzzy Logic in the conceptual model follows a combination of the systems approach, multi-criteria utility theory (MCUT) and complexity theory as discussed in chapter 3. Qualitative evaluations of portfolio components using multiple criteria (MCUT) are taken as INPUT, PROCESSED through the 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 is a system (whole) comprising of numerous interacting entities (parts) each of which is behaving in its local context according to some rule(s) or force(s)” (Caldart & Ricart, 2004:97).

Cox (1995) suggests that complex business systems are built around multiple fuzzy models representing the combined intelligence of several experts. A combination of multiple fuzzy models is required to address the problem of representing the cumulative portfolio component contribution to strategic objectives. The reason for their use 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

[6] A more detailed description of the Fuzzy Logic process can be found in *APPENDIX D – Fuzzy Logic Overview* at the end of this thesis.

portfolio components to objectives. This process is illustrated in Figure 5.2 and a detailed description of the model and its processes follows.

Figure 5.2: Combined fuzzy logic model



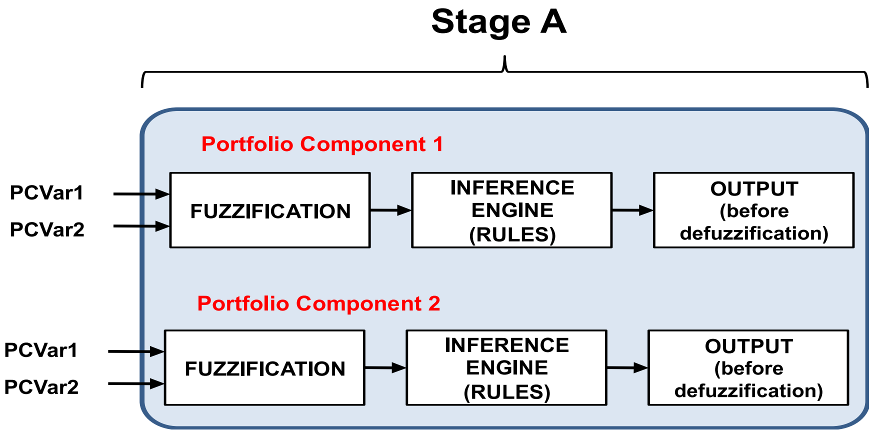
The stages and phases of the model will now be described.

5.4.1 Stage A

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. The output variable (contribution) is qualified by the values *very low, low, moderate, high* and *very high*. Membership functions are used in the fuzzification process to quantify a linguistic variable value.

The process for stage A of the fuzzy model is illustrated in Figure 5.3, followed by an explanation of the steps involved.

Figure 5.3: Illustration of Stage A of the combined fuzzy model



Phase 1 - Input Variables

For the purpose of illustrating the model, only two input variables are used. In a typical organisation, a group of portfolio management 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 below.

1. 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 organisation'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 cost, contribution to profitability, and the component's growth rate (Santhanam & Kyparisis, 1995; Ghasemzadeh & Archer, 2000; Deng & Wibowo, 2009)

2. Portfolio Component Variable 2 (PCVar2)

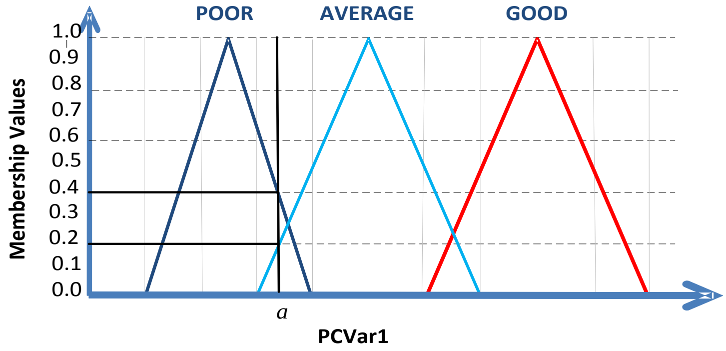
In this example PCVar2 represents durability of competitive advantage. If the portfolio component is delivering a product for which a competitor already exists, then the portfolio component will be rated ‘low’. If the product can be copied within two years, then the portfolio component will be rated 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 (MathWorks, 2011). 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 Figure 5.4 and Figure 5.5, respectively.

Figure 5.4: PCVar1 – Value

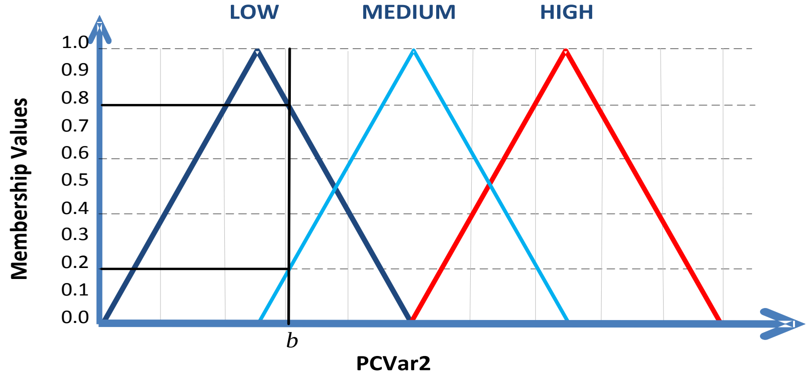


$\mu_{(PCVar1 = poor)} = 0.4$

$\mu_{(PCVar1 = average)} = 0.2$

$\mu_{(PCVar1 = good)} = 0.0$

Figure 5.5: Durability of competitive advantage



$\mu_{(PCVar2 = low)} = 0.8$

$\mu_{(PCVar2 = medium)} = 0.2$

$\mu_{(PCVar2 = high)} = 0.0$

In Figure 5.4 and Figure 5.5, the x-axis represents the domain and the y-axis represents the membership values.

The 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) (MathWorks, 2011) . The portfolio management experts in the organisation in accordance with their knowledge and experience in portfolio management and the organisation 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 organisation to the next.

The domain is not numeric since the input values are qualitative. Subjective information can now be modelled 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 5.4) and PCVar2 (represented by 'b' in Figure 5.5), and determine the degree to which these inputs belong to each of the respective membership functions. In an organisation, the portfolio management experts would evaluate the PCVar1 of a portfolio component and determine to what degree it is *poor*, *average* or *good*.

As an example, in Figure 5.4, this is represented by the dark bold vertical line that intersects 'POOR' at a membership value of 0.4 and 'AVERAGE' at a membership value of 0.2. In other words, PCVar1 is assessed as being poor to a degree of 0.4 as well as average to a degree of 0.2 simultaneously.

Similarly, the portfolio management experts would evaluate PCVar2 of the same portfolio component and determine to what degree it is *low*, *medium* or *high*. In Figure 5.5, the dark bold vertical line intersects 'LOW' at a membership value of 0.8 and 'MEDIUM' at a membership value of 0.2. In this example, the input variable PCVar2 is assessed as being low (to a degree of 0.8) as well as medium (to a degree of 0.2) simultaneously.

Phase 3 - Inference Engine

A number of rules are determined by a knowledgeable group of individuals in the organisation 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 number of rules for a system with two input variables, each having three values, is nine. A system with four variables, each having three values, would have 81 or 3^4 rules. The Mamdani style of inference is used here (MathWorks, 2011). The Mamdani method is the most commonly used fuzzy inference technique and was among the first control systems built using Fuzzy Set theory.

The following rules were applied to the input variables in the inference engine:

Table 5.2: Fuzzy rules

Rule 1	If PCVar1 is *Poor* AND PCVar2 is *High*, THEN Contribution is *Moderate.*
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 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 6	If PCVar1 is *Average* AND PCVar2 is *Low*, THEN Contribution is *Low.*
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.*
Rule 9	If PCVar1 is *Good* AND PCVar2 is *Low*, THEN Contribution is *Moderate.*

Rule Evaluation

The next step in the fuzzy logic process is to take the fuzzified inputs (for the above example these would be: $\mu_{(PCVar1\ =\ poor)} = 0.4$, $\mu_{(PCVar1\ =\ average)} = 0.2$, $\mu_{(PCVar2\ =\ low)} = 0.8$ and $\mu_{(PCVar2\ =\ medium)} = 0.2$), 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 organisation, a group of portfolio management 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 also 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. The following Table 5.3 represents the knowledge base associated with the rules described in Table 5.2.

Table 5.3: 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

How the Rule Base works

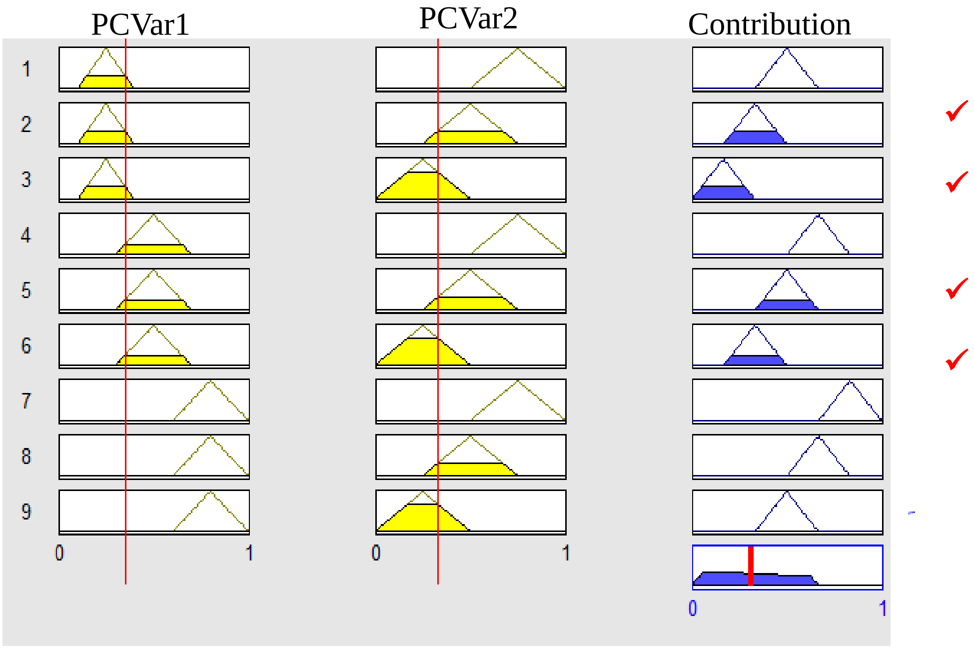
The next step is to compute the degree of membership to the membership functions (VeryLow, Low, Moderate, High or VeryHigh) of the output variable (Contribution). Once a variable is fuzzified (refer to the section on fuzzification described earlier), it takes a value between 0 and 1 indicating the degree of membership to a given membership function of that specific variable. The degrees of membership of the input variables have 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 Figure 5.4 and Figure 5.5 as well as Table 5.2 and Table 5.3, input (a) for PCVar1 has a membership degree of 0.4 to the membership function ‘POOR’ which applies to rules 1, 2 and 3 (Table 5.2), and a membership degree of 0.2 to the membership function ‘AVERAGE’ which applies to rules 4, 5 and 6. Similarly, input (b) for PCVar2 has a membership degree of 0.8 to the membership function ‘LOW’ which applies to rules 3, 6 and 9, and a membership degree of 0.2 to the membership function ‘MEDIUM’ which applies to rules 2, 5 and 8. When a rule is totally satisfied (indicated by ✓ in Figure 5.6), 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:

Table 5.4: The satisfied rules

Rule 2	**IF** PCVar1 is *Poor* (degree of 0.4) **AND** PCVar2 is *Medium* (degree of 0.2), **THEN** Contribution is *Low* (degree of 0.2) ... the lowest degree among the inputs.
Rule 3	**IF** PCVar1 is *Poor* (degree of 0.4) **AND** PCVar2 is *Low* (degree of 0.8), **THEN** Contribution is *Very Low* (degree of 0.4).
Rule 5	**IF** PCVar1 is *Average* (degree of 0.2) **AND** PCVar2 is *Medium* (degree of 0.2), **THEN** Contribution is *Moderate* (degree of 0.2).
Rule 6	**IF** PCVar1 is *Average* (degree of 0.2) **AND** PCVar2 is *Low* (degree of 0.8), **THEN** Contribution is *Low* (degree of 0.2).

Figure 5.6 below 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 5.6, 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 red (vertical) lines indicate the points of intersection on the relevant membership functions associated with the membership values for each input variable.

Figure 5.6: Rule view



The next section describes how the output values are derived.

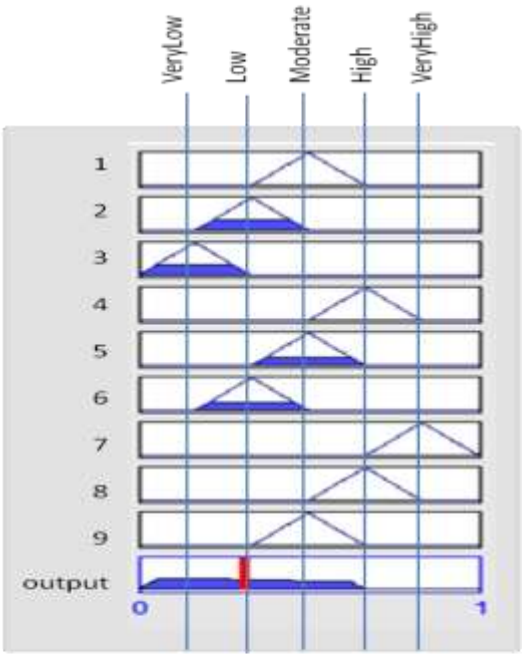
Phase 4 - Outputs

The output is the aggregation or sum of the membership functions from the satisfied rules. Aggregation is the process of unification of the outputs of all rules. We take the membership functions of all rule consequents and combine them into a single fuzzy set (MathWorks, 2011). 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 referring to Figure 5.7, the shading in the triangles indicates the degree of membership.

- *For the membership function '**VeryLow**' the degree of membership is 0.4 (based on the result of rule 3 in Table 5.4).*
- *For the membership function '**Low**' the degree of membership is 0.2 (based on the higher result of rules 2 and 6 in Table 5.4).*
- *For the membership function '**Moderate**' the degree of membership is 0.2 (based on the result of rule 5).*
- *For the membership function '**High**' the degree of membership is 0.*
- *For the membership function '**VeryHigh**' the degree of membership is 0.*

Figure 5.7: Output of rules



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. The most popular defuzzification method is the centroid method (Cox, 1995), which returns the centre of the area under the curve labelled 'output' in Figure 5.7.

Mathematically this centre of gravity (COG) can be expressed as:

Figure 5.8: Mathematical expression for CoG

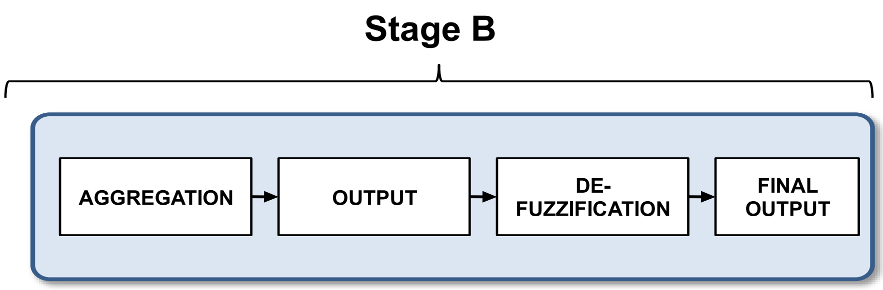
$$\mathrm{CoG} = \frac{\sum_{i=0}^{N} a_i \times m_i}{\sum_{i=0}^{N} m_i}$$

… where *COG* is the defuzzified output. In this example, the output value 0.278 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 (0.278) indicates that the portfolio component contributes to the objective to a degree of 0.278. This implies that if this were the only portfolio component selected to achieve an organizational objective, then only a low degree of the objective would be achieved. The organisation would need to select other portfolio components or amend the scope of the component such that more 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.

5.4.2 Stage B

Figure 5.9: Stage B of the combined fuzzy model



Phase 5 - Additive Aggregation

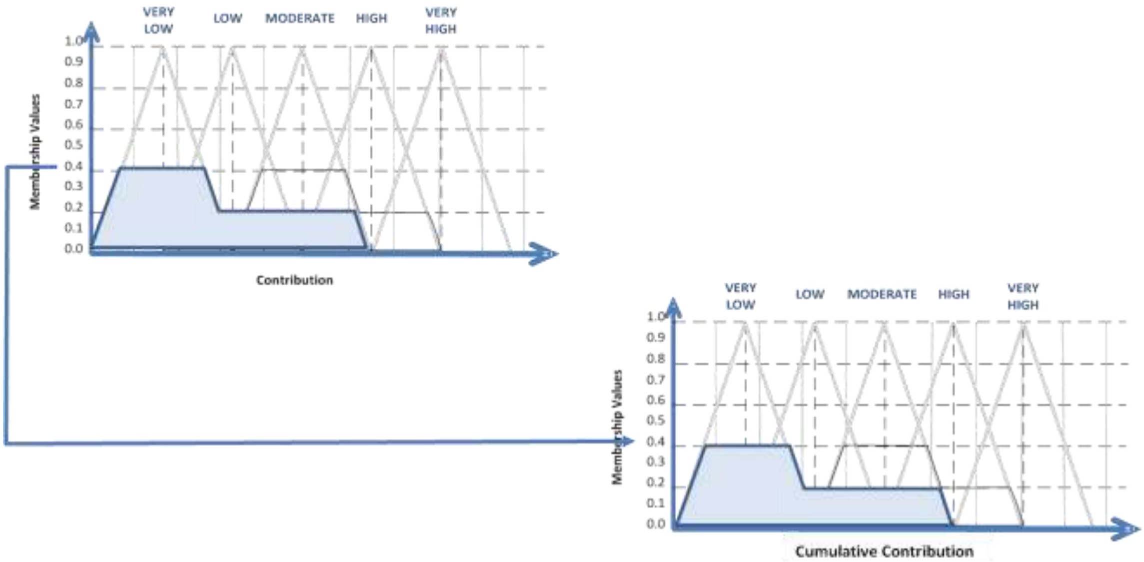
The aggregation in stage A above is the unification of the outputs of all rules per portfolio component. The aggregation in stage B is the aggregation (sum) of the outputs of all portfolio components before defuzzification.

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. Using the bounded sum method (Cox, 1995), 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 (Cox, 1995). Figure 5.10 to Figure 5.13 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. (For a detailed explanation of aggregation and implication techniques, refer to (Cox, 1995)).

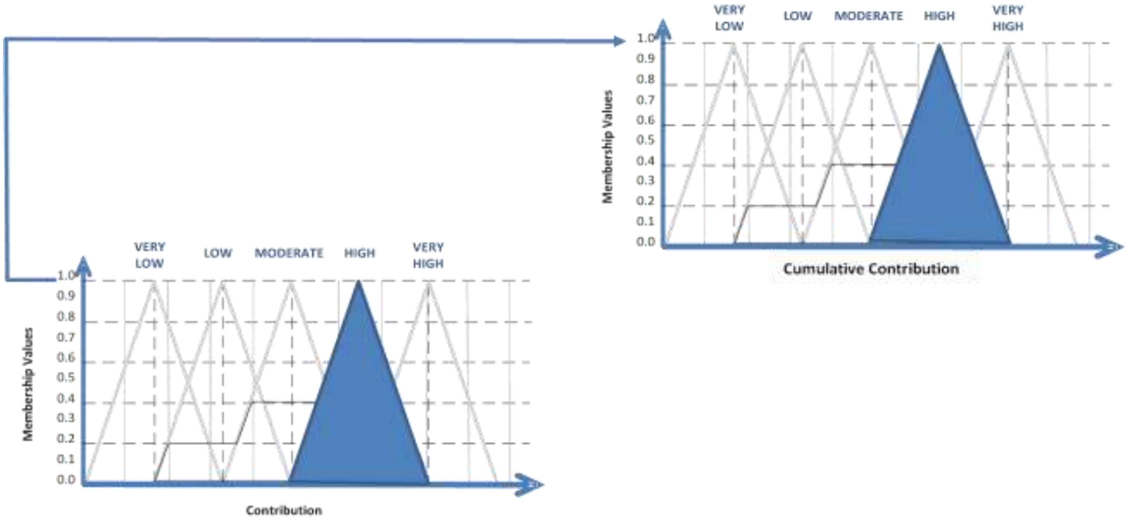
Using the output of the example used earlier for one portfolio component, the figure below shows the first step in the aggregation process.

Figure 5.10: Additive aggregation - First portfolio component



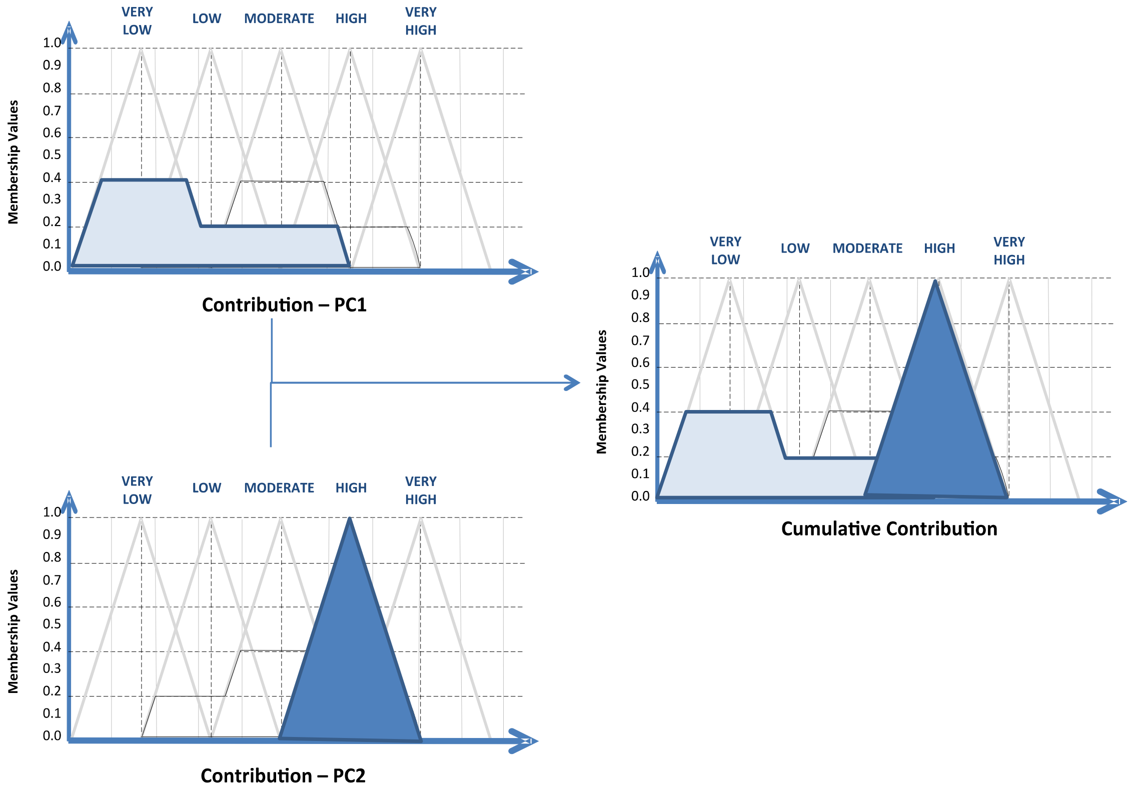
For the second portfolio component, let us assume the stage A process is followed as was done for the first portfolio component, and an output for the second portfolio component is derived, such that the output membership value is equal to 1 for the membership function ‘high’. The figure below shows how the second output is added to the final output (solution fuzzy region).

Figure 5.11: Additive aggregation - Second portfolio component



The combined output of both portfolio components is illustrated in the following figure:

Figure 5.12: Additive aggregation - Combining both portfolio components

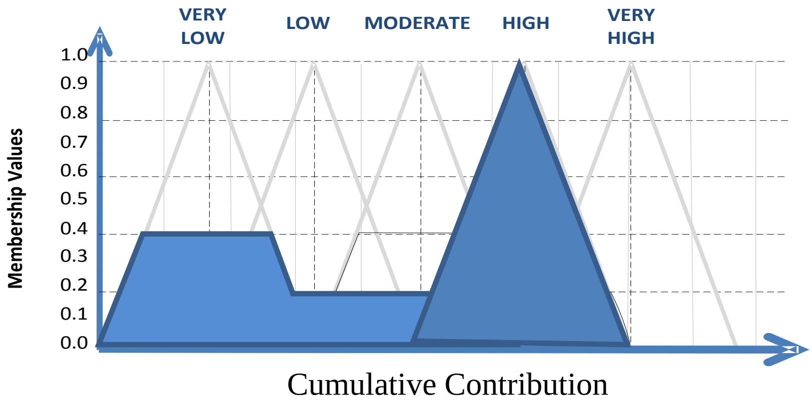


To summarize, Figure 5.10 showed the addition of the consequent fuzzy set for portfolio component 1 being added to the final output region (cumulative contribution). Figure 5.11 showed the addition of the consequent fuzzy set for portfolio component 2 being added to the final output region. Figure 5.12 showed the combined view of Figure 5.10 and Figure 5.11.

Phase 6 - Aggregated output

The aggregated output, also known as the solution fuzzy region, is illustrated in Figure 5.13.

Figure 5.13: Aggregated output



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

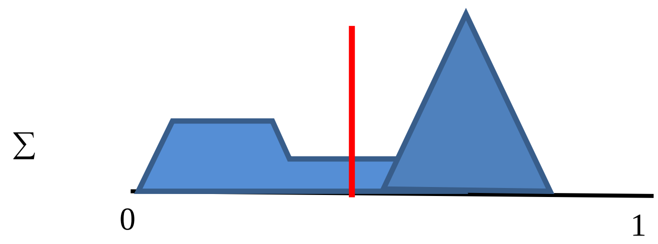
- *The membership function VeryLow has a membership value of 0.4.*
- *The membership function Low has a membership value of 0.2.*
- *The membership function Moderate has a membership value of 0.2.*
- *The membership function High has a membership value of 1.0.*
- *The membership function VeryHigh has a membership value of 0.0.*

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

Defuzzification is the last step in the fuzzy inference process. Tarighat (2012:455) states that "fuzziness 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". There are several defuzzification methods, but the most popular one is the centroid technique (Cox, 1995). It finds the point where a vertical line would slice the aggregate set into two equal masses. The vertical red line in Figure 5.14 represents this.

Figure 5.14: Aggregated fuzzy output



Phase 8 - Final output

As described above, the application of the centroid technique (Cox, 1995) results in a quantitative value. In this instance, the centroid technique 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 0.448, implying that the objective is partially achieved. This would mean that if these were the only portfolio components considered for achieving this objective, the organisation would fail in meeting its target.

5.5 Interpretation and utility of the model

From the above 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 1. 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 towards meeting the objective. The results obtained from the model can assist in decision-making regarding the composition of the portfolio.

5.6 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 organisation, 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 through the verification and validation (see Chapters 7 and 8), processes; it is illustrated 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 organisation is faced with budget constraints – as is the case in practice (Chapter4) – the model shows the contributions of portfolio components and the impact on the achievement of organizational objects if any of the components are terminated.

The model is also valuable from a research perspective as it can be extended (Chapter 6) to provide alternative perspectives to the contribution of portfolio components to organizational objectives. The opportunity exists for investigating how the model can be used to deal with a) component interdependencies, b) human resource constraints, c) influence of decision-makers on the evaluation of portfolio components, and d) the application of the model in different contexts.

5.7 Conclusion

During the investigation into the practice of PfM (Chapter 4) 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 develop a conceptual 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 were then discussed, illustrating that components have varying degrees of contribution to objectives and that one or more components can contribute to one or more objectives. This results in a complex relationship between components and objectives. The conceptual 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. The goal of this chapter is therefore achieved.

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 organisation 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 chapter 3 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.

The next chapter uses the fundamental concepts presented in this chapter and discusses the alternate perspective mentioned at the end of the last paragraph.
This implies that the concepts presented here could be applied in other ways and would be useful in future research.

6 CHAPTER 6: Extension of the conceptual model

6.1 Introduction

Chapter 5 discussed the relationship between portfolio components and organizational objectives. Figure 5.1 illustrated the many-to-many relationship between organizational objectives and portfolio components while Table 5.1 showed that more than one portfolio component could contribute to a single objective. In Table 5.1, 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 conceptual model presented in Chapter 5 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 which represented the cumulative contribution of portfolio components to organizational objectives. This chapter extends the discussion on the use of the conceptual model presented in Chapter 5.

While Chapter 5 focused on one dimension of the many-to-many relationship between portfolio components and objectives – viz. the cumulative contribution of one or more portfolio components to a single objective, decision-makers may also want to consider the second dimension of the many-to-many relationship between portfolio components and objectives – viz. the number of additional objectives to which a single portfolio component contributes. The goal of this chapter, therefore, is to illustrate how the conceptual model could be re-used to present an alternate perspective on the component-to-objective relationship.

To achieve the goal of this chapter, it is necessary to a) revisit the model presented in Chapter 5; b) demonstrate how the total contribution of individual components to multiple objectives can be computed; and c) discuss how this information can be used in the decision-making process.

Following this introduction, the conceptual model will be used to determine the individual component contribution to multiple objectives. The cumulative contribution of the individual components will then be determined. 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 organisation 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.

6.2 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 5.1 showed that Portfolio Component (PC) 1 contributes to multiple objectives (OBJ) (1, 3 and n). The figure is repeated in Table 6.1 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 objectives does not need to be equal to 1. The fact that PC1 contributes to three objectives intuitively suggests that it is an important component. However, it needs to be determined how 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 in Chapter 5 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.

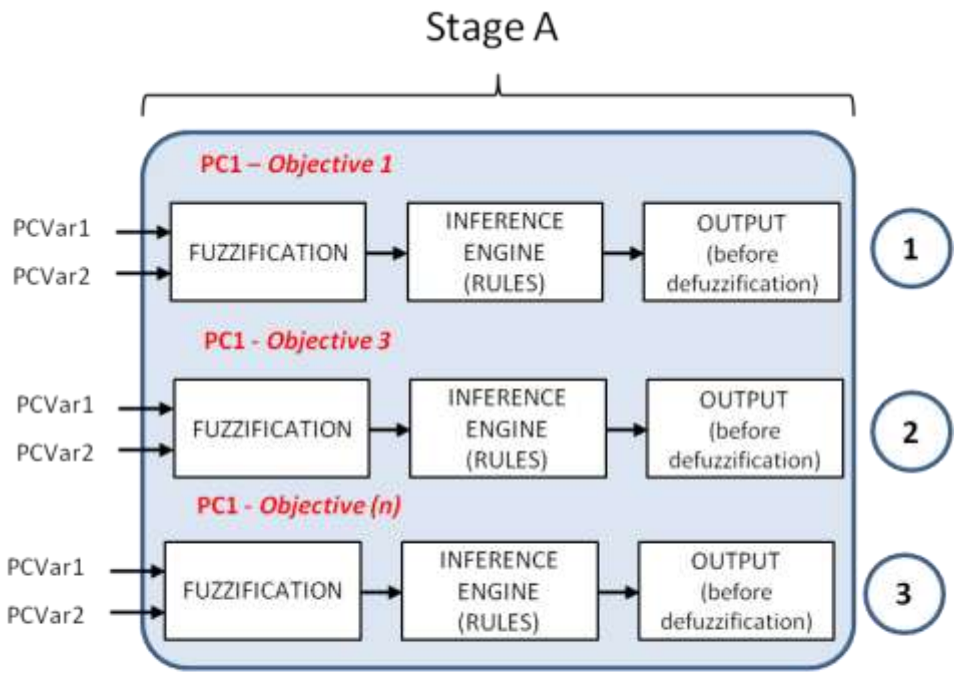
Table 6.1: Relationship between organizational objectives and portfolio components

VISION

PORTFOLIO	OBJECTIVE 1	OBJECTIVE 2	OBJECTIVE 3	OBJECTIVE 4	OBJECTIVE (*n*)
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

Figure 6.1 below 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.

Figure 6.1: Stage A process - single portfolio component contribution to multiple objectives



The process of Fuzzification, rule evaluation (inference engine) and determination of a qualitative output is described in Chapter 5. 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.

6.2.1 The 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 researcher presents:

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 which equates to the aggregation of the output membership functions*
6. *The defuzzified value representing the degree of contribution to the specific objective*

It should be noted here that the CoG (centre of gravity) defuzzification method was used in Chapter 5. However, upon further testing of the model, it was determined that this defuzzification method did not work predictably for all input values. For example, it should be possible to evaluate the input variables of a portfolio component such that the defuzzified output value equals to 1, implying that the objective is fully achieved or the portfolio component fully contributes to the objective. Using CoG, this result was not achieved. Other defuzzification methods were tested until it could be confirmed that the MoM (Mean of Maximum) method yielded predictable results. The detail regarding this validation process is discussed in Chapter 8. In addition, the shape of the membership functions were changed to a standard format than the triangles used in chapter 5. This also contributed to the predictability of the results.

1. Degree of contribution of PC1 to <u>Objective 1</u>

Let us assume that the input variables are evaluated as:

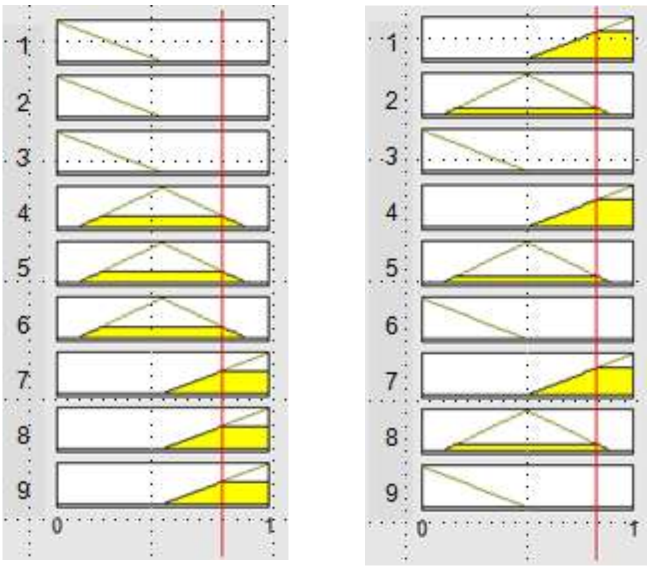
PCVar1 = Good (with a membership degree of 0.784)

PCVar2 = High (with a membership degree of 0.812)

Figure 6.2 below illustrates the membership degrees for each of the variables through the shading of the membership functions.

Figure 6.2: Rule view of the input variables for PC1 contribution to Objective 1

PCVar1 PCVar2



(0.784) (0.812)

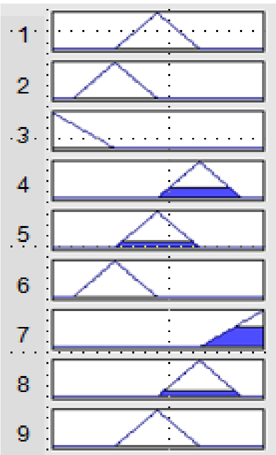
Applying the rules in the inference engine will result in the following rules being satisfied:

Table 6.2: 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.*

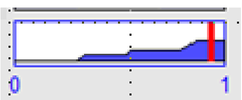
Figure 6.3 below shows the rule view of the output membership functions. The shaded triangles illustrate the degree of membership following the aggregation of the membership functions from the satisfied rules in Table 6.2. Among the satisfied rules, the membership degree of each output membership function will be the *higher* among the rules that have as a result that membership function.

Figure 6.3: Rule view of the Output membership function



The output fuzzy region for the degree of contribution of PC1 to Objective 1 is illustrated in Figure 6.4 below:

Figure 6.4: Output fuzzy region



The defuzzified value, using MoM, resulting from this output fuzzy region = <u>0.935.</u>

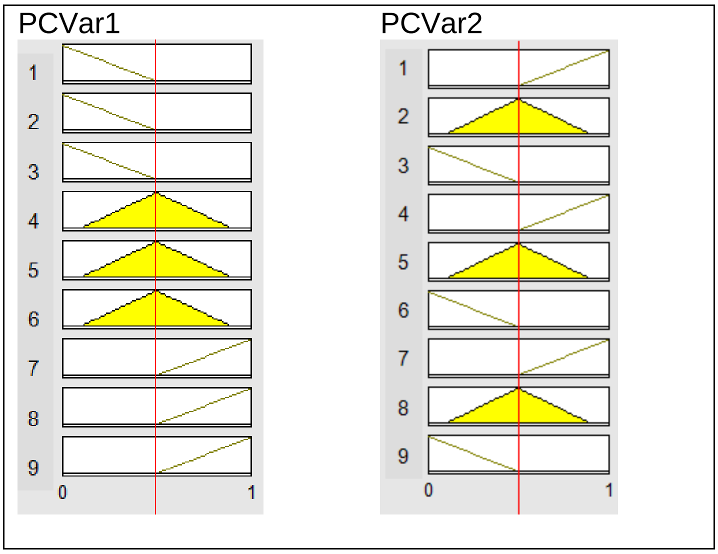
2. Degree of contribution of PC1 to <u>Objective 3</u>

Let us assume that the input variables are evaluated (see Figure 6.5) as:

PCVar1 = Average (with a membership degree of 1.0)

PCVar2 = Medium (with a membership degree of 1.0)

Figure 6.5: Rule view of the input variables for PC1 contribution to Objective 3



Applying the rules in the inference engine, the following rules will be satisfied:

Table 6.3: Satisfied rules for PC1 contribution to objective 3

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

The output membership function based on the satisfied rule is illustrated in

Figure 6.6 below while the output fuzzy region for the degree of contribution of PC1 to Objective 3 is illustrated in Figure 6.7 below:

Figure 6.6: Rule view of the output membership function

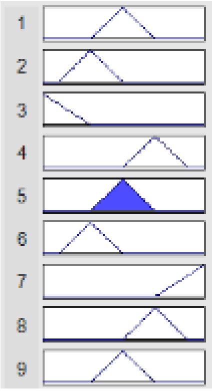
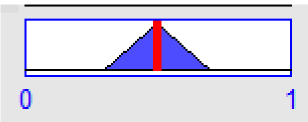


Figure 6.7: Output fuzzy region



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

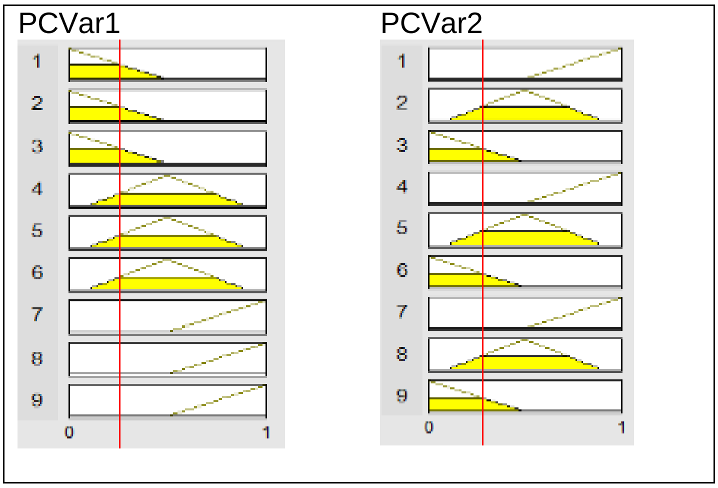
3. Degree of contribution of PC1 to Objective (n)

Let us assume, as illustrated in Figure 6.8, that the input variables are evaluated as:

PCVar1 = Poor

PCVar2 = Medium

Figure 6.8: Rule view of the input variables for PC1 contribution to objective 1



Applying the rules in the inference engine will result in the following rules being satisfied:

Table 6.4: 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.*

The output membership function based on the satisfied rules is illustrated in Figure 6.9 below while the output fuzzy region for the degree of contribution of PC1 to Objective (n) is illustrated in Figure 6.10 below:

Figure 6.9: Rule view of the output membership function

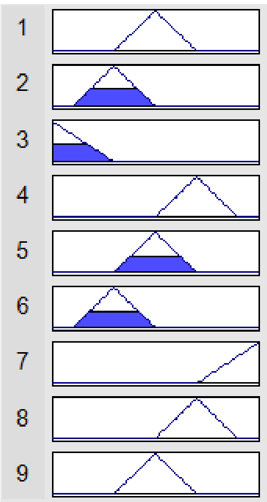
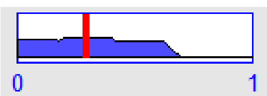


Figure 6.10: Output fuzzy region



The defuzzified value resulting from this output fuzzy region = <u>0.295.</u>

6.3 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*

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 6.5 below shows the quantitative contribution of PC1 to each of the three objectives, as well as the sum of the contributions, based on the above discussion:

Table 6.5: Cumulative contribution of PC1

	Objective 1	Objective 3	Objective (n)	TOTAL
PC1	0,935	0,5	0,295	1,73

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.

6.4 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 objectives in Table 6.5: Cumulative contribution of PC1 are 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 organisation 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 6.6 below.

Table 6.6: 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

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.

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

6.5 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 Chapter 5 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.

The goal of the chapter was achieved as it illustrated how the conceptual model could be re-used to present an alternate perspective on the component-to-objective relationship. In so doing, it implied that the concepts presented in Chapter 5 could be applicable in different ways and could be useful in future research. This adds to the strength of the conceptual model presented in this thesis.

The next chapter (Chapter 7) discusses the verification of the conceptual model. Portfolio components and organizational objectives from a participating organisation are used in the verification process. The reason for using actual components and objectives is to demonstrate that the model can be applied in an actual organisation. The verification process involves stepping through the model phases described in Chapter 5 to confirm the consistency and accuracy of the model.

7 CHAPTER 7: Model verification

7.1 Introduction

In the previous two chapters, the conceptual model for managing a portfolio has been described from two perspectives. Chapter 5 introduced the core concepts of the model using fuzzy logic as the chosen approach, and described how the combined contribution of portfolio components to organizational objectives could be determined. The focus was on many components contributing to individual objectives. Chapter 6 demonstrated how the model could be extended to consider the total contribution of single components to multiple objectives. The model, as described in Chapters 5 and 6, 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. The next step in the research is to verify the model presented in Chapter 5 while Chapter 8 will validate the model. Both chapters address the fourth research objective, which is to verify and validate the conceptual model to build confidence in its feasibility.

First, to verify the model, the researcher requested the participation of a large organisation in South Africa. The participant organisation 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 consistency and accuracy in the model by stepping through the model phases using the information from the participant organisation.

The chapter begins with a brief discussion on model evaluation and verification, followed by a description of the organizational context of the participating organisation. The portfolio components and organizational objectives used in the verification process are also described followed by a walk-through of the model phases. 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.

7.2 Model evaluation and verification

Model evaluation generally consists of two stages – verification and validation. According to Hvala, et al. (2005:1507), "verification concerns the consistency and accuracy of simulation programs compared with the associated mathematical models, while model validation concerns the level of agreement between mathematical descriptions and the real system under investigation". Model validation is an important aspect of modelling and without it a model is of little use (Neelamkavil, 1987 as cited in Hvala, Strmčnik, Šel, Milanič & Banko, 2005).

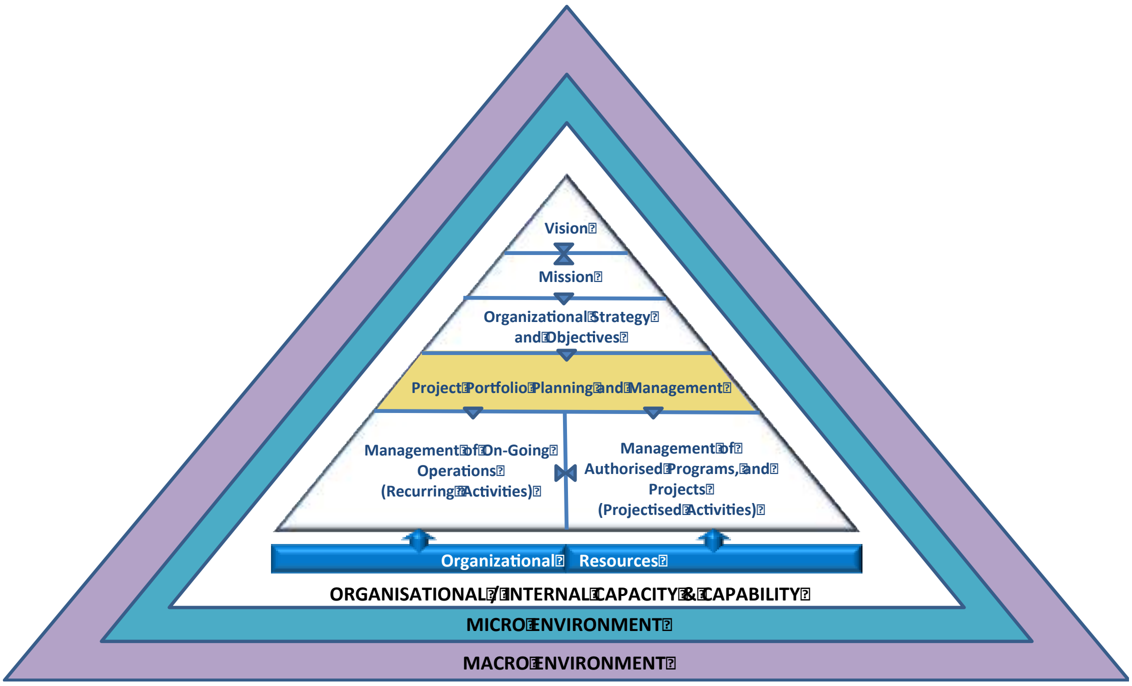
The verification process entails walking through the conceptual model phases in a stepwise fashion to ensure that every aspect of the model is tested for accuracy and consistency. A combination of organisation objectives and portfolio components are required for the verification process. To ensure confidence that the components and objectives were not chosen to suit the model, the researcher chose actual components and objectives from a participating organisation. Using actual components and objectives builds confidence that the model can work in the real world.

The next section describes the organizational context of the participating organisation to provide a background for the objectives and portfolio components chosen.

7.3 Organizational context

The organisation chosen for the verification was a large financial services institution in South Africa. Permission to use the strategy definition and initiatives (projects and programmes) in this research was granted by the Global CIO. It is necessary to describe the context or business environment in which it operates to appreciate the nature of the organisation's operations, projects, and programmes (portfolio components). The business environment within which any organisation operates involves its internal environment and external environment. The external environment is divided into the macro and micro environment (Fernando, 2011). This is illustrated in Figure 7.1 and described below.

Figure 7.1: Organizational context (adapted)



Source: Project Management Institute (2013)

7.3.1 Macro environment

The macro environment involves the locale, political, economic, and social aspects, which impact the organisation. The case study organisation (hereafter referred to as Company A) is a multinational organisation 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 requirements. The global recession at the time of writing this thesis 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.

7.3.2 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 organisations, 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 organisation has to optimize its portfolio of projects and programmes in a way which 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 organisation.

7.3.3 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 organisation'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 system, 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 above.

7.4 Information gathering for the verification process

Information gathering of the portfolio components and organizational objectives required for the verification process was undertaken by direct contact with the Enterprise Portfolio Management Office (EPMO) Operations Manager. This person was able to provide the researcher with the information related to the projects, programmes and organizational objectives. During the course of collecting the data and writing this chapter, an organizational restructure resulted in a change such that the EPMO was reconfigured into an RMO (Results Management Office) through a consolidation of some of the PMOs (Project Management Offices) and the Operations Manager took on the role of Business Manager. However, this did not affect the research, as the data was already made available prior to this change.

The researcher chose to keep the sample data to a manageable set for the purpose of verifying the model. Three criteria or input variables, six components, and five objectives were used in the verification process.

7.4.1 Portfolio components

The portfolio of projects and programmes (portfolio components) at Company A extended from mega projects and programmes to small enhancements called “work requests”. Portfolio components are categorized, firstly, as Signature Programmes, if they exceed a certain budget threshold, run over multiple years and / or are implemented across multiple geographies. Large projects or programmes 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 (IT) 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 programmes; 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.).

7.4.2 Organizational objectives used in this verification

The objectives identified for this verification were defined in the Group Information Technology (Group IT) division of Company A. The company followed the Balanced Score Card (Kaplan & Norton, 2008) methodology 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 organisation forward.

Table 7.1 below describes the objectives, measures, and targets. Table 7.2, which follows, lists the components that contribute towards achievement of the objectives:

Table 7.1: IT organizational strategic objectives

#	Objective	Description	Measure	Target	Definition/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 3 years	The cost and risk associated with maintaining ageing 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 licence.	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 3 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.

Portfolio components are associated with the selected organizational objectives as outlined in Table 7.2 below. The portfolio components are henceforth to be indicated by their abbreviations.

Table 7.2: Portfolio component descriptions

Portfolio Component	Abbreviation	Portfolio Component Description
Global Markets e-Commerce	PC1:GMC	The aim of this programme 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 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 Programme (CBT) is a vital enabler of the company's vision. Supported by a "burning platform" (declining profitability, ageing systems), 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
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 programme 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.

7.4.3 Mapping of components to objectives

Table 7.3 below 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.

Table 7.3: 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

While Table 7.3 above 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 email, storage and retrieval) - of client documents such as application forms and copies of identity and proof of residence documents. 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 StockBorrow 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 the verification of the model. The following section describes the verification process.

7.5 Verification process

The verification process is described in the phases below and includes the phases described in Chapter 5:

1. *Set up:*
    a. *Define the membership functions for the input and output variables*
    b. *Define the rules to be used in the rule engine*
2. *Describe the evaluation criteria (input variables).*
3. *Fuzzification. The evaluation of each of the three criteria for each component in terms of its contribution to the objectives.*
4. *Determine the individual contribution value by parsing the evaluations in phase 3 above through the rule engine*
5. *Determine the output*
6. *Defuzzify the individual component outputs in order to determine the individual contribution*
7. *Determine the combined contribution of those components that jointly contribute to an objective by parsing their criteria evaluations simultaneously through the rule engine*
8. *Determine the total contribution of individual components to multiple objectives by aggregating the individual contributions.*

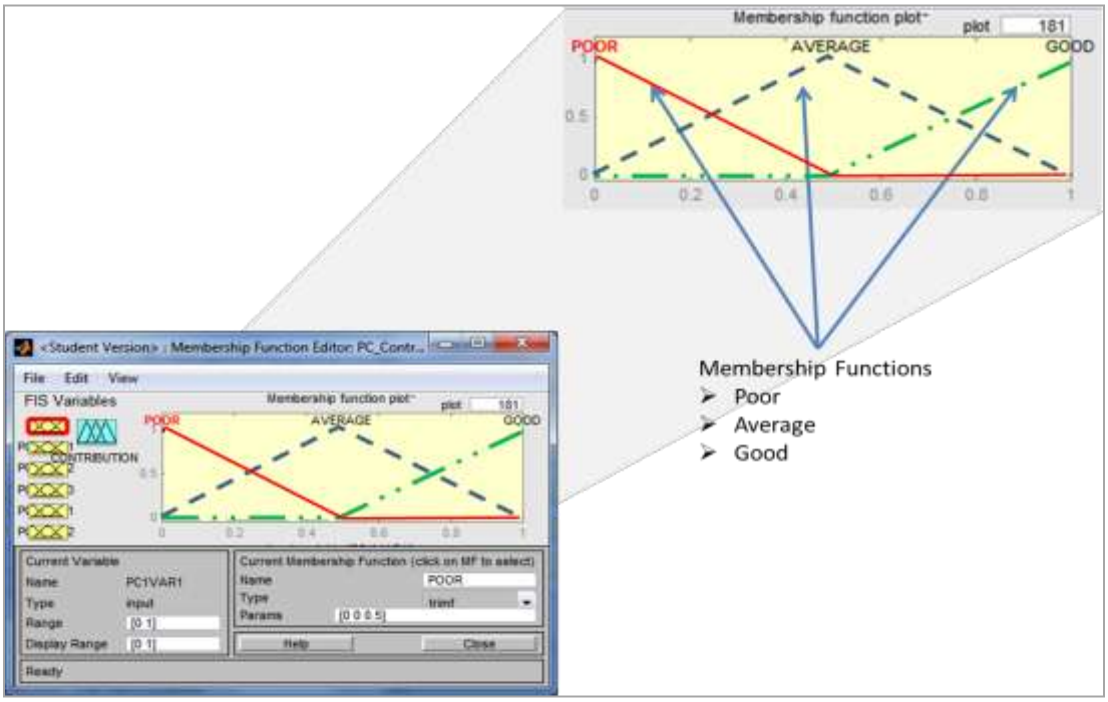
7.5.1 Phase 1: Set up

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.

7.5.1.1 Sub Phase 1a – Define the membership functions for the input and output variables

For each input variable in the system, 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 and PCVar3 are *low*, *medium* and *high.* The membership function for PCVar1 is illustrated in Figure 7.2 below:

Figure 7.2: Screenshot from MATLAB® with expanded Membership function frame



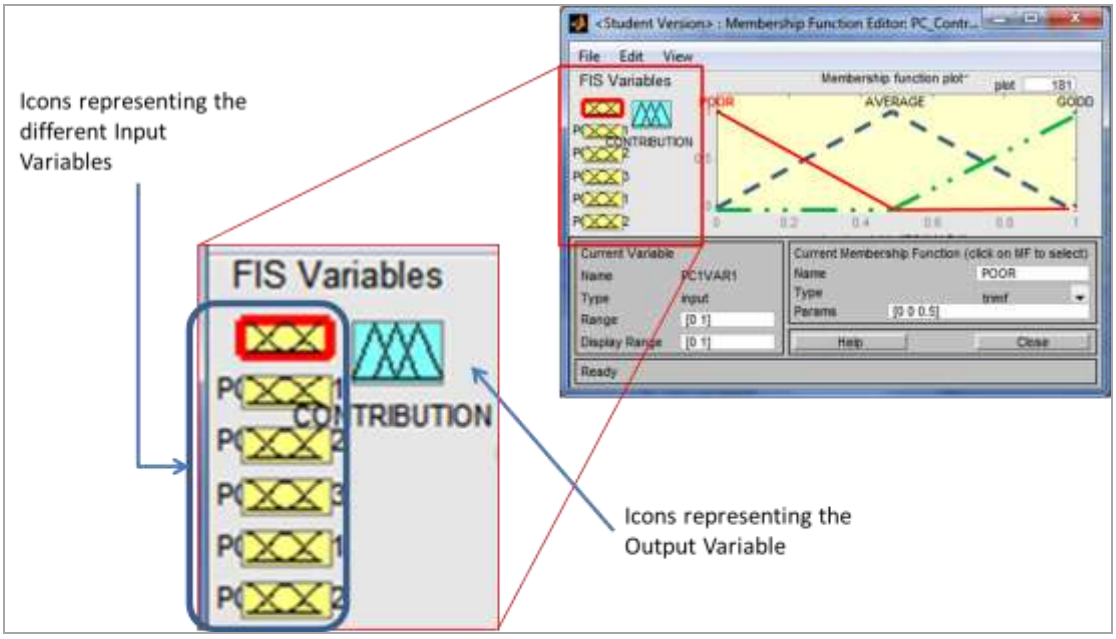
The input variables referred to here are discussed in more detail in section 7.5.3.

As an introduction to the input variables, PCVar1 refers to Value, PCVar2 represents Longevity, and PCVar3 represents the probability of successfully implementing the respective portfolio component.

The frame displaying the membership functions has been expanded and the membership functions labelled to provide clarity for the reader. Similarly, other frames have been expanded and are described below.

The next figure below (Figure 7.3) shows the frame with icons representing the input and output variables. It can be seen that there are six input variables. For the model to work in the MATLAB® tool, the three input variables have to be duplicated for each additional portfolio component. The model has been set up in the tool to cater for three variables and two portfolio components, hence six input variables have been defined.

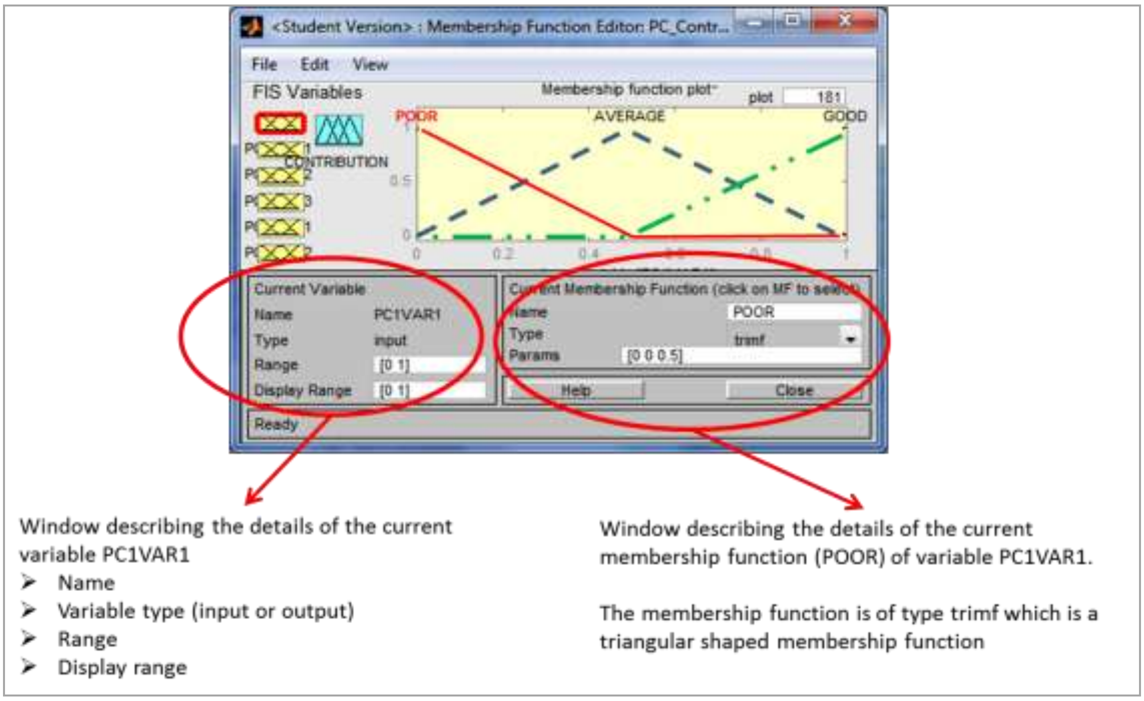
Figure 7.3: Icons representing the different input and output variables



When the user selects one of the other icons, the information on the screen changes to show the detail relevant to the specific variable.

The second half of the screen shows information related to the variable and membership functions. This is illustrated in more detail in Figure 7.4:

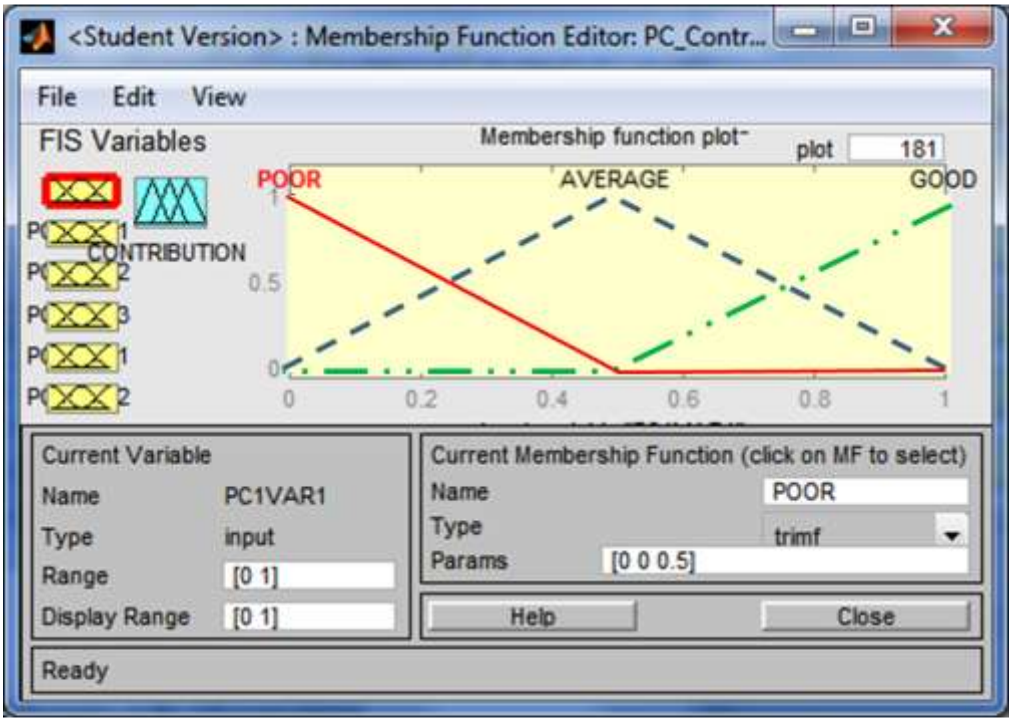
Figure 7.4: Detail in MATLAB® on the variable and membership functions



The portfolio management team would do the definition of the membership functions. This will be done before the model is used for the first time. Triangular membership functions are used for each of the input variables. Bouchon-Meunier, Dotoli, and Maione (n.d.) point out that the "only restriction that a membership function has to satisfy is that its values must be in the [0,1] range". They also state that the size of the membership function affects the effectiveness of the controller (rule engine): "If the size of an input universe is too small, then an input value out of scale would not fire any rule; if, on the contrary, the size is too large, then the system could become saturated". They further suggest that for the purpose of better control and completeness in the fuzzy inference engine, the membership functions should overlap such that the point of overlap should occur at a membership value of 0.5. The above guidelines were considered when defining the membership functions to ensure better control in the rule engine and consistency in the outputs. As a result, the shape of the membership functions for each of the three variables is the same. It is possible for the shape of the triangular membership functions to vary for each variable. The membership functions for the three variables have been defined and are illustrated from Figure 7.5 to Figure 7.7.

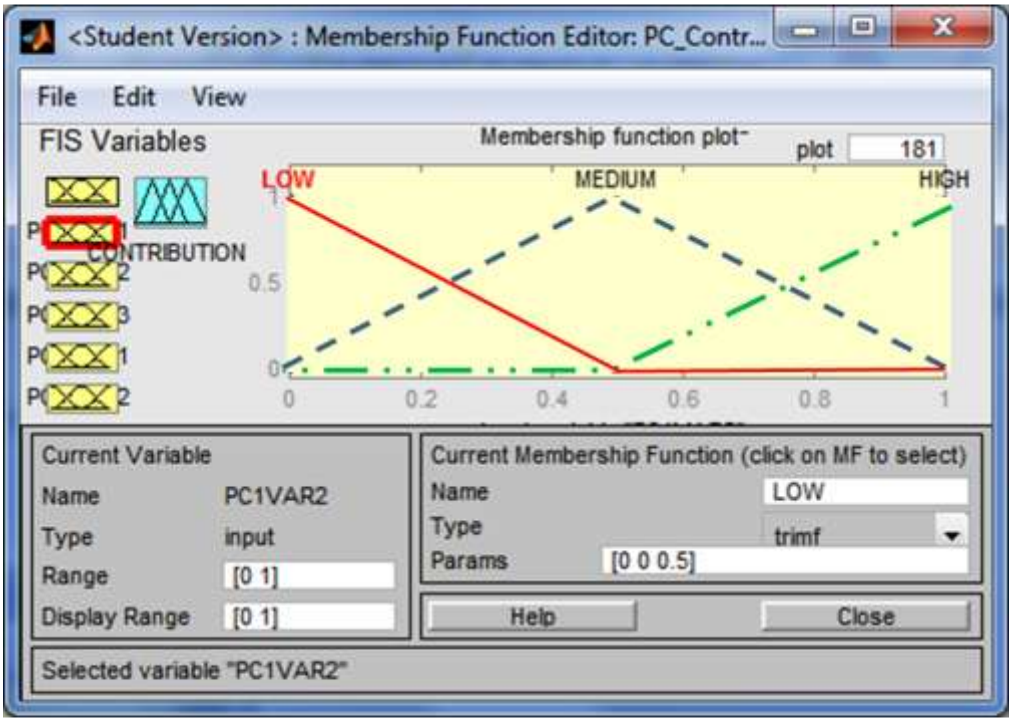
The membership functions for PCVAR1 are Low, Medium, and High.

Figure 7.5: Membership functions for PCVAR1



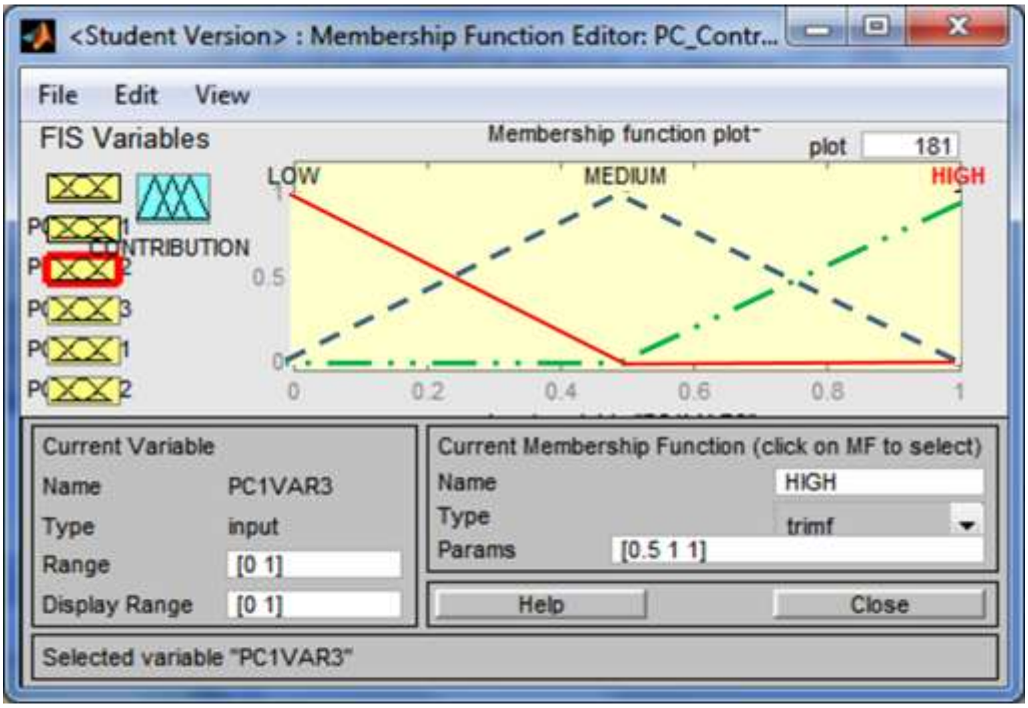
The membership functions for PCVAR2 are Low, Medium, and High.

Figure 7.6: Membership functions for PCVAR2



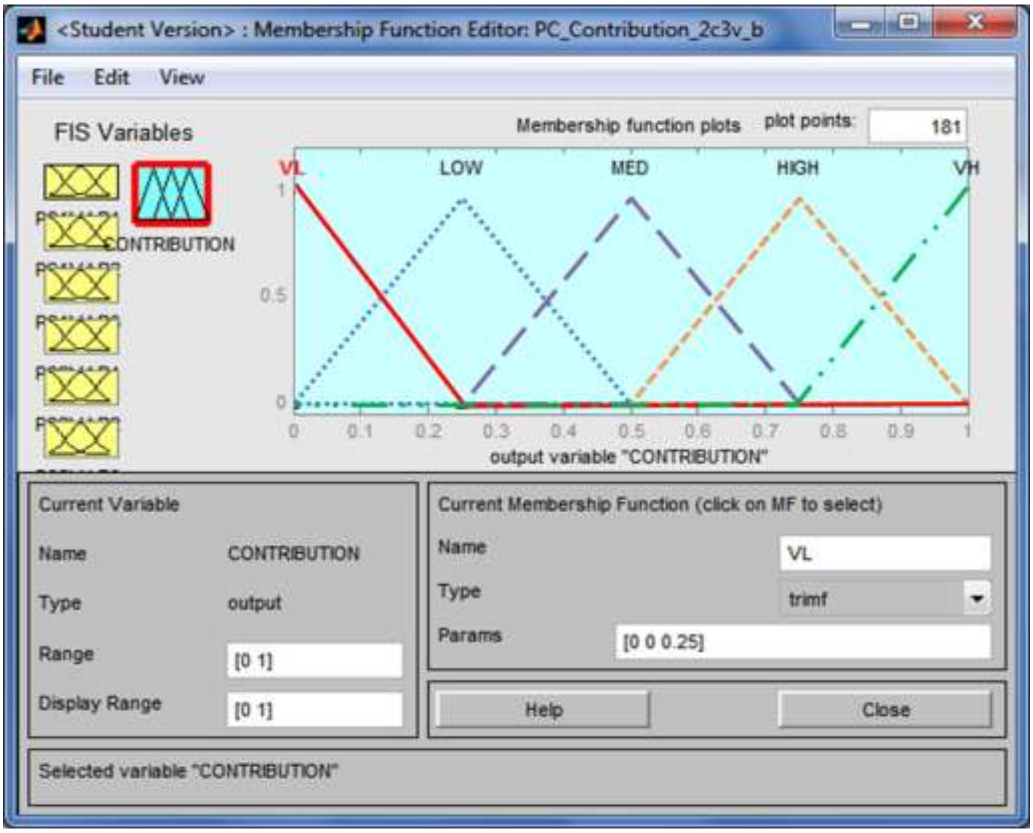
The membership functions for PCVAR3 are Low, Medium, and High.

Figure 7.7: Membership functions for PCVAR3



Now that the membership functions for the input variables have been defined, the membership functions for the output variable can also be defined. The researcher has chosen to use five membership functions in the output variable as depicted in Figure 7.8 below. The membership functions are: Very Low (VL); Low; Medium (Med); High; and Very High (VH). Five membership functions were chosen for the output variable because the researcher wanted to have a wider distribution of output values beyond just Low, Medium, and High. According to (Reznik, 1997), the number of membership functions is generally between 3 and 9. As a rule of thumb, the greater control required (i.e. the more sensitive the output should be to the input changes), the greater the membership functions are used. In terms of this, an average number of membership functions for the output variable were chosen.

Figure 7.8: Output variables (CONTRIBUTION) with its membership functions



Five membership functions were chosen for the output variable to allow a broader range of membership functions to which the rule consequents could be mapped. It was not necessary to go beyond five membership functions.

Phase 1b follows with an explanation on defining the rules for the rule engine.

7.5.1.2 Phase 1b – Define the rules to be used in the rule engine

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 (section 7.3.) – i.e., a) the organisation, b) its competitive, regulatory and operational environment, and c) the nature of its organizational objectives and projects and programmes. These factors will enable them to define the rules in a way that will be appropriate for their organisation. 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 the others. A system with three input variables that caters for a combination of two portfolio components, results in a rule set of 729 rules. Table 7.4 below provides a random sample of the rules from this application as a means of illustrating what the rules look like.

Table 7.4: Random selection of fuzzy rules from the rule engine to determine the combined contribution of portfolio components

No.	RULE
1	If (PC1VAR1 is POOR) and (PC1VAR2 is LOW) and (PC1VAR3 is LOW) and (PC2VAR1 is POOR) and (PC2VAR2 is LOW) and (PC2VAR3 is LOW) then (CONTRIBUTION is VERYLOW)
10	If (PC1VAR1 is POOR) and (PC1VAR2 is LOW) and (PC1VAR3 is LOW) and (PC2VAR1 is AVERAGE) and (PC2VAR2 is LOW) and (PC2VAR3 is LOW) then (CONTRIBUTION is VERYLOW)
50	If (PC1VAR1 is POOR) and (PC1VAR2 is LOW) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is GOOD) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is MEDIUM) then (CONTRIBUTION is MEDIUM
100	If (PC1VAR1 is POOR) and (PC1VAR2 is MEDIUM) and (PC1VAR3 is LOW) and (PC2VAR1 is GOOD) and (PC2VAR2 is LOW) and (PC2VAR3 is LOW) then (CONTRIBUTION is LOW)
200	If (PC1VAR1 is POOR) and (PC1VAR2 is HIGH) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is AVERAGE) and (PC2VAR2 is LOW) and (PC2VAR3 is MEDIUM) then (CONTRIBUTION is MEDIUM)
300	If (PC1VAR1 is AVERAGE) and (PC1VAR2 is LOW) and (PC1VAR3 is HIGH) and (PC2VAR1 is POOR) and (PC2VAR2 is LOW) and (PC2VAR3 is HIGH) then (CONTRIBUTION is LOW)
400	If (PC1VAR1 is AVERAGE) and (PC1VAR2 is MEDIUM) and (PC1VAR3 is HIGH) and (PC2VAR1 is GOOD) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is LOW) then (CONTRIBUTION is MEDIUM)
500	If (PC1VAR1 is GOOD) and (PC1VAR2 is LOW) and (PC1VAR3 is LOW) and (PC2VAR1 is AVERAGE) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is MEDIUM) then (CONTRIBUTION is MEDIUM)
600	If (PC1VAR1 is GOOD) and (PC1VAR2 is MEDIUM) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is POOR) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is HIGH) then (CONTRIBUTION is HIGH)
700	If (PC1VAR1 is GOOD) and (PC1VAR2 is HIGH) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is GOOD) and (PC2VAR2 is HIGH) and (PC2VAR3 is LOW) then (CONTRIBUTION is VERYHIGH)
729	If (PC1VAR1 is GOOD) and (PC1VAR2 is HIGH) and (PC1VAR3 is HIGH) and (PC2VAR1 is GOOD) and (PC2VAR2 is HIGH) and (PC2VAR3 is HIGH) then (CONTRIBUTION is VERYHIGH)

When evaluating the contribution of a single portfolio component to a single objective, the rule set will be reduced to consist only of the rules applicable to a single component. This is a limitation of the MATLAB® tool which requires that the rules have to be written for either a single portfolio component or multiple components. If there are two components, the rules must be set up for two components. If there three components, the additional rules must be written to cater for the permutations introduced as a result of the third component. This also applies to the addition of variables. This limitation is understandable, as the tool was not designed to cater for the model introduced in this research. Nevertheless, by building rule sets based on the number of components and variables being evaluated, the researcher is able to deal with this limitation. The following table below (Table 7.5) illustrates all the rules applicable for the evaluation of a single component contribution. A single component with three input variables only has 27 rules.

Table 7.5: Rules applicable to a single component contribution

No.	RULE
1	If (PCVAR1 is POOR) and (PCVAR2 is LOW) and (PCVAR3 is LOW) then (CONTRIBUTION is VERYLOW)
2	If (PCVAR1 is POOR) and (PCVAR2 is LOW) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is VERYLOW)
3	If (PCVAR1 is POOR) and (PCVAR2 is LOW) and (PCVAR3 is HIGH) then (CONTRIBUTION is LOW)
4	If (PCVAR1 is POOR) and (PCVAR2 is MEDIUM) and (PCVAR3 is LOW) then (CONTRIBUTION is VERYLOW)
5	If (PCVAR1 is POOR) and (PCVAR2 is MEDIUM) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is LOW)
6	If (PCVAR1 is POOR) and (PCVAR2 is MEDIUM) and (PCVAR3 is HIGH) then (CONTRIBUTION is MODERATE)
7	If (PCVAR1 is POOR) and (PCVAR2 is HIGH) and (PCVAR3 is LOW) then (CONTRIBUTION is LOW)
8	If (PCVAR1 is POOR) and (PCVAR2 is HIGH) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is MODERATE)
9	If (PCVAR1 is POOR) and (PCVAR2 is HIGH) and (PCVAR3 is HIGH) then (CONTRIBUTION is MODERATE)
10	If (PCVAR1 is AVERAGE) and (PCVAR2 is LOW) and (PCVAR3 is LOW) then (CONTRIBUTION is VERYLOW)
11	If (PCVAR1 is AVERAGE) and (PCVAR2 is LOW) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is LOW)
12	If (PCVAR1 is AVERAGE) and (PCVAR2 is LOW) and (PCVAR3 is HIGH) then (CONTRIBUTION is MODERATE)

… table continued on next page.

13	If (PCVAR1 is AVERAGE) and (PCVAR2 is MEDIUM) and (PCVAR3 is LOW) then (CONTRIBUTION is LOW)
14	If (PCVAR1 is AVERAGE) and (PCVAR2 is MEDIUM) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is MODERATE)
15	If (PCVAR1 is AVERAGE) and (PCVAR2 is MEDIUM) and (PCVAR3 is HIGH) then (CONTRIBUTION is MODERATE)
16	If (PCVAR1 is AVERAGE) and (PCVAR2 is HIGH) and (PCVAR3 is LOW) then (CONTRIBUTION is MODERATE)
17	If (PCVAR1 is AVERAGE) and (PCVAR2 is HIGH) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is MODERATE)
18	If (PCVAR1 is AVERAGE) and (PCVAR2 is HIGH) and (PCVAR3 is HIGH) then (CONTRIBUTION is HIGH)
19	If (PCVAR1 is GOOD) and (PCVAR2 is LOW) and (PCVAR3 is LOW) then (CONTRIBUTION is LOW)
20	If (PCVAR1 is GOOD) and (PCVAR2 is LOW) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is MODERATE)
21	If (PCVAR1 is GOOD) and (PCVAR2 is LOW) and (PCVAR3 is HIGH) then (CONTRIBUTION is MODERATE)
22	If (PCVAR1 is GOOD) and (PCVAR2 is MEDIUM) and (PCVAR3 is LOW) then (CONTRIBUTION is MODERATE)
23	If (PCVAR1 is GOOD) and (PCVAR2 is MEDIUM) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is MODERATE)
24	If (PCVAR1 is GOOD) and (PCVAR2 is MEDIUM) and (PCVAR3 is HIGH) then (CONTRIBUTION is HIGH)
25	If (PCVAR1 is GOOD) and (PCVAR2 is HIGH) and (PCVAR3 is LOW) then (CONTRIBUTION is MODERATE)
26	If (PCVAR1 is GOOD) and (PCVAR2 is HIGH) and (PCVAR3 is MEDIUM) then (CONTRIBUTION is HIGH)
27	If (PCVAR1 is GOOD) and (PCVAR2 is HIGH) and (PCVAR3 is HIGH) then (CONTRIBUTION is VERYHIGH)

The rules defined in the rule engine will be triggered after the fuzzification process described in Phase 3 (section 7.5.3) below.

The next phase is to choose the input variables – i.e., the variables used for evaluating the portfolio components in terms of their contribution to organizational objectives.

7.5.2 Phase 2 – Describe the evaluation criteria (input variables)

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

PCVAR1: Input Variable 1 (labelled as PCVar1 to remain consistent with the description in chapter 5).

As in Chapter 5, 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 organisation's objectives in the long term with respect to its financial attractiveness – that is, the economic feasibility which is measured by the component cost, contribution to profitability and contribution to growth (Santhanam & Kyparisis, 1995; Ghasemzadeh & Archer, 2000; Deng & Wibowo, 2009). Table 7.6 below describes the linguistic values: Poor, Average, and Good, which are used in evaluating PCVAR1.

Table 7.6: 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 greater 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 7.7 below describes the linguistic values: Low, Medium, and High, which are used in evaluating PCVAR2.

Table 7.7: 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 towards 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. (Bettis & Hitt, 1995 as cited in Petit & Hobbs, 2012:39) refer to the “potential for success under varying future circumstances and the flexibility provided by the strategic response capability” to respond to change 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 (Petit & Hobbs, 2012).

Table 7.8 below describes the linguistic values: Low, Medium, and High, which are used in evaluating PCVAR3.

Table 7.8: 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%

Now that we have defined a) the membership functions for the input variables, b) the rules for the inference engine, and c) described the three input variables and how they would be evaluated, we can now perform the Fuzzification phase, which includes the qualitative evaluation of each input variable per component.

7.5.3 Phase 3 – Fuzzification

The process of fuzzification entails determining the membership values associated with the qualitative evaluation of each of the aforementioned input variables. The membership functions for each of the variables were defined and illustrated in Phase1.

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 organisation, they can make a consensus decision regarding the evaluation of each component.

Table 7.9 below 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

Table 7.9: Qualitative evaluations of portfolio components

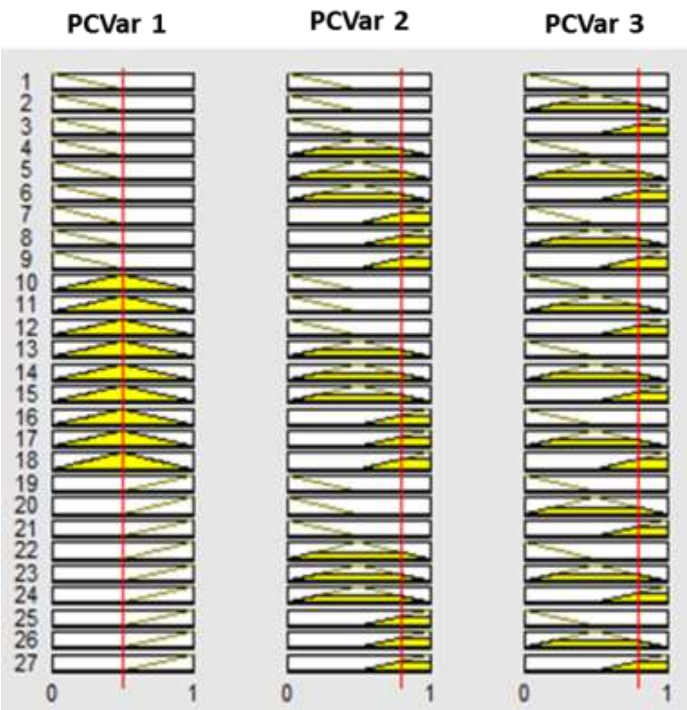
Values used for evaluating each variable: Value (PCVAR1): *P=Poor; A=Average; G=Good* Longevity (PCVAR2) and Probability for successful implementation (PCVAR3): *L=Low; M=Medium; H=High*	Business Growth			Reduce the cost of operations in Retail Banking			Adhere to compliance and regulatory requirements			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

* Abbreviations are given in full in Table 7.2: Portfolio component descriptions.

The next step in the fuzzification process is to take the qualitative inputs and determine the degree to which these inputs belong to each of the respective membership functions. In an organisation, the portfolio management team would evaluate the input variable 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).

Referring to Table 7.9 above, we notice that for PC2: CBT the input variables have been evaluated as AHH (Average, High, High) for each of the three variables when evaluating the component’s contribution to Objective 2. The degree to which each variable has been evaluated is represented by the respective red line in Figure 7.9 below.

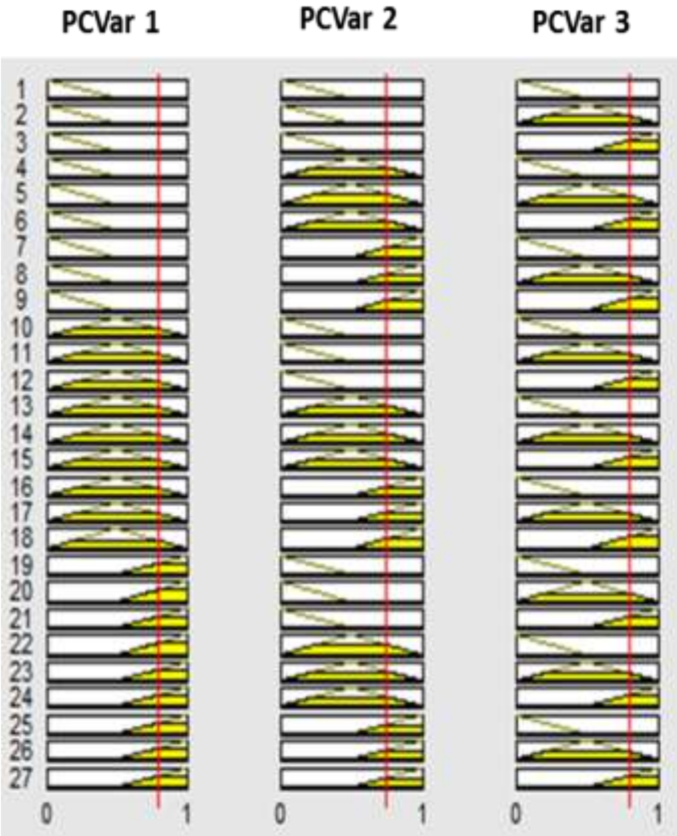
Figure 7.9: Evaluations for (PC2)



In Figure 7.9 above, PCVar1 is evaluated as Average and the red line cuts through the centre of the AVERAGE membership function. PCVar2 is evaluated as High such that the red line cuts the MEDIUM and HIGH membership functions (the middle and right hand side triangles). PCVar3 is evaluated as High such that its red line also cuts the MEDIUM and HIGH membership functions.

Similarly, for PC3: ECM, the input variables have been evaluated as GHH (Good, High, High) for each of the three variables when evaluating the component's contribution to objective 2. The degree to which each variable has been evaluated is represented by the respective red line in Figure 7.10.

Figure 7.10: Evaluations for (PC3)



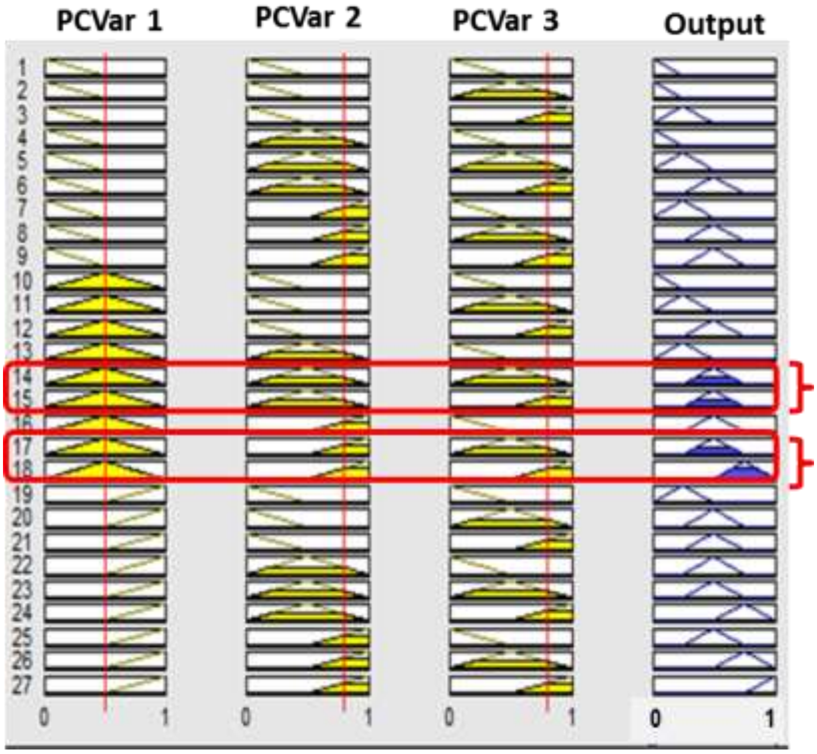
In Figure 7.10, PCVar1 is evaluated as Good such that the red line cuts through the AVERAGE and GOOD membership functions. PCVar2 is evaluated as High such that the red line cuts the MEDIUM and HIGH membership functions. PCVar3 is evaluated as High such that its red line also cuts the MEDIUM and HIGH membership functions.

The points at which the red lines cut through the membership functions represents the degree to which each input belongs to each respective membership function. The degree of belonging is equal to the membership value - the value between 0 and 1 on the y-axis of each of the 27 graphs in Figure 7.9 and Figure 7.10. These values are used as input to the rule engine. The application of the rules is discussed in the next section.

7.5.4 Phase 4 – Applying the rules in the Rule engine

In the previous phases, each of the input variables were evaluated qualitatively, and the degree of membership (membership value) was determined after plotting the red line on the membership functions for each variable. In this system of portfolio components and organizational objectives, there is more than one input variable per portfolio component. The degree of membership for the consequent membership function (output) will be the minimum value of the degree of membership for the different inputs. This is illustrated in the following Figure 7.11. The membership functions of the input variables are shaded in yellow while the membership functions of the output variable are shaded in blue.

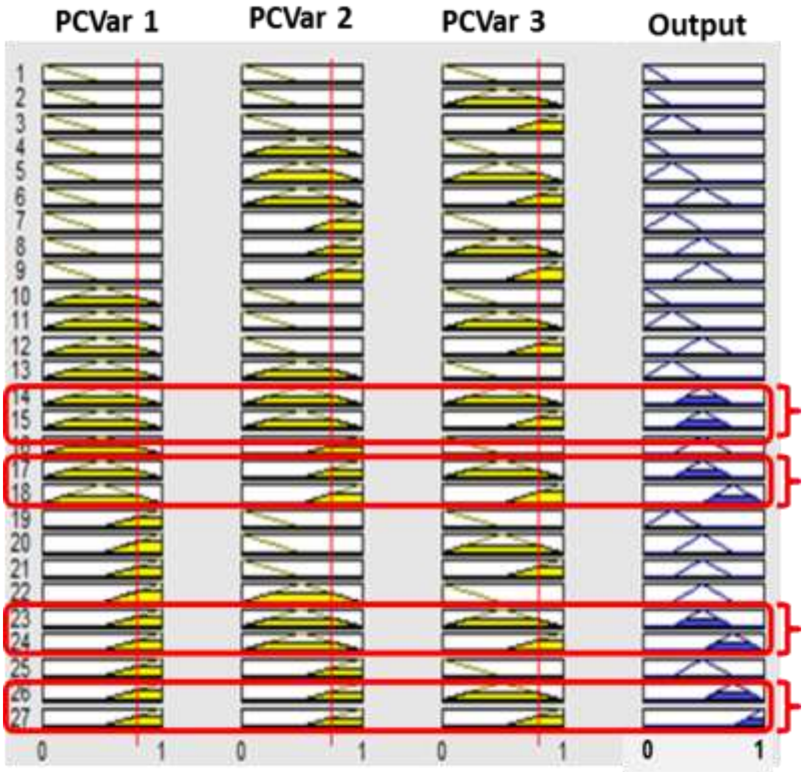
Figure 7.11: Application of rules for (PC2)



Only rules that are satisfied result in an output membership function with a membership degree equal to the lowest membership degree among the input variables. The rules satisfied for PC2 are rules 14, 15, 17, and 18. These are outlined using a rectangular border and parentheses.

Similarly, the output membership functions for PC3 are determined and illustrated here:

Figure 7.12: Application of rules for (PC3)



The rules satisfied for PC3 are rules14, 15, 17, 18, 23, 24, 26, and 27. These are outlined using rectangular borders and parentheses. This process is applied for each of the portfolio components.

The next phase discusses the derivation of the outputs.

7.5.5 Phase 5 – Output

The output is the aggregation or sum of the membership functions from the satisfied rules. The membership functions of all rule consequents are combined into a single fuzzy set (also known as a fuzzy region). The input of the aggregation process is the list of consequent membership functions (identified by the dotted line in Figure 7.13 below), and the output is one fuzzy set for each output variable. Among the satisfied rules, the membership degree of each output fuzzy region will be the *higher* among the rules that have as a result that membership function. The figures that follow (Figure

7.14 and Figure 7.15) show the final output (identified by the ellipse) for PC2 and PC3 respectively. The output fuzzy regions have been redrawn to make the image clearer.

Figure 7.13: Consequent membership functions

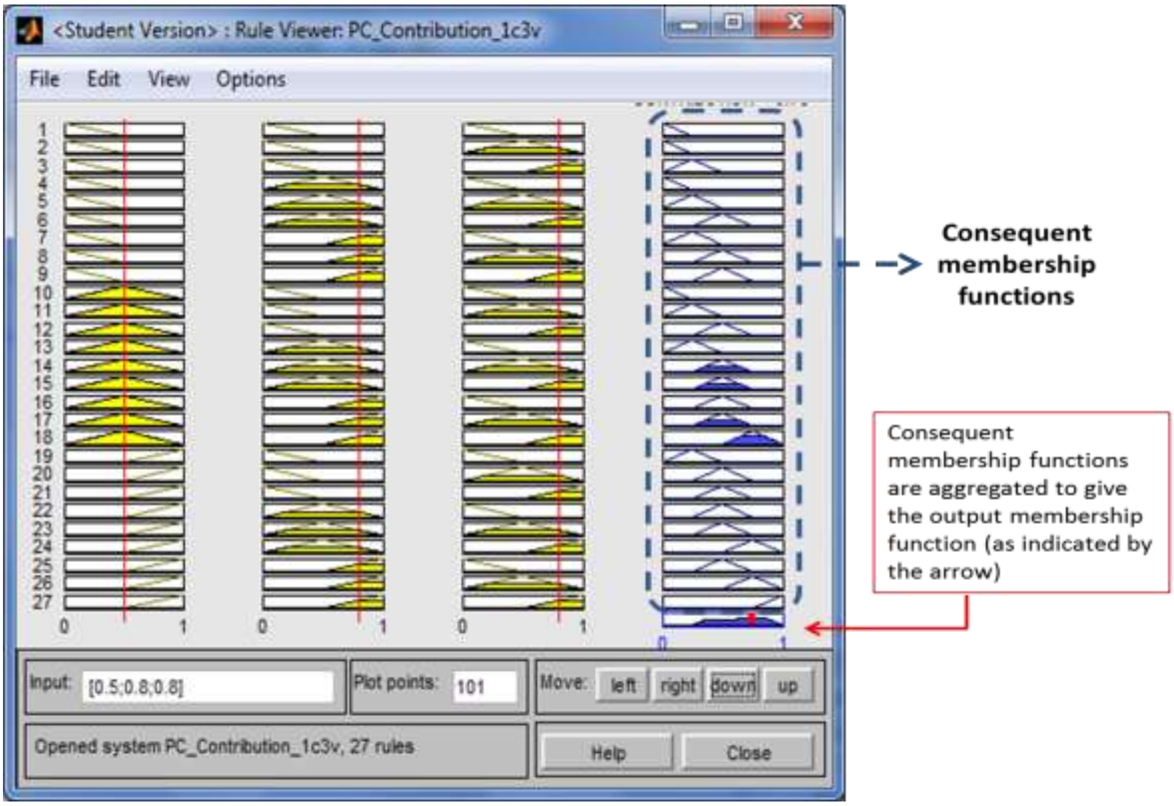


Figure 7.14: Output for PC2

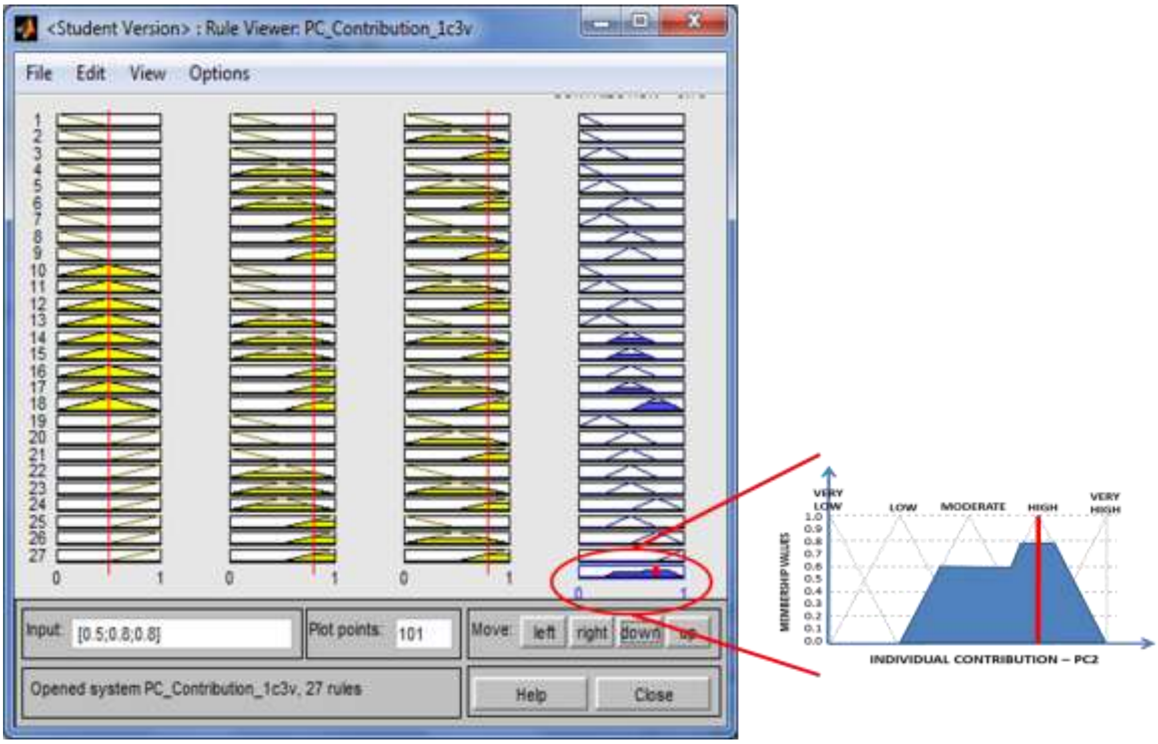
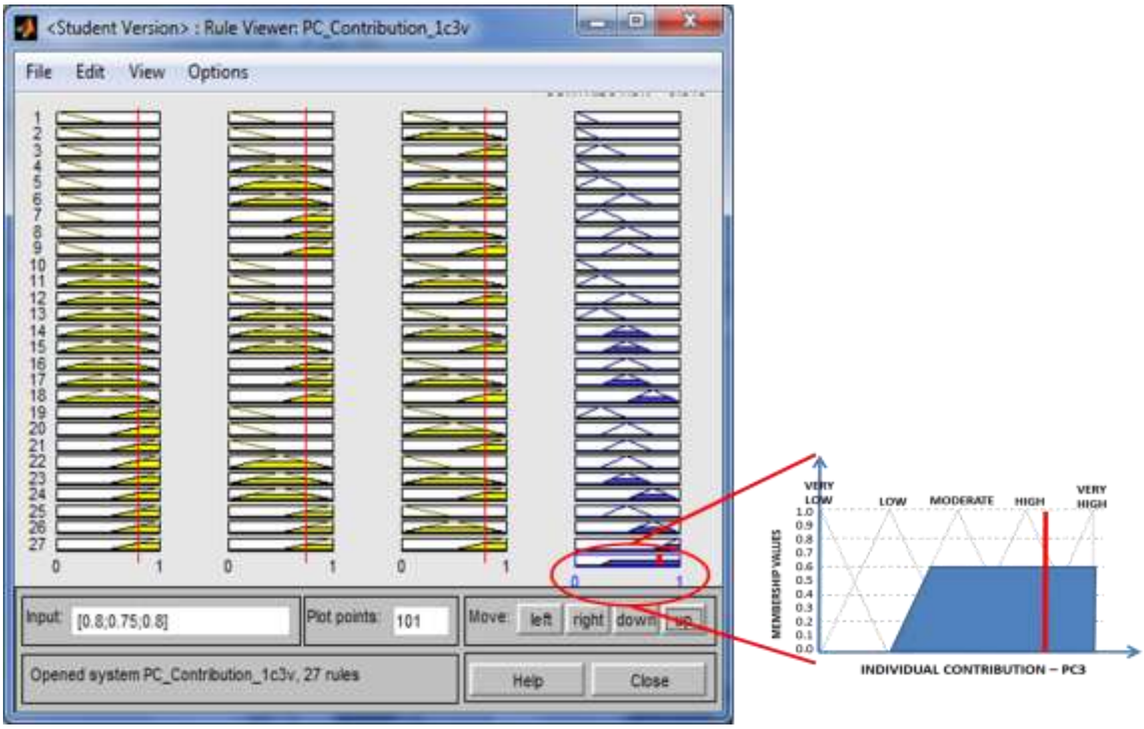
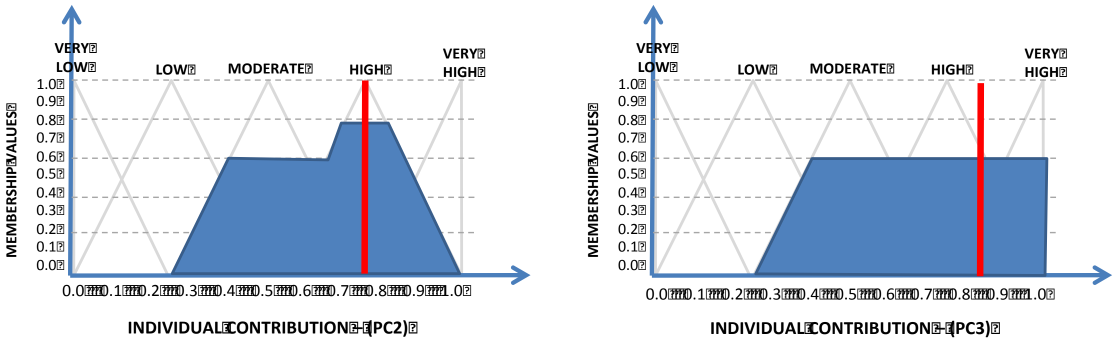


Figure 7.15: Output for PC3



To summarize, the individual output fuzzy regions (representing individual contribution) for PC2 and PC3 are:

Figure 7.16: Output fuzzy regions for PC2 and PC3



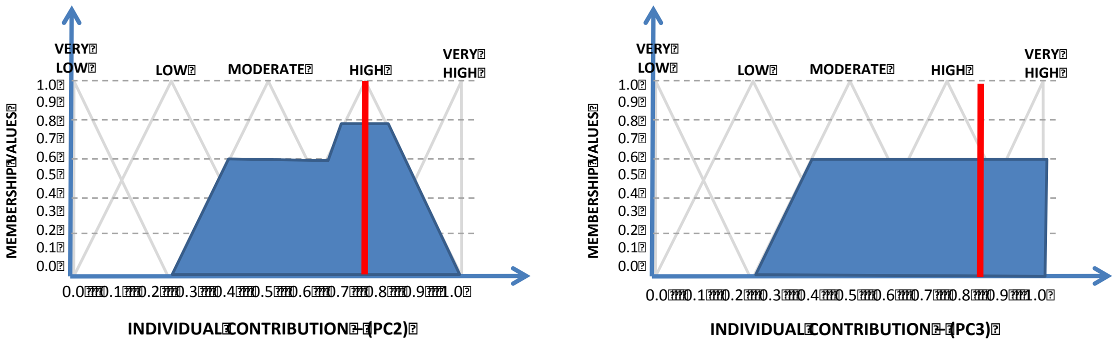
7.5.6 Phase 6 – Defuzzification

The output membership functions are now defuzzified to determine the individual contribution values. It is important to note that to determine the combined contribution of components to objectives, this step is excluded. However, for the purpose of illustrating the contributions and the impact of decisions regarding individual components later in the chapter, it is necessary to determine the individual contributions here.

The defuzzification process takes the output fuzzy set (fuzzy region) as an input and through a defuzzification method, defuzzifies the output fuzzy region into a crisp value which represents the individual component's contribution. The defuzzification method used in this verification process is MoM (Middle of Maximum). A comparison between the CoG and MoM methods are provided in section 8.2.1.

The bold vertical lines in the following figure (Figure 7.17) represent the result of the defuzzification method and the point at which it intersects the x-axis is the crisp value that represents the portfolio component's contribution.

Figure 7.17: Individual contribution for PC2 and PC3



The defuzzified value for PC2 is 0.750 and the defuzzified value for PC3 is 0.815.

Similarly, the crisp contribution values for each of the other components are determined. To avoid unnecessary repetition, only PC2 and PC3 are taken through the illustration process.

The table below (Table 7.10) shows the individual (crisp) contribution values for all of the portfolio components.

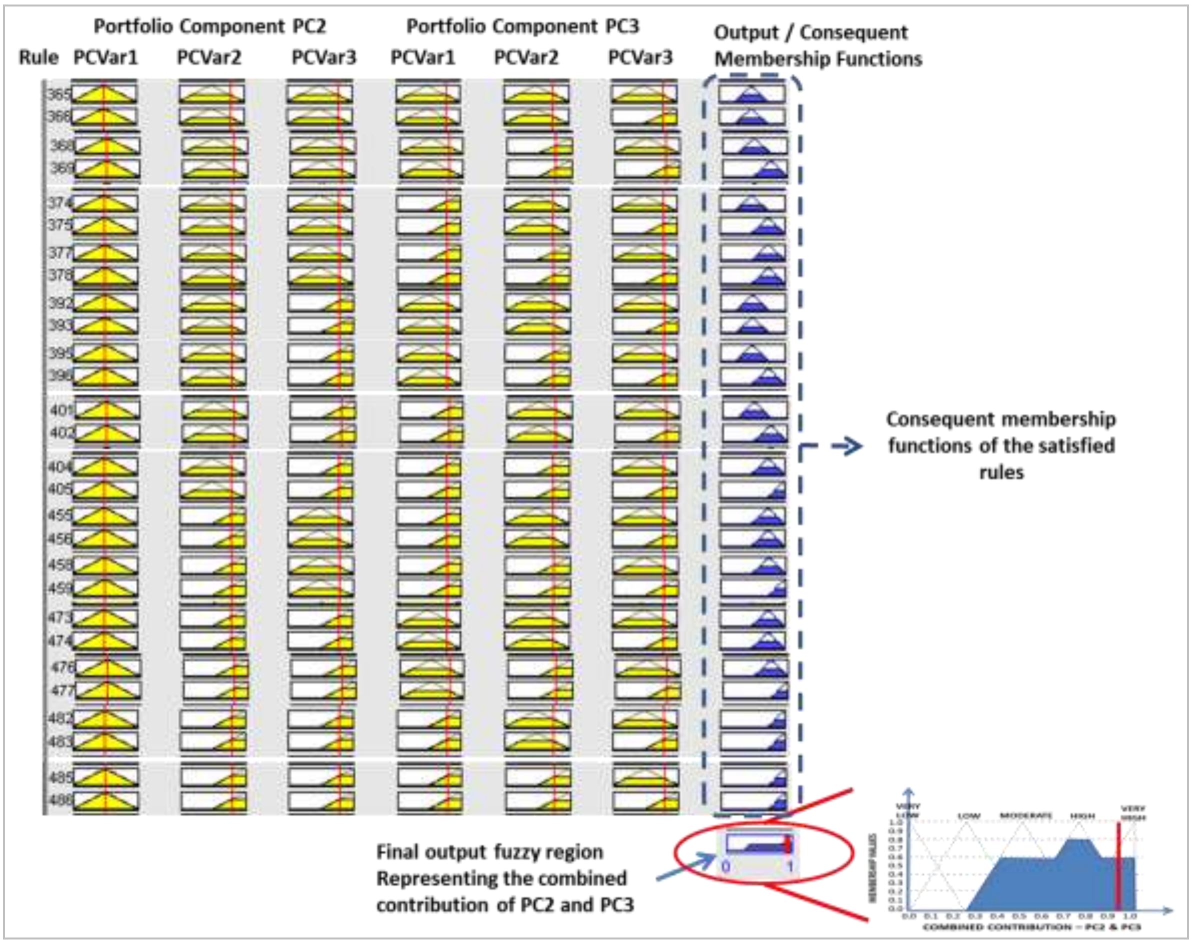
Table 7.10: Individual contribution values

	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

7.5.7 Phase 7 – Determine combined contribution

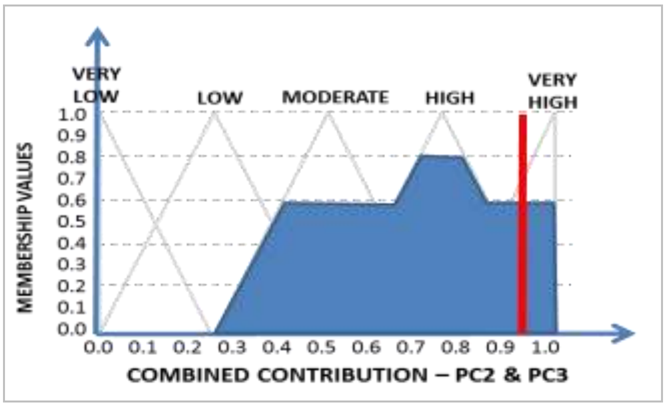
As described in Chapter 5, to determine the combined contribution of components that jointly contribute to specific objectives, it is necessary to enter the criteria evaluations for the relevant components into the rule engine simultaneously. For example, to determine the combined contribution of components PC2 and PC3 to Objective 2, their evaluations are entered into the rule engine at the same time. As described in Chapter 5, this is to ensure no loss of information in the fuzzy logic system. The rules described in Phase 1 apply when determining combined contribution of two components to the same objective. When PC2 and PC3 are evaluated simultaneously with the evaluations described earlier, the following rules are satisfied in the rule engine (See Figure 7.18 below):

Figure 7.18: Satisfied rules for combined evaluation of PC2 and PC3



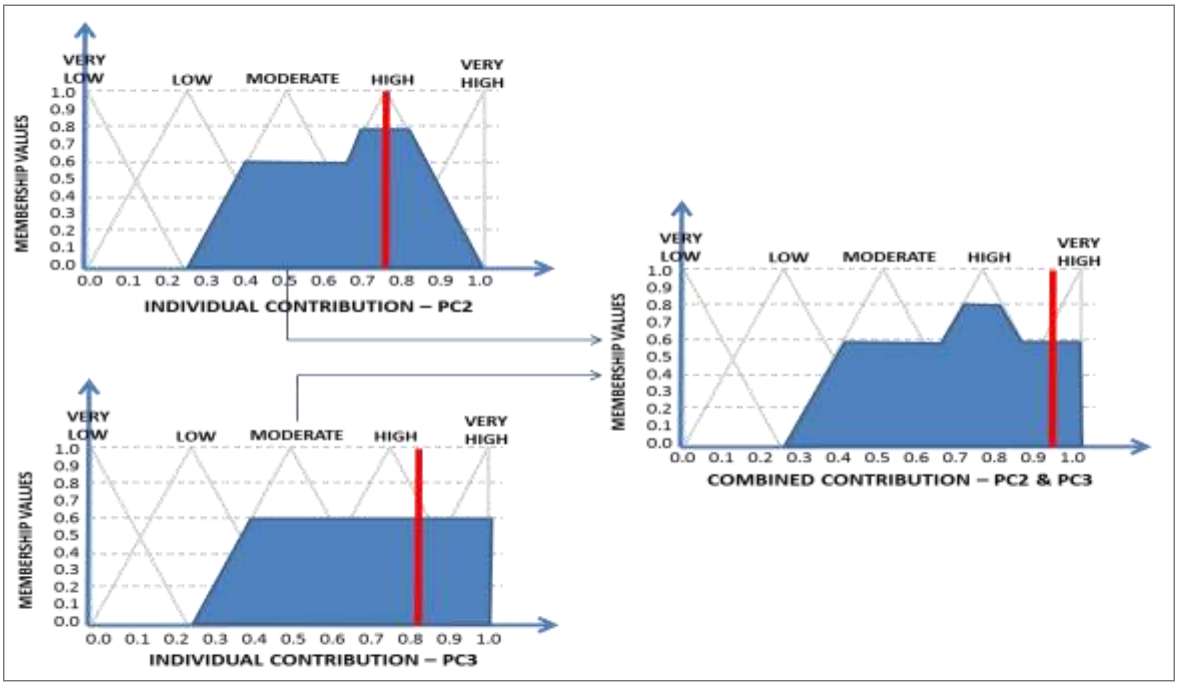
The consequent membership functions are aggregated to provide a final output fuzzy region that represents the cumulative contribution of PC2 and PC3. Applying the defuzzification method described earlier results in a crisp value of 0.940 for the cumulative contribution of PC2 and PC3 to objective 2. This is represented in the bold vertical line in Figure 7.19 below:

Figure 7.19: Final output fuzzy region representing the cumulative contribution of PC2 and PC3



The result illustrated in Figure 7.18 and Figure 7.19 is the same as aggregating the individual output fuzzy regions of PC2 and PC3 to provide the final output fuzzy region representing the cumulative contribution of PC2 and PC3. This is illustrated in Figure 7.20 below. The point at which the bold vertical line intersects the x-axis in the final output fuzzy region is equal to 0.940.

Figure 7.20: Individual membership functions combined to produce the combined contribution



Similarly, the combined contribution of PC3 and PC4 to Objective 3, and PC2 and PC5 to objective 4 are determined. Table 7.11 shows the individual and combined contributions of the portfolio components to the respective objectives.

Table 7.11: Combined contributions - all portfolio components 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

It can be determined from analysing the combined contributions that the organisation's objectives, individually or collectively, will not be fully met as none of the combined contributions is equal to 1. PC2 and PC3 together almost achieve Objective 2 while the remaining objectives are only partially achieved.

To improve this situation, Company A must either increase the scope of existing components or add components to achieve the remainder of each of the objectives. Take, for example, PC1 – Global Markets eCommerce. It contributes to the objective of 'Business Growth' by establishing an electronic trading platform that will facilitate business growth through the development of an electronic trading platform for Global Markets which will provide clients with research, pre-trade services, cross asset trading, pricing, risk management, liquidity distribution and post-trade services. While this is important and relevant, an objective like 'Business Growth' will require additional components in order to be fully achieved. The merger or acquisition of a smaller bank in an African country, or the establishment of additional branches or other forms of banking in countries with poor infrastructures are some of the initiatives that could initiate components that contribute to the 'Business Growth' objective. The model clearly shows that there is scope for additional components that would contribute to the achievement of Objective 1 – and for that matter all other objectives illustrated in Table 7.11 above.

7.5.8 Phase 8 – 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 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 to only single objectives. This view of the total contribution of portfolio components to objectives is illustrated in Table 7.12 below.

Table 7.12: 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	

There are now two perspectives to viewing the data in Table 7.12. 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 5. 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 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 7.12 based on their total individual contributions 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 culling a portfolio component.

7.6 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 thesis 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 organisation would exercise when setting up the portfolio. Instead, it is the management response to a change in the organisation'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 organisation 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 current global economic crisis has caused many organisations to critically evaluate their investment in projects and programmes (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 towards the achievement of organizational objectives.

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

1. How much have we invested in the component thus far and is the cost justified?
2. What percentage of the total cost of the portfolio component is required to complete the component?
3. If the portfolio component has not commenced, can it be delayed to the next financial year?
4. 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?
5. What has the portfolio component delivered to date and can the remaining deliverables be deferred to the new financial year?

An analysis of the above 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 towards achieving the organizational objectives.

Let us assume that due to the budget cuts, the portfolio investment committee chooses to terminate one of the portfolio components. Table 7.13 below 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.

Table 7.13: 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.

None of the reasons given in the table above consider the degree of contribution towards achieving organizational objectives. Making a decision based purely on the above considerations will affect the level of success the organisation 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 thesis. Table 7.14 below shows the contribution of the portfolio components before the decision is made while Table 7.15 later in this chapter, shows the contributions of the portfolio components after the decision to terminate the portfolio components.

Table 7.14: Combined contributions before portfolio components 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

Terminating PC1 would mean that no contribution is made towards the achievement of Objective 1 (Business Growth), as PC1 is the only component identified towards achieving Objective 1. This is illustrated in Figure 7.21.

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 (Core Banking Transformation Programme). The rules for determining the contribution of PC3 will not be considered. The output fuzzy region for PC3 will not be combined with the output region of PC2 resulting in the output region of PC2 being equal to the final output region. This is illustrated in Figure 7.22 below.

Figure 7.21: Illustration of output fuzzy region after PC1 is terminated

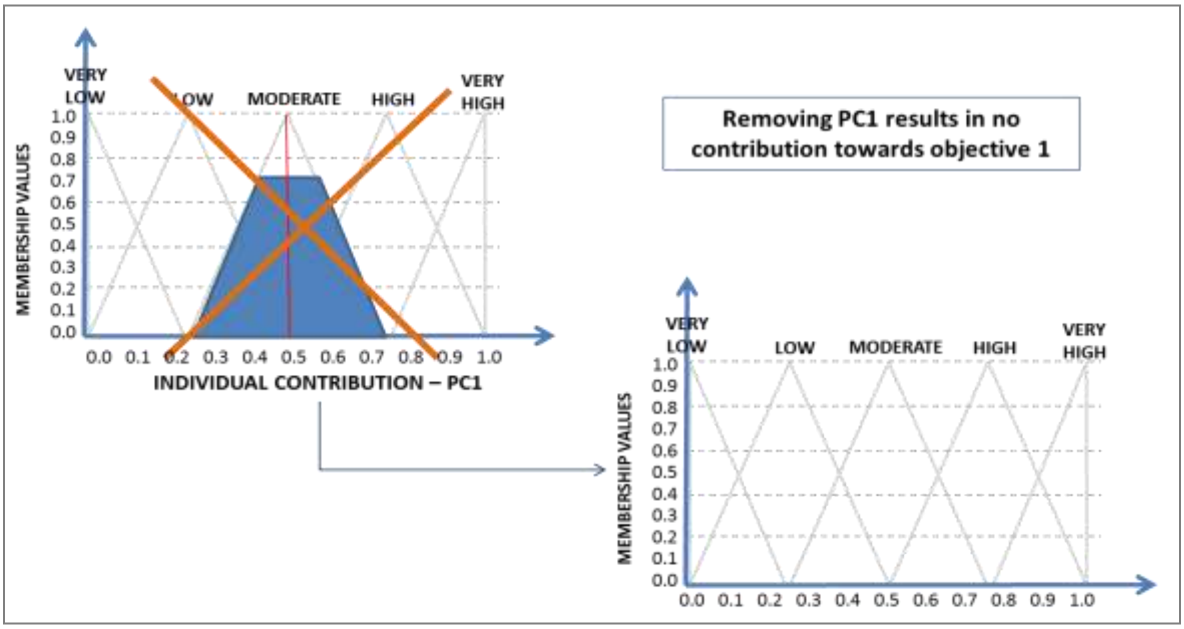
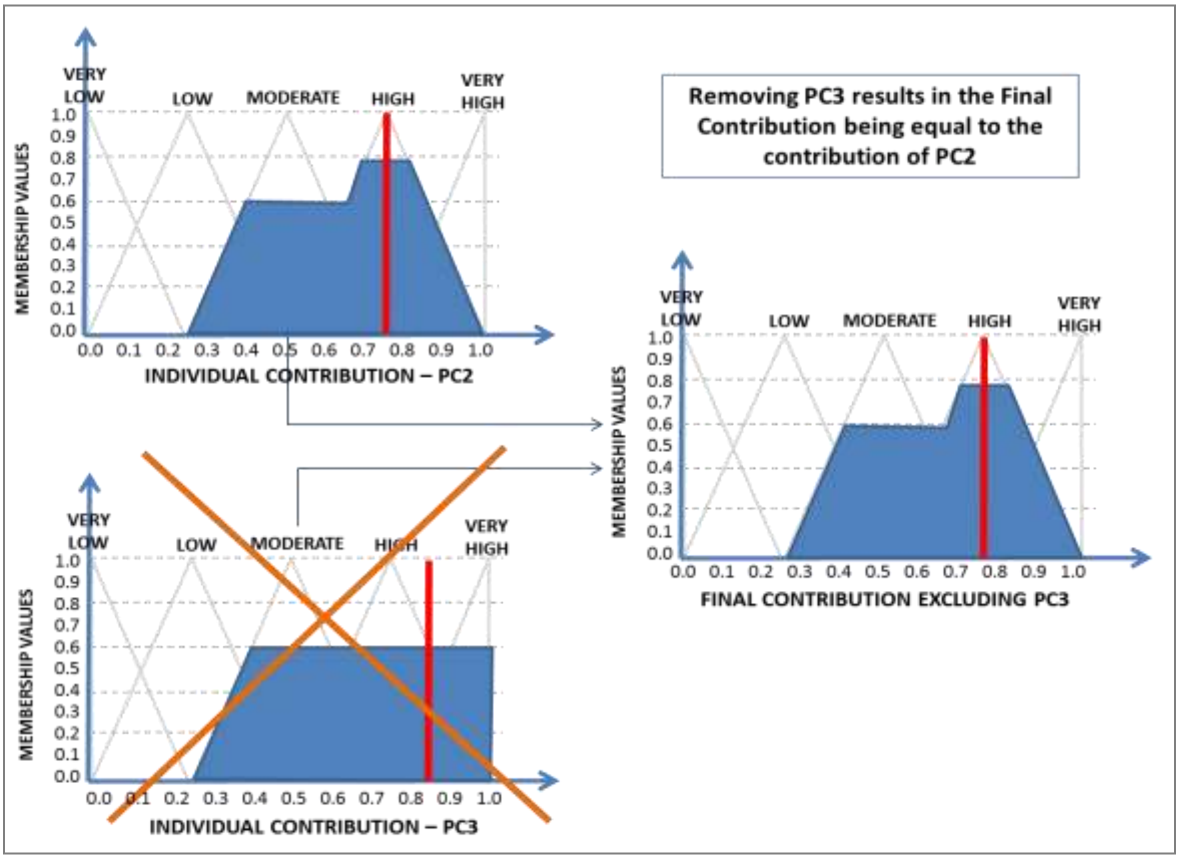


Figure 7.22: Illustration of the removal of PC3 from the combined contribution to Objective 2

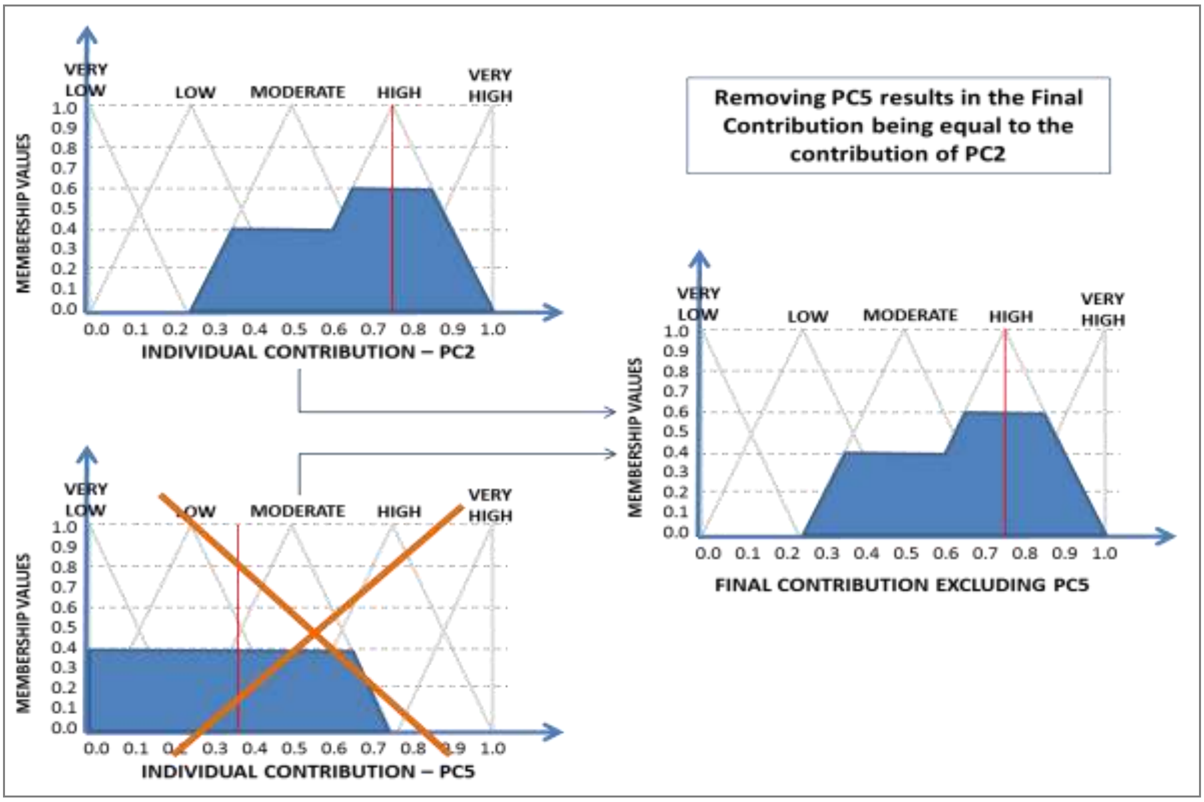


Removing PC3 also impacts Objective 3 (Adhere to compliance and regulatory requirements). For Objective 3 only PC4 is considered when determining the contribution towards achieving the objective.

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.

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) – (see Figure 7.23 below).

Figure 7.23: Illustration of output fuzzy region after PC5 is terminated



The impacts of terminating PC1, PC3, or PC5 are illustrated in Table 7.15 below, which shows the comparative contribution before and after the components have been terminated.

Table 7.15: 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	~~**0.500**~~								
PC2: CBT			0.750	0.750			0.750	0.750		
PC3: ECM			0.815	~~**0.815**~~	0.500	~~**0.500**~~				
PC4: CPA					0.245	0.245				
PC5: ITAPS							0.375	~~**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

7.7 Observations

1. Terminating PC1 results in no advancement towards 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) i.e. the original contribution minus the resultant contribution after the component has been terminated, is equal to the degree of change.
2. 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 of PC3 and PC4 to *objective 3* is equal to (0.600 – 0.245 = 0.355). By terminating PC3, the total reduction in the contribution of PC3 to this set of objectives is equal to (0.190 + 0.355 = 0.545)

3. 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.
4. 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 above, 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.

7.8 The benefit of using this model

The scenario illustrates 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. 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 to terminate PC5 as it makes the smallest contribution to organizational objectives. This action would ensure that the organisation makes the right decisions regarding its investments in portfolio components as they relate to achieving the organisations 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 a few considerations that decision-makers would take into account when optimizing the portfolio. Other considerations such as objective priority and component dependency remain outside the scope of this thesis and can be considered in future research.

7.9 Conclusion

This chapter looked at the verification of the conceptual model described earlier in Chapter 5. A participant organisation was used to provide information regarding their organizational objectives and portfolio components, which were used in the verification 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 stepping through the model phases using the information from the participant organisation. The verification process was conducted. It 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. Each phase of the model was discussed and illustrated with figures and tables to show inputs, processes, and outputs.

In addition to the stepwise verification, a “What-If” scenario was presented; illustrating how the information produced by the model will aid decision-making. These processes contributed towards the verification of the model.

The scenario 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. This demonstrates the value of this model and its alignment with addressing the problem identified by this research, which was:

> *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.*

The next chapter (Chapter 8) looks at the validation of the model. Validation entails performing tests on the model that confirm whether or not the model addresses the problem it was meant to address. Three tests are chosen for this purpose and are described in more detail in Chapter 8. The validation process is aimed at building confidence that the model is an appropriate solution to the problem being solved by this research.

8 CHAPTER 8: Model Validation

8.1 Introduction

The previous chapter discussed the verification of the model presented in Chapters 5 and 6. Then in Chapter 7 the organizational context of the candidate organisation was described. This included the organizational objectives and portfolio components used in the verification process, and the chapter walked through, step-by-step, the model phases using the components and objectives from the candidate organisation. Chapter 7 partly addressed the fourth research objective of verifying and validating the conceptual model and proved that the technical aspects of the model work.

The purpose of this chapter is to address the second part of the aforementioned research objective – i.e., the validation of the model. Model validation builds greater confidence in the model and confirms that it addresses the problem it was designed to address.

To achieve the goal for this chapter, the researcher must determine which tests are suitable for testing the validity of this model, and then conduct the tests to prove or disprove the validity of the model. The findings from the validation are discussed in the conclusion section of this chapter.

The remainder of this chapter focuses on a) a discussion on model validation, b) identification and performance of validation tests for the model presented here, c) a discussion on the visualization of data and the use of dashboards, d) the use of a dashboard to visually illustrate the impact of decisions related to managing the portfolio, and e) concluding observations.

8.2 Model Validation

Buranathiti, et al., (2006:588) observe that, "model validation has become an increasingly important issue in the decision-making process". They define model validation as "a means to systematically establish a level of confidence of models." They go on to state that whereas "*model verification* is considered to be a confirmation process that a model can accurately represent the given mathematical model, … *model validation* is considered to be a confirmation process that the prediction of a model can adequately predict the underlying physics" Buranathiti, et al., (2006:588). Qureshi, Harrison and Wegener (1999:105) confirm that "validation procedures play an important role in establishing the credibility of models, improving their relevance and acceptability". Validation helps to confirm that the model represents reality (Chapurlat, Kamsu-Foguem, & Prunet, 2003).

Yilmaz (2006:286) states that "conceptual model validation is defined as determining that the theories and assumptions underlying the conceptual model are correct and the representation of the validated requirements is reasonable at the correct level of fidelity for the intended purpose of the model". Specifically, reference is made to the "conceptual model's structure, logic, mathematical and causal relations, and processes" and the need for the model to be a "reasonably valid and accurate representation of the real system".

Nguyen (2005:25) points out that the validation of models faces several challenges. The first challenge has to do with the complexity of a model while the second challenge has to do with the integration of human behaviour into the model. He observes that "human behaviour is highly unpredictable and difficult to model quantitatively".

Forrester and Senge (1980) distinguish between model testing and validation. They describe model testing as “the comparison of a model to empirical reality for the purpose of corroborating or refuting the model” Forrester and Senge (1980:414). They go on to say that “model structure can be compared directly to descriptive knowledge of real-system structure, and model behavior may be compared to observed real-system behavior”. They further define validation as “the process of establishing confidence in the soundness and usefulness of a model.” They believe that ‘confidence’ is the appropriate criterion because “there can be no proof of the absolute correctness with which a model represents reality” Forrester and Senge (1980:414).

Nguyen (2005:35) states that the important characteristics of the aforementioned framework are “the focus of validation on the structure of the model system, the vital roles of the experts’ knowledge/experience and qualitative and informal tests (e.g. extreme condition test and pattern test) in the validation process. These characteristics are reflected by the extensive use of terms such as soundness, plausibility and confidence”

With reference to Beck, 2002; Parker, Letcher & Jakeman, 2002; Beck & Chen, 2000; Poch, Comas, Rodriguez-Roda, Sànchez-Marrè and Cortés, 2004; Refsgaard, Henriksen, Harrar, Scholten, and Kassahun, 2005 as cited in Nguyen (2005) it is noted that what fosters a shift of model validation from scientific theory testing to evaluating the appropriateness of the model as a tool designed for a specific task are the following: a) the increase in complexity of decision-making models, b) the decrease in the usefulness of quantitative validation approaches due to uncertainty of field data for model calibration, and c) the challenges associated with peer review approaches due to conflicts of interest. What also has value in validating the model is to judge its trustworthiness according to the quality of its design in performing a given task, and using the information or experience obtained from the interactions and dialogues between the modeller(s), experts and in particular - stakeholders.

Forrester and Senge (1980) describe a number of tests that are aimed at establishing confidence in a model. These are grouped in terms of *model structure*, *model behaviour*, and *policy implication* and are briefly described below. These tests are also supported by authors such as Qudrat-Ullah (2005) and Barlas (1994)

Model structure tests assess structure and parameters without examining relationships between structure and behaviour. These tests include:

1. *Structure verification*
2. *Parameter verification*
3. *Extreme conditions*
4. *Boundary adequacy (structure)*
5. *Dimensional consistency*
6. *Other tests*

Model behaviour tests analyse the the behaviour generated by the model structure. For example, the test will check how well the model generated behaviour matches observed behaviour. These tests include:

1. *Behaviour reproduction – (historical)*
2. *Behaviour prediction – (future)*
3. *Behaviour anomaly*
4. *Family member*
5. *Surprise behaviour*
6. *Extreme policy*
7. *Boundary adequacy (behaviour)*
8. *Behaviour sensitivity*
9. *Other tests*

The policy implication tests focus on comparing policy changes in a model and its associated reality. They attempt to check that the response of a real system to a policy change corresponds to the response predicted by the model. Examples of such tests include:

1. *System improvement*
2. *Changed behaviour prediction*
3. *Boundary adequacy (policy)*
4. *Policy sensitivity*

Not all tests are required to be performed. The model only needs to be assessed relative to its purpose (Forrester & Senge, 1980; Nguyen, 2005). To determine which tests should be conducted, the researcher had to first determine what would ensure confidence in the model. According to Forrester and Senge (1980); Rykiel (1996); Parker, Letcher and Jakeman (2002), the purpose of a model should guide the process of its validation. These authors maintain that there has been an increasing consensus among researchers and modellers that a model's purpose is the key factor to determine the selection of the validation tests and the corresponding validity criteria.
Based on the above argument, let us revisit the purpose of the model presented in this thesis.

In Chapter 5 of this thesis, it was discussed that 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 organisations could have. This emphasizes the need not only to link strategy and execution, but also to be able to assess the contribution of the components being executed to the strategy. To understand the degree to which portfolio components contribute to the achievement of organizational objectives also aids the organisation to understand 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 organisation needs a mechanism to help management in the decision-making with regard to rebalancing the portfolio. The purpose of the conceptual model introduced in Chapter 5 is to:

1. *Convert qualitative evaluations of portfolio components into quantitative values representing the degree of contribution of the portfolio components towards achieving the organizational objectives.*
2. *To monitor the degree of achievement of organizational objectives*
3. *To enable decision-making with regard to managing the portfolio*

Given the purpose of the model, the tests appropriate for validating the model in this thesis are:

1. ***Model Structure - Extreme conditions test:*** *This test tests the first aspect of the model purpose – that is to test that when converting qualitative evaluations of portfolio components into quantitative values representing the degree of contribution to objectives, extreme values are tested to ensure that the model will provide predictable results under such conditions.*

   Forrester and Senge (1980:418) point out that this test is important for discovering flaws in a model as "proposed formulations look plausible until considered under extreme conditions". Testing a model under extreme conditions or for extreme input values ensures that the model can handle the full range of possible input values.

2. ***Model behaviour - Behaviour prediction test:*** *This test assesses whether the achievement of objectives can be monitored.*

   Forrester and Senge (1980) suggest that a model should indicate future behaviour. They describe two behaviour prediction tests – firstly, the pattern-prediction test which examines whether or not a model generates qualitatively correct patterns of future behaviour, and secondly, the event-prediction test which focuses on a particular change of circumstances, such as a sharp drop in market share.

3. ***Policy implication - Structure verification test:*** *This test assesses whether the model enables portfolio management decision-making.*

   This test involves comparing model assumptions to descriptions of decision-making and organizational relationships found in relevant literature (Forrester & Senge, 1980). The model should, therefore, represent portfolio management decision-making as it happens in reality or described in literature.

The following sections describe how each of the three tests are applied to prove or disprove the three aspects of the model purpose stated earlier in this chapter.

8.2.1 Extreme conditions test

Barlas and Kanar (1999) describe extreme condition tests as the assignment of extreme values to selected parameters and the comparison of model-generated behaviour to the anticipated (or observed) behaviour of the real system. These tests are effective because they can discover flaws in the model structure (Barlas & Kanar, 1999; Forrester & Senge, 1980) as well as "enhance the usefulness of a model for analyzing policies that may force a system to operate outside historical regions of behaviour" (Forrester & Senge, 1980:418).

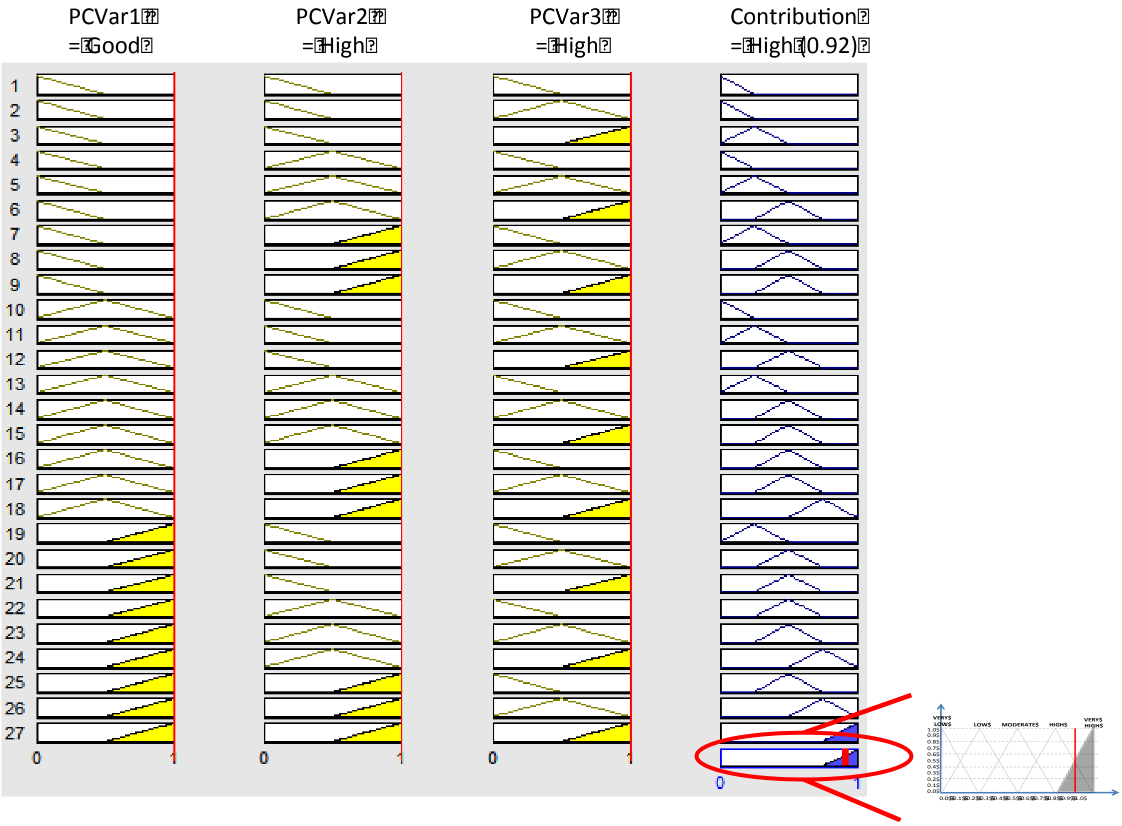
During the further development of the model in Chapter 6, a number of scenarios were run in order to test if the expected output was being achieved for different input variable values. Most of the scenarios produced acceptable results; however, the researcher recognized that the model had to be tested for extreme values as well to ensure that the model was able to handle such values and produce predictable results.

Initial tests of the model did not produce the expected results for extreme values. For example, it is expected that if all the input variables are evaluated as ‘high’ for contributing components such that the membership value = 1, then the output – the degree to which the objective is achieved, should be equal to 1. That is, the objective is fully achieved. This was not the case initially. On further analysis and investigation, it was determined that the defuzzification method used in the model in Chapter 5 prevented the expected result.

Initial versions of the model used the Centre of Gravity (CoG) (Cox, 1995) defuzzification method (see Chapter 5). This defuzzification method produces a value equal to the average of the output fuzzy region. By the nature of the calculation of CoG, the output value (component contribution) will never be equal to 1, implying that even if the input variables were all evaluated as high for a component, the expected result that the objective will be fully achieved will not be affirmed. Alternate defuzzification methods were tested until the MoM method (Cox, 1995) produced the expected results for the extreme input values.

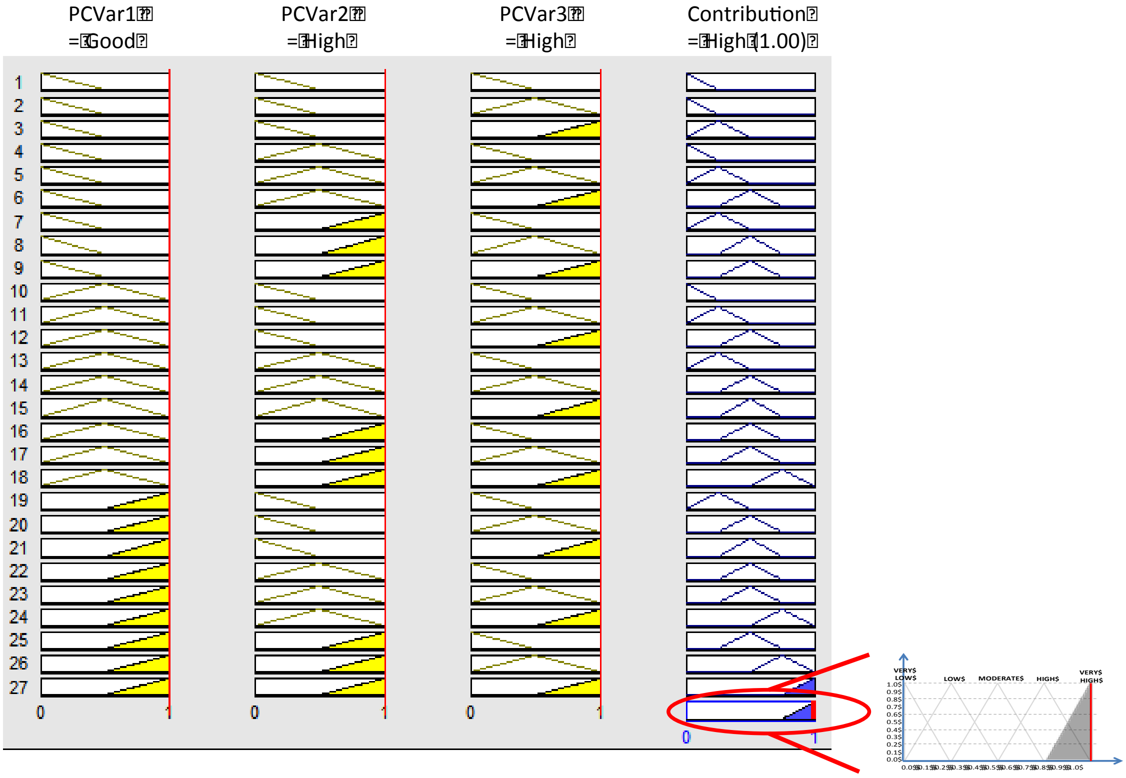
The figures below show the result of an evaluation of the input variables of a component using the CoG method (see Figure 8.1) and then the MoM method (see Figure 8.2). In Figure 8.1 it can be seen that despite the input variables being evaluated as PCVar1=Good, PCVar2=High, and PCVar3=High, the contribution value = 0.92 when the CoG defuzzification method is used.

Figure 8.1: Result of using COG



In Figure 8.2, however, for the same evaluations of the input variables, the contribution value is equal to 1 (which is what is expected) indicating that when all input variables are evaluated to the maximum degree, the associated objective will be fully achieved.

Figure 8.2: Result of using MOM



Testing the model to ensure that for extreme input values the expected output is achieved ensured that the right defuzzification method was used in the model. This is critical to the model as the right defuzzification method will ensure that the contribution of portfolio components to objectives will be computed correctly.

8.2.2 Behaviour Prediction Test

Forrester and Senge (1980:424) describe the (behaviour) event-prediction test as focusing on “a particular change in circumstances, such as a sharp drop in market share or a rapid upsurge in a commodity price, which is found likely on the basis of analysis of model behaviour”. They continue by highlighting the fact that “evaluation of the event-prediction test should hinge on the dynamic nature of an event and identification of conditions leading to it rather than on the exact time when the event will occur”. This test is used to validate the model in terms of the third purpose – monitoring the degree of achievement of objectives. Organisations plan a path for success by setting organizational goals and objectives that must be realised over a period of time. The extent to which each objective is achieved is important to inform management how well the organisation is progressing towards achieving its goals. In the course of achieving its objectives, the organisation may suffer setbacks, which would require them to make adjustments to their project portfolio(s). The test must confirm whether the model will behave predictably when a change in circumstances occurs, such as external financial pressure that leads to a reduction in the portfolio budget.

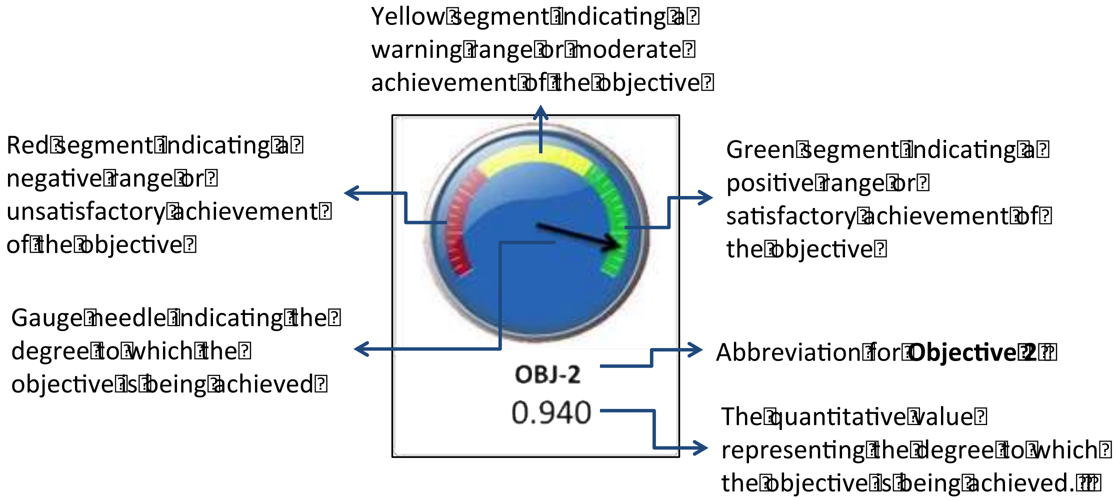
To illustrate how the model would respond to a change in circumstances as described above, a dashboard is used, as a visualization tool, to present the results of the test. The next section first describes the use of dashboards to represent data and then describes how the model is used to respond to the particular change in circumstance.

8.2.2.1 Representing data using dashboards

Executive management in organisations make performance management decisions based on critical data and information presented in the form of dashboards, also referred to as scorecards, or report cards (Allio, 2012). Dashboards present information regarding key performance indicators which management analyses 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 visualization of information is supported by Yi (n.d.) who states: "The visual or graphical representation of data is often significantly easier and faster to process than textually-based representation of data".

Staniland (2012) describes various charts, such as pie, column, bar, scatter, lines, bubble, sparkline, bullet, and gauge that are generally used in dashboards. It is out of the scope of this research to discuss the benefits and drawbacks of the various charts. For the purpose of the behaviour-prediction test, the gauge chart (IBM, n.d.)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. This is supported by the IBM handbook (n.d.), which states: “On a gauge chart, the value for each needle is read against the coloured data range or chart axis. 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 coloured data range mentioned in the reference, resembles the fuzzy logic concept of looking at the data in terms of ranges rather than purely static values. Figure 8.3 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 green region.

Figure 8.3: Sample gauge diagram



The red, yellow and green regions that appear in the gauge, partition the range of values into three segments. These regions provide further information to decision makers. If the gauge needle points anywhere in the *green* 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 gauge needle points anywhere in the *yellow* 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.

If the gauge needle point anywhere in the *red* 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 8.4 below, which shows the gauge charts for each of the objectives as well as supporting information. Each section is described as follows:

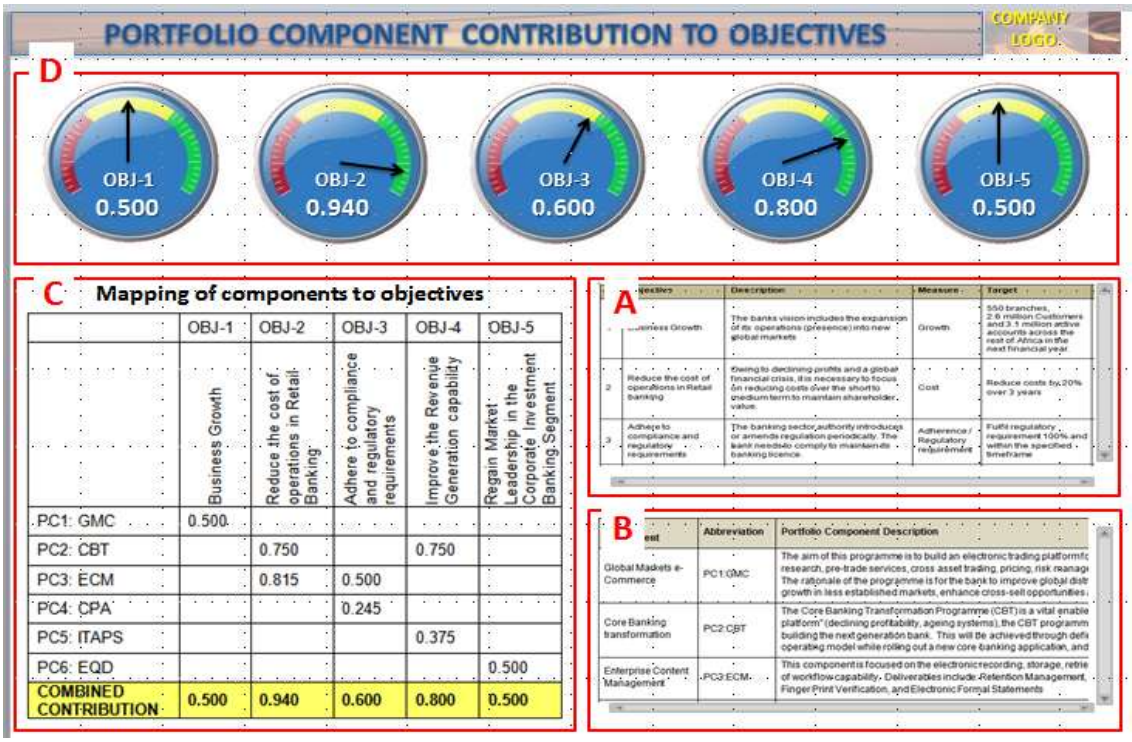
Section A: In this section, the organizational objectives including the measures and targets are described.

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.

Figure 8.4: Sample dashboard*



***Note:** the sample dashboard is for illustrative purposes only.*

The next section will describe how the model can be used to respond to a change in circumstance. This is to validate the third aspect of the purpose of the model, which is to monitor achievement of objectives.

Before we deal with the change in circumstance, let us first establish what the original state of the portfolio is before the change in circumstance. The data from Chapter 7, Table 7.11, which describes the combined contribution of components to objectives, is repeated here:

Table 8.1: Combined contribution to objectives

	OBJ-1	OBJ-2	OBJ-3	OBJ-4	OBJ-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
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**

The data described in the above figure can be represented graphically on a dashboard. The degree to which each objective is achieved is illustrated using the gauge charts in Figure 8.5 below:

Figure 8.5: Gauge charts showing the degree of achievement for each objective

Now that the portfolio component contributions have been graphically represented in a dashboard using gauge charts, we can immediately get a sense – in terms of monitoring the achievement of objectives – of how well the objectives are being achieved. It can be seen in Figure 8.5 that the overall achievement of objectives is mediocre as the gauge charts of three of the five objectives show that these objectives are achieved in the *yellow* range while the remaining two objectives are achieved in the *green* range. The visual depiction helps us see the impact more easily than a table of numbers would. Next the researcher discusses how the model will deal with a change in circumstance.

Due to the recent global economic downturn at the time of writing this chapter, organisations have had to aggressively curb spending. While all areas of the business are affected, the scope for this research is focused on the project portfolio and how it is impacted by the external 'event' or change in circumstance. The focus on cost-cutting naturally leads to a reduction in the available budget for portfolio components, implying that fewer components can be developed and implemented than originally planned. This further implies that the degree to which the objectives will be achieved will also be reduced. The model responds to this change in circumstance by enabling decision-makers (the portfolio investment committee) to consider portfolio components for termination in a way that limits the negative impact on the achievement of objectives.

Table 7.13 (in Chapter 7) listed three possible components for termination based on plausible reasons as to why each of the components should be terminated. It was pointed out, however, that in order to make better decisions regarding the termination of a portfolio component, the portfolio investment committee had to take into account the contribution of each of the components to the organizational objectives. Without this knowledge, the portfolio investment committee could decide to terminate a component that results in a significant negative impact to the achievement of the organisation's objectives rather than an alternative component that results in a smaller impact to the organisation's objectives. The following paragraphs will demonstrate how the dashboard will be used to illustrate the impact of terminating each of the selected components so that the portfolio investment committee can make better decisions to minimize the negative impact on the achievement of organizational objectives.

Let us begin by showing the original position of the degree of achievement of each of the objectives before terminating any components. This is illustrated from Figure 8.6 to Figure 8.8 by the black arrows (needles) in each of the gauge charts representing the respective objectives. 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 colour. 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.

In addition, Figure 8.6 to Figure 8.8 shows that:

1. The black arrows represent the original position before any of the three components are considered for termination.
2. The red dotted arrow indicates the position if PC1 is terminated (Figure 8.6). The difference between the black and red arrow visually illustrates the impact on the achievement of Objective 1.

3. The yellow dotted arrow (in Figure 8.7) indicates the impact of terminating PC3 on Objectives 2 and 3.
4. The white dotted arrow (in Figure 8.8) indicates the impact of terminating PC5 on Objective 4.
5. 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.

Figure 8.6: Gauge chart showing the original and new objective achievement positions after terminating PC1

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

Figure 8.7: Gauge chart showing the original and new objective achievement positions after terminating PC3

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

Figure 8.8: Gauge chart showing the original and new objective achievement positions after terminating PC5

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

It can be seen in the above figures 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 red italics font in the rows below the gauge charts illustrate this. For Objective 1, the red 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 8.6). Terminating PC3 would impact objectives 2 and 3. It can be seen from Figure 8.7 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. This is illustrated by the white dotted arrow in the gauge chart for Objective 4 in Figure 8.8.

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. In this case, terminating PC5 would achieve this.

The behaviour prediction test confirms that the model will behave predictably when a change in circumstance occurs, such as external financial pressure that leads to a reduction in the portfolio budget. The use of dashboards as a visualization tool illustrates the decision making process when such a change in circumstance occurs.

8.2.3 Structure verification test

This test validates the model in terms of the first purpose – which is to enable decision-making with regard to managing the portfolio. Forrester and Senge (1980:416) describe this test as a comparison of a model with the structure of the real system represented by the model. They state that “in order to pass the structure verification test, the model structure must not contradict knowledge about the structure of the real system” and that “structure verification may also involve comparing model assumptions to descriptions of decision making … found in relevant literature”. This is supported by (Kiani, Shirouyehzad, Bafti, and Fouladgar, 2009).

The model presented in this thesis (Chapter 5) focuses on portfolio management decision-making. The structure of the model is built on a) the many-to-many relationship between portfolio components and organizational objectives, b) considers the linguistic evaluation of portfolio components in relation to the individual and cumulative contribution to objectives, and c) converts the qualitative evaluations into quantitative values for comparison so that decisions can be made regarding the balance of the portfolio. Terminating a component, for example, will depend on the ability to determine which component has the smallest effect on objectives. In validating this against the literature, we find that the second edition of the *Standard for portfolio management* (Project Management Institute, 2008b: 66) states that “portfolio balancing provides the component mix with the greatest potential to collectively support the organisation's strategic initiatives and achieve strategic objectives. … Portfolio balancing includes the evaluation and management of trade-offs … to align with the strategic business objectives. … Components that deliver a lower level of benefit are removed from the portfolio to allow the organisation to focus on higher priorities."

The process of balancing the portfolio, as described in the *Standard* (Project Management Institute, 2008b) can be summarised as follows: The portfolio management team uses expert judgement to assess inputs needed to determine how to balance the portfolio. Portfolio components are evaluated in terms of the level of benefit (or contribution) to strategic (or organizational) objectives. Various tools and techniques are used in the "Balance Portfolio" process – these include scenario analysis and graphical analytical methods. Portfolio balancing decisions are made by the portfolio management team and the adjusted portfolio is communicated to stakeholders. The model described in this thesis follows the similar structure, but uses fuzzy logic to reduce the subjectivity involved in assessing the components. The model produces an evaluation of the contribution of components to objectives allowing the decision-making to be done by the portfolio management team. The structure verification test confirms that the model follows the portfolio management decision making structure described in the literature.

8.3 Conclusion

In this chapter, the researcher showed that the model presented in this thesis is valid in terms of its purpose and the problem it was intended to solve. A variety of model validation tests were assessed and three tests were conducted as part of the validation task.

The three tests chosen for conducting the model validation looked at model structure, model behaviour, and policy implications. These tests were chosen based on their suitability for testing the model in terms of its purpose, which has to do with a) the derivation of the degree of contribution of portfolio components to organizational objectives, b) the ability to monitor the extent to which organizational objectives are achieved, and c) the enabling of decision-making with regards to managing the portfolio.

Given that all three tests were successfully passed, it can be confirmed that the objectives, and hence the goal of this chapter, which was the validation of the conceptual model, was achieved. There can, therefore, be greater confidence in the conceptual model as both the verification and validation of the model has been completed.

The next chapter (Chapter 9) is the conclusion of the thesis. A summary is provided for each research objective in terms of the purpose of the objective and the outcomes related to the objective. The chapter concludes with a confirmation that the research problem was addressed and final remarks on the contribution and limitations of this research and recommendations for future research.

9 CHAPTER 9: Conclusion

9.1 Introduction

The concept of PfM (Project Portfolio Management) is understandable due to its association with, and application of concepts in the financial portfolio management discipline. In addition, it was discussed in Chapter 3 that the PfM discipline draws from various theories, which support the PfM processes. However, while there might be a general understanding of the concept of portfolio management drawn from its application in financial investments and the theories referred to in this thesis, the practical application of PfM still has gaps and lacks consistency. This was evident from the investigation into the practice of PfM discussed in Chapter 4, which lead to the development of the conceptual model presented in Chapter 5, an extension of the model in chapter 6, and the verification and validation of the model in Chapters 7 and 8.

The goal of this chapter is to synthesize the thesis and confirm that the research objectives have been met. To achieve this goal, the objectives for this chapter include a) providing a summary of the preceding chapters; b) confirming that the problem statement has been addressed; and c) demonstrating the value and contribution of this research to academia and practice. The remainder of this chapter d) summarises each of the preceding chapters individually highlighting key aspects from the relevant chapters; e) recaps the findings from the investigation into the practice of PfM; f) briefly discusses the conceptual model, its verification and validation; and g) confirms how the research problem has been addressed. In addition, the h) contribution of this research to the body of knowledge; i) the limitations of this research as well as j) recommendations for future research are discussed towards the end of this chapter.

9.2 Summary of chapters

Chapter 1 provided an introduction to the research and presented a case for the need for this research. Three factors were identified as motivational factors for this research. These were, a) previous research by the researcher, which recognized the lack of scientific research in the discipline of PfM, b) the global economic climate which required organisations to review their decision-making specifically around their project related investments, and c) compliance to corporate governance requirements which brought about a focus on strategic alignment of IT to business, optimizing expenses and improving the value of IT and IT performance in achieving the organisation's objectives.

In Chapter 1 it was noted that while the concept of PfM is understandable and is generally accepted by practitioners, there still appears to be a gap between what is proposed in literature and the practical implementation of PfM. It was acknowledged that elements of PfM existed in companies, such as the utilization of financial models to make investment decisions, but the practice of PfM, when compared to literature, was incomplete. Earlier articles emphasized the selection of projects when establishing the portfolio while there was less coverage on how the decision-making process regarding the portfolio components could be exercised. These observations presented an opportunity for further research. Chapter 1 also stated the research objectives and the problem that was being addressed by this research. To reiterate, the research objectives, were to:

1. *Provide a context for PfM describing the need for the research*
2. *Investigate the practice of PfM in South Africa in order to gain insight regarding the alignment between current literature and practice.*
3. *Develop a conceptual model as a solution to the problem.*

4. *Verify and validate the conceptual model to build confidence in its feasibility and describe how it would be used to improve PfM decision-making.*

The problem statement identified for this research was:

> *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.*

Chapter 2 presented the research methodology and design. The approach taken in this chapter was to discuss the research design for each research objective, taking into consideration the layers of the research onion introduced in Chapter 2. For Objective 1, a literature review was done to provide a context for PfM. Objective 2 required an extended literature review to prepare the semi structured interview instrument, which was used to collect data on the practice of PfM in South African organisations. The data was qualitatively analysed and the findings presented in Chapter 4. Objective 3 required modelling to develop a conceptual representation of the proposed solution to the problem identified in the initial research (discussed in Chapter 4). Verification and validation of the conceptual model was done to complete the fourth objective. Multiple research methods were thus required to investigate and address the problem identified in this thesis.

For Chapter 3, the current literature on PfM was reviewed and it was found that while there were a number of trade articles and books introducing the concepts of PfM, there was also a lack of scientific research that represented the theory of PfM. Chapter 3 provided the context for PfM by confirming a definition and describing the relationship of established theories to PfM from the literature review. The theories that had relevance to PfM were, Modern Portfolio Theory (MPT), Multi-Criteria Utility Theory (MCUT), Organizational Theory (OT), Complexity Theory (CT), and Systems Theory (ST). Following is a brief summary of how these theories relate to PfM.

1. *MPT offers the metaphor of investment management, which inspired the idea of viewing projects, programmes and other activities in an organisation as investments that needed to achieve organizational objectives and provide a return on investment.*
2. *MCUT is used in the IT investment management process and project selection. The notion of using multiple criteria to evaluate portfolio components was adopted in the early stages of the model where component contribution to objectives is evaluated.*
3. *OT brings together various aspects of organisations, such as strategy, structure, design, complexity, and decision-making. PfM is an organizational capability and is subject to, and must address, the challenges faced by the organisation. The organizational context of PfM is considered throughout this research – from the definition of PfM, the illustration of how the established theories relate to PfM, the investigation into the practice of PfM, and the development of the conceptual model.*
4. *CT relates to how individual components of a system work together to create complex behaviour. The relationships between entities, the internal structure and external environment, and the way in which complex systems behave has relevance for the PfM discipline. This is because the diverse relationships among portfolio components and the complex relationship between portfolio components and organizational objectives forms a complex system.*

5. *ST was the fifth theory that was considered for this thesis. The systems thinking philosophy was applied to the model presented in this thesis. The model uses the ST foundation of input-process-output was used in the model where portfolio components are evaluated based on a set of criteria, the evaluations are used as input into the fuzzy logic process, the inputs are processed through the fuzzy logic rule engine and an output is produced which represents the contribution value of the portfolio components.*

Each of the five theories played a role, either conceptually or practically in the development of the model presented in this thesis. These theories collectively provide the theoretical foundation for PfM. The purpose and scope of this research was not to develop a new theory for PfM but to rather use existing theories to provide a context for PfM.

Chapter 4 focused on a comparative analysis between the literature and practice of PfM. A general observation from the analysis is that literature and practice are partially misaligned. For example, the requirement of having governance bodies that authorize the portfolio components and their respective funding is described in the literature and adopted in practice. Other aspects, such as a) changing the portfolio only when there's a change in strategy; b) the role and responsibilities of the portfolio manager; or c) the way in which human and financial resources are allocated, suggests that there are shortcomings in both the literature and practice of PfM. The literature needs to reflect on what is more practical in some aspects, while in other aspects, practice needs to move towards the recommendations in the literature.

An important observation not adequately addressed in the literature, and which practitioners have a concern about is the aspect of decision-making as it relates to the portfolio components. It was reported that decisions made about which components to progress and which to terminate were based on the subjective defence of a few decision-makers (C.N. Enoch & Labuschagne, 2010a). This meant that even if the right components were chosen upfront, there was a lack of confidence that those components remained closely aligned to organizational objectives and offered the best return in benefits. Nevertheless, these components were progressed and supported during the PfM process. This is a fundamental issue to the success of PfM in an organisation. Subjective decision-making with a lack of understanding of 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 presented; c) the degree to which objectives are being achieved is understood; and that d) the maximum benefits of the portfolio can be achieved.

The conceptual model presented in Chapter 5 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 6 introduced an extension (an additional perspective) to the conceptual model. While Chapter 5 focused on the contribution of *multiple components* to individual objectives, Chapter 6 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 – viz., 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 affects 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. This opens the possibility for further research, which could expand on the application of the conceptual model presented in this thesis.

Chapter 7 looked at the verification of the conceptual model using actual portfolio components and organizational objectives from a participating organisation. The chapter began by providing an organizational context related to the participating organisation. Also provided was information regarding the organizational objectives and portfolio components selected for the verification process. The verification of the model in this chapter illustrated 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, and the benefit of using the model in this thesis was discussed. The scenario illustrated that without a way of determining portfolio component contributions to organizational objectives, it would be quite easy for decision makers to terminate the wrong components.

Following verification, the model had to be validated. This was described in Chapter 8. Three tests were chosen for model validation. The purpose of validating the model is to build confidence in the model in terms of its representation of reality and the fulfilment of its purpose. In addition, the use of a dashboard as a visualization technique for decision-making was used to illustrated how decisions about management of the portfolio can be made – specifically when it comes to choosing which components to terminate when the organisation is placed under pressure to make such decisions. The validation confirmed that the model fulfils its purpose in that the model enables decision-makers to get an insight into their decisions before committing them and - thus ensuring better-informed decision-making.

The following sections revisit the research objectives introduced in Chapter 1.

9.3 Objective 1: Context for project portfolio management.

The purpose of this research objective, discussed in Chapter 3, was to provide a theoretical foundation in terms of an understanding of PfM for this research. This was necessary so that the remainder of the thesis had a point of reference regarding the definition of PfM and the theories that support or contribute to the PfM discipline. A definition for PfM was confirmed following a review of the literature. The common elements from definitions offered by various authors are restated here:

- *The **translation** of strategy and objectives (organizational objectives) into projects, programmes, 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.***

These key elements were represented in a diagram that was an adaptation or extension of the diagram in the latest *Standard* (3rd edition), which represented the context for PfM.

PfM was further contextualized through five established theories that were identified as contributing to the discipline of PfM. These were: a) modern portfolio theory, b) multi-criteria utility theory, c) organizational theory, d) complexity theory, and e) systems theory. A background to the theoretical foundation of each theory was presented. The relevance of each theory to this research and to the discipline of PfM was also discussed.

9.4 Objective 2: The practice of project portfolio management in South Africa

The purpose of this investigation, discussed in Chapter 4, was to confirm the need for further research. The key findings from the investigation are summarized here.

1. **Strategy:** While organisations define strategy and select projects to address the tactical requirements of the organisation, there is a lack of direct translation of the strategy into portfolio components that focus specifically on achieving the organizational objectives.

2. **Governance:** All organisations represented in the investigation had one or more committees that decided on which portfolio components to authorize and what budget to allocate to the portfolio(s).
3. **Resource Allocation:** While budget allocation was done at a portfolio level based on affordability of the various business units within an organisation, portfolio components were not ranked against each other across these business units. As a result, portfolio components that contributed less to the organizational objectives in one business area could enjoy funding while another component of greater value in terms of contribution did not, due to limited funds in that business unit or portfolio.
4. **Change Management:** With the exception of one organisation, the remaining organisations had a change management capability to manage the deployment of new components into the organisation
5. **Portfolio Balance:** According to the *Standard*, 2nd edition, only a significant change in strategic direction should impact the portfolio mix, however, in practice, new portfolio components are considered throughout the financial year without there being a change in strategy. This would not necessarily be a problem if the organisations had available funds; however, the organisations that were interviewed assigned available budget to components requiring funding during the forecasting or planning period. After the new financial period had commenced, new components were proposed which were evaluated individually and which required funds from other components to be reallocated to the new component if approved.
6. **Portfolio Manager:** The role of the portfolio manager is not fully understood and in organisations that had such a role, these individuals fulfilled a line-function role to project and programme managers. They were not positioned in the organisation as outlined in the *Standard* – which is defined to include, a)

measuring and monitoring the value to the organisation through KPIs; b) providing key stakeholders with assessments of component selection, prioritization, and performance; c) continuously reviewing, reallocating, reprioritizing, and optimizing the portfolio, ensuring alignment with changing organizational goals and opportunities; and d) maintaining portfolio management processes, to mention a few key responsibilities.

7. **Benefits Realization:** The assessment of benefits realization and management was lacking in all organisations investigated. Benefits are stated upfront in the business case justification for the portfolio component, but organisations were still grappling with how to measure or track the achievement of those benefits. Some respondents did not even see the value in tracking benefits to begin with.
8. **Decision Making:** A notable concern was the decision-making process regarding portfolio components once the portfolio was in progress. Choosing the right components upfront becomes irrelevant if the wrong decisions are made during the course of managing the portfolio. The researcher recognized this as an important problem to solve.

In addition to these findings, the process of investigating the practice of PfM in South African organisations revealed reasons for misalignment between the literature and the practice of portfolio management. These included:

1. Divergent approaches to portfolio management. Literature mainly proposes a top-down approach while in practice it is more a bottom-up approach,
2. There are differing views on whether there should be a single or multiple portfolios in an organisation,
3. Participants in the research identified factors such as project management and organizational maturity as critical success factors for the practice of portfolio

management. These were not evident in the literature at the time of the investigation,

4. The majority of participants in the research were unaware of the Standard for portfolio management even though it was in its second edition at the time of the investigation. Participants who said their organisations practiced PfM confirmed that they had adopted a home-grown approach rather than follow any standard or approach that was more widely accepted as good practice.
5. Despite a substantial body of knowledge in the discipline of portfolio management, the investigation into the practice of the discipline revealed that while there was a general awareness of the concept, there was still a lack of understanding of what PfM entailed.

The investigation confirmed that there was a need to do further research. The decision was taken to delve into the PfM decision-making process specifically, with the aim of providing a mechanism to enable better decision-making.

9.5 Objective 3: A conceptual model as a qualitative solution to the problem

A conceptual model was described in Chapter 5 as an aid in the portfolio management decision-making process. It enables the evaluation of individual components in order to determine the individual *and* combined contribution of portfolio components to organizational objectives. The evaluation of components is qualitative in nature as decision-makers tend to use linguistic terms like low, medium, and high when describing a component's contribution to objectives. The qualitative evaluation must be converted into quantitative values for comparison – hence the use of Fuzzy Logic as a technique for this model. The model is unique in that it uses Fuzzy Logic, in particular, combined fuzzy models, to convert the qualitative evaluation of portfolio components into quantitative values so that an objective comparison between components could be achieved. The combined fuzzy models aid the determination of *cumulative* contributions of multiple components to one or more objectives. Having tried numerous options for the conceptual model, it can be confirmed that the combined fuzzy model addresses the portfolio management challenge of determining the individual and cumulative contribution of portfolio components to organizational objectives, through the qualitative evaluation of portfolio components, using multiple criteria in order to deliver a quantitative value that represents the degree of contribution.

To demonstrate the extensibility of the model, Chapter 6 was developed to show how the concepts described in Chapter 5 could be used in a different way. The component-to-objective relationship was viewed from the perspective of a single component contributing to multiple objectives. The total contribution that a single component makes to the set of objectives can be computed by adding the individual contributions of the component. The components can be ranked according to their total contributions across multiple objectives, providing further information to decision-makers regarding the impact of their decisions related to portfolio components. Terminating a component that has a high degree of contribution to multiple components would impact the achievement of those objectives. It would be prudent for the decision makers to focus on components that have less of an impact on the objectives. Chapter 6 confirms that the concepts introduced in Chapter 5 can be extended; implying that the opportunity for further research using the model presented in this thesis and extending it, exists.

9.6 Objective 4: Verification and validation of the model

Model verification is concerned with proving consistency and accuracy of the model. Validation, on the other hand, is concerned with testing the model so that confidence in the model can be attained. The verification process in Chapter 7 stepped through the model phases and illustrated the mechanics of the model using actual components and objectives from a participating organisation.

The aim of the validation process in Chapter 8 was to obtain confidence that the model addresses the problem it was meant to address. Three tests were chosen for conducting the model validation. The model was a) tested in terms of its ability to deliver predictable results under extreme conditions; b) its behaviour when circumstances change; and c) its ability, from a structural point of view, to enable decision-making. The validation process confirmed that the model fulfils its purpose, which was threefold – a) to convert qualitative evaluations of portfolio components into quantitative values representing the degree of contribution of the portfolio components; b) to monitor the degree of achievement of organizational objectives; and c) to enable better decision-making in the course of managing the portfolio. In addition, it was demonstrated that the use of dashboards, and specifically gauge charts, can aid in the decision-making process as the data from the model can be visualized. The model was thus verified and validated.

9.7 The problem addressed

The problem statement for this thesis was:

> *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.*

This research addressed the problem by reviewing the literature, investigating the practice of PfM, understanding the issues and concerns of the practitioners, and developing a model that is able to take qualitative evaluations of portfolio components as input into a process that converts those evaluations into quantitative values. The evaluations are in relation to the degree of contribution to organizational objectives. Not only are individual contributions determined, but the model is able to determine the *cumulative* contribution of components to objectives also through the use of combined fuzzy models. This does two things: firstly, the decision-makers get an understanding of which components are jointly contributing to an objective. Their decisions regarding individual components will be influenced by this knowledge. Secondly, by having visibility of the combined contributions, decision-makers also are able to see the degree to which objectives are being achieved. The model presents information that will enable decision-makers to make the right decisions regarding the portfolio components.

To make the output of the model more visual, a dashboard was used to represent the data (component contributions) showing the situation before a decision regarding the termination of one or more components is made, as well as what would happen if the decision to terminate a component were made. The use of dashboards was discussed in Chapter 8 and it was shown that the use of dashboards to illustrate scenarios and results graphically adds to the understanding of the portfolio, making the comparisons between decision options clearer. Decision makers can see the direct impact of their decisions on the organizational objectives and can, therefore, make decisions that will ensure the maximum benefit is achieved for those objectives. The research objective of improving decision-making in portfolio management is thus achieved.

9.8 Contribution of the research

This research contributes to the body of knowledge of PfM and is beneficial to organisations 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 organisations and offers an objective view on organizationally aligned components. This is important for compliance with a country’s corporate governance requirements. In South Africa, for example, organisations are encouraged to adopt “King III” (see section 1.2. of this thesis for a detailed discussion on the King III requirements relevant for this thesis).

Secondly, this research 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, programmes, and operational activities) must be aligned to *organizational objectives* of the organisation. Understanding this relationship will improve the operation of PfM in organisations.

Thirdly, this research uses existing knowledge (in the form of Fuzzy Logic) 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), scoring models, matrices, and pair-wise 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, this research presents a mechanism for improving decision-making in PfM. 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, this research illustrated how established theories can be related to PfM. At the time of writing this thesis evidence of scientific research describing the relationship between established theories and PfM, to the extent of what was described in this thesis, did not exist.

This research thus makes important contributions to the project portfolio management body of knowledge, fuzzy logic application in new domains, organizational governance, and management decision-making.

9.9 Research limitations

Although this research provided valuable contributions to the body of knowledge, there are some limitations associated with it:

1. The model was verified with a small set of components and objectives in a single organisation to prove the concept. The limitation is that other combinations of components and objectives in other types of organisations were not tested.
2. Setting up the model (selection of evaluation criteria, definition of the membership functions for the input and output variables, the specification of the rules, and the setting up of the parameters for the linguistic evaluations) requires human intervention. This allows for subjectivity and can influence the outcome of the model for a specific organisation.
3. While multiple approaches to PfM exist, this research used the *Standard for portfolio management*, 2^{nd} edition as the representation of PfM literature. The limitation here is that the model has not been directly tested against other PfM approaches.
4. The model is dependent on how the portfolio is set up. In other words, the limitation is that it does not influence which components are selected when setting up the portfolio, but works with what is currently in the portfolio.

Despite these limitations, the model is still valid and can be used in organisations and for further research.

9.10 Recommendations for future research

Further research can be done to extend the model to look at aspects like the influence of weighted objectives on decisions regarding components, the interdependencies between components, the mandatory nature of regulatory or compliance components, and the consideration of human resource capacity and capability to determine how these aspects would influence a component's contribution or the achievement of objectives, and hence, decision-making regarding the portfolio mix. For example, if two or more components are interdependent, then terminating one of those components has an impact on the remaining interdependent components. It may result in the other components being incomplete and as a result, may require the organisation to terminate the cluster of interdependent components. A researcher would need to investigate the conditions or circumstances under which decisions regarding interdependent components would be made. They could look at criteria or factors that would influence particular decisions.

The model presented in this thesis did not take into account the varying degree of influence of decision-makers. In Fuzzy Logic models, a weighting factor can be applied to distinguish levels of influence amongst organisation experts or decision-makers. Among the members of the portfolio investment committee (i.e., the experts or decision-makers), there are those, whose evaluation of portfolio components, carry a higher weighting due to the level of their expert knowledge and the confidence in their opinions, for example, and their evaluations should therefore be weighted more favourably. The basis on which this is done and the process for doing it can be researched and added to this model.

PfM concepts can be applied across any organizational context or industry. The model presented here was verified and validated using data from a large bank. The criteria for evaluating components and the rules that are applied in the fuzzy rule engine could vary for different types of organisations - from pharmaceutical to construction and engineering. It would be worth researching the application of this model in these and other industries.

9.11 Personal Reflection

The body of knowledge around PfM is growing rapidly. During the course of this research (from conception to completion), the Project Management Institute 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 recent PMI research and education conferences.

The implementation of PfM in an organisation 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 organisation. 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 programmes.

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 to how they make decisions. In addition, the vision, mission and values of an organisation further influence the decision-making process.

The model presented in this thesis 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 organisation 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 organisation achieves the maximum benefit from its investment in their portfolio of projects.

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11 APPENDIX A – Comparison of structured, unstructured and semi structured Interview methods

Table 11.1: Comparison of Interview methods based on views from (Creswell, 2009; Saunders et al., 2009)

STRUCTURED INTERVIEWS:	**UNSTRUCTURED INTERVIEWS:**	**SEMI STRUCTURED INTERVIEWS:**
In structured interview, questions are short and specific. The researcher must read questions exactly as they appear and keep the identical order. Ideally, response categories are predetermined and will enable the researcher to fit the pre-coded response categories to the respondents answer.	In unstructured interviews, the researcher attempts to establish a rapport with the respondent. The interviewer is freer to probe new areas that may arise as the interview tends to follow the respondent's interest or concerns. The ordering of the questions is less important than in the structured interview.	In semi-structures interviews, the researcher will have a list of themes and questions to be covered. The questions asked will depend on the organizational context in relation to the research. The order of questions may also vary depending on the conversation. Additional questions may be added to explore specific responses in more detail.
	ADVANTAGES	
The Questionnaire is prepared in advance All respondents answer the same set of questions Responses are easier to summarise The number of questions is known and responses gauged	By asking general questions the researcher gains more complete information and more insight. Greater flexibility of coverage and new areas to be explored is allowed	The predefined themes and questions help guide the interview and form a basis for analysis Some flexibility is allowed to delve into detail or clarification where necessary
	DISADVANTAGES	
Structured interviews are inflexible Areas of investigation are predetermined which implies that exploration into other avenues is prohibited Respondents have to be cut-off if their responses deviate from the topic	Responses are more difficult to code Interviews will vary in length Responses are harder to analyse due the volume of work and the potential variability in responses	The length of interviews will vary Responses may be difficult to code if the conversation is allowed to continue too far from the predefined themes.

12 APPENDIX B – Data Analysis from Investigation into the practice of project portfolio management in South African Organisations

12.1 Analysis of data from interviews

In chapter 2, the process to identify respondents and conduct the interviews, were described. It was further mentioned that the interviews were digitally recorded and transcribed using MSWord. The MSWord documents were then loaded into Atlas.ti (CAQDAS) where analysis was done. This section discusses the analysis that was done.

Each interview transcript was coded using the “ATLAS.ti” qualitative analysis tool. The codes were not predefined. The researcher kept an open mind when coding the transcripts in the sense that he looked beyond the answers relating to the questions for any information in the form of recommendations for improving the portfolio management approach.

The following table summarizes the responses by code name. The code name refers to a key thought or important aspect mentioned by the respondents during the interview process. In the table, the number of responses per code name is listed along with a summary of what was meant by the code name.

The table appears on the next page.

Table 12.1: Summary of responses by code name

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Accountability for Initiatives	3	Respondents indicated that the accountability for initiatives lay with business unit executives.
Approval of Initiatives	4	Organisations tend to have a formal structure (committee) that meets monthly to evaluate the project requests and give approval for the release of funds for these projects (initiatives).
Benefits Tracking	23	A small percentage of respondents indicated that benefits are tracked in their respective organisations. In some cases, the enterprise project office did the monitoring and tracking. In other cases, the executive committee that approved the initiatives did a non-scientific assessment of whether or not the stated benefits were achieved. Other respondents indicated that while benefits are specified in the business case, active tracking of the realization of these benefits is missing. One respondent suggested that the specification of benefits upfront is done subjectively and based on many assumptions. In the 20 years that he has been involved in running IT, the calculated benefit never equalled the actual benefit. He suggested that the value one gets from tracking the realization of benefits is the learning that the organisation develops in terms of the validity of the benefit specification. Another respondent questioned the value of conducting a benefit tracking exercise as the budget for the initiative has already been spent and the cost to conduct the benefit tracking is just a further expense.
Benefit Tracking tools	1	One respondent indicated that his organisation uses Microsoft Excel for tracking the benefits for their initiatives.

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Change management	18	Change management is done at a project and program level according to the respondents. This goes as far as communication about the project and training of the new IT application that is being implemented.
Preparation for change	3	One organisation recognized, however, that change management at an organizational (broader transformation) level is weak. Change that involves organisation restructuring and fundamental business process changes are not managed well. Another organisation admitted that they didn't do change management at all and that it was something they would look into in future.
Distinguishing between project and non project activities	21	Most organisations use some criteria such as cost, cross-divisional impact, effort, or risk, of an initiative to determine whether or not it should be run as a project. Organisations generally view "business-as-usual" maintenance, support and system enhancements as non-project activities.
Effectiveness of approach for translating strategy to initiatives	20	Organisation A (Bank) felt that the approach they used was effective but recognized that global pressure in their industry would require them to improve the current approach. Organisation B (Bank) felt they could use a model that would significantly improve their ability to prioritize and track the realization of their strategic objectives. An important observation from a respondent in organisation B was that projects focus at the tactical level with too many resources being invested in the "tactical things". Other organisations felt that the approach they used was adequate at the time.

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Enhancing and maintaining the approach	12	One organisation claimed to have had a scoring system for prioritizing and selecting initiatives. The area for improvement observed by the CIO was the ability to prevent people from manipulating the scoring system. People submitting requests for project approval soon worked out the scoring mechanism and would provide inputs to the system in a way that would result in their preferred projects being scored highly. This defeated the purpose of the scoring system. Another organisation felt the need for better strategic alignment of portfolio management goals and measures as opposed to alignment to only business unit or product house objectives. A second respondent from the above mentioned organisation felt that project portfolio management should be managed similarly to financial (share trading) portfolio management and that better co-operation between business and IT would enhance their portfolio management practice.
Existence of a portfolio management model	22	Of the 22 respondents, 7 answered "yes" to having used a portfolio management model. However, 1 was an emphatic "yes" and his organisation employed the services of a consulting firm to develop an approach in-house. 2 other organisations also developed an approach in-house based on the experience and knowledge of the management within their respective organisations. 1 organisation made reference to the fact that they use CA's project portfolio management tool offering (Clarity) The remaining 3 organisations referred to either Prince 2 or a system development life cycle model. None of the respondents interviewed were aware of any 'formal' or recognized portfolio management model that could be referenced.

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Funding of initiatives	28	Prevalent in Banks was the existence of a central committee which decided on allocation of funds per initiative. Their process included a forecast being done for the coming year. Initiatives were categorized as those that were expensed in the current year (referred to as income statement projects) and those that were capitalized (costs recovered over a period up to ten years) In the medical and life insurance organisation, the cost to run projects was considered part of their operational costs. With regard to the revenue services organisation, their prioritization system allowed them to easily determine the selection of projects based on the available funds from the treasury. If the prioritization was correct, then the available funds were allocated to the top projects.
Improving success in the organisation	5	A previous CIO pointed out that “the degree of success is still dependant on the right projects with the right amount of change introduced” and that portfolio management could improve the success of organisations. He attributed the improved customer service, compliance, and improvement in revenue collection to the practice of portfolio management which involved choosing the right projects and aligning them across all the strategic objectives.
Linking portfolio management and architecture	1	One respondent observed the importance of linking portfolio management to business architecture in order to move from a baseline to a target state.
Portfolio Management approach	5	One organisation spent about a year developing part of their methodology before benefits could be realized. The then CIO observed that portfolio management was not run well in any organisation in South Africa.
Positioning portfolio management		A senior director at one of the banks acknowledged project portfolio management as an important capability. However, he cautioned about where the capability should

in the organisation		reside in the organisation.
CODE NAME	**NUMBER OF RESPONSES**	**COMMENT / SUMMARY**
Prioritizing Initiatives	35	Organisation 1 (Retail bank) used 4 criteria for prioritizing initiatives: Strategic enablement Efficiency & Effectiveness – i.e. will the initiative make the organisation more efficient & effective Affordability – can the organisation afford to do the initiative Growth / Survival – will the initiative help the organisation grow. This was added as a result of the current economic conditions. Another organisation (Bank) establishes the key themes and the basis for prioritization but tailor the project list to the funding pool and resource availability. They do consider strategic goals, regulatory compliance, customer satisfaction, net present value, non financial benefits, resource availability, scope and complexity. The third organisation (Retail bank) didn't have a formal prioritization mechanism. Prioritization was based on "gut-feel" and done through the business area heads giving their opinion about what was important in their business area. In one organisation, IT does the prioritizing of initiatives without business involvement. The revenue services organisation used a scoring mechanism (system) that was completed by the business and the process facilitated by the PMO. The system would then use the inputs from the different business areas and rank all the proposed initiatives based on 4-5 criteria – such as strategic alignment, cost, and risk. A short term insurer admitted that while they use financial measures such as NPV, ROI and IRR, they have struggled to get the right prioritization model which works well. An investment bank used a "first come, first served"

		approach to prioritization. The remaining organisations followed similar approaches as the above mentioned organisations, prioritizing regulatory and compliance projects as most important and deciding on the remaining priorities through a process of discussion at an executive level.

CODE NAME	**NUMBER OF RESPONSES**	**COMMENT / SUMMARY**
Recommendations for a portfolio management approach	7	The head of architecture in one organisation suggested that the gap between portfolio management and enterprise architecture be closed as well as better business and IT alignment with the appropriate governance structures to enable process improvement. The head of project management and IT architecture in a retail bank felt that if portfolio management was used the way it should be used, there could be more co-operation between business and IT and projects would start and end in business. Another respondent recognized that a link was missing between the strategic objectives and the projects that are undertaken as well as a lack of a ‘map’ which indicates how the strategic objectives are going to be achieved. The respondent from the cell’phone network organisation identified the lack of a structured approach with regard to portfolio and program management.
Reprioritizing new initiatives	19	In organisations where a budgeting cycle is followed and a committee exists where decisions are made about which projects are funded and run, there is allowance for new initiatives during the financial year. The committee evaluates the business case of the new initiative and decides whether or not to proceed with it based on what funds can be made available and the importance of the new initiative. Where necessary, the relevant business heads are requested to stop or delay other initiatives in order to fund the new, more important initiative.

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Resource Allocation and Resource Management	4 18	Each organisation has its own model for managing and allocating resources. In one retail bank, resources were drawn from a resource pool. Another retail bank organized its resources in centres of excellence (IT functional streams) such project management, business analysis, development and testing. Across these functional streams, in a matrix structure, portfolios existed and were aligned to business areas such as Home loans, Vehicle Finance, Banking Products, etc. The portfolios would have resources assigned from the functional streams. These resources remained dedicated to the portfolio for a period of time and built up expertise in that business area. In other organisations, resources were assigned or seconded to initiatives by their line manager (business area head).
Responsibility overseeing a group of initiatives	17	The general response was that the individual that had oversight of a group of initiatives held the responsibility for the budgets, resources, timelines, risks, issues, and scope.
Responsibility of the prioritization committee	4	Typically, the prioritization committee had the responsibility of evaluating options, making tradeoffs, and tracking progress of initiatives at an enterprise level. In addition, they ensured the correct allocation of funds.
Responsibility for the selection and overall management of initiatives	22	This responsibility was assumed by the executives in the relevant prioritization committees across the interviewed organisations as they generally represented the various business areas within their organisations. Within their business areas, the executives, with their senior managers, would select the initiatives they want to run – within the constraints of the initial budget allocation. The business managers were accountable for the delivery of the initiatives while the IT project management was responsible.

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Revision of budget estimates	1	One organisation (a retail bank) indicated that across the bank, every quarter, a revision of previous budget estimates is done. This exercise did not only relate to project investments but also operational budgets. The estimate revisions gave the organisation an opportunity to cut back on expenses (reduce spending on initiatives / project investments) sooner than later – if necessary.
Role of the PMO	2	One organisation in particular emphasized the role of the PMO (project management office). The PMO ensured that projects not only aligned to the business strategy but continued to remain aligned.
Scope of portfolio management	6	One of the banks viewed the responsibility of project portfolio management as extending beyond "solution delivery" to "services of solutions". Another bank observed that in the portfolio role, one needed to have an understanding of strategy. The respondent pointed out that the current portfolio managers in his organisation were probably good project and/or program managers and were now fulfilling the role of portfolio manager. He saw this as a fundamental issue. His advice was that the portfolio management had to be elevated above the project management role. A second respondent from the same bank pointed out the need for portfolio management measurements and goals to be aligned to the organisation's business goals.
Specifying benefits	18	Most respondents indicated that the benefits to be achieved by the initiatives (projects) being run are specified in the relevant business case.
Stopping initiatives	1	One respondent indicated that decisions were taken to stop initiatives; however, no formal methodology for doing this was used. Projects were generally stopped in his organisation if someone raised a concern and questioned the validity of a project.

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Strategic alignment	7	Across the organisations interviewed, there wasn't a clear indication that the initiatives being run within the respective organisations were aligned to strategy. One bank illustrated the fact that when strategy changes, the initiatives that have not commenced yet, may be stopped in view of the new strategy, and other initiatives aligned to the new strategy are started. The revenue services organisation made a deliberate attempt to ensure strategic alignment of initiatives. The respondent attributed the business success to strategic alignment.
Structure for managing initiatives	4	With regard to the structure for managing initiatives, reference was made to the typical project management governance where a steering committee exists to oversee the running of a particular project. Reference was also made by one respondent on the way their portfolios were structured. Portfolio management was based in IT and the portfolios were structured according to the way the business was organized. So, for example, the different product areas (Home Loans, Vehicle finance, Card, etc.) had a portfolio associated with them and a portfolio manager managing one or more portfolios. The respondent felt that this structure did not make sense – suggesting, by implication, that a better structure existed.
Translation of strategy		Annual review of strategy Budgets are the drivers for selecting initiatives and alignment to strategy is considered after the budget allocation. Focus is on improvement (system and / or products) as opposed to being driven by strategy. There's a lack of integration across 'portfolios' / divisions. Strategic objectives are decided at the executive level. Business divisions are allowed to determine what

		initiatives they want to run. The understanding was that the strategic objectives would determine the initiatives / project investments, however, no organisation could prove that this was done. Profitability needs take precedence to strategic objective 'wants'. Testing strategic alignment after the project / initiative has been selected, is a means towards providing further justification for the project / initiative. What is lacking is the deliberate translation of strategy into prioritized and sequenced initiatives towards meeting the strategic objective or goal.

CODE NAME	NUMBER OF RESPONSES	COMMENT / SUMMARY
Understanding of portfolio management	3	During the course of the interviews, some respondents stopped to check the understanding of portfolio management. One respondent acknowledged that portfolio management "means many things to many people". He confirmed his understanding – which was to do with the alignment of projects to the company strategy. Another respondent who has had work experience in Africa, America and Europe confirmed that portfolio management is a new discipline and similarly to the project management discipline, portfolio management would need to go through some stages before it reached maturity.

12.2 Preliminary findings from the research

The use of codes to bring order, structure and meaning to raw data (Strauss and Corbin, 1990) was done. The researcher also searched for relationships among emerging categories of data (Marshall and Rossman, 1995) and code families were created. The coding resulted in some key topics emerging from the data.

Some of the key topics elicited from the interviews included:

Strategic alignment and translation of strategy - there was no clear indication that the initiatives being run within the respective organisations were aligned to strategy. Strategic objectives were decided at the executive level once a year. Business divisions were allowed to determine what initiatives they wanted to run. The understanding was that the strategic objectives would determine the initiatives / project investments; however, no organisation could prove that this was the case.

Budget is the driver for selecting initiatives and alignment to strategy is considered after the budget allocation. Focus is on improvement (system and / or products) as opposed to being driven by strategy. Profitability needs take precedence to strategic objective ‘wants’.

Testing strategic alignment after the initiative has been selected, is a means towards providing further justification for the initiative. What is lacking is the deliberate translation of strategy into prioritized and sequenced initiatives towards meeting the strategic objective or goal.

Only the revenue services organisation confirmed having a deliberate process which ensured strategic alignment of initiatives and attributed the success of the organisation to this.

Responsibility for the selection and overall management of initiatives - This responsibility was assumed by the executives in the relevant prioritization or investment committees across the interviewed organisations as they generally represented the various business areas within their organisations. Within their business areas, the executives, with their senior managers, would select the initiatives they wanted to run – within the constraints of the initial budget allocation. The business managers were accountable for the delivery of the initiatives while the IT project management was responsible.

Responsibility of the prioritization committee - Typically, the prioritization or investment committee had the responsibility of evaluating options, making tradeoffs, and tracking progress of initiatives at an enterprise level. In addition, they ensured the correct allocation of funds.

Funding initiatives - Prevalent in Banks was the existence of a central committee which decided on allocation of funds per initiative. Their process included a forecast being done for the coming year. Initiatives were categorized as those that were expensed in the current year (referred to as income statement projects) and those that were capitalized (costs recovered over a period up to ten years).

With regard to the revenue services organisation, their prioritization system allowed them to easily determine the selection of projects based on the available funds from the treasury. If the prioritization was correct, then the available funds were allocated to the top projects.

Effectiveness of approach for translating strategy into initiatives - one organisation (Bank) felt that the approach they used was effective but recognized that global pressure in their industry would require them to improve the current approach.

Another bank felt they could use a model that would significantly improve their ability to prioritize and track the realization of their strategic objectives.

An important observation from a respondent in the latter organisation was that projects focus at the tactical level with too many resources being invested in the "tactical things".

The key message from the respondents was that organisations that used a project portfolio management approach tended to develop the approach internally to their organisation. None of the organisations interviewed use the Standard for Portfolio management or any other approach, model, or methodology.

All respondents acknowledged awareness of the PMI's PMBOK and/or Prince2 project management methodology but were unaware of the PMI's Standard for Portfolio Management. At least 3 respondents referred to Prince 2 or a home-grown software development life cycle as their "model" for portfolio management. This suggests that while reference is made to portfolio management in organisations, there appears to be a lack of understanding of what it entails.

Amongst the banks, a formal process existed around the budgeting cycle where an investment council or committee regarding project approval and budget allocation made decisions. However, this process didn't exist for project investments only. It included the operational budgets of the various business divisions.

13 APPENDIX C – Consent Letter

Consent letter sent to all respondents:

Clive Enoch (PMP)
University of Johannesburg
South Africa

March 2009

Dear Research Participant,

RE: RESEARCH TO DETERMINE THE USE AND EFFECTIVENESS OF PROJECT PORTFOLIO MANAGEMENT IN SOUTH AFRICAN ORGANISATIONS

The purpose of the investigation is to illicit opinion on the subject of Project Portfolio Management.

The research project objectives are to:

1. *Establish the effectiveness of project portfolio management*
2. *Determine the implementation criteria for effective Project Portfolio Management*

The investigation is not intended for commercial resale but is being used to complete a DCom (Doctorate of Commerce) degree through the University of Johannesburg.

METHOD OF INVESTIGATION

A qualitative approach for this project was chosen, with a literature survey and interviews as the mechanisms for data collection. The researcher wants to determine from respondents the effectiveness of the portfolio management approach they've adopted, taking into account behavioural aspects.

Your input to this research is important as you can provide valuable insight based on your knowledge and experience in your organisation and/or industry.

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Auckland Park Bunting Campus | Auckland Park Kingsway Campus
Doornfontein Campus | Soweto Campus

UNIVERSITY OF JOHANNESBURG

ETHICAL CONSIDERATIONS

The researcher will respect the rights, values and desires of respondents. As such, the following safeguards are used:

a) The research purpose and objectives are stated above
b) The interview will only proceed with consent from the respondent
c) Written interpretations and reports will be made available to respondents for verification

CONCLUSION

The researcher is grateful for your participation and contribution to this research and hence the advancement of portfolio management in general.

Sincerely,

Researcher: Clive Enoch
Tel: 0834095021
Email: clivee@mtnloaded.co.za

Promoter: Professor L. Labuschagne
Tel: 0115591218
Email: lesl@uj.ac.za

UNIVERSITY OF JOHANNESBURG

CONSENT

I ______________________________, (ID: ______________________________),

agree to participate in research to determine the use and effectiveness of project portfolio management in South African organisations conducted by Clive Enoch through the University of Johannesburg.

I understand that the information provided will be used for research purposes only.

The information provided is given in my capacity as (job title) ______________________________

at (company name) ______________________________

Signed at: ______________________ on ______________________ / 2009

Signature: ______________________

UNIVERSITY OF JOHANNESBURG

14 APPENDIX D – Fuzzy Logic Overview

14.1 Introduction

Fuzzy logic is a tool capable of modelling complex, uncertain and vague data and is considered appropriate to deal with uncertainty in a portfolio component environment.

Fuzzy logic was introduced by Lotfi Zadeh in 1965 in a chapter entitled "Fuzzy sets" in the journal *Information and Control* (Zadeh, 1965). Zadeh laid the foundation for fuzzy logic and reasoning by proposing the idea of the fuzzy algorithm. The theory has advanced in concepts and application over the decades. In the early 1990s, fuzzy logic was applied to home electronics products and the general public became aware of it (Tanaka, 1997).

Fuzzy logic is a broad theory including fuzzy set theory, fuzzy logic, fuzzy measures and others. It is designed to deal with vagueness and imprecision. It is very effective in areas where human reasoning is needed, which is usually imprecise (Hosmer, 1993). Fuzzy logic can help in making subjective opinions more objective.

Cebeci and Beskese (2002:93) state that "the theory of fuzzy logic builds on the idea of non-statistical uncertainty" and argues that "conventional probabilistic models provide inappropriate descriptions of certain kinds of uncertainties". In particular, "linguistic imprecision is believed to be a major cause of … lexical uncertainty. While conventional stochastic uncertainty deals with the uncertainty of whether a certain event will occur or not, lexical uncertainty … deals with the uncertainty of the definition of the event itself. Humans often evaluate various concepts differently" (93).

When evaluating the performance and value of portfolio components within a portfolio, stakeholders and members of investment committees make subjective assessments. The RAG (Red, Amber, Green) status is one such example of a subjective evaluation. In some instances, parameters (threshold values) are assigned to indicate when a status changes from Green to Amber to Red, but in most cases, evaluation of some factors is done subjectively. Fuzzy evaluation and reasoning techniques or approaches offer a way of dealing with subjective evaluation.

14.2 Fuzzy Logic Systems

A fuzzy logic system receives an input and delivers either a fuzzy set or a crisp value. It contains four essential components: a rule set, a fuzzifier, an inference engine and a defuzzifier. Rules may be provided by experts or can be extracted from numerical data. The rules are expressed as a collection of IF-THEN statements. These statements are related to fuzzy sets associated with linguistic variables (Mendel, 1995).

The fuzzifier maps the input values into the fuzzy sets to obtain degrees of membership. It is used to activate rules, which are described in terms of the linguistic variables. The inference engine of the fuzzy logic system maps the antecedent fuzzy (IF part) sets into consequent fuzzy sets (THEN part). This engine handles the way in which the rules are combined. In practice, only a very small number of rules are actually used in engineering applications of fuzzy logic (Guo & Peter, 1994). In most applications, crisp numbers must be obtained at the output of a fuzzy logic system. The defuzzifier maps output fuzzy sets into a crisp number, which becomes the output of the fuzzy logic system.

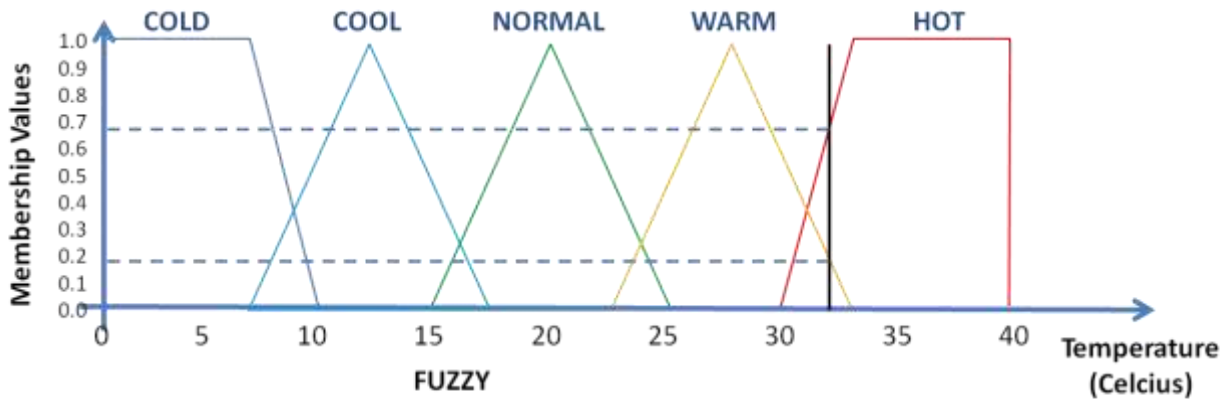
14.2.1 Membership Functions

A membership function is a curve that defines how each point in the input space is mapped to a membership value between 0 and 1. The input space is also referred to as the universe of discourse (MathWorks, 2011).

14.2.2 Fuzzification

The first step in fuzzy logic processing is to transform input values into fuzzy inputs. To do this, membership functions must first be defined for each input. A member of a fuzzy set belongs to that set to a certain degree. The degree of membership is determined by the membership function. Once membership functions are defined, fuzzification takes an input value and compares it with the stored membership function information to produce fuzzy input values.

Figure 14.1: Fuzzy sets for temperature



The figure above illustrates five fuzzy sets – Cold, Cool, Normal, Warm and Hot. The bold (black) line shows that a temperature of 32 ^{o}C belongs to the HOT fuzzy set with a membership degree of 0.7. It also belongs to the WARM fuzzy set with a membership degree of 0.2.

14.2.3 Fuzzy Rules

Fuzzy logic systems use rules to indicate the relationship between variables (observations) and outcomes (actions). The rules have an IF (precondition) … THEN (consequence) structure. The precondition can consist of multiple conditions linked with AND or OR conjunctions and negated with a NOT. The computation of fuzzy rules is called fuzzy inference (Shull, n.d.). The set of rules must be determined in terms of the problem to be solved. Experts in the specific domain typically define these rules.

14.2.4 Defuzzification

Defuzzification converts the fuzzy output set into a crisp output. Techniques such as the Centroid method, where the crisp value of the output variable is computed by finding the value of the centre of gravity of the membership function, or the Maximum method, where the crisp value of the output variable is the maximum truth-value (membership weight) of the fuzzy subset, are used. Defuzzification is the last step in the fuzzy logic process and the output is interpreted for the context in which it is used (Cox, 1995).

15 APPENDIX E – Paper presented at PMI REC2010

PROJECT PORTFOLIO MANAGEMENT: A COMPARATIVE ANALYSIS

(C.N. Enoch & L. Labuschagne, 2010a)

PROJECT PORTFOLIO MANAGEMENT: A COMPARATIVE ANALYSIS (7,575)

Clive N. Enoch (MCom, PMP®, Prince2), University of South Africa and Prof. Les Labuschagne (DCom), University of South Africa

ABSTRACT

Project portfolio management is the process by which an organization focuses its limited resources on the development of new products and operational enhancements. It is primarily responsible for the evaluation and prioritization of current and prospective projects together with other ongoing initiatives. Its functions also include accelerating, decelerating, or terminating projects based on evolving organizational requirements. The project portfolio management process is regarded as an ongoing process rather than an evaluation that is conducted at specific review points only.

During the past decade, a substantial body of knowledge has been developed on various approaches to project, IT (Information Technology) and application portfolio management. Many books have been published on the topic and most recently, the Project Management Institute (PMI®) has published the second edition to its *Standard for portfolio management*. This was used as the foundation for comparative analysis in this research.

This paper follows an exploratory research approach by investigating the practice of project portfolio management and reporting on the preliminary findings from an investigation conducted in early 2009. Several interviews were conducted with representatives from large organizations in South Africa to determine the practice of project portfolio management. The research was further scoped to focus only on professional services organizations and, more specifically, on projects that included an IT component.

The semi-structured interviews were transcribed and analyzed using Computer Assisted Qualitative Data Analysis (CAQDAS) software. The results were then compared with the *Standard for portfolio management* to determine whether there are any gaps between theory and practice.

This qualitative approach allows for a comparison of theory and practice and, through the findings, seeks to develop a better understanding of the practice within the South African context. This improved understanding can then assist in the development of future editions of the *Standard for portfolio management*. The results of this research can also be used to compare the practices in a developing country such as South Africa with those of other developing and developed countries.

Key words: project portfolio management, qualitative research, exploratory approach, organizational strategy, organizational governance

INTRODUCTION!

A standard can be defined as "a published document which sets out specifications and procedures designed to ensure that a material, product, method or service is fit for its purpose and consistently performs in the way it was intended" (Standards Australia, (n.d.)). The International Standards Organization (ISO) defines a standard as "a documented agreement containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes and services are fit for their purpose" (International Standards Organization, (n.d.)).

The Project Management Institute (PMI®) developed the *Standard for project portfolio management* – the first edition was published in 2006 (Project Management Institute [PMI], 2006) and the second edition in 2008 (PMI, 2008a). According to the PMI®, "The Standard for Portfolio Management addresses a gap in the management-by-project field across all types of organizations ... that is, the need for a documented set of processes that represent generally recognized good practices in the discipline of portfolio management"(PMI, 2008a).

While project and program management are traditionally focused on doing projects right, portfolio management is focused on doing the right projects (Cameron, 2005; Cooper, Edgett, & Kleinschmidt, 2000; Merkhofer, 2006). The term “portfolio” is also traditionally associated with a collection of financial investment instruments (such as stocks and bonds) (Bonham, 2005). This paper does not attempt to address those types of portfolios. The area of investigation for this research encompasses project, application and IT portfolio management and will hereafter be referred to collectively as PfM.

PfM is the continuous process of selecting and managing the optimum set of project oriented initiatives to deliver maximum business value (Cameron, 2005). For some organizations, “simply categorizing IT investments and using the portfolio as a communication tool is enough, whereas other organizations elect to apply a detailed statistical and management process discipline to their business and IT investments” (Rosser, 2001, as cited in Cameron, 2005).

The overall concept of PfM has been supported by authors in the field of project management and IT risk management. Levine (2005) states that there is a desire in organizations to implement a PfM capability, even though, in some instances, they have little interest in project management itself. Maizlish and Handler (2005) note that the definition and practical aspects of PfM are not obvious, or widely accepted, and that less than 20% of companies maintain an active PfM framework. They add that there are elements of PfM that exist in all companies and that most companies utilize simple and straightforward financial models to make investment decisions. These authors suggest that for these companies, the PfM framework is incomplete.

Given the above definitions of a standard, the intended purpose of the *Standard for portfolio management*, and the observations from some authors in the field of PfM, this investigation seeks to determine the current practice of PfM in the South African context. This will facilitate a better understanding of the discipline and allow for improvements and future comparison with other countries.

The remaining sections of the paper include:

1. A literature review
2. The research methodology and data collection
3. A discussion on PfM theory and practice
4. The conclusion

REVIEW OF LITERATURE

Gliedman (2002) discusses the various components of PfM and shows how available tools meet the needs of the portfolio manager. In a later paper, Gliedman (Gliedman & Brown, 2004) lays out the basic concepts and definition of PfM, and its relationship to other management processes. He defines a portfolio as consisting of current, new, externally mandated and infrastructure initiatives.

Contributions to the body of knowledge of PfM have been made by authors such as Leliveld and Jeffery, 2003; Kersten and Verhoef, 2003; Pennypacker, 2005; Maizlish and Handler, 2005; Bonham, 2005; Turbit, 2005; Levine, 2005; D'Amico, 2005; Martinsuo and Lehtonen, 2007; Blichfeldt and Eskerod, 2008; Glickman, 2008; Montibeller, Franco, Lord, and Iglesias, 2009; Laslo, 2009; Freitas, De Souza, and De Almeida, 2009 and several others.

Levine (2005), Maizlish and Handler (2005) and Kalin (2006) have recognized that while the concept and promise of PfM are generally accepted, there remains a gap in the complete understanding of PfM and its components. This suggests that there might be a gap between what literature suggests and what is being practiced.

The next two sections contain a description of the theory (based on research that is presented in literature) and practice (what is being done by practitioners in organizations), respectively.

The concept of theory

Koskela and Howell (2002) state that:

1. A theory provides an explanation of observed behavior, contributes to understanding and provides a prediction of future behavior.
2. A theory, when shared, provides a common language or framework, through which the cooperation of people in collective undertakings, such as projects and organizations, is facilitated and enabled.
3. A theory gives direction in pinpointing the sources of further progress and as a condensed piece of knowledge, empowers novices to do the things that formerly only experts could do.
4. When explicit, testing the validity of the theory in practice leads to learning.

Similarly, the PMI® *Standard for project portfolio management* – second edition (PMI, 2008a) provides a common language or framework through a documented set of processes, that enable individuals or organisations new to PfM the opportunity to begin using the generally accepted good practices without having to develop a unique set from start.

The rest of the paper investigates the application of PfM in practice, in order to learn more about the discipline, specific to the South African context.

The concept of practice

Wenger (1999) describes the concept of practice as a result of collective learning that "reflects the pursuit of enterprises" - which he described earlier as being anything from ensuring physical survival to seeking lofty pleasures – "and social relations". Using the example of claims processors, he states that "the collective construction of a local practice ... makes it possible to meet the demands of the institution" and that the "claims processors make the job possible by inventing and maintaining ways of squaring institutional demands with the shifting reality of actual situations". He goes on to describe the concept of practice as “connotes doing ... in a historical and social context that gives structure and meaning to what we do”.

The above description is in essence the meaning of practice as it would relate to any discipline or context and, therefore, is applicable to understanding the practice of PfM by the organizations represented in this study.

In the next section the possible existence is investigated of a gap between theory, as presented by literature and specifically the *Standard for portfolio management* (PMI, 2008a), and practice, as what is being done by practitioners in organizations.

The gap between theory and practice

Van de Ven and Johnson (2006) examined three ways in which a gap between theory and practice can be framed. The three explanations presented were:

1. The gap between theory and practice is a knowledge transfer problem – the assumption being that practical knowledge in a professional domain derives at least in part from research knowledge. The problem is one of translating research knowledge into practice.
2. Theory and practice represent distinct kinds of knowledge. Each reflects a different ontology (claim) and epistemology (method) for addressing different questions.
3. Both theory and practice incorporate a strategy of arbitrage – the gap is a knowledge production problem. It is a question of how individuals and organizations develop the means for addressing complex problems.

Van de Ven and Johnson (2006) observe that academic journals, such as *Academy of Management Journal (2001)*, the *British Journal of Management (2001)* and the *Academy of Management Executive (*2002), have highlighted growing concerns that academic research has become less useful for solving practical problems and that the gap between theory and practice is widening. They also acknowledge the fact that professional knowledge workers are not developing awareness around relevant research and are criticized for not putting practice into theory. According to Van de Ven and Johnson (2006), this results in organizations not learning fast enough.

Van de Ven and Johnson (2006) also argue that the quality as well as the impact of research improves substantially when researchers do the following:

1. Confront questions and anomalies existing in reality,
2. Organize the research project as a collaborative learning community of scholars and practitioners with diverse perspectives,
3. Conduct research that systematically examines not only alternative models and theories, but alternative practical formulations of the question of interest, and
4. Frame the research and its findings to contribute knowledge to academic disciplines and to one or more domains of practice.

PfM theory is represented through journal and conference papers, books, research reports and most recently, through the *Standard for portfolio management* (PMI, 2008b). The extent to which PfM is used in South African organizations was considered unknown before this research as no literature could be found on it. It was therefore necessary to conduct an investigation among organizations in South Africa to determine how PfM is practiced and compare it with the *Standard for portfolio management* to determine if there were any gaps, thereby leading to learning.

In the next section the research methodology and the data collection process that was used are discussed.

RESEARCH METHODOLOGY AND DATA COLLECTION

Introduction

For this investigation, a qualitative research methodology was used. A qualitative study is defined as an inquiry process of understanding a social or human problem based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting (Creswell, 1994; Saunders, Lewis, & Thornhill, 2003).

Qualitative research explores a topic when variables and theory base are not well known (Creswell, 1994). For this research the theory base is known while its effectiveness was considered unknown. Exploratory research is used for a research problem when there are very few or no earlier studies to which reference can be made for information about the issue or problem. The aim of this type of study is to look for patterns, ideas, or hypotheses, rather than testing or confirming a hypothesis (Hussey & Hussey, 1997).

The above approach is relevant for this investigation as its purpose was to investigate the use of existing theory as well as assess the current practice of PfM.

Data Collection and Analysis

A two-tier approach was used to collect data through a literature survey which was then used to inform the development of a semi-structured interview guide.

A literature survey is the process of locating, obtaining, reading and evaluating the research literature in the area of interest (Bordens & Abbott, 2002). It is a systematic, explicit and reproducible method for identifying, evaluating and interpreting the existing body of recorded work produced by researchers, scholars and practitioners. It is often conducted to provide evidence that the chosen practice is likely to be effective (Fink, 1998). The importance of reviewing the literature is to discover the most recent theorizing about a subject, and to avoid duplicating a previous study (Mouton, 2001).

An interview is a purposeful discussion between two or more people. The use of interviews helps gather valid and reliable data that is relevant to the research objectives. The use of qualitative research interviews provides a rich, detailed set of data (Saunders et al., 2003). A purely structured or unstructured interview has several disadvantages; however, combining structured and unstructured questions appropriately to use the strengths of both approaches enhances the process (Bordens & Abbott, 2002).

In an exploratory study, interviews help find out what is happening (practice) and then seek new insights (Robson, 2002). Unlike surveys, the interview allows the researcher to explore the interviewee's perspective in more detail.

The interview instrument was developed using the themes (sections) that described the PfM context in the *Standard for portfolio management* (PMI, 2008). For example, based on the section on organization strategy, the researcher developed the question regarding the process followed by the respective organizations to translate strategic objectives into initiatives. (Note: Table 1 below lists the themes and associated questions.)

A database of potential respondents representing various large organizations in South Africa was developed as a result of previous research conducted by one of the researchers (*omitted at the request of PMI®*) as well as through formal invitation at a project management conference held in South Africa in 2008. Delegates at the PMSA 2008 – Strategy to Reality Conference held in South Africa in 2008 were approached individually by one of the researchers and asked if they would be willing to participate in the research. The purpose of the research was described to the delegates and confidentiality and anonymity assured.

An initial sample size of 18 interviewees was selected to participate in the research. This was done by inviting individuals who fit a particular profile which comprised chief information officers (CIOs), senior IT managers, portfolio and program managers and business division heads. These management levels were chosen because of their awareness and knowledge of and experience in project, program and portfolio management. According to Glaser and Strauss (as cited in Shaw, 1999), the minimum number of respondents is determined by whether or not new data is being acquired. In other words, the process of conducting further interviews should stop when the researcher finds that the respondents are giving the same or similar responses. Early on in the interview process, the researcher found that the responses received were similar, but realized that this was due to the fact that most respondents at that stage were all from the financial services sector and their processes and approach to PfM were similar. The researcher proceeded to interview respondents from other sectors such as insurance and telecommunications until it was determined that no new information was being obtained. At this point, 22 respondents representing 15 organizations and 8 sectors had participated in the interview process.

Face-to-face interviews were conducted with key individuals in the various organizations from different sectors – which included financial services, insurance (short-term and medical), government, mining, telecommunication, energy utility and a manufacturer of defense force vehicles - to better understand the process and level of perceived success achieved in using PfM in their respective organizations. Each interview was digitally recorded using a digital voice recorder and later transcribed into a text document. The transcripts were quality controlled by the researcher by reading while listening to the recorded interviews to ensure that all the information from the interviews was captured correctly. The transcripts were then loaded into a Computer Assisted Qualitative Data Analysis (CAQDAS) software tool called ATLAS.ti – version 6.

> ATLAS.ti is a workbench for the qualitative analysis of large bodies of textual, graphical, audio, and video data. It offers a variety of tools for accomplishing the tasks associated with any systematic approach to unstructured data, e.g., data that cannot be meaningfully

analyzed by formal, statistical approaches. In the course of such a qualitative analysis, ATLAS.ti helps you to explore the complex phenomena hidden in your data (Muhr & Friese, 2004).

At the time of writing this paper, the complete user's guide (manual) for version 6 was still being developed. Only a supplementary document describing the new features in version 6 was available.

In order to generate a comprehensive understanding, the data was inductively analyzed (Patton, 2002).This was done by organizing and structuring data according to the topics which respondents identified as being important. Literature recommends that the inductive analysis of qualitative data involves:

- The reading and rereading of transcripts and field notes (Easterby-Smith et al., 1991, in Shaw, 1999),
- The use of codes to bring order, structure and meaning to raw data (Strauss & Corbin, 1990),
- The constant comparison of the codes and categories which emerge with subsequent data collected and also with concepts suggested by the literature (Glaser & Strauss, 1967, in Shaw, 1999), and
- The search for relationships among emerging categories of data (Marshall & Rossman, 1999)

This supports the exploratory research approach.

Quality control of data

During the coding process, it became apparent that some of the transcripts did not load into the CAQDAS tool correctly. Some paragraphs, for example, were duplicated and in two transcripts words were replaced with special characters. Upon investigation, it was determined that there was a conversion problem when using MSWord 2007 documents. The documents were then saved in MSWord 2003 format and reloaded. This corrected the problems described above.

In the code report generation, the CAQDAS tool indicated that comments were made by a certain respondent; however, the actual comment did not show in the report. The researcher manually corrected this section in the relevant transcript and manually updated the code report. Although the researcher intervened to ensure completeness and accuracy of the output from the tool, the data was not manipulated or changed in any way. Only the sections that the report referenced were copied.

The next section presents a discussion on the use of the PMI®'s *Standard for portfolio management* as the literature or theoretical base for deriving the interview questions, linking the responses and preliminary findings to the theory and describing the general observations from the investigation.

PROJECT PORTFOLIO MANAGEMENT THEORY AND PRACTICE

In order to assess the practice of PfM, the researchers recognized the need to frame the interview questions in the context of PfM theory. It was decided to use the PMI®'s *Standard for portfolio management*, second edition (PMI, 2008a), specifically the elements (section headings) contained in the *Standard* as it provides a documented set of processes that are recognized in the discipline of PfM. Furthermore, the *Standard* was published at the time that the interview questions were being developed. It further represented a recent publication on the subject. The *Standard* was also developed through contributions from more than 400 volunteers across 36 countries over a three- to five-year period. The content, therefore, is a collective consensus which extends beyond the views of select individuals such as authors mentioned already.

Theory - *Standard for portfolio management*

The *Standard for portfolio management* provides guidelines for the portfolio management processes, tools and techniques and discusses knowledge areas such as governance and risk management. The *Standard* addresses the topics that would be of interest to practitioners, such as the link between portfolio management and organizational governance, strategy, operations management, and project and program management.

The purpose of the *Standard for portfolio management*, as outlined in the *Standard*, is to "describe generally recognized good practices associated with portfolio management". It focuses on portfolio management "as it relates to the disciplines of project and program management" and is an extension to the *A guide to the project management body of knowledge* (PMBOK® Guide), fourth edition (PMI, 2008b). The *Standard for portfolio management* defines a portfolio as, "A collection of projects and programs and other work that are grouped together to facilitate the effective management of that work to meet strategic business objectives."

The *Standard* states that it is "an expansion" to the PMBOK® Guide, which suggests that the development of the *Standard* was guided from a project management perspective – this can be interpreted as a bottom-up approach. Other frameworks, such as the V2P framework, suggest a top-down approach (Marnewick & Labuschagne, 2008). For the purpose of this investigation, however, it provides a point of reference for PfM.

The interview instrument consisted of seven themes, each containing a number of interview questions. Semi-structured interviews were conducted, which meant that additional questions to the pre-defined set were asked where more clarification or information was required (Saunders et al., 2003).

Basing the questions on the themes covered in the *Standard* makes the comparison between what is suggested in theory and what is done in practice more direct. The assessment of whether or not a gap exists between theory and practice can be done.

The following table describes the themes (as described in the *Standard*) used in formulating some of the questions in the interview instrument.

Table 1 - Interview themes

Themes (T)	Brief Summary	Interview Question (Q)
T1. Organizational 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.	Q1. What process does your organization follow to translate its strategic objectives into initiatives? Q2. Briefly explain the process used to select initiatives.
T2. Organizational Governance	Establishes the limits of power, rules of conduct and protocols of work that organizations can use effectively to advance strategic goals and objectives. Here the researchers wanted to determine the existence of a governing body which took on the responsibility for selecting initiatives as well as overseeing the performance of those initiatives.	Q3. Who is responsible for the selection and overall management of these initiatives? Q4. What are the responsibilities of the individual/committee?

T3. Operations Management	Operational budget may be influenced by portfolio management decisions – including allocation of resources to support portfolio components. Distinguishing work into project and non-project activities has a bearing on how budget is allocated.	Q5. Explain the process to approve and fund initiatives. Q6. What criteria do you use to distinguish between project and non-project activities?

Themes (T)	**Brief Summary**	**Interview Question (Q)**
T4. Organizational Impacts	Portfolio management interacts with and impacts a number of organizational functions. The achievement of portfolio objectives may impact functional groups within an organization.	Q7. Explain how you deal with the impact of initiatives on organizational structure and culture.
T5. Planning & Maintenance	The alignment process deals with the identification, categorization, evaluation, selection, prioritization and authorization of initiatives.	Q8. What criteria are used to prioritize initiatives? Q9. Explain how resources are managed across initiatives. Q10. Explain the process to approve and fund *new* initiatives.
T6. Role of the Portfolio Manager	A senior manager responsible for prioritizing projects, measuring value to the organization (benefits realization), communicating portfolio performance to	Q11. What are the responsibilities of the individual who oversees a group of initiatives?

	stakeholders and reviewing project and program progress.	
T7. Performance Measurement/ Metrics	Aggregate measures of strategic goal achievement, financial contribution, asset maintenance and development, end user satisfaction, stakeholder satisfaction, risk profile and resource capability.	Q12. Are the benefits that are to be achieved through these initiatives documented at the start of the initiatives? Q13. Does the business track or measure the benefits that are being realized through these initiatives?

Additional questions that were more general in nature were included that did not form part of the above seven themes.

The next section covers the preliminary findings based on the analysis of the transcribed interviews. This, in essence, is a first iteration analysis of the data, reporting on the responses to the interview questions. Detailed analysis of the data constitutes future research.

Practice – Preliminary analysis of interviews

The use of codes to bring order, structure and meaning to raw data (Strauss & Corbin, 1990) was done. This entailed the researcher reading the transcripts and identifying statements related to the questions or aspects of PfM. Descriptive codes were assigned to these statements. The researcher also searched for relationships among emerging categories of data (Marshall & Rossman, 1999). The codes mostly reflected the topic of the questions being posed, but other important information that was not necessarily expected was also revealed. As an example, one respondent mentioned the concept of linking portfolio management and business architecture.

In the following paragraphs the general consensus of respondents regarding the questions posed is described, except where it was deemed necessary to describe the specific practice of one or more organizations.

Theme: T1. Organizational Strategy

Q1. Translation of strategy

Strategic goals and objectives are generally set by the executive committee or board and reviewed annually in all organizations. The initiatives planned for the coming year are identified by business division or function heads, who attempt to address day-to-day needs such as compliance, legislation, enhancing profitability, reducing cost and improving pricing. From the strategy translation process described by the respondents, only two respondents (representing two different organizations in the same sector) indicated a process that closely resembled a direct translation of strategy into initiatives as opposed to identifying initiatives and then trying to justify them back to the strategic objectives.

Q2. Process to select initiatives

Business division or function heads identify the initiatives they wish to run. These initiatives are then submitted to a committee for approval. In organizations where the process is administered by a project office, a consolidated list across business divisions is collated and submitted to the committee for approval.

One organization develops key themes and uses a ranking mechanism to select initiatives. As with the other organizations, however, budget is the final determinant of which initiatives are approved.

Theme: T2. Organizational Governance

Q3. Responsibility for selection of initiatives

The selection of initiatives that are approved for funding is done by a governance body or committee which is made up of a subset of an executive committee and which includes business division heads and executive committee representatives. The names given to these committees include “Programs of Work”, “Investment Committee”, “Strategic Initiatives Investment Committee”, “Change Council” and “PRIORC Committee” and will hereafter be referred to collectively as “investment committee”.

Q4. Responsibilities of the initiative selection committee

The responsibilities of these committees include evaluating (initiative) options, making tradeoffs between initiatives, tracking the progress of initiatives and ensuring that the budget is utilized / apportioned appropriately.

Theme: T3. Operations Management

Q5. Funding the initiatives

In the financial services sector, a forecast is made for the following year, listing all the projects and associated budget requirements at a very low confidence level. The overall budget (total spend for initiatives) is decided at an executive level and apportioned to the various business divisions generally based on the size of the division. Through a process of arbitrage, the investment committee (refer to question 3) decides which projects are important enough to get funding.

One organization relies on an allocation of funds from Treasury to cover operational expenses. After allocating funds to the operational budget of the organization, an amount is made available for initiatives and is allocated according to the ranked order of these initiatives.

At one of the insurance companies, the total fund for initiatives is calculated as a percentage of net earned income and is split into three categories, namely strategic initiatives, other projects and maintenance/support.

Q6. Distinguishing between project and non-project initiatives

With regard to distinguishing between project and non-project initiatives, criteria used by the various organizations include:

1. Defined start and end date
2. A budget threshold
3. Cross-divisional impact
4. Duration

Theme: T4. Organizational Impacts

Q7. Managing change

Except for one organization, all other organizations indicated that they have a change management function that manages the change in the organization. One respondent distinguished tactical change from strategic change and acknowledged that change management at a strategic level in this organization was non-existent.

Theme: T5. Planning and Maintenance

Q8. Criteria for prioritizing initiatives

Different organizations use different criteria. Below is a consolidated list of criteria used across the various organizations:

1. Strategic enablement – will the initiative meet the strategic objectives of the organization?
2. Impact – how will the initiative influence the efficiency and effectiveness of the organization?
3. Affordability – does the organization have the funds to embark on the initiative?
4. Capacity – does the organization have the resources to work on the initiative?
5. Regulatory compliance – does the organization have a choice whether to implement or not?
6. Complexity – is the initiative and its context well understood?
7. Business need or benefit – what will the value of the completed initiative be?

8. Financial measures – based on the internal rate of return (IRR), return on investment (ROI) and net present value (NPV), is this a worthy investment?

Only two organizations use a weighted scoring system to prioritize their initiatives.

Q9. Allocating and managing resources across initiatives

Across the organizations different approaches are used. In one organization, resources are drawn from a center of excellence to work on initiatives. Another organization organizes their resources according to specific disciplines (project management, business analysis, development and testing) and resources are allocated from these centers of excellence to portfolios. The allocation of business resources, however, was considered not to be done well by most interviewees.

Another organization uses a central pool of resources which includes a secondment of business resources for use on initiatives. Only one organization uses a portfolio management tool to manage the allocation of resources.

Other organizations allocate resources from the relevant business areas.

Q10. Approving and funding new initiatives

As part of the formalized budgeting process in the financial services sector specifically, business divisions, through their portfolio manager, submit requests for new initiatives either at the monthly progress meetings or a quarterly revised estimate meetings. As far as possible, the portfolio budget is not increased. This requires the portfolio manager to reprioritize initiatives within his/her portfolio.

In one organization, initiatives that are underway are allowed to continue. Any new initiatives are only prioritized against those initiatives that have not started.

Another organization applies the same rigor to any new initiatives as it does in the forecasting process at the beginning of the year. It uses its scoring system to verify the importance of the new initiatives against other initiatives; then it approaches Treasury for additional funds or delay other initiatives in favor of the new, more critical initiative.

All organizations use a business case to justify the initiatives. If it is justified to run the initiative in the current financial year, the organization attempts to use the budget allocated for initiatives for the current financial year and to delay other initiatives.

Theme: T6. Role of the Portfolio Manager

Q11. Responsibility of the person overseeing a group of initiatives

In one of the organizations, the responsibilities of the person overseeing a group of initiatives include meeting objectives, delivering benefit, managing risks and dependencies and managing stakeholders.

In organizations within the financial services sector, such a person is given the title of Portfolio Manager; however, the responsibilities are centered on a line management function within a functional competency. The business analysts, for example, report to a business analysis (BA) portfolio manager who manages the BA resources and the quality of their deliverables. The portfolio manager manages project managers and is responsible for project budgets within the portfolio.

In one organization, the responsibility of overseeing initiatives lies with the CIO and the head of the project office. Depending on the scope of the initiatives, program managers sometimes play a role in overseeing a group of initiatives.

The remaining organizations use a program manager to fulfill this function. The role of a portfolio manager does not exist in these organizations.

Theme: T7. Performance Measurement/Metrics

Q12. Benefit specification

Q13. Benefit realization tracking

All of the organizations interviewed said that benefits associated with an initiative are specified in the business case; however, benefit realization tracking is done in only two of the fifteen organizations.

One of the respondents from a financial services organization suggested that benefits are postulated and based on many assumptions. In his 20 years of experience, he had never come across an initiative where the calculated benefit was realized. He suggested that the only value that could be derived is the learning regarding which areas in the organization estimate the benefits more accurately.

One of the C-level executives did not see the need for tracking benefit realization as the achievement of benefits, or the lack thereof, does not change the fact that money has already been spent.

Responses to additional questions

Interviewees were also asked whether or not they used a portfolio management model for the purposes of PfM. Some organizations developed a portfolio management approach internally but none of the respondents were aware of the *Standard for portfolio management* or any other formal model. All respondents were aware of and most used a formal *project* management standard or methodology – either the PMBoK® standard or the Prince 2® methodology. At least three respondents confused a project management methodology with a portfolio management methodology.

With regard to the effectiveness of the approach being used in the respective organizations, most respondents indicated that their approach worked for them and was "fit for purpose".

One respondent felt, however, that the use of a model and appropriate tools would improve the strategic alignment and determination of spend. Another respondent indicated that while the current approach provided some structure, more could be done towards optimizing the execution of strategic objectives.

In the next section a comparison is drawn between the *Standard* and practice (as determined from the interview responses) by tabulating the theory and practice codes used in the preceding sections as well as observations from the preliminary findings. The third column indicates whether a gap exists.

Project Portfolio Management Theory versus Practice

The table below illustrates the comparison between the themes in the *Standard* and the practice in organizations. The codes in the theory and practice columns refer to the more detailed descriptions in the preceding table (Table 1). A gap is indicated where the practice of a particular theoretical theme varies from the theoretical definition/description of that theme.

Table 2 – A Comparison of Theory versus Practice

Theory (Themes)	Practice (Questions)	Existence of Gap (Y/N)	Comment/Observation
T1 Organizational Strategy	Q1. What process does your organization follow to translate its strategic objectives into initiatives?	Y	Except for one organization, the direct translation of strategy into initiatives is not practiced.
	Q2. Briefly explain the process used to select initiatives.	Y	The process for selecting initiatives in practice is flawed as focus is given to addressing the tactical needs of the organization rather than the strategic needs.
T2 Organizational Governance	Q3. Who is responsible for the selection and overall management of these initiatives?	N	Governance bodies in the form of committees exist to make decisions regarding the selection of and budget approval for initiatives.
	Q4. What are the responsibilities of the individual/committee?	N	The committees set up to perform the governance regarding budget approval for initiatives carry out their mandate as required by the respective organizations.

Theory (Themes)	Practice (Questions)	Existence of Gap (Y/N)	Comment/Observation
T3 Operations Management	Q5. Explain the process to approve and fund initiatives.	Y	In practice, the amount to be spent on initiatives in any given year is decided at a higher level than the designated portfolio management. Finances are apportioned to different business divisions, which then fund the initiatives as they see fit. As a result, owing to a lack of forced ranking of initiatives across divisions, some initiatives in one division enjoy funding while other more important initiatives in another division are overlooked.
	Q6. What criteria do you use to distinguish between project and non-project activities?	Y	The *Standard* defines a portfolio to include programs, projects and other work (including the management of ongoing, recurring operational activities); in practice, ongoing operational activities are not included in portfolios.
T4 Organizational Impacts	Q7. Explain how you deal with the impact of initiatives on organizational structure and culture.	N	The *Standard* does not explicitly include change management processes but acknowledges that the achievement of the portfolio objectives will impact the business divisions within an organization. With the exception of one organization, the change management capability for individual projects and programs exists in organizations.

Theory (Themes)	Practice (Questions)	Existence of Gap (Y/N)	Comment/Observation
T5 Planning & Maintenance	Q8. What criteria are used to prioritize initiatives?	Y	The *Standard* states that the criteria used must be defined by the organization and that the prioritization activities include classification of components according to strategic categories, assignment of weighted scores for ranking components and the determination of priority within the portfolio. This is achieved partially in practice. Organizations do use criteria but from the lists provided, strategic categories are not obvious.
	Q9. Explain how resources are managed across initiatives.	N	Every organization attempts to manage resource allocation to initiatives but is constrained by the adequate availability of sufficiently skilled resources. While different approaches are followed for allocating and managing resources, no gap between theory and practice is evident.
	Q10. Explain the process to approve and fund *new* initiatives.	Y	Under the Monitor Business Strategy Changes process step in the *Standard*, only a significant change in strategic direction will impact component categorization or prioritization, which will require rebalancing the portfolio. In practice, a significant change in strategic direction is not required for new initiatives to be considered. As long as the initiative can be justified through a business case and the funds can be made available, the initiative is approved.

Theory (Themes)	Practice (Questions)	Existence of Gap (Y/N)	Comment/Observation
T6 Role of the Portfolio Manager	Q11. What are the responsibilities of the individual who oversees a group of initiatives?	Y	The role of the portfolio manager is outlined in the *Standard*. In organizations with a portfolio management role, the responsibilities are limited to fulfilling a line function role within a project management competency.
T7 Performance Measurement/ Metrics	Q12. Are the benefits that are to be achieved through these initiatives documented at the start of the initiatives? Q13. Does the business track or measure the benefits that are being realized through these initiatives?	Y	According to the *Standard*, the portfolio manager is responsible for measuring and monitoring the value to the organization through key performance indicators. In practice, while benefits are specified in the business case, there is a lack of effort in tracking the achievement of the stated benefits.

From the above table it can be seen that there are indeed gaps between PfM theory and practice. The following are some explanations for the existence of these gaps:

1. In some organizations the need for PfM often originated from senior management as a mechanism to collectively manage several initiatives in order to achieve a specific result. This constitutes a top-down approach to the development of an organizational PfM framework. In other organizations PfM originated from middle management as a mechanism to conveniently group together initiatives to have better control over resources and to track their progress. This constitutes a bottom-up development of an organizational PfM framework. These two divergent points of origin would lead to different frameworks being developed.

2. Some participants were of the opinion that all initiatives collectively form a single portfolio as it is the collective interaction between the components that leads to organizational results. Others supported multiple portfolios based on the range of products (e.g. home loans, vehicle finance and credit cards in a retail bank). Still others viewed portfolios according to strategic goals or drivers having each goal represented by a portfolio with all related initiatives across business functions being managed within that portfolio. The underlying view of a singular versus multiple portfolios would influence the resulting PfM framework.

3. Several participants indicated that the development and incorporation of PfM into their organizations were exacerbated by factors such as constantly changing organization structures, immature project management practices and internal politics. Many also commented on senior management's lack of understanding of what PfM was. This indicates that both project management maturity and organizational maturity impact the practice of PfM.

4. None of the respondents interviewed acknowledged awareness of the portfolio management standard or any other formal model or approach. In organizations where PfM was actively being pursued, the approach was developed in-house. Practice was therefore based on need rather than on theory or existing literature. This suggests that there is still a lack of awareness of PfM in allied disciplines, as most of the interviewees did not follow a project management career path.

5. Even though PfM has a relatively substantial body of knowledge (journal and conference papers, White Papers, standards and books), a comprehensive awareness and understanding (knowledge) of what PfM entails is lacking. This is evident from the absence of:
   - a competency development framework for portfolio managers
   - formal certification of portfolio managers
   - empirical evidence on the value of portfolio management

With reference to Van De Ven and Johnson's view (2006) on framing the gap between theory and practice mentioned earlier in this paper, the findings from this investigation suggest that the gap between PfM theory and practice is a knowledge production problem.

CONCLUSION

In current global markets, as a result of the economic turmoil, organizations are placed under further pressure to do more with less. This suggests that there is a greater need to utilize scarce resources optimally in order to achieve the organization's strategic intent. PfM is the function in the organization that will help to achieve this if it is positioned and used correctly.

This investigation set out to determine the practice of PfM in South African organizations as it relates to the *Standard for portfolio management*.

Despite the fact that several interviewees indicated that their organizations did not apply the *Standard,* they still perceived their organizations to be successful in achieving their strategic objectives. This seems counterintuitive and indicates a lack of understanding of the link between PfM and organizational success.

While PfM is being considered and tried in some form in organizations, none of the organizations interviewed recognize any formal approach, model or methodology which they could adopt. The role of the portfolio manager appears to be merely a line function (next level of reporting) for project and program managers. Although some organizations exercise some rigor around their budgeting process, their mechanism for ensuring the creation and identification of initiatives following strategy definition is weak, if not lacking completely.

The selection, prioritization and authorization of initiatives are left to the subjective defense of business area executives. There is a lack of forced ranking of initiatives across business areas to ensure that only the most strategically aligned initiatives are run. It was illustrated by an executive in one of the banks during the interview that projects (initiatives) address tactical problems and, as a result, more resources are allocated to tactical endeavors rather than addressing the strategic objectives.

It can be argued that despite the focus of investment on tactical problems as opposed to achieving strategic objectives, organizations are still successful. However, organizations may be successful for other reasons, such as a unique product offering, service or presence in the market. One respondent reported, however, that their organization achieved increasing success since adopting a portfolio management approach and getting better alignment of initiatives with strategic objectives.

The theory of PfM has developed over the past few years and while there is still a need for scientific contribution to the theory, the existing body of knowledge provides a useful reference for practitioners. Despite the available literature, however, the practice of PfM is limited in its implementation and, therefore, requires further investigation.

It can be concluded from this investigation that there are gaps between theory and practice in PfM and these gaps need to be addressed. These include the translation of strategy into executable initiatives, the categorization of initiatives using a common set of decision filters and criteria, identification and management of portfolio risks, prioritization of initiatives across portfolios as opposed to within portfolios, balancing portfolios and monitoring and responding to business strategy changes. The gap exists because organizations are using a "home-grown" approach and are not following a recognized approach or standard. This implies that there is scope for improving the implementation and practice of PfM in South African organizations.

Further analysis of the data obtained in this investigation is needed to develop a deeper understanding of:

1. the reasons for the gaps and how to close them (by changing the theory and/or practice),
2. developing and implementing a new PfM model into an existing organizational structure,
3. how to measure the organizational value of PfM,
4. determining whether the Standard can be used in any organizational context or only in specific ones.

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16 APPENDIX F – Paper presented at PMSA conference 2010

PROJECT PORTFOLIO MANAGEMENT: AN INVESTIGATION INTO SOUTH AFRICAN PRACTICES

(C.N. Enoch & L. Labuschagne, 2010b)

PROJECT PORTFOLIO MANAGEMENT: AN INVESTIGATION INTO SOUTH AFRICAN PRACTICES

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ABSTRACT

Project portfolio management (PfM) is the process by which an organisation focuses its limited resources on the collective development of new products and operational enhancements. It is primarily responsible for the evaluation and prioritization of current and prospective projects together with other ongoing initiatives. Its functions also include accelerating, decelerating, or terminating projects based on evolving organisational requirements. The PfM process is regarded as an ongoing process rather than an evaluation that is conducted at specific review points only.

Despite the existence of formal guides such as the Standard for Portfolio Management published by the Project Management Institute, and several other literatures, anecdotal evidence suggests that there might be a misalignment between the Standard for Portfolio Management and practice in South African organisations. The investigation focused on the practice of portfolio management within a South African context, and takes a qualitative research approach consisting of several semi-structured interviews being conducted with representatives from large organisations. The research was further scoped to focus only on professional services organisations and, more specifically, on projects that included an Information Technology (IT) component.

The results show that there is a clear misalignment between what is practiced in South African organisations and what is presented in the Standard for Portfolio Management. Based on this result, the paper explains the differences and concludes that there is a need for organisations to be able to determine the impact of PfM decisions on strategic objectives.

The value of this paper is that it confirms many of the commonly held beliefs surrounding PfM by providing scientific evidence for it. The insight provided will assist in the development of enhancements to the Standard for Portfolio Management to support organisations in achieving its strategic objectives.

KEY WORDS:
project portfolio management, qualitative research, exploratory approach, organisational strategy, organisational governance

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INTRODUCTION

Project and program management are focused on doing projects right. Portfolio management is focused on doing the right projects (Cameron, 2005; Cooper, Edgett, & Kleinschmidt, 2000; Merkhofer, 2006). The term “portfolio” is also associated with a collection of financial investment instruments (such as stocks and bonds) (Bonham, 2005). This paper does not attempt to address those types of portfolios. The area of investigation for this research encompasses project, application, and portfolio management specific to the domain of Information Technology (IT) and will hereafter be referred to collectively as PfM.

According to Cameron, 2005, PfM is the continuous process of selecting and managing the optimum set of project-oriented initiatives to deliver maximum business value. For some organisations, “simply categorizing IT investments and using the portfolio as a communication tool is enough, whereas other organisations elect to apply a detailed statistical and management process discipline to their business and IT investments” (Rosser, 2001, as cited in Cameron, 2005). This observation indicates that organisations practice varying degrees / levels of PfM. However, the impact of this on organisational success is not yet understood.

Maizlish and Handler (2005) note that, among organisations, there is limited adoption of the definition and practice of PfM. They add that elements of PfM exist in most organisations and that simplistic financial models are often utilised to make investment decisions. This is still evident in research conducted in 2009, the findings of which are presented in this paper.

In addition to the above, Blichfeldt and Eskerod (2008) recognise that while PfM is critical to organization performance, many organizations do not perform well when it comes to PfM. Their observations reveal that despite efforts to practice PfM, organizations experience problems such as adequate allocation of resources to the right projects.

The Standard for project Portfolio Management (PMI, 2008), hereafter referred to as the PfM Standard, describes a portfolio as “a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives.” The PfM Standard goes on to state that “portfolio management includes the processes for identifying the organisational priorities, making investment decisions, and allocating resources” and that the organisation has a right to question any work being undertaken where the portfolio components are not aligned to the organisation’s strategy.

Comparing the observation by Maizlish and Handler (2005), Blichfeldt and Eskerod (2008), the findings of this research, and what the PfM Standard describes as project portfolio management, there is still a misalignment between PfM as it is described in literature (including normative and espoused theory [Crawford, 2006]) and practice. The goal of this paper, therefore, is to investigate the reasons for this misalignment between PfM theory and practice, providing insight into what the misalignment is, why it exists, and what the impact is thereof on organisational success. Two conceptual frameworks are used to illustrate the misalignment between theory and practice.

The value of this research is that it provides insight and assists in the development of knowledge in the area of PfM.

The remaining sections of the paper include:

1. A literature review that covers the concept of theory and practice
2. The research methodology and data collection
3. A theoretical framework for PfM based on the literature survey
4. A practice framework for PfM based on the results of the semi-structured surveys
5. The comparison between the theoretical and practice frameworks and the impact on organisational success
6. Conclusion

LITERATURE REVIEW

In this section, a description of theory (based on what is presented in literature) and practice (what is being done by practitioners in organisations), is presented.

The Concept of Theory

Koskela and Howell (2002) state that:

- A theory provides an explanation of observed behaviour, contributes to understanding, and provides a prediction of future behaviour.
- A theory, when shared, provides a common language or framework, through which the cooperation of people in collective undertakings, such as projects and organisations, is facilitated and enabled.
- A theory gives direction in pinpointing the sources of further progress and as a condensed piece of knowledge, empowers novices to do the things that formerly only experts could do.
- When explicit, testing the validity of the theory in practice leads to learning.

Similarly, the PfM Standard provides a common language or framework through a documented set of processes that provide individuals or organisations new to PfM the opportunity to begin using the generally accepted good practices without having to develop a unique set from start. Based on Koskela and Howell's (2002) definition of a theory, the PfM Standard serves as the theoretical basis for PfM for the purposes of this paper.

The Concept of Practice

Wenger (1999) describes the concept of practice as a result of collective learning that "reflects the pursuit of enterprises"—which he described earlier as being anything from ensuring physical survival to seeking lofty pleasures—"and social relations." Using the example of claims processors, he states that "the collective construction of a local practice ... makes it possible to meet the demands of the institution" and that the "claims processors make the job possible by inventing and maintaining ways of squaring institutional demands with the shifting reality of actual situations." He goes on to describe the concept of practice as "connot[ing] doing ... in a historical and social context that gives structure and meaning to what we do."

The above description is in essence the meaning of practice as it would relate to any discipline or context. For the purposes of this paper, practice is seen as those activities that are collectively performed by people that are focused on achieving the goals and targets of the organisation. These activities are therefore instrumental in yielding a predetermined result.

In the next section, the existence of a misalignment between theory and practice is elaborated upon.

Misalignment between Theory and Practice

Van de Ven and Johnson (2006) examined three ways in which a misalignment or gap between theory and practice can be framed. The three explanations presented can be summarised as follows:

- The gap between theory and practice is a knowledge transfer problem, with the assumption being that practical knowledge in a professional domain is derived, at least in part, from research knowledge. The problem is one of translating research knowledge into practice.
- *Theory and practice represent distinct kinds of knowledge. Each reflects a different ontology (claim) and epistemology (method) for addressing different questions and are therefore not expected to be fully aligned.*
- *Both theory and practice incorporate a strategy of arbitrage, i.e. the gap is a knowledge production problem. It is a question of how individuals and organisations develop the means for addressing complex problems within a very specific context.*

Van de Ven and Johnson (2006) observe that academic journals, such as *Academy of Management Journal*, the *British Journal of Management,* and the *Academy of Management Executive*, have highlighted growing concerns that the gap between theory and practice is widening as academic research becomes less useful for solving practical problems. They acknowledge the fact that professional knowledge workers are not developing awareness around relevant research and are criticized for not putting practice into theory. According to Van de Ven and Johnson (2006), this results in organisations not learning fast enough.

Van de Ven and Johnson (2006) also argue that the quality as well as the impact of research improves substantially when researchers do the following:

- Confront questions and anomalies existing in reality (practice)
- Organise the research project as a collaborative learning community of scholars and practitioners with diverse perspectives
- Conduct research that systematically examines not only alternative models and theories, but alternative practical formulations of the question of interest
- Frame the research and its findings to contribute knowledge to academic disciplines and to one or more domains of practice

For the purposes of this paper, PfM theory is represented through journal and conference papers, books, research reports, and, most recently, through the PfM Standard. The extent to which PfM is used in South African organisations was considered unknown before this research, as no literature could be found on it. In the absence of such knowledge, an investigation was conducted among organisations in South Africa to determine how PfM is practiced in comparison to the PfM Standard to determine the degree of alignment, thereby contributing to the South African body of knowledge in this domain.

In the next section, the research methodology and the data collection process that was used are discussed.

RESEARCH METHODOLOGY

In this research, an exploratory approach was adopted as no previous study could be found regarding the practice of PfM in South Africa. The aim of this study, therefore, was to investigate the extent to which PfM was being practiced relative to existing theory, look for patterns, ideas and hypotheses (Hussey & Hussey, 1997).

A qualitative research methodology was selected for this investigation. A qualitative study is defined as a process of inquiry aimed at understanding a social or human problem and is based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting (Creswell, 1994; Saunders, Lewis, & Thornhill, 2003). For this reason, semi-structured interviews were used as the research instrument.

Selection of the respondent sample

The researcher selected individuals of a particular profile, which included chief information officers (CIOs), senior IT managers, portfolio and program managers, and business division heads as these individuals were aware of or had experience with PfM principles in their respective organisations. This was important for the study as it set out to investigate the practice of PfM and not the individual's theoretical knowledge of the discipline.

Eighteen interviewees were initially identified to participate in this research. The minimum number of respondents is determined by whether or not new data are being acquired. In other words, the process of conducting further interviews should stop when the researcher finds that the respondents are giving the same or similar responses (Glaser and Strauss as cited in Shaw, 1999). The researcher proceeded to interview respondents until it was determined that no new information was being obtained. At this point, 22 respondents representing 15 organisations in 8 sectors had participated in the interview process.

Data Collection and Analysis

The literature survey was used to inform the development of a semi-structured interview instrument. Interviews were conducted with selected individuals from various large organisations in South Africa through which data was collected and analysed.

A literature survey is a systematic, reproducible process for identifying, obtaining, reading, evaluating, and interpreting the existing body of knowledge recorded by researchers, scholars, and practitioners (Fink, 1998 and Bordens & Abbott, 2002). Reviewing the literature is important in order to discover the most recent theorising regarding a subject and also aids in avoiding the researcher duplicating a previous study (Mouton, 2001).

Interviews are used to gather valid and reliable data that are relevant to the research objectives. The interview is a purposeful discussion between two or more people and provides a rich, detailed set of data (Saunders et al., 2003). Combining structured and unstructured questions appropriately is more advantages than using either structured or unstructured questions (Bordens & Abbot, 2002). Using interviews in an exploratory study helps to uncover what is happening in practice and seeks new insights through understanding the interviewee's perspective in greater detail (Robson, 2002).

The PfM Standard was primarily used in developing the questions for the interview instrument as it represented the most recent literature of PfM at the time of formulating the interview instrument. Further, the PfM Standard provides a documented set of processes recognised by the PfM community.

Interviews were conducted over a period of three months. Each interview was digitally recorded and later transcribed into a text document. The transcripts were then loaded into a Computer Assisted Qualitative Data Analysis Software (CAQDAS) tool called ATLAS.ti – version 6. The transcripts were coded through a process of re-reading the transcripts, identifying key concepts and statements, and labelling these using the CAQDAS tool, with descriptive codes. Codes were not developed before analysis but rather determined during analysis and based on what the interviewees said. Codes were then grouped into themes.

The next step was to determine the relationship among the themes. These relationships are represented in the practice framework. In order to have better understanding of the alignment between theory and practice, a comparison was made between the conceptual framework and the theoretical framework.

The next section discusses the theory and practice of PfM leading to the theoretical framework and the conceptual framework.

PROJECT PORTFOLIO MANAGEMENT – THEORY AND PRACTICE

Theoretical Framework

Wood, Kerr, and Brink, (2006) describe a theoretical framework as one whose variables have been studied before and have been found to be related to one another.

The theoretical framework illustrated here was based on the organisational context of portfolio management described the PfM Standard. Based on the PfM Standard, the following themes were extracted:

- *Vision, Mission and Organisational Strategy and Objectives illustrate the components used to set the organisation's performance targets.*
- *High-level Operations Planning and Management and Project Portfolio Planning and Management establish the distinct initiatives required to achieve the organisation's performance targets.*
- *Management of On-going Operations and Management of Authorized Programs and Projects correspond to performing activities to realize the organisation's performance targets."*

Figure 1 below uses the PfM Standard as foundation and modifying it by providing additional detail resulting in the theoretical framework for PfM.

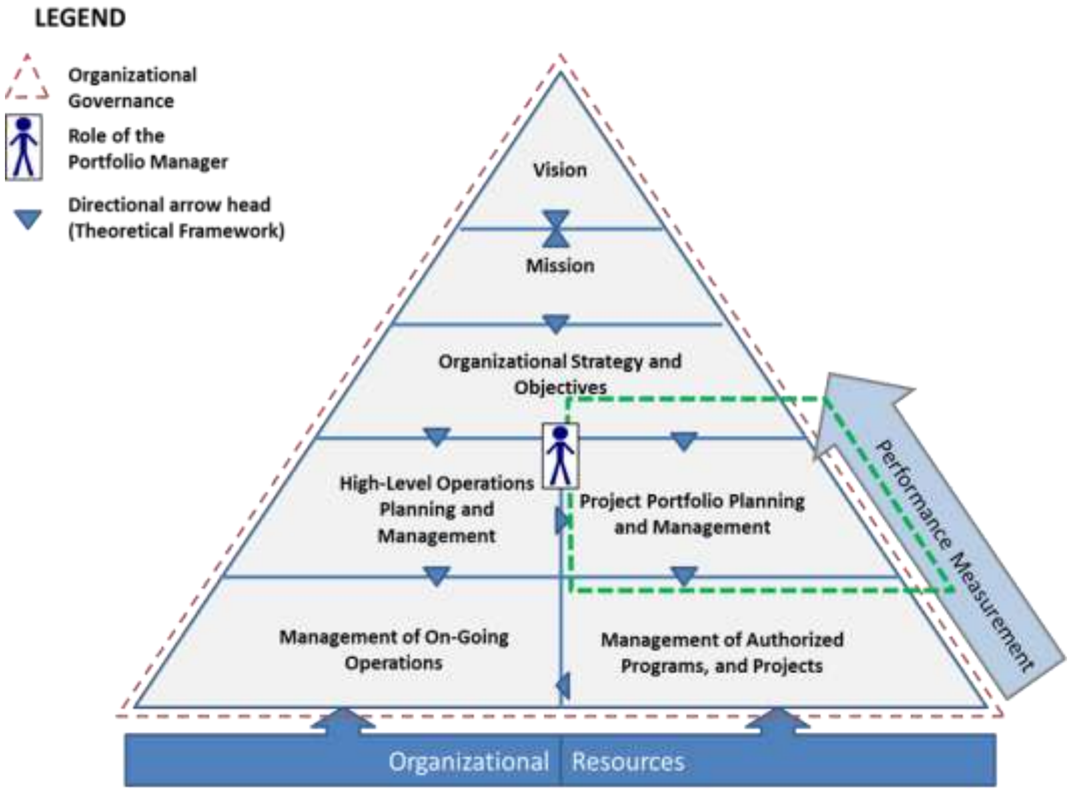
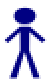
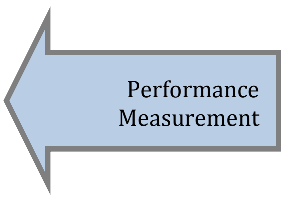


Figure 1. Theoretical Framework (modified from the Standard for Portfolio Management, 2nd edition) (PMI, 2008)

The following icons (elements) were added to the organisational context of portfolio management in the PfM Standard in order to make distinct the themes determined in the research. This was done to enable a comparison between the theoretical and practice frameworks later on.

	This indicates the areas where the portfolio manager is involved.		This represents governance at an organisational level which is overarching to portfolio management.		This illustrates that the benefits a project is intended to deliver must be tied back to the organisation strategy

The theoretical framework themes described:

1. Organisational Strategy

The organisational strategy is a result of the strategic planning cycle, where the vision and mission are translated into a strategic plan. The strategic plan is then subdivided into a set of initiatives.

2. Organisational Governance

According to the PfM Standard, “organisational governance establishes the limits of power, rules of conduct and protocols” of work that organisations can use to effectively advance strategic goals and objectives. Portfolio management is seen as a discipline within organisational governance and is both a framework and a management activity. As a framework, it provides a mechanism to translate strategy into a portfolio of initiatives, while as a management activity; it “ensures actualization of initiatives through the use of organisation resources”. (PMI, 2008)

Here the researchers wanted to determine the existence of a governing body which responsible for selecting initiatives as well as overseeing the performance of those initiatives.

3. Operations Management
Operational budget may be influenced by PfM decisions including allocation of resources to support portfolio components. Distinguishing work into project and non-project activities has a bearing on how budget and resources are allocated.

4. Organisational Impacts
PfM interacts with and impacts a number of organisational functions. The achievement of portfolio objectives may impact functional groups within an organisation and it is important to understand how this impact is managed.

5. Planning and Maintenance
The alignment process in the PfM Standard deals with the identification, categorisation, evaluation, selection, prioritisation, and authorisation of initiatives.

6. Role of the Portfolio Manager
The PfM Standard describes a portfolio manager as a senior manager responsible for (amongst other things) prioritising projects, measuring value to the organisation (benefits realisation), communicating portfolio performance to stakeholders, and reviewing project and program progress.

7. Performance Measurement/Metrics
These are the measures of strategic goal achievement, financial contribution, asset maintenance and development, end-user satisfaction, stakeholder satisfaction, risk profile, and resource capability.

The above themes served as the foundation for the development of the semi-structured interview instrument.

Practice Framework

In this section, the researchers give a summary of the findings from the semi-structured interviews followed by a conceptual framework that shows the relationships between the various components.

A summary of the responses follows and is based on what the majority of interviewees stated. The majority is based on more than seventy per cent of the respondent sample

Table 1: Summary of findings

Theory (Themes)	Comment / Observation
T1 Organisational Strategy	The direct translation of strategy into initiatives is not practiced.
	The process for selecting initiatives is flawed as focus is given to addressing the tactical needs of the organisation rather than the strategic needs.
T2 Organisational Governance	Governance bodies in the form of committees exist to make decisions regarding the selection of and budget approval for initiatives.
	The committees set up to perform the governance regarding budget approval for initiatives carry out their mandate as required by the respective organisations.
T3 Operations Management	The amount to be spent on initiatives in any given year is decided at a higher level than the designated portfolio manager. Finances are apportioned to different organisational divisions, which then fund the initiatives as they see fit. As a result, owing to a lack of ranking of initiatives across divisions, some initiatives in one division enjoy funding while other more important initiatives in another division are overlooked.
	Initiatives conducted as part of the ongoing operational activities are not included in the project portfolios.
T4 Organisational Impacts	A change management capability for individual projects and programs exists in organisations.
T5 Planning & Maintenance	The selection and prioritisation of initiatives according to strategically aligned criteria is achieved partially. Organisations do use criteria although strategic categories are not obvious.
	Every organisation attempts to manage resource allocation to initiatives but is constrained by the inadequate availability of sufficiently skilled resources. Different approaches are followed for allocating and managing resources.
	A significant change in strategic direction does not allow for new initiatives to be considered. While an initiative can be justified through a business case and the funds can be made available, the initiative is supported.
T6 Role of the Portfolio Manager	In organisations with a portfolio management role, the responsibilities are limited to fulfilling a line function role within a project management competency.
T7 Performance Measurement / Metrics	While benefits are specified in the business case, there is limited tracking of the achievement of the stated benefits.

From the detailed analysis of the data, a conceptual practice framework was developed.

Wood, *et al* (2006) describe a conceptual framework as an explanation that is informed by literature of how the themes in the study relate to each other and provide and explanation of why.

The following practice framework illustrates the relationships between the key themes based on the interview results. This highlights the misalignment between the PfM theory and practice. Following the practice framework is an elaboration on the main differences when compared to the theoretical framework with supporting quotes from interviewees (in italic font). Only the areas that differ from the theoretical framework are discussed.

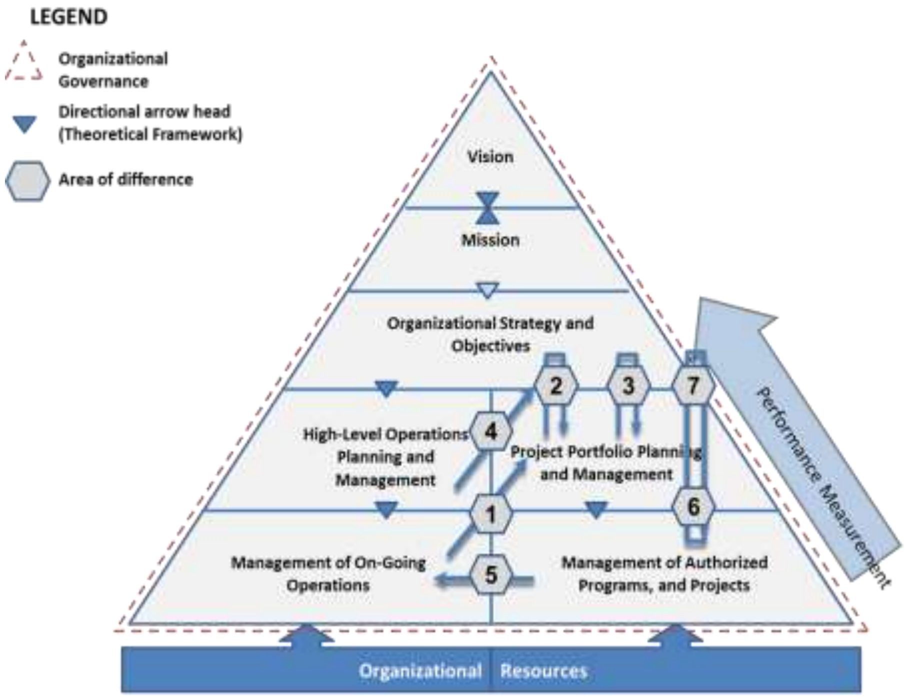


Figure 2. Practice Framework (modified from the Standard for Portfolio Management, 2nd edition) (PMI, 2008)

Origins of Projects

While the theory suggests that the organisation strategy and objectives are translated into initiatives which establish strategy and operational portfolios, in practice, there is a low correlation between strategy and identification of initiatives.

> *"So if you look at our collection of projects versus the strategic goals map, you'll find a low correlation."*

Only two organisations indicated using a top-down approach. Other organisations chose a bottom-up approach, that is, business division managers choose initiatives that address day-to-day needs such as meeting legislative and regulatory requirements, profitability needs, and system enhancements as their portfolio of projects. These are generally not driven by the strategy.

- ***Portfolio Composition***

The organisations represented in this study have 'investment' committees that decide the selection of initiatives / projects based on predefined criteria. They evaluate options, make trade-offs, and ensure the limited budget is allocated to the right projects.

> *"The selection is the responsibility of the business that we serve as IT and for that we have a committee to do the selection process"*

However, the number of approved projects / initiatives is determined by available budget as opposed to first determining the projects that advance strategy and then determining the required spend. This implies that the budget, instead of strategy, drives the portfolio mix. Nevertheless, the investment committees fulfil the governance role within the "project portfolio planning and management' function.

With regard to the operational project portfolio, it was found that in practice, the project portfolio tends to be made up of IT (information technology) related projects and not the recurring activities managed as operational projects as suggested by the *Standard*.

Portfolio governance

The prioritization criteria used by the respondent organisations reflect the desire to align projects with strategy, consider the available human and financial resource capacity, evaluate risk by assessing complexity, as well as address regulatory compliance and ensure a return on investment.

> *"First of all, in the strategic planning process, obviously we've changed from aggressive growth to a maintain position strategy and as a consequence we now needed to look at which projects would support a maintain strategy rather than aggressive growth."*

While it is important, for most organisations to align projects to strategy, this is only a validation / verification step. It does not ensure that the correct projects / initiatives were chosen in the first place, or that existing projects are adjusted (delayed or slowed down, stopped completely, or rescoped) to accommodate the new or amended strategy. By continuing the projects down the road of the original business case – which was supposedly based on the previous strategic objectives – implies further wastage of money and resources on a 'lost cause' project.

With regard to new proposals for projects, these are presented to the investment committee for approval and the governance process applied at the beginning of the year (point 1) is applied throughout the year for new proposals.

Portfolio Budget

The budget for initiatives for the coming year is determined by the investment committee. The funds are apportioned according to categories of projects or size of business division. One organisation applied a scorecard that ranked projects and allocated funds to projects according to their ranking.

> *"...into the last quarter of the preceding year, we will determine the budget pool for the following year and that budget pool is generally determined by a percentage of our net earned premium. … the pool of money then divided into three pots of money, and essentially the pots of money take care of strategic initiates, the other projects and the maintenance aspect of our spend. Operational aspects of our spend and once those pots are allocated then to draw money from those pots each strategic initiative goes through a prioritization process."*

> *"we would look at the strategy, and we would then just list what we thought the projects were. So we didn't care if we listed a hundred initiatives / projects as a result of the strategy. We then took each of those and put it through the scorecard, and the scorecard, as I said, would say how aligned is it to strategy, which area of the strategy it was aligned to …"*

In order to request funding, the operational areas submit their list of projects to the investment committee for approval and selection. If the head of the operational area or a representative on the committee can justify the projects strongly enough, the operational area will get the budget to run the projects.

> *"Annually, as dictated by the budgeting cycle, a process is run with each of the portfolios with their business counterparts to understand what projects would be required for the following year. There's a kind of self assessment within each portfolio to understand what projects should continue, what projects should stop, what new projects would be required, so there's a - each area gets their set together and then they take it to the* 'investment committee' *that makes a final selection. … the final selection is partly based on the allocation of the budget to each functional area."*

- ***Organisational Impact***

To manage the impact of commissioning projects, organisations employ change management processes within their projects. Change management is, however, done at a tactical level and not at a strategic level.

> *"So I think at a tactical level its fine, I think at the overall strategic impact level change managements not existent."*

The decisions regarding the number of initiatives and projects to be executed in an organisation in a particular period may also be dependent on the amount of change the rest of the organisation is willing or able to tolerate.

What appears to be missing is a consolidated view of the change the organisation is experiencing. In other words, while change through individual projects is managed, the total impact (sum of the individual projects) is not well understood.

> *"I think also where we've been quite weak is linking organisational change to the consequences of IT change so you implement a new system it changes peoples jobs, the processes, accountabilities, measurement, culture and you don't line it up with all the things that need to happen in the organisation so when IT people walk away, then they've implemented a project but they haven't, the bank hasn't been changed, and that in part explains why many things don't achieve what they set out to achieve."*

Role of the portfolio manager

It is evident from the responses that the role of the portfolio manager is not well understood. In some organisations there is a job title for a portfolio manager even though the responsibilities may be limited to managing project and portfolio managers as well as being responsible for the portfolio budget and facilitating the process within a portfolio regarding the identification of initiatives / projects.

Some organisations see the portfolio management responsibility being carried out by different management levels within the IT organisation – i.e. either by the CIO, Head of Project Office, or Program Managers

> *"The understanding was that a portfolio manager would work within an area of the organisation to understand the strategy of that area and then help define the necessary IT projects to deliver that strategy." … "In the model we've got is a portfolio manager. He effectively has responsibility over program and project managers (who) would retain responsibility for a project. … The responsibilities, for example, of the portfolio manager - I had responsibility across the budget for Credit, for appointing program and project managers, and ensuring that the program and project management methodology was met."*
>
> *"Program Manager is to deliver strategy, coordinate and prioritize resources across projects, to manage links between projects and to manage the overall cost and risk of a group of projects. Not to micromanage."*

The role of the portfolio manager in practice is limited to the "Project Portfolio Planning and Management" and "Management of Authorized Programs and Projects" functions.

Portfolio Performance Measurement

The benefits expected to be achieved as a result of implementing a project or initiative are indicated upfront in the business case in order to justify doing the project. Some organisations assess the achievement of those benefits post implementation but there wasn't any indication that the achievement of benefits (or lack thereof) were fed back to the investment committee or checked against the strategic objectives. Organisations don't have a way of tracking the impact of not achieving strategic objectives as a result of projects being delayed or not delivered or not realizing the anticipated benefit.

> *"Well I think that's one of the key issues around this and that is that I don't know how you measure the benefits because its always based on excel spreadsheet with somebody, sucked out of their thumb. And, I think what you can do is analyse the cost of the project quite accurately, normally you cant measure the income benefit, you cant manage the, measure the cost reduction benefit, you can do financial based calculations to show this, based on these assumptions, this is what the uptake would be and this is what the income would be and this is what the profits going to be. Or, based on assumptions of cost reductions its going to reduce cost by so much therefore this things going to pay back over such and such a period. It's always based on postulated benefits. So, is some of that put in, yes. Is it well done, no. Over time we do do a analysis of the cost of a project, if its more than the original number at a given level, it'll have to come back to the committee for re-approval and for extension of dates and all of that. And for the larger projects we do a post implementation revue to see whether the benefit that was calculated equalled what we actually got, and I've never seen one that met that original calculation. Not in 20 years of running IT."*

It is evident from the comparison between the theoretical and practice frameworks that a misalignment exists. Using Van de Ven and Johnson's (2006) three ways for framing a misalignment or gap between theory and practice, the following emerges:

1. *Knowledge transfer problem – This is a possible explanation as the majority of the interviewees did not know of the Standard.*
2. *Distinct kinds of knowledge – This would not be valid as the Standard was developed through consensus of practitioners for practitioners.*
3. *Knowledge production problem – This is a possible explanation as the Standard does not take the organisational context into consideration.*

CONCLUSION

The purpose of this paper was to investigate the degree of alignment between PfM theory and practice through the analysis of semi-structured interviews, providing insight into PfM.

As stated in the introduction, this study confirms that elements of PfM exist in most organisations. Knowledge of the practice of PfM in South Africa was limited and further investigation was necessary to develop a deeper understanding and contribution to the body of knowledge.

The five key findings of the research is summarised as follows:

- *The organisational strategy and objectives set the performance targets for the organisation and determine the initiatives that must be executed in order to achieve that strategy and, subsequently, move the organisation forward. However, organisational resources (financial and human) are consumed by initiatives addressing maintenance needs of the organisation. This suggests that organisations have the potential to be more successful if the utilization of resources were refocused towards addressing strategic objectives.*

- *Organisations tend to focus their attention on IT related initiatives and exclude operational activities from their portfolios. This is due to operational activities being budgeted for as part of the operating costs while IT projects are more easily quantified in terms of effort and cost estimation. The potential for inefficient utilisation of resources is higher in these organisations as there is no visibility of operational projects through the lens of PfM.*

- *The concept and role of change management, whether it is done by the portfolio manager or some other individual or team, is not explicitly covered by the PfM Standard. Nevertheless, organisations employ this function on their projects. As a communication and alignment 'vehicle', change management plays an important role at a strategic and portfolio management level.*

- *The role of the portfolio manager is limited in practice. Without the right level of authority, such an individual or team would find it difficult to carry out their mandate. In most organisations, this would be a completely new role at a senior level and would require the backing and support of executive level management.*

- *The achievement of the performance targets set by the strategic objectives must be measured in order to confirm the extent to which the organisation is progressing towards realising its strategy. Organisations do not have a way of tracking the impact of not achieving strategic objectives as a result of projects being delayed or not delivered or not realising the anticipated benefit.*

What has become evident is that there is a need for organisations to be able to determine the impact of PfM decisions on strategic objectives. Future research will focus on developing such a mechanism.

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17 APPENDIX G – Paper presented at PMI REC2012

PROJECT PORTFOLIO MANAGEMENT: USING FUZZY LOGIC TO DETERMINE THE CONTRIBUTION OF PORTFOLIO COMPONENTS TO ORGANIZATIONAL OBJECTIVES

(C.N. Enoch & L. Labuschagne, 2012)

Project Portfolio Management: Using Fuzzy Logic To Determine The Contribution Of Portfolio Components To Organizational Objectives

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Abstract

Organization success is dependent on the organization's ability to realise its objectives successfully. At a basic level, project portfolio management focuses the organization on doing the right projects and efficiently allocating resources to those projects. Selecting the right projects is not enough. It is also necessary to understand the individual and collective contribution of these projects to the organizational objectives so that decision making regarding portfolio balancing and the determination of gaps in meeting objectives is better informed. The complexity associated with this problem increases with the number of projects and organizational objectives as there is a many-to-many relationship between projects and organizational objectives. Fuzzy logic was investigated as a possible technique for representing this complexity. The article proposes a combined fuzzy model for determining the degree of contribution each project in the portfolio makes towards organizational objectives.

The research methodology followed a modelling approach and an application illustrating how the model would work is described towards the end of this paper. The value of such a model lies in the ability to make informed decisions based on the

relationship between projects and objectives. These decisions include cancelling, delaying or even changing projects in order to better meet the strategic objectives.

Key words: portfolio management; fuzzy logic; organizational performance; organizational objectives; modelling

Introduction

Earlier approaches to project portfolio management (PPM) were focused on categorizing the landscape of existing projects in organizations without paying much attention to driving strategy implementation (Berinato, 2001; Kersten and Verhoef, 2003; Ross, 2005; D'Amico, 2005; Jeffrey and Leliveld, 2004). Ward and Peppard (2004), however, 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 portfolio of projects available and required. Projects could now be categorized according to their business contribution.

Subsequently, authors have given increasing focus to the role of single project management in achieving portfolio efficiency (Martinsuo and Lehtonen, 2007), alignment of the project portfolio to corporate strategy, vertical integration and value creation through portfolio management (Thiry and Deguire, 2007), the translation of strategy into programmes and projects, organization performance and the role of the project/programme management office (Aubry, Hobbs and Thuillier, 2008), project portfolio control and performance (Müller, Martinsuo and Blomquist, 2008) and the influence of business strategy on PPM and its success (Meskendahl, 2010).

While many articles and books have been written on the topic of measuring organizational success, the contribution of projects and programmes to strategic objectives, and hence to organizational success, remains difficult to measure. Aubry, Hobbs and Thuillier (2008) observe in literature that project success, and by implication, portfolio and organization success, "is measured by the business objectives". They note that "there is no consensus on the way to assess the value of performance in project management" and that "the financial approach alone cannot give a correct measure of the value of project management for the organisation". They go on to state that project success "is a vague approximation and, as such, a rather imperfect system for measuring results" and suggest that new approaches are needed. Indeed, project success cannot only be measured by delivering on time and within budget, but in terms of portfolio management, success should be measured on the contribution the projects (individually and collectively) make in achieving the organizational objectives.

In determining the contribution of projects to organizational objectives, the researcher had to consider the quantitative and qualitative measures of assessment of projects and a form of reasoning that would be suitable to model such a system. The research process towards developing a solution for determining the degree of the individual and collective contribution of projects to organizational objectives involved assessing various approaches employed in portfolio management, such as multi-criteria utility theory (Stewart and Mohamed, 2002), but no approach could be found that addressed the problem directly. Fuzzy logic was identified as a possible approach to developing a model as it deals with approximate reasoning and degrees of truth values, and has the ability to handle numeric and non-numeric (linguistic) variables. This is important as the proposed model assesses the *degree* of contribution of projects. Fuzzy logic as a theoretical approach was examined. The application of fuzzy logic involved developing and testing various mathematical models until the model proposed in this paper was developed.

The remaining sections of this paper include a review of the literature, a description of the research approach, presentation of the proposed model as well as concluding remarks.

The Relationship between Strategy Definition and Strategy Execution

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 is supported by Kaplan and Norton (2008), who state, “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.” This emphasizes the need not only to link strategy and execution, but also to be able to assess the contribution of the components being executed to the strategy.

The Project Management Institute (2008) describes the process of translating the organization’s strategy into components that will be executed to achieve the strategy. In so doing, they begin to illustrate the need for project portfolio management.
According to the institute (Project Management Institute, 2008), 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 projects and programmes which, through their execution, ultimately achieve the organizational objectives. Projects, programmes and other work make up the portfolio and are therefore referred to as portfolio components. 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 in the following way:

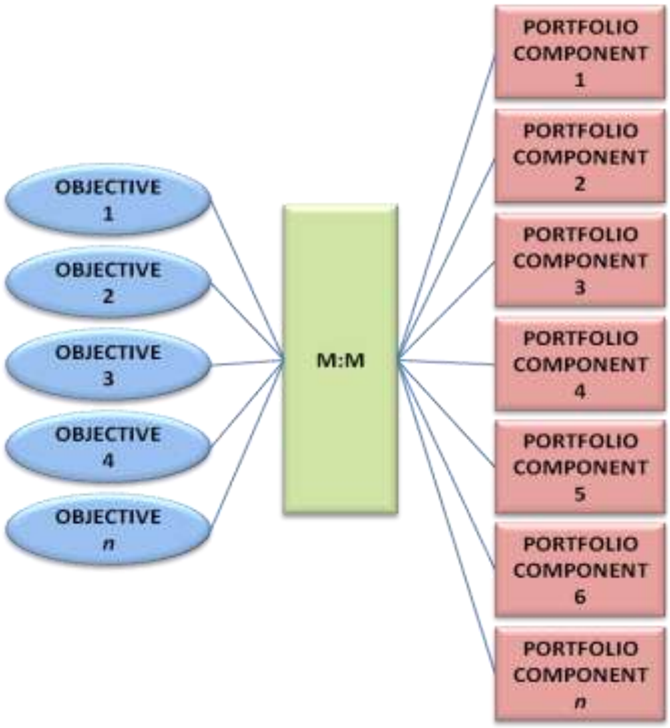

Figure 1: Many-to-many relationship between organizational objectives and portfolio components

In the figure above, 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 2, 3 and (n). The degree of contribution of each component varies from one to the other.

An alternate depiction of this relationship is given in figure 2.

		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 n					j

Figure 2: Relationship between organizational objectives and portfolio components

It is also important to understand the relationships between portfolio components. While PC1 and PC3 contribute to the achievement of objective 1, they do not necessarily have to be related to each other in 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 programme 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 figure 2, therefore 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 components to a single objective.

Understanding the degree of contribution of portfolio components to the achievement of organizational objectives aids the organization in also 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 in management 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 above, 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 100%, it may be necessary for the organization to consider doing additional portfolio components in order to close the gap and achieve the objective fully.

The challenge is in being able to quantitatively assess the individual and collective contribution of portfolio components to organizational objectives. In this paper, the researchers explore fuzzy logic as a means to do this.

Research Design

For this paper, modelling was chosen as the research approach. According to Egger and Carpi (n.d.), “modeling involves developing physical, conceptual, or computer-based representations of systems. Scientists build models to replicate systems in the real world through simplification, to perform an experiment that cannot be done in the real world, or to assemble several known ideas into a coherent whole to build and test hypotheses”. They suggest that as a research method, it is necessary to define the system that is being modelled. This involves determining the boundaries for the model as well as the variables and their relationships. Once a model is built it can be tested using a given set of conditions (Egger and Carpi, 2011).

Cooper and Schindler (2008) define a model as “a representation of a system that is constructed to study some aspect of that system or the system as a whole”. They point out that “models differ from theories in that a theory’s role is explanation whereas a model’s role is representation”. They further state that “a model’s purpose is to increase our understanding, prediction and control of the complexities of the environment”.

They also suggest that in business research, three types of models are typically found. These are descriptive, predictive and normative. Descriptive models are used more frequently to describe complex systems. Predictive models are used to forecast future events. Normative models are used for control – informing decision makers about the actions to be taken. The model described in this paper can be described as a predictive model as it can be used to predict the degree of contribution of portfolio components based on initial qualitative assessments.

Models are developed through the use of inductive and deductive reasoning. “Inductive reasoning allows the modeller to draw conclusions from the facts or evidence in planning the dynamics of the model. The modeler may also use existing theory, managerial experience, judgment, or facts deduced from known laws of nature … deductive reasoning serves to create particular conclusions derived from general premises” (Cooper and Schindler, 2008). In this instance, inductive reasoning was used in the development of the proposed model.

With regard to research model classification, the University of Southampton (n.d.) suggests that there is “no common agreement on the classification of research models” but proposes the following five categories:

- *Physical model: A physical model is a physical object shaped to look like the represented phenomenon, usually built to scale – such as small-scale versions of vehicles or buildings.*
- *Theoretical model: This generally consists of a set of assumptions about some concept or system; is often formulated, developed and named on the basis of an analogy between the object or system that it describes and some other object or*

different system; and it is considered an approximation that is useful for certain purposes.

- *Mathematical model: A mathematical model refers to the use of mathematical equations to depict relationships between variables. It is an abstract model that uses mathematical language to describe the behaviour of a system.*
- *Mechanical model: A mechanical (or computer) model tends to use concepts from the natural sciences, particularly physics, to provide analogues for social behaviour. It is often an extension of mathematical models.*
- *Symbolic interactionist model: This is generally a simulation model. That is, it is based on artificial (contrived) situations, or structured concepts that correspond to real situations. It is characterized by symbols, change, interaction and empiricism, and is often used to examine human interaction in social settings.*

The model proposed in this paper uses fuzzy logic and is therefore aligned with the mathematical model category. Cox (2005) states that fuzzy logic “from a modelling perspective, can represent such elastic and imprecise concepts as high risk, a long duration, a tall person, and a large transaction volume”, and that it “provides a way of finding the degree to which an object is representative of a concept or the degree to which a state is representative of a process”. He adds that “these degrees play a subtle but critical role in the evaluation of fuzzy models and fuzzy systems” in that “they represent not only the degree of membership in a concept … but such important modelling concepts as supporting evidence, numeric elasticity, and semantic ambiguity”. This paper proposes the use of a fuzzy logic model to describe the degree of contribution one or more portfolio components make towards achieving the organizational objectives. The model is described in more detail in the next section.

Proposed Fuzzy Model

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 proven to be very successful in a wide range of applications (Sowell, 2005).
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 (Sowell, 2005).

The use of fuzzy logic in research related to PPM is also gaining popularity. At the time of writing this paper, a number of articles on the use of fuzzy logic had been written on the area of project selection (Laarhoven and Pedrycz, 1983; Chen and Gorla, 1998; Machacha and Bhattacharya, 2000; Wang and Hwang, 2005; Huang, Chu and Chiang, 2006; Chen and Cheng, 2009). This paper focuses on quantitatively assessing the contribution of those selected projects to organizational objectives. In order to comply with the submission requirements for this paper, the researcher chose to place a more detailed description of *the fuzzy logic process* in the appendix. In addition, authors such as Earl Cox (1995) have written numerous books on the application of fuzzy logic.

The relationships between organizational objectives and portfolio components make up a complex system. “A complex system is a system (whole) comprising of numerous interacting entities (parts) each of which is behaving in its local context according to some rule(s) or force(s)” (Caldart and Ricart, 2004). Earlier, Baccarini (1996) proposed that “project complexity be defined as consisting of many varied interrelated parts and can be operationalized in terms of differentiation and interdependency”. He later described types of complexity as being organizational (vertical and horizontal differentiation as well as the degree of operational interdependencies) and technological (the transformation processes which convert inputs into outputs).

The relationships among portfolio components, the integration and interdependency between portfolio components, and the varying degrees of contribution add to the complexity of the total system of portfolio components and organizational objectives.

Complex business systems are built around multiple fuzzy models representing the combined intelligence of several experts (Cox, 1995). A combination of multiple fuzzy models is required to address the problem of representing portfolio component contribution to strategic objectives. The reason for using multiple models 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 entered into the model, the rules are applied 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 and then applying defuzzification to produce a crisp value that represents the quantitative contribution of portfolio components to objectives.

Combining fuzzy models tends to increase the overall information entropy (disorder and loss of information) associated with the entire system. To maintain the information in the complete system, the combination of solution fuzzy regions using the additive aggregation method before defuzzification is used (Cox, 1995).

Figure 3 below describes the total system or model being proposed. In the figure, stages A and B represent separate fuzzy models which are combined to form a single conceptual fuzzy logic model.

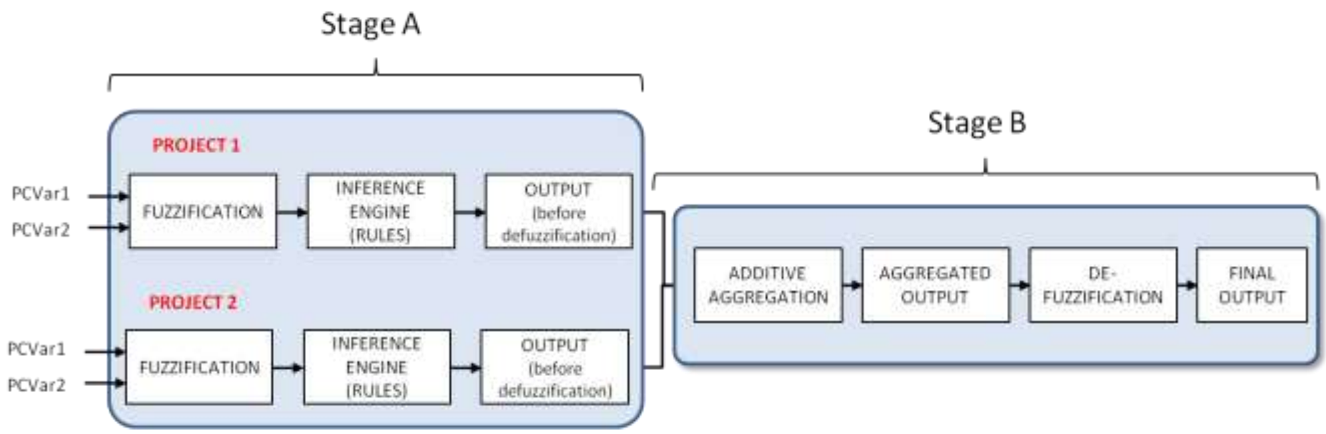

Figure 3: Combined fuzzy logic model

The model is described in more detail in the following sections.

Stage A

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. The output variable (contribution) is qualified by the values *very low, low, moderate, high* and *very* *high*. Membership functions are used in the fuzzification process to quantify a linguistic variable value.

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.

The process for stage A of the fuzzy model is illustrated in figure 4, followed by an explanation of the steps involved.

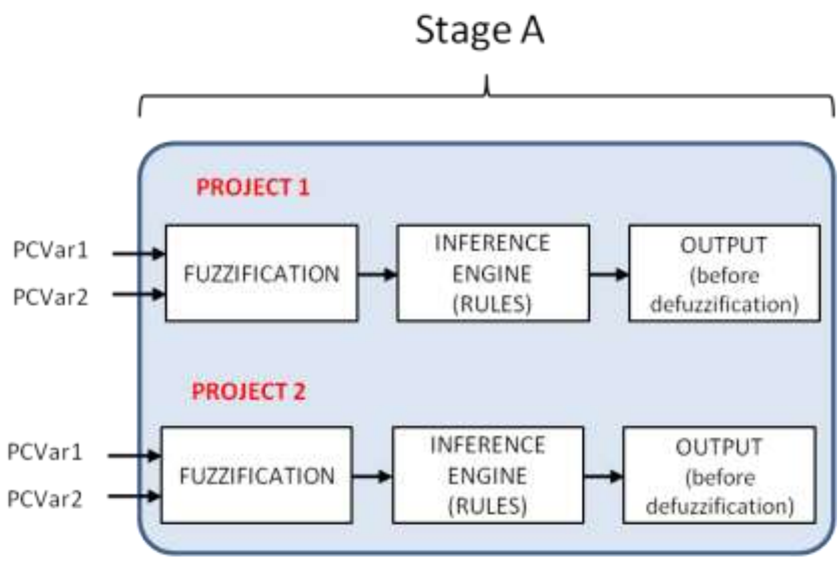

Figure 4: Illustration of stage A of the combined fuzzy model

Phase 1 - Input Variables

For the purpose of illustrating the model, only two input variables are used. In a typical organization, a group of portfolio management 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 below.

1. 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 cost, contribution to profitability and the component's growth rate (Deng and Wibowo, 2009; Ghasemzadeh and Archer, 2000; Santhanam and Kyparisis, 1995).

2. Portfolio Component Variable 2 (PCVar2)

In this example PCVar2 represents 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 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 5 and 6, respectively.

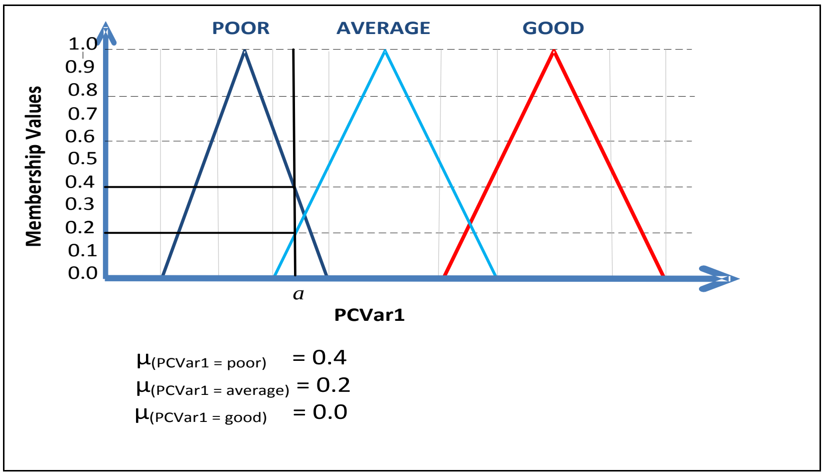

Figure 5: PCVar1 - Value

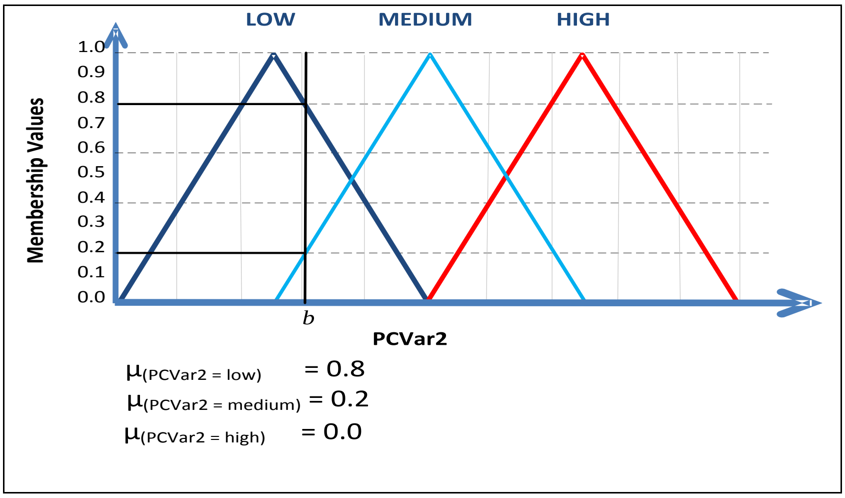

Figure 6: PCVar2 - Durability of competitive advantage

In figures 5 and 6, the x-axis represents the domain and the y-axis represents the membership values.

The 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 definition of the membership functions would be done by the portfolio management experts in the organization in accordance with their knowledge and experience in portfolio management and the organization. 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 modelled 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 5) and PCVar2 (represented by 'b' in figure 6), and determine the degree to which these inputs belong to each of the respective membership functions. In an organization, the portfolio management experts would evaluate the PCVar1 of a portfolio component and determine to what degree it is *poor*, *average* or *good*.

As an example, in figure 5, this is represented by the dark bold vertical line which intersects 'POOR' at a membership value of 0.4 and 'AVERAGE' at a membership value of 0.2. In other words, PCVar1 is assessed as being poor to a degree of 0.4 as well as average to a degree of 0.2 simultaneously.

Similarly, the portfolio management experts would evaluate PCVar2 of the same portfolio component and determine to what degree it is *low*, *medium* or *high*. In figure 6, the dark bold vertical line intersects 'LOW' at a membership value of 0.8 and 'MEDIUM' at a membership value of 0.2. In this example, the input variable PCVar2 is assessed as being low (to a degree of 0.8) as well as medium (to a degree of 0.2) simultaneously.

Phase 3 - Inference Engine

A number of rules are determined by a knowledgeable group of individuals in the organisation 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 number of rules for a system with two input variables, each having three values, is nine. A system with four variables, each having three values, would have 81 or 3^4 rules. The Mamdani style of inference is used here (MathWorks, 2011). The Mamdani method is the most commonly used fuzzy inference technique and was among the first control systems built using fuzzy set theory.

The following rules were applied to the input variables in the inference engine:

Rule 1 If PCVar1 is *Poor* AND PCVar2 is *High*, THEN Contribution is *Moderate.*

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 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 6 If PCVar1 is *Average* AND PCVar2 is *Low*, THEN Contribution is *Low.*

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.*

Rule 9 If PCVar1 is *Good* AND PCVar2 is *Low*, THEN Contribution is *Moderate.*

Table 1: Fuzzy rules

Rule Evaluation

The next step in the fuzzy logic process is to take the fuzzified inputs (for the above example these would be: $\mu_{(PCVar1 = poor)} = 0.4$, $\mu_{(PCVar1 = average)} = 0.2$, $\mu_{(PCVar2 = low)} = 0.8$ and $\mu_{(PCVar2 = medium)} = 0.2$), 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 portfolio management 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 also 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. The following matrix represents the knowledge base associated with the rules described in table 1.

		PCVar2		
		Low	Medium	High
PCVar1	Poor	Very Low	Low	Moderate
	Average	Low	Moderate	High
	Good	Moderate	High	Very High

Table 2: Knowledge base associated with fuzzy rules

How the Rule Base Works

The next step is to compute the degree of membership to the membership functions (VeryLow, Low, Moderate, High or VeryHigh) 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 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 5 and 6 as well as tables 1 and 2, input (a) for PCVar1 has a membership degree of 0.4 to the membership function 'POOR' which applies to rules 1, 2 and 3 (table 1), and a membership degree of 0.2 to the membership function 'AVERAGE' which applies to rules 4, 5 and 6. Similarly, input (b) for PCVar2 has a membership degree of 0.8 to the membership function 'LOW' which applies to rules 3, 6 and 9, and a membership degree of 0.2 to the membership function 'MEDIUM' which applies to rules 2, 5 and 8. When a rule is totally satisfied (indicated by ✓ in figure 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:

Rule 2 **IF** PCVar1 is *Poor* (degree of 0.4) **AND** PCVar2 is *Medium* (degree of 0.2), **THEN** Contribution is *Low* (degree of 0.2) ... the lowest degree among the inputs.

Rule 3 **IF** PCVar1 is *Poor* (degree of 0.4) **AND** PCVar2 is *Low* (degree of 0.8), **THEN** Contribution is *Very Low* (degree of 0.4).

Rule 5 **IF** PCVar1 is *Average* (degree of 0.2) **AND** PCVar2 is *Medium* (degree of 0.2), **THEN** Contribution is *Moderate* (degree of 0.2).

Rule 6 **IF** PCVar1 is *Average* (degree of 0.2) **AND** PCVar2 is *Low* (degree of 0.8), **THEN** Contribution is *Low* (degree of 0.2).

Table 3: The satisfied rules

Figure 7 below 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 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 red (vertical) lines indicate the points of intersection on the relevant membership functions associated with the membership values for each input variable.

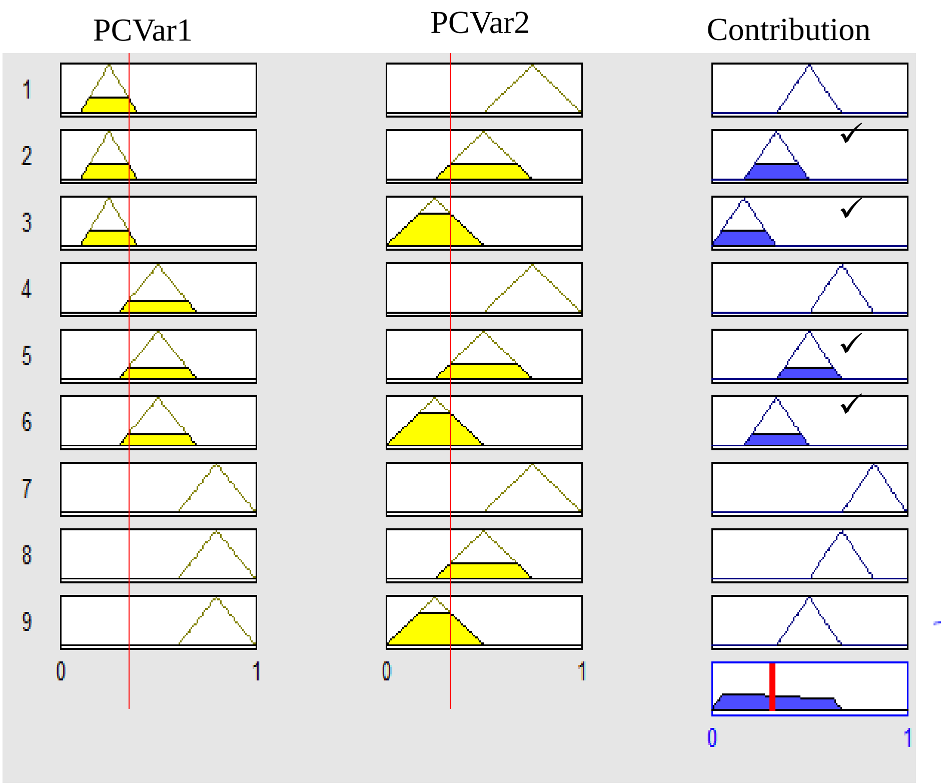

Figure 7: Rule view

How the output values are derived is described in the next section.

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 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.

Referring to figure 8, the shading in the triangles indicates if there is a degree of membership.

For the membership function '**VeryLow**' the degree of membership is 0.4 (based on the result of rule 3 in table 3).

For the membership function '**Low**' the degree of membership is 0.2 (based on the higher result of rules 2 and 6 in table 3).

For the membership function '**Moderate**' the degree of membership is 0.2 (based on the result of rule 5).

For the membership function '**High**' the degree of membership is 0.

For the membership function '**VeryHigh**' the degree of membership is 0.

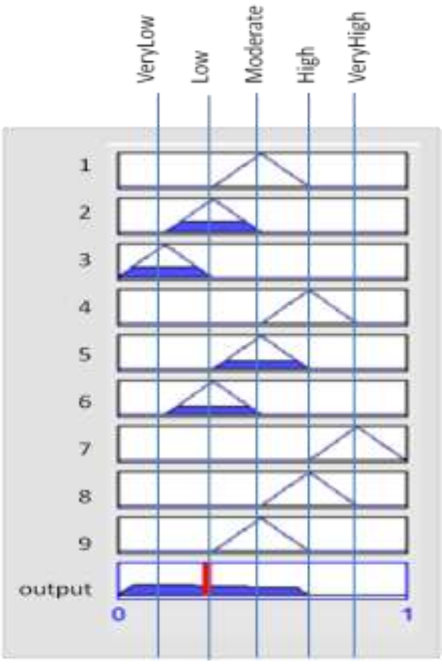

Figure 8: Output of rules

To calculate the quantitative contribution of a single portfolio component with two input variables, the aggregated output must be defuzzified in order to get a single output value. The most popular defuzzification method is the centroid method (Cox, 1995), which returns the centre of the area under the curve labelled ‘output’ in figure 8.

Mathematically this centre of gravity (COG) can be expressed as:

$$\mathrm{COG} = \frac{\int_{a}^{b} \mu_A\,(x)x\,dx}{\int_{a}^{b} \mu_A\,(x)x\,dx}$$

where *COG* is the defuzzified output, $\mu_i(x)$ is the aggregated membership function and x is the output variable. In this example, the output value 0.278 represents the contribution of the portfolio component to an objective. An output value of 1 would imply that the objective is fully achieved (100%); hence, the output value in this example (0.278) indicates that the portfolio component contributes to the objective to a degree of 27.8%.

This implies that if this was the only portfolio component selected to achieve an organizational objective, then only 27.8% 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 or all of the 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

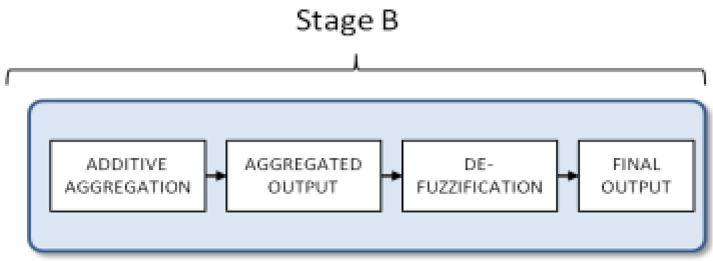

Figure 9: Stage B of the combined fuzzy model

Phase 5 - Additive Aggregation

The aggregation in stage A above 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.

In order 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. Using the bounded sum method (Cox, 1995), 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 (Cox, 1995). Figures 10(a-d) 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. (For a detailed explanation of aggregation and implication techniques, refer to Cox (1995), Chapter 2).

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

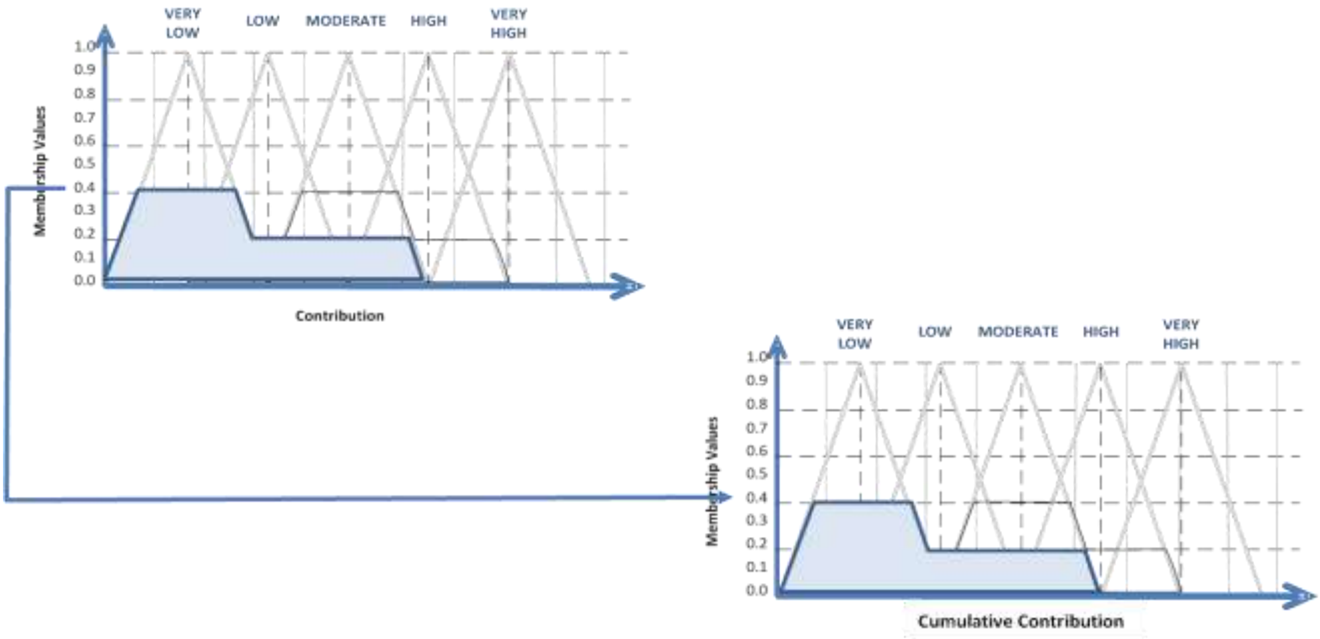

Figure 10a: Additive aggregation – first portfolio component

For the second portfolio component (figure 3), 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 the output membership value is equal to 1 for the membership function 'high'. The figure below shows how the second output is added to the final output (solution fuzzy region).

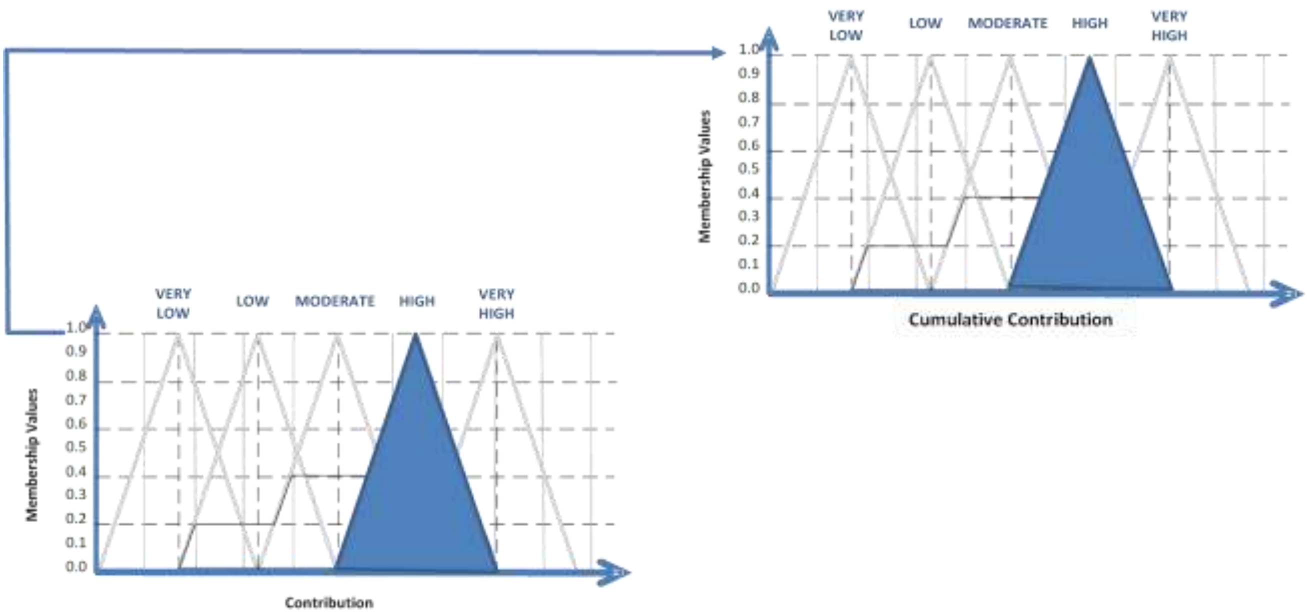

Figure 10b: Additive aggregation – second portfolio component

The combined output of both portfolio components is illustrated in the following figure:

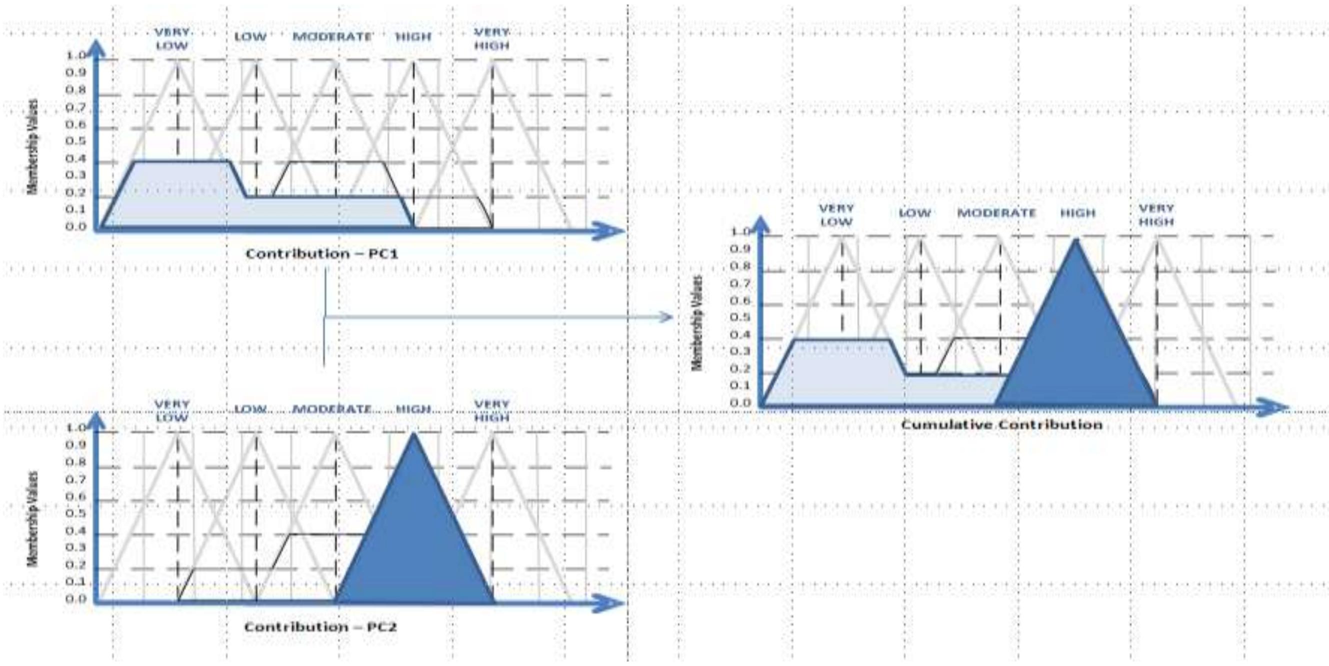

Figure 10c: Additive aggregation – combining both portfolio components

To summarise, figure 10a showed the addition of the consequent fuzzy set for portfolio component 1 being added to the final output region (cumulative contribution). Figure 10b showed the addition of the consequent fuzzy set for portfolio component 2 being added to the final output region. Figure 10c showed the combined view of figures 10a and 10b.

Phase 6 - Aggregated Output

The aggregated output, also known as the solution fuzzy region, is illustrated in figure 10d.

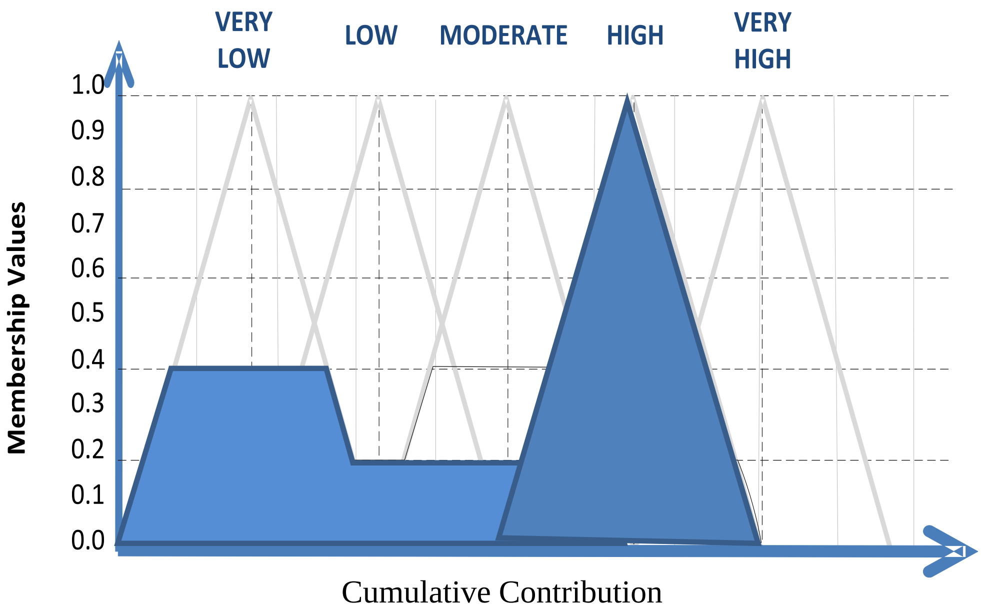

Figure 10d: Aggregated output

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

- *The membership function VeryLow has a membership value of 0.4.*
- *The membership function Low has a membership value of 0.2.*
- *The membership function Moderate has a membership value of 0.2.*
- *The membership function High has a membership value of 1.0.*
- *The membership function VeryHigh has a membership value of 0.0.*

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 inference process is defuzzification. Fuzziness 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. There are several defuzzification methods, but the most popular one is the centroid technique (Cox, 1995). It finds the point where a vertical line would slice the aggregate set into two equal masses. This is represented by the vertical red line in figure 11.

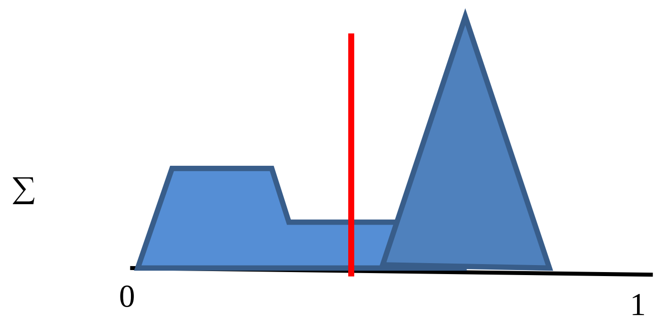

Figure 11: Aggregated fuzzy output

Phase 8 - Final Output

As described above, the application of the centroid technique (Cox, 1995) results in a quantitative value. In this instance, the centroid technique 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 0.448, implying that the cumulative contribution of the two portfolio components is 44.8% of the objective. This would mean that if these were the only portfolio components considered for achieving this objective, the organization would fail in doing so.

Interpretation and Utility of the Model

From the above 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, i.e. 100%. This is indicated by the fact that the degree of contribution is not equal to 1. There is still potential for additional portfolio components to be added in order to achieve the objective fully. Alternatively, the scope of the selected portfolio components could be amended such that their contribution can be improved towards 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 making better informed decisions. For example, if the organization, due to budget constraints, wants to determine which portfolio component can be stopped, 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 stopped.

Conclusion

Organization success is dependent on the organization's ability to realise its objectives successfully. At a basic level, portfolio management focuses the organization on doing the right projects and efficiently allocating resources to those projects. Selecting the right projects is not enough. It is also necessary to understand the individual and collective contribution of these projects to the organizational objectives so that decision making regarding portfolio balancing and the determination of gaps in meeting objectives is better informed.

Previous research has revealed that there is a lack of understanding of the link between portfolio management and organizational objectives. Decisions regarding the portfolio and its components are made subjectively and the implications of the decisions for the organizational objectives are not fully understood.

The degree of contribution of portfolio components to organizational objectives is an important aspect of project portfolio management as it brings us closer to ensuring organization success through the successful execution of the right components. The model proposed in this paper can assist organizations in determining gaps in terms of components required to achieve organizational objectives as well as aid in the decision making regarding the portfolio composition when confronted with imposed constraints such as a reduction in budget.

The fuzzy logic model assists with the subjective evaluation of portfolio components in terms of criteria relevant to individual organizations. The model proposed here addresses the complexity of the problem by combining fuzzy models and allowing the assessment of a variable number of components. In addition, the model can be expanded to incorporate additional input variables should an organization choose to do so.

While the MATLAB tool was used to illustrate the model using two portfolio components, the need for a new tool or enhancements to existing tools has been identified to harness the true potential of the model, enabling easier input of portfolio component evaluations, allowing for additional criteria and enabling the simulation of outcomes of decisions regarding the portfolio components. For example, if it is decided to stop a portfolio component due to resource constraints, such a tool would need to illustrate in a dashboard format the implications of the decision on the achievement of the objectives to which the component contributes.

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18 APPENDIX H – Journal article

PROJECT PORTFOLIO MANAGEMENT: A MODEL FOR IMPROVING DECISION-MAKING

C.N. Enoch & L. Labuschagne (2013)

To Be Submitted to International Journal of Project Management

Improving project portfolio management decision-making using a fuzzy logic approach

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Abstract

The recent global economic crisis and the compliance and regulatory requirements imposed on organisations have heightened the importance of decision-making when it comes to project investments. To successfully manage the project portfolio and ensure that the achievement of organizational objectives are maximised, a model to enable better decision-making when managing the portfolio is required. Earlier approaches to project portfolio management (PfM) were focused on categorising the landscape of existing projects and programmes in organisations without paying much attention to driving strategy implementation or the importance of decision-making when managing the portfolio. This paper considers the many-to-many relationship between portfolio components and organizational objectives and proposes a conceptual model using fuzzy logic as a technique for determining the individual and cumulative contribution of projects and programmes (portfolio components) to the achievement of organizational objectives, enabling better decision-making when determining which components to accelerate, suspend or terminate.

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Key words: portfolio management; fuzzy logic; organizational performance; organizational objectives; modelling; portfolio components

Introduction

Organisation success depends on the organisation's ability to realise its objectives. This is achieved through the successful delivery of the right projects, programmes and operational activities (portfolio components) within the organisation (Jonas 2010; Meskendahl 2010; Voss 2012). Project portfolio management, at a fundamental level, focuses the organisation on doing the right portfolio components, as well as allocating scarce resources appropriately (Cooper, Edgett & Kleinschmidt, 2000; Blomquist & Müller, 2006; Ibrahim, 2011; Rayner & Reiss, 2012; Project Management Institute, 2013). Until now, the primary focus in project portfolio management has been on the selection and prioritisation of projects and programmes (Petit & Hobbs, 2012); however, merely choosing the right portfolio components is not enough as decisions made during the management of the portfolio could negate the effort in setting up the portfolio. Instead, the focus needs to shift towards finding ways to ensure that the right decisions are made with regard to portfolio components such that the portfolio and, ultimately the organisation succeeds (Meskendahl, 2010).

Poor decision-making will result in poorly managed portfolios leading to poor portfolio and organisation performance. When an organisation is faced with factors such as a change in circumstance, like the recent global economic downturn (New York Times, n.d.; United Nations, n.d.), or a focus on corporate governance, for example, it has to become more responsible with its decision-making related to portfolio components (Institute of Directors Southern Africa, 2009; Marnewick & Labuschagne, 2011). Decisions regarding which portfolio components to suspend, progress, or terminate must be made in order to keep the portfolio optimised (Project Management Institute, 2013). Not terminating components when faced with budget constraints, results in resources remaining engaged in components impacts the delivery of all components and, ultimately, the achievement of organizational objectives. The goal of this article, therefore, is to propose a mechanism to enable better decision-making when it comes to managing the project portfolio – post the selection of portfolio components.

The objectives of this article, are to first, describe the relationship between organizational objectives and portfolio components; second, to show how the individual and combined contribution of portfolio components to organizational objectives are calculated using the model presented in this article; and third, to demonstrate how the portfolio component contribution can be used in the decision-making process.

The remainder of this article discusses the problem associated with poor decision-making in project portfolio management (PfM); the relationship between organizational objectives and portfolio components; proposes a conceptual model (C.N. Enoch & Labuschagne, 2012) as a solution; and discusses the value of the model to organisations.

Literature review

PfM decision making

According to (Project Management Institute, 2013:5), PfM is “the coordinated management of one or more portfolios to achieve organizational strategies and objectives”. The *Standard* goes on to state that PfM “provides the opportunity for a governing body to make decisions that control or influence the direction of a group of portfolio components as they work to achieve specific outcomes”. The governing body mentioned in the *Standard*, is sometimes referred to as a “Investment Committee”, “Strategic Initiatives Committee”, “Change Council”, “PRIORC Committee” (C.N. Enoch & Labuschagne, 2010a) or “Portfolio Review Board (PRB)” (Killen, 2012). For the purpose of this article, the term Project Portfolio Investment Committee (PPIC) will be used.

The responsibilities of the PPIC include shaping the portfolio by determining which components (projects, programmes, operational activities) should make up the portfolio, making trade-offs between components, tracking progress of individual components, ensuring portfolio budget is appropriately apportioned and utilized (C.N. Enoch & Labuschagne, 2010a). PfM “provides a high-level strategic perspective that enables organizations to identify and respond to trends and opportunities” and “ decisions require consideration of multiple factors and the ability to envision alternative future consequences of project decisions across a portfolio” (Killen, 2012:2).

From an investigation into the practice of PfM, it was found that “the selection, prioritization, and authorization of initiatives are left to the subjective defense” (C.N. Enoch & Labuschagne, 2010a) of the PPIC. This has negative consequences for the organisation if it cannot determine the impact of those decisions on the achievement of its objectives (C.N. Enoch & Labuschagne, 2010b, 2012).

Killen (2012) observes that management decisions often consider multiple criteria and large amounts of data. She points out that PfM decision making is especially challenging due it complex and dynamic nature. She suggests that due to cognitive limitations of human decision makers, visual techniques can be used to compensate and improve decision making capability. Enoch and Labuschagne (2012) add that to ensure effective PfM decision-making, the decision makers must consider the individual and cumulative contribution of portfolio components to organizational objectives. Further, a mechanism is required to consider the qualitative evaluation of multiple criteria related to individual components and determine the quantitative degree of contribution so that the PPIC can be presented with data enabling them to make better informed decisions and understanding the impact on the achievement of organisational objectives. This prompted the move in this research towards developing a model that would enable better PfM decision-making.

Research Methodology

Modelling

A model is usually constructed because it is easier to comprehend or manipulate than the real thing. (Olivier, 2004) states that models are often used to propose a new idea or concept. He suggests that modelling as a research methodology is used to provide simplicity, comprehensiveness, generality, exactness and clarity.

According to (Egger & Carpi, n.d.), "modelling involves developing physical, conceptual, or computer-based representations of systems. Scientists build models to replicate systems in the real world through simplification, to perform an experiment that cannot be done in the real world, or to assemble several known ideas into a coherent whole to build and test hypotheses". They suggest that as a research method, it is necessary to define the system that is being modelled. This involves determining the boundaries for the model as well as the variables and their relationships. Once a model is built it can be tested using a given set of conditions (Egger & Carpi, n.d.).

The next section discusses the relationship between portfolio components and organizational objectives.

The 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 organisations could achieve. This is supported by (Kaplan & Norton, 2008:1), who state, "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". This implies that the strategy definition and strategy execution must support each other. The organisation's vision, mission, values, strategy and operational requirements (known as organizational objectives) are translated into one or more portfolios of components that must be executed within an agreed timeframe and according to agreed requirements in order to deliver the outcomes expected by the organizational objectives (Harvey A. Levine, 2005; Maizlish & Handler, 2005; Project Management Institute, 2013).

Linking the organisation'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 in the following way:

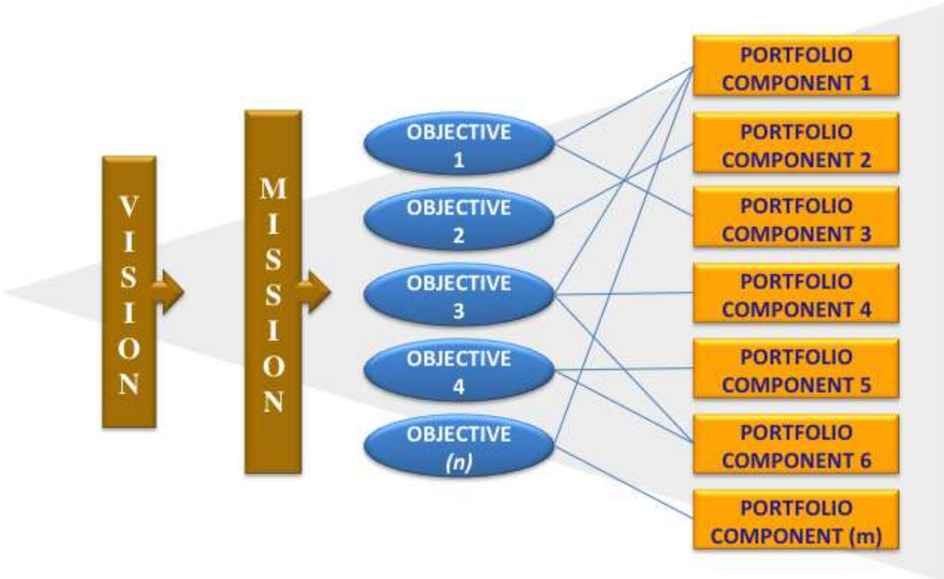

Figure 18.1: Many-to-many relationship between organizational objectives and portfolio components (Adapted from Enoch & Labuschagne (2012)**).**

In Figure 18.1 above, each portfolio component (PC) contributes to one or more objectives. For example, PC1 contributes towards achieving objectives 1, 3 and (n). PC3 also contributes to the achievement of objective. PC2 contributes towards achieving objective 2, and objective 4 could be achieved by components 5 and 6. However, the degree of contribution of each component varies one from the other.

The evaluation of how much a component contributes to an objective can be quantitative or qualitative in nature. Decision-makers prefer to use linguistic terms (words from a natural language instead of numerical values), such as ‘Low’, ‘Medium’, and ‘High’, to evaluate component contribution. To illustrate this, Figure 18.2 uses Harvey balls - partly shaded circular ideograms (free dictionary) to show the degree of contribution of each component to the respective objective(s). For example, the contribution of PC1 to objective 1 can be described as ‘high’ when compared to its contribution to objectives 3 and (n). A Harvey ball that is almost completely shaded illustrates this. Similarly, the contribution of PC1 to objective 3 is ‘low’ while its contribution to objective (n) can be described as ‘medium’ – illustrated by a half-shaded Harvey ball

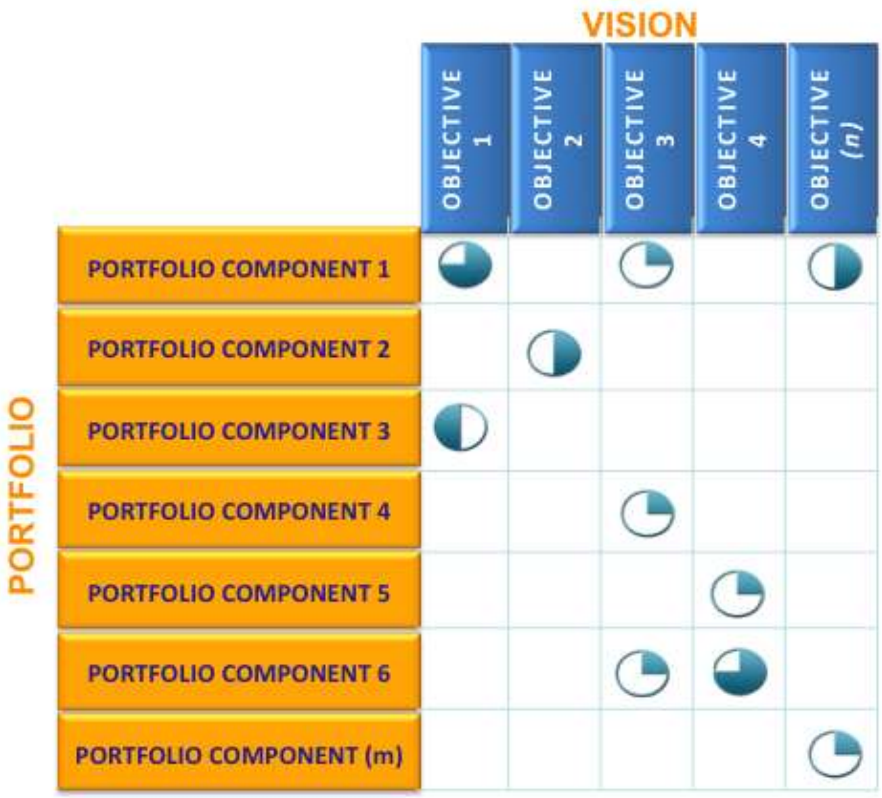

Figure 18.2: Relationship between organizational objectives and portfolio components (Adapted from Enoch & Labuschagne (2012)**).**

Understanding the degree of individual and cumulative contribution of portfolio components to the achievement of organizational objectives aids the organisation in also understanding the impact of decisions made in relation to those components. The calculation of the cumulative contribution of multiple components to a single objective is not merely a summation of the individual contribution values as the combined evaluation of criteria is considered in determining the cumulative contribution value.

In practice, decisions regarding portfolio components are left to the subjective defence of a few decision-makers (C.N. Enoch & Labuschagne, 2010a). If these decision-makers have incomplete information or are unable to determine the consequence of their decisions before they are made, then the result for the organisation is poor performance and wastage. For example, if there is a change in circumstances such as a reduction in the available funds for portfolio components, the organisation can choose to stop or slow down components based on their contribution to organizational objectives. To do this, decision-makers need to have an understanding of the cumulative contribution of components. In practice, organisations tend to evaluate options, and make trade-offs based on available funds (C.N. Enoch & Labuschagne, 2010b); however, this is done without an understanding of the impact on the achievement of objectives.

In literature, methods such as AHP - Analytical Hierarchy Process (Saaty, 1980), scoring, and ranking are proposed for evaluating portfolio components, but these have limitations according to (Chen & Cheng, 2009). The issues associated with such methods is that first, they do not take the qualitative evaluation of components and convert them into quantitative values but rather force the decision-makers to choose a quantitative value. Second, components are compared against each other rather than evaluating them in terms of their individual or cumulative contribution to organizational objectives.

To effectively compare components, quantitative values must be derived. The challenge is in converting the qualitative evaluations into quantitative values. A mechanism for deriving or computing the *cumulative* contribution of portfolio components is required. To address these requirements, a technique is needed 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 (Cox, 1995) would be a suitable technique to use in the conceptual 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 sections.

Fuzzy Logic overview

Lotfi Zadeh introduced Fuzzy Logic in 1965 in a chapter entitled “Fuzzy sets” in the journal *Information and Control* (Zadeh, 1965). The theory of fuzzy logic has advanced in concepts and application over the decades. Fuzzy Logic is a technique that can take subjective information and make it more objective and has proven to be very successful in a wide range of applications (Ma, Lu, & Zhang, 2010; Sowell, 2005). The various disciplines in which fuzzy logic has been used successfully include, but are not limited to, engineering (Mendel, 1995); decision support (Lin & Hsieh, 2004); artificial intelligence, genetic algorithms (Cox, 2005); and capital budgeting (Karanovic & Gjosevska, 2012); control theory (Birle, Hussein, & Becker, 2013).

A fuzzy logic system receives an input and delivers either a fuzzy set or a crisp value as an output. It contains four components: a rule set, a fuzzifier, an inference engine and a defuzzifier. Rules may be provided by experts or can be extracted from numerical data. The rules are expressed as a collection of IF-THEN statements. These statements are related to fuzzy sets associated with linguistic variables (Mendel, 1995). The fuzzifier maps the input into the fuzzy sets to obtain degrees of membership. This is needed in order to activate rules, which are in terms of the linguistic variables. The inference engine of the fuzzy logic system maps the antecedent fuzzy (IF part) sets into consequent fuzzy sets (THEN part). This engine handles the way in which the rules are combined. In practice, only a small number of rules are actually used in applications of fuzzy logic (Guo & Peter, 1994). In most applications, crisp numbers must be obtained at the output of a fuzzy logic system. The defuzzifier maps output fuzzy sets into a crisp number, which becomes the output of the fuzzy logic system.

The use of fuzzy logic in research related to project portfolio management is also gaining popularity. At the time of writing this paper, a number of articles on the use of fuzzy logic had already been written over a number of years on the area of project selection (C.-T. Chen & Cheng, 2009; K. Chen & Gorla, 1998; Huang et al., 2006; Laarhoven & Pedrycz, 1983; Machacha & Bhattacharya, 2000; Wang & Hwang, 2007). This research; however, focuses on qualitatively assessing the individual and cumulative contribution of those selected projects to organizational objectives at the point of making decisions regarding the portfolio components. For a more detailed explanation on Fuzzy Logic, refer to authors such as (Tanaka, 1997; Cox, 1995, 2005; Sowell, 2005; Othman & Ku-Mahamud, 2010).

The relationships between organizational objectives and portfolio components make up a complex system. “A complex system is a system (whole) comprising of numerous interacting entities (parts) each of which is behaving in its local context according to some rule(s) or force(s)” (Caldart & Ricart, 2004:97). Earlier, (Baccarini, 1996:202) proposed that “project complexity be defined as consisting of many varied interrelated parts and can be operationalized in terms of differentiation and interdependency”. He later described types of complexity as being organizational (vertical and horizontal differentiation as well as the degree of operational interdependencies) and technological (the transformation processes which convert inputs into outputs).

The relationships among portfolio components, the integration and interdependency between them, and the varying degrees of contribution add to the complexity of the total system of portfolio components and organizational objectives. Complex business systems are built around multiple fuzzy models representing the combined intelligence of several experts (Cox, 1995). A combination of multiple fuzzy models is required to address the problem of representing cumulative portfolio component contribution to strategic objectives.

The next section discusses the conceptual model developed through this research.

Conceptual model for portfolio management decision-making

The previous section introduced the fact the complex business systems are built around multiple fuzzy models and that a combined fuzzy model is required for the problem being addressed here. The reason for using a combined fuzzy model is to allow for the variability in the number of portfolio components contributing to the organizational objectives. For each portfolio component, qualitative evaluations of the input variables are fuzzified, rules are applied and a fuzzy output is derived. To determine the contribution value for an individual component would require the fuzzy output for each component to be defuzzified. However, to determine the cumulative contribution of multiple components to a single objective requires that the fuzzy outputs of these components be aggregated before defuzzification takes place (Cox, 1995). Figure 18.3 below illustrates the conceptual model and an explanation of the model follows.

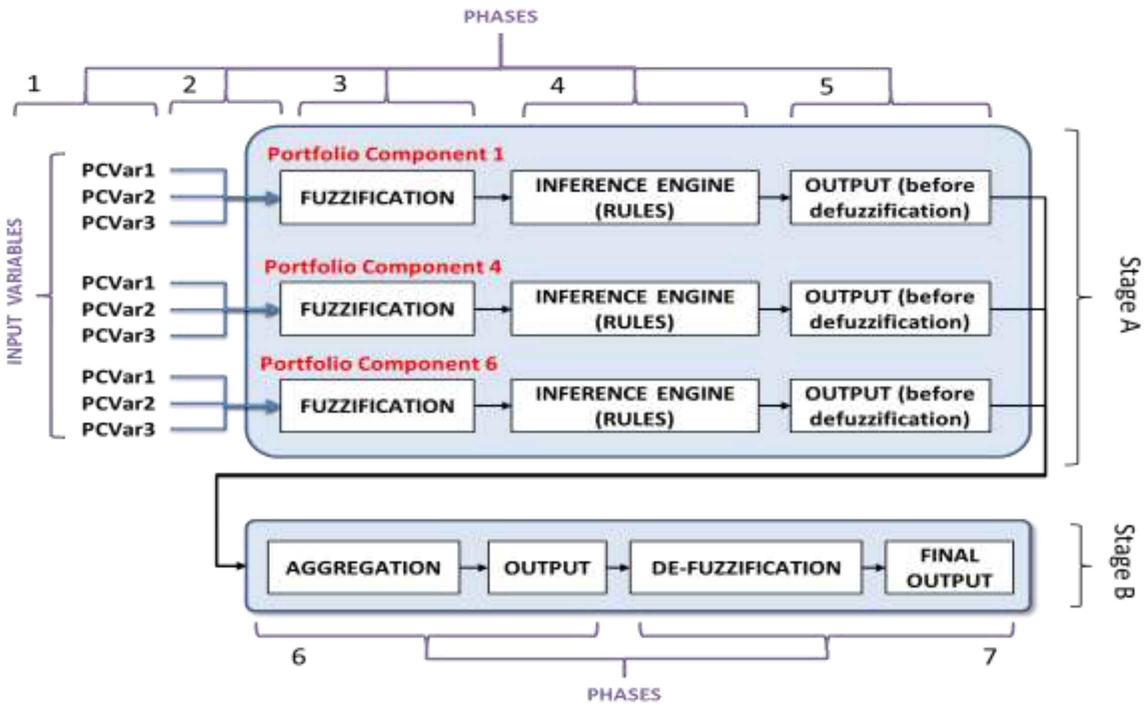

Figure 18.3: Conceptual model for the cumulative contribution of portfolio components to organizational objectives

The conceptual model in Figure 18.3 is made up of two stages – STAGE A and STAGE B. Stage A shows the fuzzy logic process for three portfolio components (1, 4, and 6). This is to indicate that in order to determine the cumulative contribution of portfolio components to an objective, multiple components must be evaluated simultaneously. For each portfolio component, three input variables (PCVar1, PCVar2, PCVar3) are indicated at the beginning of Stage A in the figure. Within the shaded area, the following phases are shown – FUZZIFICATION, INFERENCE ENGINE (RULES), and OUTPUT (before defuzzification).

Stage B consists of additional phases – AGGREGATION, OUTPUT, DE-FUZZIFICATION, and FINAL OUTPUT. In this stage the individual fuzzy outputs before defuzzification of each component from stage A is aggregated. The aggregation process provides an output that is then defuzzified to produce a quantitative value (final output), which represents the cumulative contribution of these portfolio components to a single organizational objective.

The phases in stage A and stage B are repeated every time the model simulated. When the model is used for the first time, however, additional phases are required to set up the model elements such as the input variables and rules used in the inference engine. These phases along with the model phases will now be discussed in more detail.

Phase 1: Setup input variables and fuzzy rules

Before the model can be simulated, the PPIC must:

a) Agree on what input variables they will use to evaluate each portfolio component. Input variables are evaluation criteria such as:
   - ***Value (PCVar1)*** – This criterion 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 which is measured by the component cost, contribution to profitability and contribution to growth (Deng & Wibowo, 2009; Ghasemzadeh & Archer, 2000; Santhanam & Kyparisis, 1995)
   - ***Longevity (PCVar2)*** – This refers to the length of time before the product being delivered needs to be enhanced (Enoch & Labuschagne, 2012)
   - ***Probability of successful implementation in uncertain circumstances (PCVar3)*** - The contribution towards organizational objective achievement is higher if the probability of implementation success is high (Petit & Hobbs, 2012)

b) Describe the parameters for the linguistic values (Low, Medium, High) for each input variable. These linguistic values represent the membership functions of the fuzzy logic system. Figure 18.4 below illustrates the membership functions as defined in the MATLAB® Fuzzy Logic toolbox. The toolbox allows one to model complex system behaviours using simple logic rules, and then implementing these rules in a fuzzy inference system (MathWorks, n.d.).

While the MATLAB® tool was used to illustrate how the model would work using limited components, the need for a new tool or enhancements to existing tools is required to harness the true potential of the model, enabling easier input of portfolio component evaluations, allowing for additional criteria and enabling the simulation of outcomes of decisions regarding the portfolio components.

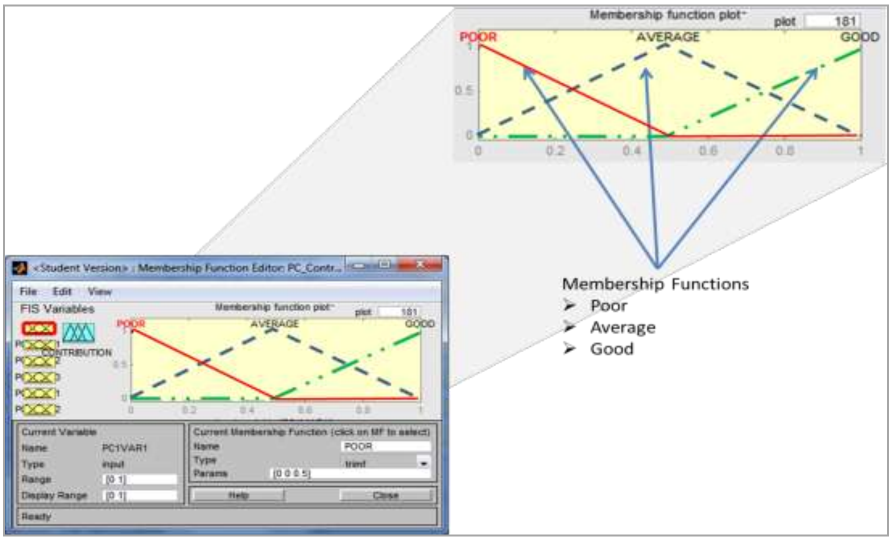

Figure 18.4: Screenshot from MATLAB® with the Membership function frame expanded

The output membership functions of the fuzzy logic system are also defined here (even though they are used in later phases) and are illustrated in Figure 18.5.

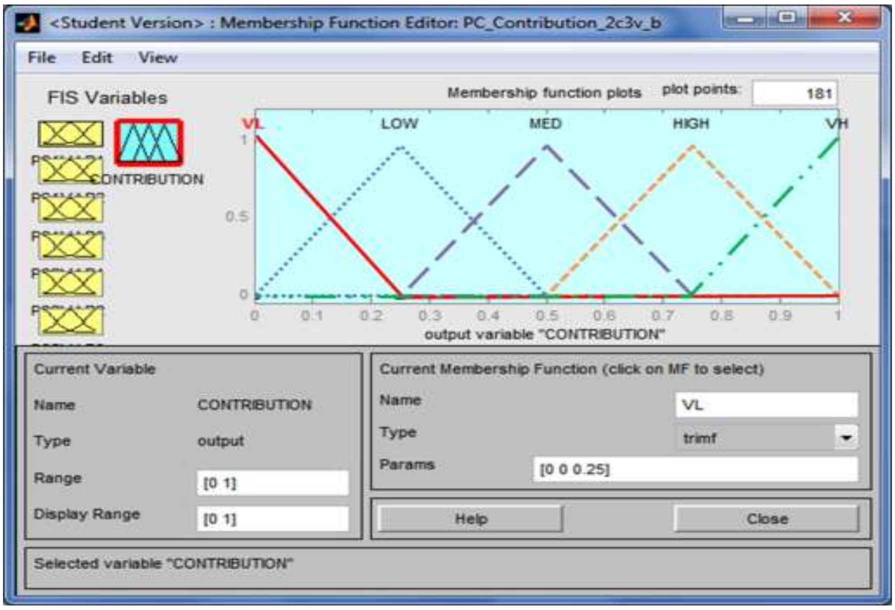

Figure 18.5: Output variable (CONTRIBUTION) with its membership functions

c) Describe the "IF…THEN" rules for the Inference Engine which will be applied to the fuzzified input values in order to produce the output fuzzy values. Table 2 illustrates a random sample of the 729 rules used in this fuzzy logic system.

Table 2: Random selection of fuzzy rules from the rule engine for determining the combined contribution of portfolio components

No.	RULE
1	If (PC1VAR1 is POOR) and (PC1VAR2 is LOW) and (PC1VAR3 is LOW) and (PC2VAR1 is POOR) and (PC2VAR2 is LOW) and (PC2VAR3 is LOW) then (CONTRIBUTION is VERYLOW)
10	If (PC1VAR1 is POOR) and (PC1VAR2 is LOW) and (PC1VAR3 is LOW) and (PC2VAR1 is AVERAGE) and (PC2VAR2 is LOW) and (PC2VAR3 is LOW) then (CONTRIBUTION is VERYLOW)
50	If (PC1VAR1 is POOR) and (PC1VAR2 is LOW) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is GOOD) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is MEDIUM) then (CONTRIBUTION is MEDIUM
100	If (PC1VAR1 is POOR) and (PC1VAR2 is MEDIUM) and (PC1VAR3 is LOW) and (PC2VAR1 is GOOD) and (PC2VAR2 is LOW) and (PC2VAR3 is LOW) then (CONTRIBUTION is LOW)
200	If (PC1VAR1 is POOR) and (PC1VAR2 is HIGH) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is AVERAGE) and (PC2VAR2 is LOW) and (PC2VAR3 is MEDIUM) then

	(CONTRIBUTION is MEDIUM)
300	If (PC1VAR1 is AVERAGE) and (PC1VAR2 is LOW) and (PC1VAR3 is HIGH) and (PC2VAR1 is POOR) and (PC2VAR2 is LOW) and (PC2VAR3 is HIGH) then (CONTRIBUTION is LOW)
400	If (PC1VAR1 is AVERAGE) and (PC1VAR2 is MEDIUM) and (PC1VAR3 is HIGH) and (PC2VAR1 is GOOD) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is LOW) then (CONTRIBUTION is MEDIUM)
500	If (PC1VAR1 is GOOD) and (PC1VAR2 is LOW) and (PC1VAR3 is LOW) and (PC2VAR1 is AVERAGE) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is MEDIUM) then (CONTRIBUTION is MEDIUM)
600	If (PC1VAR1 is GOOD) and (PC1VAR2 is MEDIUM) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is POOR) and (PC2VAR2 is MEDIUM) and (PC2VAR3 is HIGH) then (CONTRIBUTION is HIGH)
700	If (PC1VAR1 is GOOD) and (PC1VAR2 is HIGH) and (PC1VAR3 is MEDIUM) and (PC2VAR1 is GOOD) and (PC2VAR2 is HIGH) and (PC2VAR3 is LOW) then (CONTRIBUTION is VERYHIGH)
729	If (PC1VAR1 is GOOD) and (PC1VAR2 is HIGH) and (PC1VAR3 is HIGH) and (PC2VAR1 is GOOD) and (PC2VAR2 is HIGH) and (PC2VAR3 is HIGH) then (CONTRIBUTION is VERYHIGH)

Phase 2: Evaluation of portfolio components

In Figure 18.6 below, it can be seen that for each portfolio component that contributes to an organizational objective, the model considers three input variables (PCVar1, PCVar2, and PCVar3). The model allows for more variables but for the purpose of illustration, three input variables are used here. The PPIC evaluates each portfolio component (indicated by the dotted line) in terms of each of the input variables. Each input variable is qualified by linguistic values such as *poor*, *average* and *good* for PCVar1 and *low*, *medium* and *high* for PCVar2 and PCVar3. The following paragraphs describe each input variable.

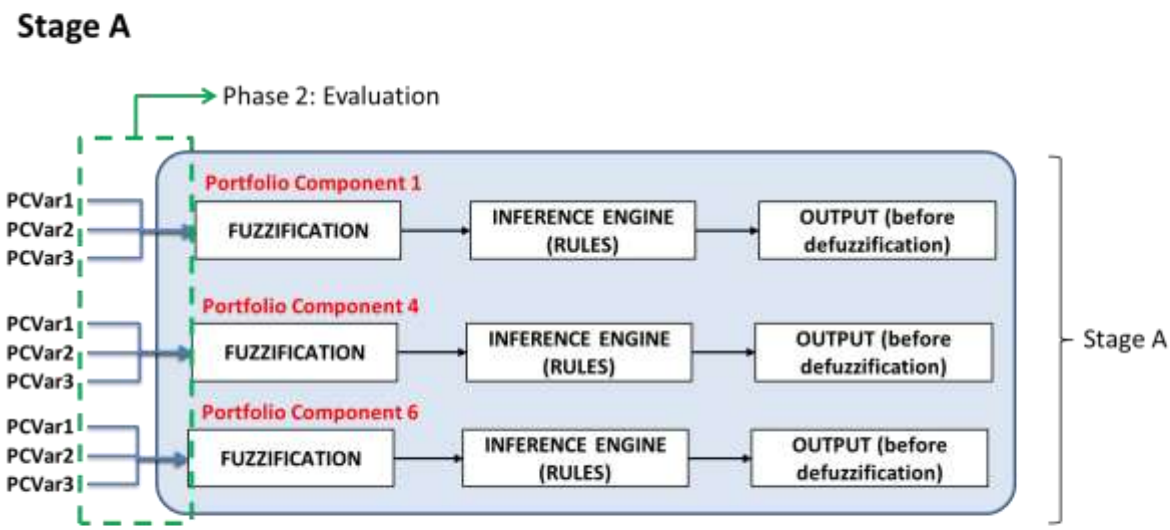

Figure 18.6: Illustration of Stage A of the conceptual model

PCVAR1: Input Variable PCVar1 represents 'Value'. The value that a portfolio component is expected to deliver is an important criterion when determining the portfolio component's contribution. Table 7.6 describes the parameters for the linguistic values: Poor, Average, and Good, which are used in evaluating PCVAR1.

Table 3: Linguistic value descriptions for 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 greater than 2.5% of total profit in a given year

PCVAR2: Input Variable 2 represents longevity. The longer a product is expected to last without needing enhancements, the higher the component evaluation. Table 7.7 describes the linguistic values: Low, Medium, and High, which are used in evaluating PCVAR2.

Table 4: Linguistic value descriptions for 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 represents the probability of successfully implementing the portfolio component. This refers to the likelihood of success in delivering the product of the component fully. 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 (Petit & Hobbs, 2012).

Table 7.8 describes the linguistic values: Low, Medium, and High, which are used in evaluating PCVAR3.

Table 5: Linguistic value descriptions for 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%

Now that the parameters for the linguistic values are known, the evaluations for portfolio components can be done.

The table below illustrates evaluations that have already been done for a set of components contributing to objectives from a participating organisation. The association of the portfolio components to objectives is therefore different to that described in the conceptual model earlier.

In the table, the input variables described earlier are represented as follows:

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

Table 6: Qualitative evaluations of the portfolio components

Values used for evaluating each variable: PCVAR1 (V): *P=Poor; A=Average; G=Good* PCVAR2 (L) and PCVAR3 (P): *L=Low; M=Medium; H=High*		ORGANISATIONAL 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		
	Input variables	V	L	P	V	L	P	V	L	P	V	L	P	V	L	P
PORTFOLIO COMPONENTS	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

Once the portfolio components have been evaluated, the fuzzification process can take place.

Phase 3: Fuzzification

The process of fuzzification entails determining the membership values associated with the qualitative evaluation of each of the aforementioned input variables. The qualitative inputs are used to determine the degree to which these inputs belong to each of the respective membership functions described in phase 1. In an organisation, the portfolio management team would evaluate the input variable 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). For the purpose of illustration, only PC2 and PC3 are shown in the figures below, however, the same process applies to all portfolio components.

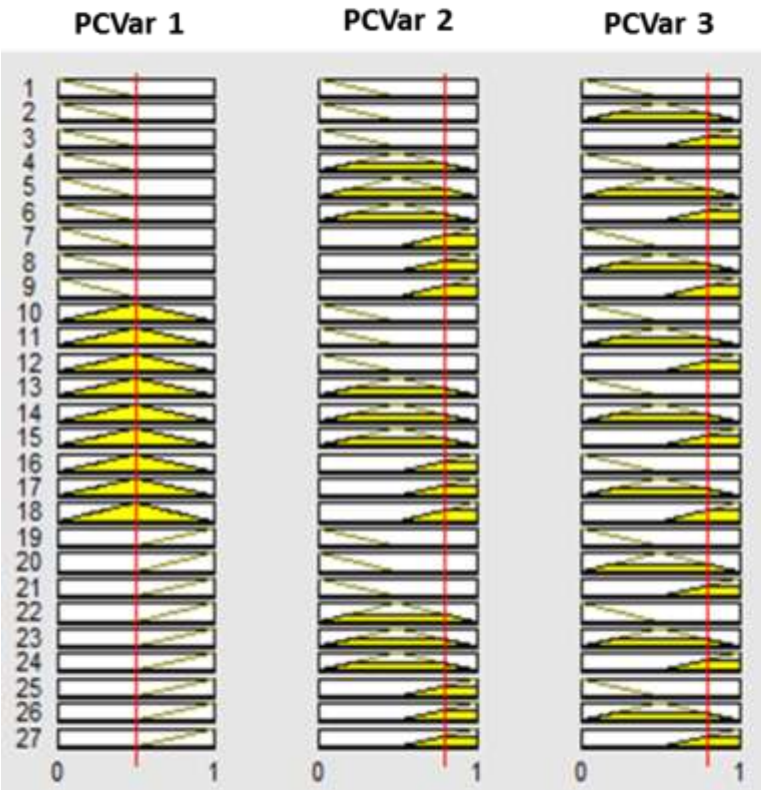

Figure 18.7: Evaluations for PC2

In Figure 18.7, PCVar1 is evaluated as Average and the red line cuts through the centre of the AVERAGE membership function. PCVar2 is evaluated as High such that the red line cuts the MEDIUM and HIGH membership functions (the middle and right hand side triangles). PCVar3 is evaluated as High such that its red line also cuts the MEDIUM and HIGH membership functions.

Similarly, for PC3, the evaluation of each input variable is shown in the following figure:

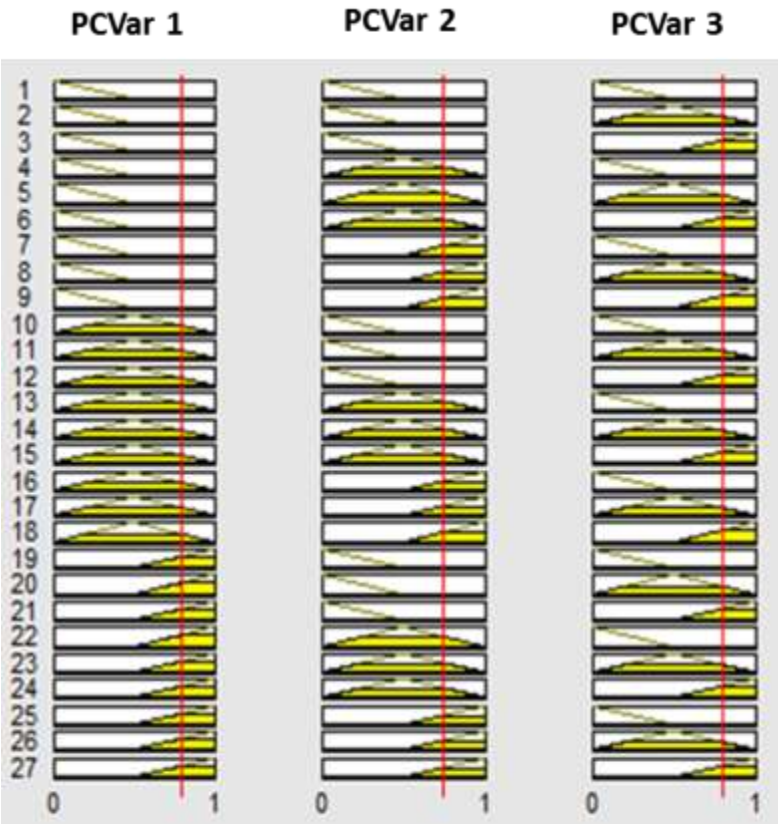

Figure 18.8: Evaluations for PC3

In Figure 18.8, PCVar1 is evaluated as Good such that the red line cuts through the AVERAGE and GOOD membership functions. PCVar2 is evaluated as High such that the red line cuts the MEDIUM and HIGH membership functions.

PCVar3 is evaluated as High such that its red line also cuts the MEDIUM and HIGH membership functions. The points at which the red lines cut through the membership functions represents the degree to which each input belongs to each respective membership function. The degree of belonging is equal to the membership value - the value between 0 and 1 on the y-axis of each of the 27 graphs in Figure 18.7 and Figure 18.8. The next phase takes the fuzzified inputs and applies the rules in the inference engine.

Phase 4: Applying the rules in the Inference Engine

In the previous phases, each of the input variables were evaluated qualitatively, and the degree of membership (membership value) was determined after plotting the red line on the membership functions for each variable. In this system of portfolio components and organizational objectives, there is more than one input variable per portfolio component. The degree of membership for the consequent membership function (output) will be the minimum value of the degree of membership for the different inputs. The following figure illustrates this. The membership functions of the input variables are shaded in yellow while the membership functions of the output variable are shaded in blue.

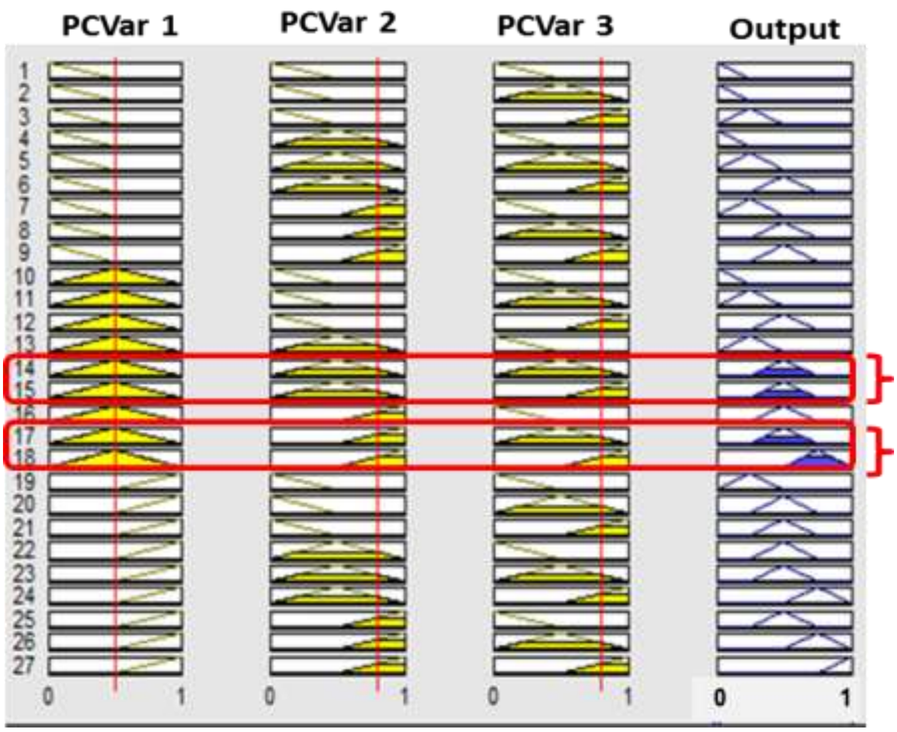

Figure 18.9: Application of rules for PC2

Only rules that are satisfied result in an output membership function with a membership degree equal to the lowest membership degree among the input variables. The rules satisfied for PC2 are rules 14, 15, 17, and 18. These are outlined using a rectangular border and parentheses in Figure 18.9.

Similarly, the output membership functions for PC3 are determined and illustrated here:

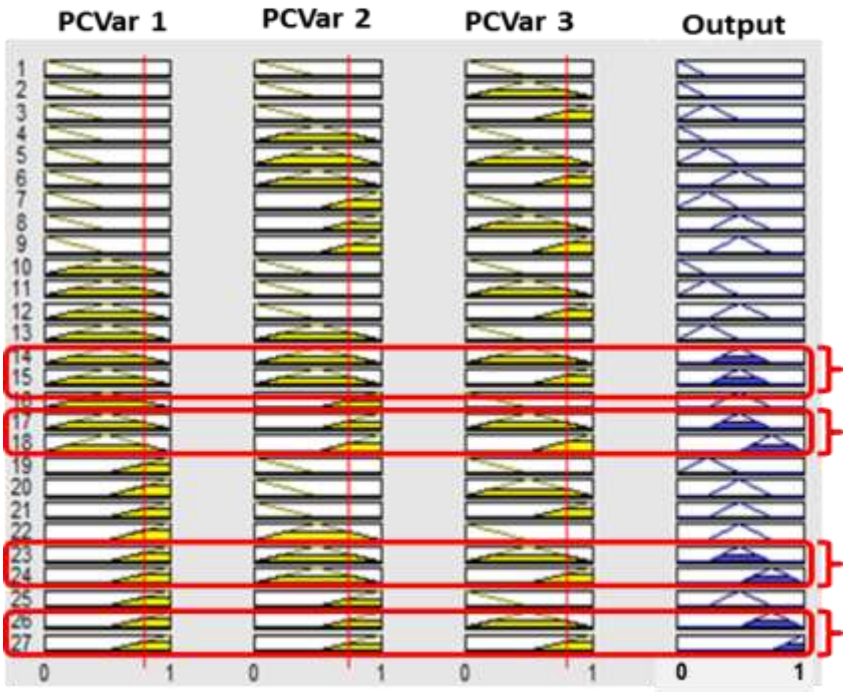

Figure 18.10: Application of rules for PC3

The rules satisfied for PC3 are rules14, 15, 17, 18, 23, 24, 26, and 27. These are outlined using rectangular borders and parentheses in Figure 18.10. This process is applied for each of the portfolio components. The next phase determines the fuzzy output for each component.

Phase 5: Output

In order to get the fuzzy output for each component, the consequent membership functions per satisfied rules are aggregated (Figure 18.11).

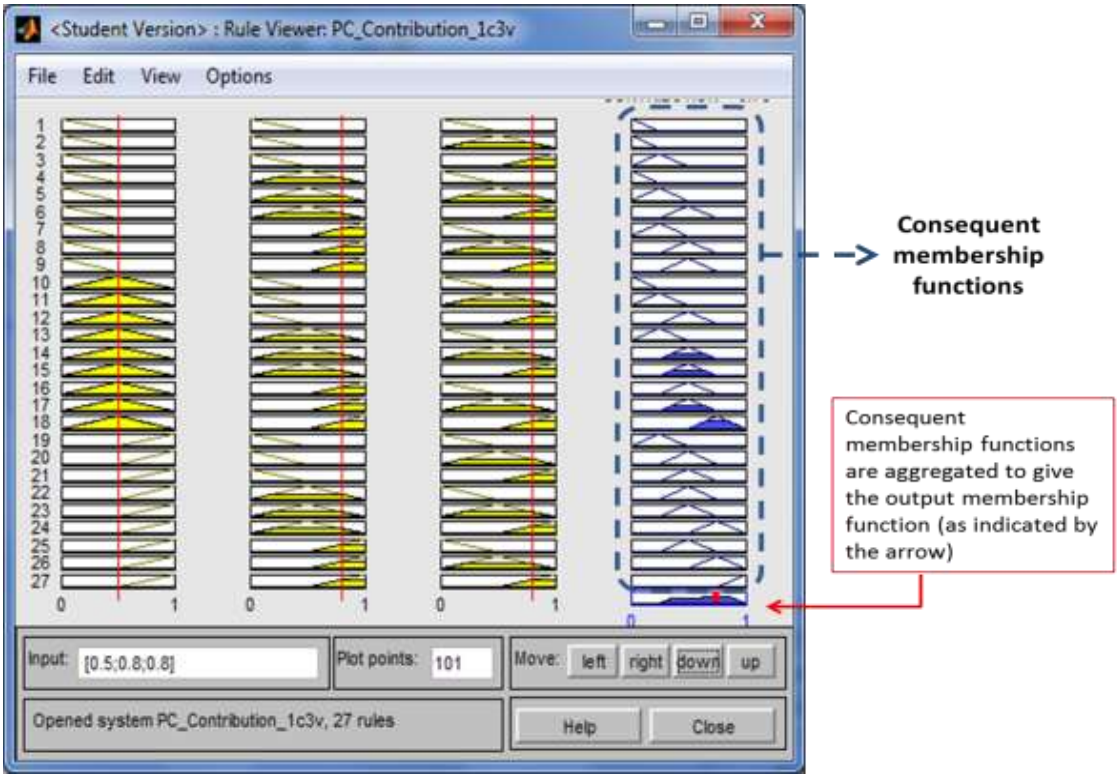

Figure 18.11: Consequent membership functions

The output is the aggregation or sum of the membership functions from the satisfied rules. The membership functions of all rule consequents are combined into a single fuzzy set (also known as a fuzzy region).

The individual output fuzzy regions (representing individual contribution) for PC2 and PC3 are presented in Figure 18.12: Output fuzzy regions for PC2 and PC3:

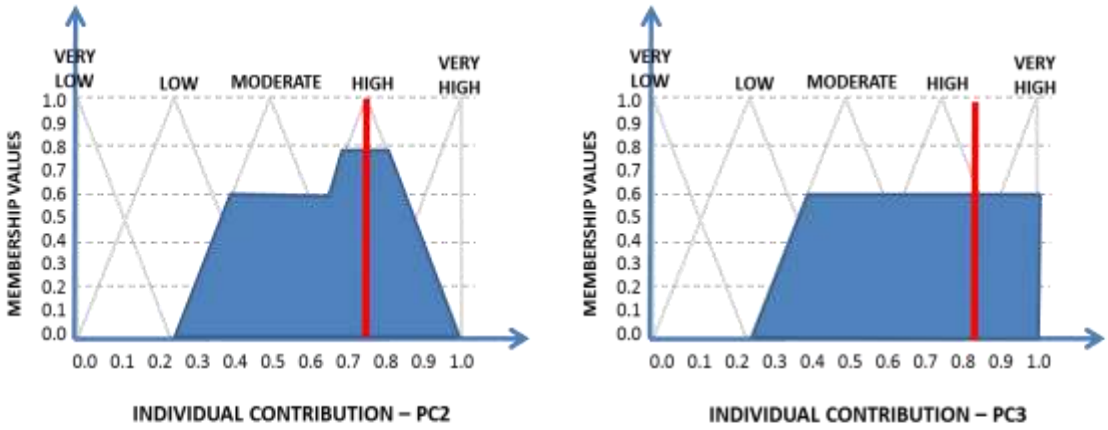

Figure 18.12: Output fuzzy regions for PC2 and PC3

If we wanted to determine the individual contribution values, the output fuzzy regions presented in the previous figure would be defuzzified to produce the contribution value at the end of stage A. However, as we want to determine the combined contribution of PC2 and PC3, we need to move to stage B. The defuzzification process is described in more detail in phase 8.

Phase 6: Determine the combined contribution

Conceptually, in this phase the output fuzzy region of each co-contributing component is aggregated to provide the combined contribution output fuzzy region. This is achieved by evaluating the contributing components simultaneously in the MATLAB® tool. When PC2 and PC3 are evaluated simultaneously with the evaluations described earlier, the following rules are satisfied in the rule engine:

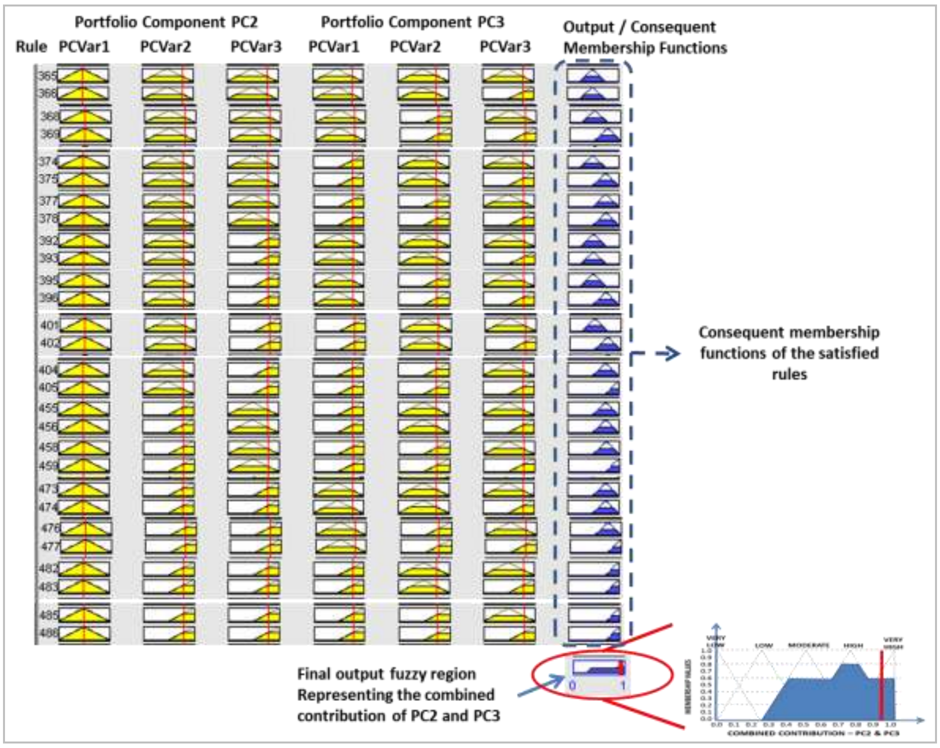

Figure 18.13: Satisfied rules for combined evaluation of PC2 and PC3

The consequent membership functions are aggregated to provide a final output fuzzy region that represents the cumulative contribution of PC2 and PC3.

Conceptually, the combination of PC2 and PC3 can be represented as follows:

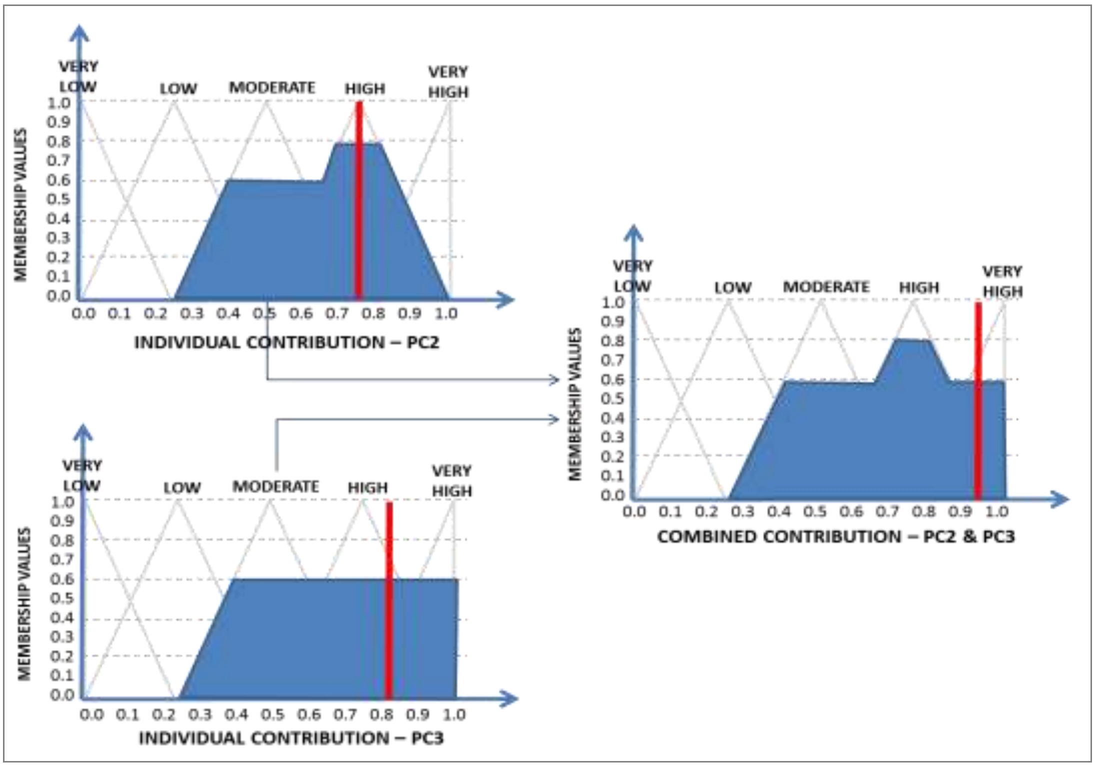

Figure 18.14: Combining individual membership functions to produce the combined contribution membership function

Phase 7: Defuzzification of combined contribution

The defuzzification process takes the output fuzzy region representing the combined contribution of PC2 and PC3 and applies a defuzzification method that determines a crisp value representing the combined or cumulative contribution of the two components. The bold vertical lines in the previous figure represent the result of the defuzzification method and the point at which it intersects the x-axis is the crisp value that represents the cumulative contribution of PC2 and PC3 to objective 2. The defuzzification method used here was MOM (Middle or Mean of maximum).

The Mean of maximum defuzzification method is a technique that “takes the output distribution and finds its mean of maxima to come up with one crisp number. This is computed as follows:

$$z = \sum_{j=1}^{l} \frac{z_j}{l},$$

Figure 18.15: Mean of Maximum formula

… where z is the mean of maximum, z_j is the point at which the membership function is maximum, and l is the number of times the output distribution reaches the maximum level.” (Sivanandam, Sumathi, & Deepa, 2007).

The model has now been applied to determine the contribution values of the portfolio components. The following table shows the individual and combined contributions of the portfolio components to organizational objectives introduced earlier.

Table 7: Combined contribution values of all 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
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

This, then, is the result of applying the model to determine the individual and cumulative contribution of portfolio components to organisational objectives.

This result can be used to analyse the extent to which objectives are being achieved. It can also be used when determining which components to terminate, for example, as scenarios can be run to show the impact of terminating one or more components.

An analysis of the contribution values in Table 7 reveals that the organisation's objectives of the combined contribution values are equal to 1. PC2 and PC3 together almost achieve objective 2 while the remaining objectives are only partially achieved. In order to improve this situation, company A must either increase the scope of existing components or add components to achieve the remainder of each of the objectives. Take, for example, PC1 – Global Markets eCommerce. It contributes to the objective of 'Business Growth' by establishing an electronic trading platform that will provide clients with research, pre-trade services, cross asset trading, pricing, risk management, liquidity distribution and post trade services. While this is important and relevant, an objective like 'Business Growth' will require additional components in order to be fully achieved. The merger or acquisition of a smaller bank in an African country, or the establishment of additional branches or other forms of banking in countries with poor infrastructure are some of the initiatives that could initiate components that contribute to the objective of 'Business Growth'. The model clearly shows that there is scope for additional components that would contribute to the achievement of objective 1 – and for that matter all other objectives illustrated in Table 7.

The next section introduces dashboards as a mechanism that takes the contribution values as input and visually illustrates the impact of decisions on the achievement of objectives using gauge charts.

Decision-Making with the aid of dashboards

Executive management in organisations make performance management decisions based on critical data and information presented in the form of dashboards, also referred to as scorecards, or report cards (Allio, 2012).

Dashboards present information regarding key performance indicators which management analyses and makes decisions based on their analysis. The dashboard used here will aid in showing the results from running multiple scenarios providing information to the portfolio investment committee that will enable better informed decision making regarding the management of the portfolio. Illustrating the scenarios and the results graphically, adds to the understanding of what is going on in the portfolio.

To aid the decision making process, dashboards can be used to present the data in a way that enables decision-makers to visualise the potential impact of their decisions before it is made so that they can consider what-if scenarios before committing their decision. To illustrate this, gauge charts (IBM, n.d.) were chosen to represent the data from the model (Figure 18.16 to Figure 18.18). These charts show the impact of decisions made by the PPIC. The red, yellow and green regions that appear in each gauge, partition the range of values into three segments. The coloured data ranges resemble the fuzzy logic concept of looking at the data in terms of ranges rather than purely static values. These segments provide further information to decision makers. If the needle (arrow) points anywhere in the *green* 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 (arrow) points anywhere in the *yellow* 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. If the needle (arrow) points anywhere in the *red* 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.

To show how the gauge charts can be used, let us look at a scenario where the portfolio investment committee decide to terminate a portfolio component due to recent budget cuts. They consider terminating PC1, PC3, or PC5. To show the impact of the potential decision, the model is simulated three times, each time without one of the three components, and the result is presented in the gauge chart. In Figure 18.16, the black arrows represent the original position before any of the three components are considered for termination. The red dotted arrow (Figure 18.16) indicates the position if PC1 is terminated. The difference between the black and red arrow visually illustrates the impact on the achievement of objective 1.

					
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 18.16: Gauge chart showing the relative positions after terminating PC1

The yellow dotted arrow (Figure 18.17) indicates the impact of terminating PC3 on objectives 2 and 3.

					
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 18.17: Gauge chart showing the relative positions after terminating PC3

The white dotted arrow (Figure 18.18) indicates the impact of terminating PC5 on objective 4.

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 18.18: Gauge chart showing the relative positions after terminating PC5

In addition, 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 above figures 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 italics font in the rows below the gauge charts illustrate this. For objective 1, the dotted arrow (needle) points to the zero position indicating that terminating the component (PC1) contributing to this objective will result in zero contribution to objective 1 (Figure 18.16). Terminating PC3 would impact objectives 2 and 3. It can be seen from (Figure 18.17) that the degree of change in achieving objective 3 is bigger than the degree of change in achieving objective 2. Importantly, however, terminating PC3 impacts two objectives and the cumulative impact would be greater than terminating PC1. Terminating PC5 will result in a small impact to objective 4. This is illustrated by the white dotted arrow in the gauge chart for objective 4 in (Figure 18.18).

The portfolio investment committee can now monitor the achievement of the objectives and establish the impact a change, such as terminating a component, has on the achievement of the objectives. The model enables the portfolio investment committee to make the better decisions regarding the termination of components such that the achievement of the organizational objectives is least impacted.

The next section describes the verification and validation process for the model.

Value and contribution of this research

This research contributes to the body of knowledge of project portfolio management and is beneficial to organisations in the following ways:
First, the model provides a benefit in terms of good governance when it comes to the decision-making around portfolio components and the achievement of organizational objectives. It reduces the subjective; gut-feel decision-making that presently exists in organisations and offers an objective view on organizationally aligned components. This is important for compliance with a country's corporate governance requirements. Second, this research provides a better understanding of the complex relationship between portfolio components and organizational objectives and shows the importance of considering the cumulative contribution of components to objectives to understand the impact of portfolio management decisions on the achievement of the organisation's objectives. Third, this research uses existing knowledge (in the form of Fuzzy Logic) in a new way. A combined fuzzy model was developed and applied to PfM decision-making. This adds to the understanding of how Fuzzy Logic can be applied in PfM.

Conclusion

The global financial crisis, as well as, compliance to corporate governance makes it necessary for organisations to improve portfolio management decision-making as wrong decisions have a direct influence on portfolio and organisation performance. In addition, understanding the extent to which organizational objectives are achieved (given the components that contribute to their achievement) enables the organisation to take the necessary actions to close any gaps in achieving those objectives.

This article described the relationship between portfolio components and organisational objectives and proposed a model that takes, as input, the qualitative evaluation of portfolio components, based on multiple criteria, and through a fuzzy logic process, delivers a quantitative value that represents the individual and cumulative contribution of these components to organizational objectives. The model assists organisations in determining gaps in terms of components required to achieve organizational objectives fully as well as aid in the decision-making regarding the portfolio composition when confronted with imposed constraints such as a reduction in budget. The model addresses the complexity of the problem by combining fuzzy models and allowing the assessment of a variable number of components. In addition, the model can be expanded to incorporate additional input variables (criteria), components and objectives than what was used in this article. This model empowers decision-makers to make the right decisions; thereby ensuring the organisation achieves the maximum benefit from its investment in their portfolio components.

Although this research provided valuable contributions to the body of knowledge, some limitations include the fact that the model was validated with a small set of components and objectives in a single organisation to prove the concept. The limitation is that other combinations of components and objectives in other types of organisations were not tested. Setting up the model (selection of evaluation criteria, definition of the membership functions for the input and output variables, the specification of the rules, and the setting up of the parameters for the linguistic evaluations) requires human intervention. This allows for subjectivity and can influence the outcome of the model for a specific organisation. Lastly, the model is dependent on how the portfolio is set up. In other words, the limitation is that it does not influence which components are selected when setting up or shaping the portfolio, but works with what is currently in the portfolio.

Despite these limitations, the model is still valid and can be used in organisations and for further research. Further research can be done to extend the model further to look at aspects like the interdependencies between components, the mandatory nature of regulatory or compliance components, and the consideration of human resource capacity and capability in order to determine how these aspects would influence a component's contribution or the achievement of objectives, and hence, decision-making regarding the portfolio mix. The varying degree of influence of decision-makers is another aspect that can be investigated. In Fuzzy Logic models, a weighting factor can be applied to distinguish levels of influence amongst organisation experts or decision-makers. Among the members of the portfolio investment committee (i.e. the experts or decision-makers), there are those, whose evaluation of portfolio components, carry a higher weighting due to the level of their expert knowledge and the confidence in their opinions, for example, and their evaluations should, therefore, be weighted more favourably. The basis on which this is done and the process for doing it can be researched and added to this model.

Finally, project portfolio management concepts can be applied across any organizational context or industry. The model presented here was verified and validated using data from a large bank. The criteria for evaluating components and the rules that are applied in the fuzzy rule engine could vary for different types of organisations - from pharmaceutical to construction and engineering. It would be worth researching the application of this model in these and other industries.

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