Improving the existing project manager-to-project practice of a specific organization (organization A) in Botswana

Lone Seboni

Submitted in accordance with the requirements for the Degree of

Doctor of Philosophy

The University of Leeds

School of Civil Engineering

Institute for Resilient Infrastructure

September 2016

The candidate confirms that the work submitted is his own, except where work which has formed part of a jointly authored publication has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

All aspects of the publications (indicated below, including associated chapters in this thesis) were undertaken by the candidate. However, the candidate benefited from guidance and suggestions from the named co-authors who played the usual role of supervisor.

Chapter 7:

Seboni, L.Tutesigensi, A. and Bower, D. (2013). Managerial decision making regarding the allocation of project manager resources to projects: The case of Botswana. In Kocaoglu, D.F. (ed.), *Technology Management in the IT-Driven Services (PICMET), 2013 Proceedings of PICMET '13:, July 28 2013-Aug. 1 2013*, pp.487-510.

Chapter 8:

Seboni, L. and Tutesigensi, A. (2014b). Development and verification of a conceptual framework for project manager-to-project (PM2P) allocations in multi-project environments. In Kocaoglu, D.F. (ed.), *Proceedings of PICMET '14, 27-31 July 2014, Kanazawa, Japan*. IEEE, pp.2477-2496.

Chapter 9:

Seboni, L. and Tutesigensi, A. (2014a). Allocating project managers to projects in a multi-project environment. In: Raiden, A. (Ed.) and Aboagye-Nimo, E. (ed.), *Proceedings of the 30th Annual ARCOM Conference,* 1-3 September 2014*,* Portsmouth, UK. Association of Researchers in Construction Management, pp.825-834.

Seboni, L. and Tutesigensi, A. (2015b). Project manager-to-project allocations in practice: an empirical study of the decision-making practices of a multi-project based organization. *Construction Management and Economics*, **33**(5-6), pp.428-443.

Chapter 10:

Seboni, L. and Tutesigensi, A. (2015a). A mathematical model for allocating project managers to projects. In: Raiden, A. (Ed.) and Aboagye-Nimo, E. (ed.), *Proceedings of the 31th Annual ARCOM Conference*, 7-9 September 2015, Lincoln, UK, Association of Researchers in Construction Management, pp. 3-12.

This copy has been supplied on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

© <2016> “The University of Leeds and” <Lone Seboni>

The right of Lone Seboni to be identified as Author of this work has been asserted by him in accordance with the Copyright, Designs and Patents Act 1988.

This work is dedicated to my mother, Dolly Seboni.

Acknowledgements

Firstly, I would like to acknowledge the in-depth, critical reviews and constructive feedback from my sole supervisor, Dr Apollo Tutesigensi. This includes continued support, invaluable guidance and patience with every aspect of my stay in England during the PhD process. I am indebted to Mr Krisen Moodley (my adviser) for his mentorship, all of which have been invaluable.

Secondly, I would like to acknowledge the University of Botswana for sponsoring the research, Government of Botswana for awarding research permits to allow the research to be conducted and all the organizations that participated in the research, particularly the main case study organization (organization A), for official permission to be used as a case study.

Thirdly, I wish to acknowledge the invaluable input from Professor Paul Newman, including the help and support from a number of other academics and practitioners in the general field of management, including cognate fields of inquiry.

I would also like to thank my family for their support, love and understanding during my prolonged absence from home whilst on my doctoral program. Special thanks to all other people, including the examiners, who contributed to my thesis.

Above all, I wish to thank God for giving me the strength and wisdom to persevere through the challenging but interesting journey associated with the PhD process, in which I acquired and implemented the necessary skills and expertise to solve a real-life industry problem.

Abstract

Empirical studies on the project manager-to-project (PM2P) practice in multi-project environments (MPEs) are limited. Little has been done to study existing PM2P practices in Botswana (a new context), despite evidence of the negative impact of existing practices on organizational performance. Approaches to improve PM2P allocation decisions and get them right first time have become necessary to complement intuition, in making effective decisions (Patanakul et al., 2007) that save costs and lost time in rectifying mismatches between project managers and projects (Skabelund, 2005).

Researchers have proposed approaches to improve the PM2P practice (Choothian et al., 2009; Patanakul et al., 2007). These approaches, whilst demonstrating the value to be derived from improving the PM2P practice in MPEs, have limitations such as: predominant focus on USA context, lack of comprehensiveness in consideration and modelling of influencing factors, and lack of user-friendliness. This thesis builds on existing best practice and proposes a new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana, to potentially optimize performance.

A mixed methods study involving 109 interviews and questionnaires with practitioners in Botswana was conducted over three fieldwork stages, leading to development of a comprehensive new approach. This new approach was verified and validated to improve organization A’s existing PM2P practice. The new approach combines concepts from four disciplines. It complements intuition and enables practitioners to use it directly for the first time, in improving their existing PM2P allocation decisions.

The results from a study of existing PM2P practices in Botswana revealed lack of accountability in decision making, and reliance on intuition. A conceptual framework for understanding effective PM2P practices in MPEs was developed and used to elucidate organization A’s existing PM2P practice. The results showed a lack of consideration of a comprehensive list of factors influencing PM2P allocation decisions, including mismatches between project managers and projects. Validation of the proposed new approach revealed evidence of its value to improve organization A’s existing PM2P practice, in comparison with the status quo.

The new approach facilitates a more effective PM2P practice, leading to potential reductions in: mismatches between project managers and projects, time, cost and hence increased organizational performance. Future work is needed to extend the scope to accommodate flexibility of the proposed new approach to different applications and contexts.

Table of contents

List of Tables

List of Figures

List of Terms and Definitions

Annotations	Analysis of comments that serve as quick and brief notes about specific text segments being read (Bazeley, 2007).
Auto coding	NVivo's tool that provides for automatic organisation of data, such that developing themes can be easier to manage (Bazeley and Jackson, 2013).
Case node	A container holding all the information pertaining to a particular unit of analysis, in the context of qualitative data analysis using NVivo (Bazely, 2012; Gibbs, 2002).
Code book	A list of the names of all the thematic nodes and their descriptions.
Coding	The identification and labelling of themes, to allow making links between concepts being examined and the relevant text from informants' responses (Bazeley and Jackson, 2013; Coffey et al., 1996).
Conceptual framework	A network of concepts, factors or variables that explains the main things to be studied, represented either graphically or in narrative form (Miles and Hubberman, 1994).
Decision support system	A computerized information system used to support decision-making in an organization.
Dialog box	A means to obtain instructions from a user and execute them through programming code.
Empirical evidence	Information acquired through observation or measurement of phenomena, to derive knowledge from actual measurement/observation rather than from literature or belief.
Factor analysis	A useful data reduction technique for examining relationships between variables, in the context of concepts being studied.
Framework matrices	Grids or tables containing summarized data arising from cell coding.
Matrix coding query	One of the most complex NVivo queries that identifies and

	cross-tabulates pairs of project items being searched for and displays them in a matrix, to allow comparison of coded content.
Memos	Notes or commentary prompted by a reading of the whole document rather than a section of it, usually in relation to reflective thoughts.
Node	A container for ideas, concepts, categories and themes (Bazeley and Jackson, 2013).
Queries	A way of asking questions of the data by instructing NVivo to search throughout the entire data or scoped data, for all text that meets defined criteria (Bazeley and Jackson, 2013).
Resource	A firm's productive elements, owned and controlled by the firm (Amit and Shoemaker, 1993; Sheehan, 2005).
See also links	One of the NVivo tools that are used to make connections between different project items.

List of Abbreviations

AHP	Analytic Hierarchy Process.
CAQD	Computer Assisted Qualitative Data.
COIN-OR	COmputational INfrastructure for Operations Research.
CPU	Central Processing Unit.
DSS	Decision Support System.
ELECTRE	Elimination Et Choix Traduisant la REalite.
FW	Fieldwork.
GUI	Graphical User Interface.
ILP	Integer Linear Programming.
K-S	Kolmogorov Smirnorf.
MIP	Mixed Integer Programming.
MPE	Multi-Project Environment.
NatCen	National Centre for Social Research, UK.
NUD*IST	Non-numeric, Unstructured Data* Indexing, Searching and Theorizing.
PHs	Project Heads.
PMO	Project Management Office.
PM2P	Project Manager-To-Project.
QDA	Qualitative Data Analysis.
QSR	Qualitative Research Solutions.
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution.
VBA	Visual Basics for Applications.

List of Appendices

Chapter 1
Introduction

The purpose of this chapter is to introduce the contents of the thesis. This purpose is achieved through the following sections: significance of this thesis; background to the research problem; aim and objectives; outline of methodology; scope of the research; and outline of thesis structure. The chapter ends with a summary.

1.1 Significance of this thesis

27% of a senior manager's time as well as annual costs of about $105 billion are lost on rectifying mismatches in the allocation of project managers-to-projects (PM2P), arising from unsuitability of employees to tasks (Skabelund, 2005). The cost implications of making sub-optimal PM2P allocations show that research into the PM2P allocation decision (Adams et al.,1979; Bowen et al., 1994; Ireland, 1997; Kuprenas et al., 2000; Mian and Dai, 1999; Pennypacker and Dye, 2002), is one of the critical success factors influencing organizational performance. Empirical studies conducted in the context of USA (Choothian et al., 2009; Patanakul and Milosevic, 2006, Patanakul et al., 2003, 2004, 2007), have demonstrated the importance of improving the PM2P practice in MPEs, in terms of increased organizational performance. These studies, while significant in demonstrating the value of effective PM2P practices, have not addressed the issue of empirical evidence from other countries such as Botswana. No attempt has been made to study and report on PM2P practices in the context of Botswana. This attempt is important because of evidence of existing PM2P practices in Botswana that rely on managerial intuition, project manager availability and number of years in service (Farole, 2014; Hughes, 2014), rather than a balanced approach that considers all influencing factors.

1.2 Background to the research problem

Approaches to improve PM2P allocation decisions and get them right first time have become necessary to achieve both project and organizational success (Patanakul et al., 2007). Researchers (see Choothian et al., 2009; Patanakul et al., 2007) have proposed conceptual frameworks and mathematical models to improve the allocation of project managers-to-projects, referred to in this thesis as the PM2P practice. These conceptual frameworks and mathematical models are not comprehensive in terms of consideration of influencing factors and their modelling, including lack of user-friendliness to industry practitioners.

Given that the PM2P practice is a complex multi-criteria decision making problem, conceptual frameworks and mathematical models are important to guide practitioners in making effective and balanced decisions that save costs arising from mismatches in PM2P allocations (Skabelund, 2005). There is a link between PM2P allocation decisions and organizational performance (Brown and Eisenhardt, 1995; Patanakul, 2009; Patanakul and Milosevic, 2006, 2008; Patanakul et al., 2007; Pinto and Slevin, 1989a). This link implies that improving the PM2P practice increases organizational performance.

Empirical studies on PM2P practices, applicable to MPEs, are currently limited. This view is echoed by empirical studies in (Choothian et al., 2009; Patanakul, 2004; Patanakul et al., 2003, 2004, 2007), which are directly relevant to this thesis. However, these empirical studies are focussed predominantly on one country (United States of America), conducted in the context of the high technology industry and applicable to new product and software development projects. Following a literature search (as at January 2012), the author found these empirical studies to be the only relevant studies that directly propose PM2P allocation models applicable to MPEs. Other empirical studies conducted in Israel (Hadad et al., 2012, 2013), Iran (Sebt et al., 2009, 2010), Thailand (Ogunlana et al., 2002) and Egypt (El-Sabaa, 2001), in the context of the construction industry, are not specific to MPEs. However, this study draws from these empirical studies, to develop a novel and comprehensive PM2P approach that is user-friendly to practitioners of a specific organization in Botswana. The absence of empirical studies conducted in the context of other geographic regions and countries such as Botswana, including evidence of existing sub-optimal PM2P practices in Botswana (section 1.1), presents an opportunity for improvement.

This study fills the knowledge gap noted in section 1.1, by extending existing knowledge on PM2P practices to a new context (organization A in Botswana). This approach is consistent with research originality definitions in (Dunleavy, 2003; Phillips, 1993; Phillips and Pugh, 2005), which suggest that one can make a contribution by: (1) studying something in a new context or country, that has hitherto been done elsewhere, and (2) conducting empirical research to discover new facts, either through examining phenomenon that has not previously being examined or carrying out research involving a case study in a new geographic region or organization that has hitherto been studied.

This study provides a management tool for use directly by practitioners in improving the existing PM2P practice of a specific organization (organization A) in Botswana, given the negative impact of existing PM2P practices on organizational performance. Whilst practitioners in organization A will benefit directly from this study, the study outcomes also address identified gaps in extant literature and advances the understanding of existing knowledge on PM2P practices in MPEs.

Given the discussions in sections 1.1 and 1.2, there was a need to extend limited empirical studies on PM2P practices (focussed primarily on USA context) to a new context that has hitherto not been explored. The findings from a USA context, although significant in demonstrating the value of improving PM2P practices, are not sufficient to explain the PM2P practice in the context of Botswana, on the basis of contextual factors (Patanakul et al., 2007). The need to study and report on PM2P practices in a new context, is part of a main approach that contributes to an improved way of allocating project managers-to-projects in the context of Botswana. This main approach led to identification of five objectives that are collectively linked to addressing the study aim, as defined in the next section.

1.3 Aim and objectives

The aim of this thesis is to develop a new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana, to potentially optimize organizational performance. The following five objectives were identified and conducted in sequence, to facilitate adequate achievement of the aim:

1. to evaluate existing PM2P practices in MPEs of Botswana (objective 1);
2. to develop a conceptual framework for understanding effective PM2P practices in MPEs (objective 2);
3. to describe the existing PM2P practice of a specific organization (organization A) in Botswana (objective 3);
4. to propose a new approach to improve organization A’s PM2P practice (objective 4); and
5. to validate the new approach (objective 5).

These five objectives are taken together to address the aim and constitute a robust response to the research problem and aim. The five objectives are tightly linked by the need to address the study aim and that aim required an overall mixed methods approach that is contextual to Botswana. Coherence arises from the fact that all five objectives must be taken together, in an incremental and sequential manner, which combines all identified objectives in terms of sufficiently accomplishing the overall study aim. It is not possible to conduct the work involving say objectives 1, 3 and 5, without the work involving objectives 2 and 4, to adequately accomplish the study aim. It is only after completing the work involving all five objectives and in a sequential manner, that the overall study aim can be sufficiently achieved, in terms of establishing a coherent whole for the PhD work. Therefore, this work builds into a coherent research project, by virtue of sequentially conducting the work involving all five objectives in order to achieve the study aim.

The link between each objective and thesis chapter addressing that objective is presented in Figure 1-1. Achievement of these objectives, as part of accomplishing the study aim, is re-examined in section 12.1.

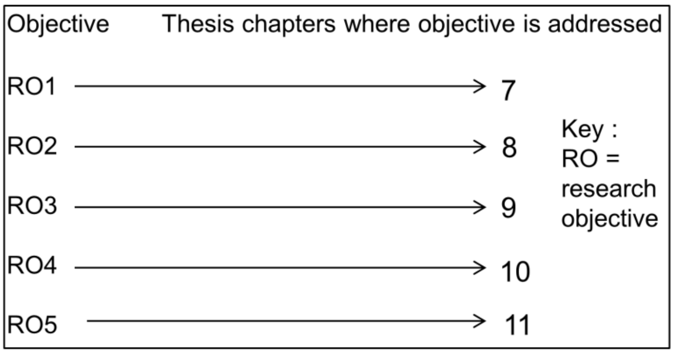


Figure 1-1 Thesis chapter location where each objective is addressed

1.4 Outline of methodology

The study aim and objectives (section 1.3) were addressed through an overall mixed methods approach. The basis of adopting this approach was to fully address the research problem and aim, through three stages of sequential data collection.

Stage 1 involved a survey of existing PM2P practices in Botswana’s MPEs and literature reviews to lay a foundation for the entire study. Evidence from both literature and industry practice was used, leading to the development of a comprehensive conceptual framework that builds on existing knowledge (in terms of what constitutes an effective PM2P practice in MPEs). The conceptual framework was then used as a guideline to inform the next stage of data collection.

Stage 2 involved a case study approach to illuminate a complete description of the existing PM2P practice of a specific organization (organization A) in Botswana, using the developed conceptual framework that represents best practice. This stage formed the main emphasis of this study, outcomes of which were used as a basis to develop a new approach to improve the existing PM2P practice in organization A, consistent with the study aim.

Stage 3 involved a case study approach to validate the proposed new approach, in terms of potential to improve the existing PM2P practice in organization A. A case study approach comprising in-depth semi-structured interviews with twenty-one practitioners from within and outside the immediate scope of the project management function, was used in the validation. The different stages of data collection relate directly to each other, in the context of an overall mixed methods approach to adequately address the study aim, with the outcomes from a previous stage used to informing a subsequent stage.

1.5 Scope of the research

This thesis is concerned with studying different aspects of the issues surrounding the PM2P practice in MPEs, with an emphasis to improve the existing PM2P practice of a specific organization (organization A) in Botswana. Whilst the proposed new approach was validated in direct comparison with organization A's existing PM2P practice, actual implementation of this new approach is beyond the scope of this thesis. The reasons are due to the stringent timelines of a PhD project, versus implementation timelines. The scope inclusion items are presented below.

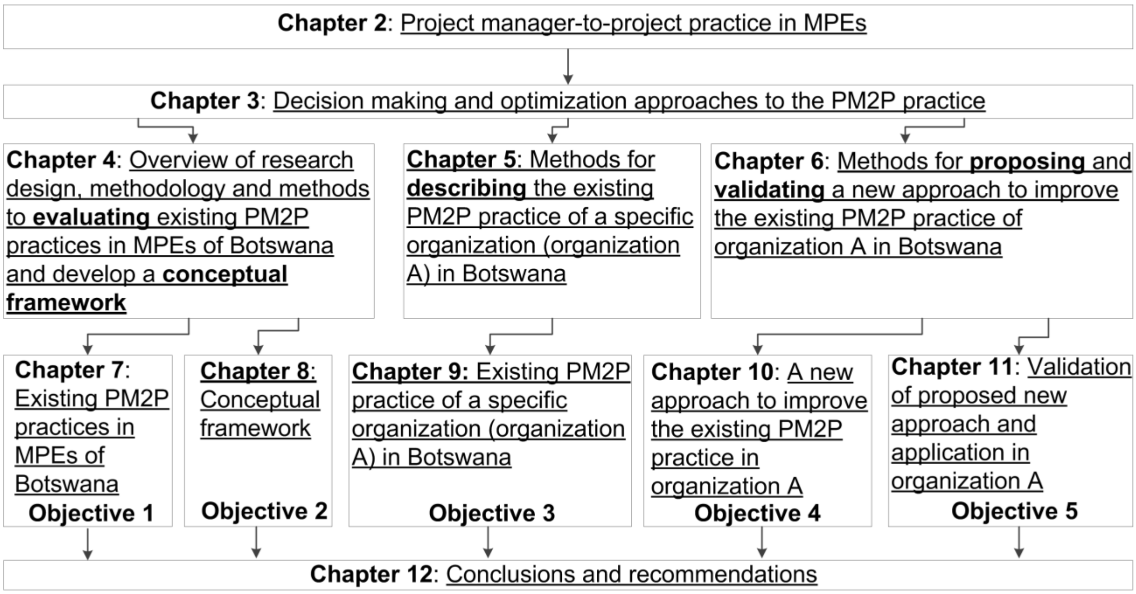
i. This study was confined to a MPE, in the context of allocating project managers-to-projects and not other types of resources;
ii. This study primarily covered underground mineral exploration projects, to illuminate the existing PM2P practice of a specific organization (organization A) in Botswana (the main case study);
iii. This study was confined to the following informant groups: (1) project heads, responsible for making PM2P allocation decisions; (2) project managers, impacted by PM2P allocation decisions, and (3) senior management, responsible for making organizational strategic decisions that influence PM2P allocation decisions;
iv. Theories on leadership and project success are not within the principal focus of this thesis, except their relevance and influence on the PM2P practice.

v. Details regarding whether the decision maker is competent to make PM2P allocations or how he/she is identified, are not within the scope of this thesis. The assumption is that the decision maker is competent but needs tools to complement his/her PM2P decision making.

1.6 Outline of thesis structure

The arguments in this thesis are structured into 12 chapters. Chapter 1 is excluded because it is the current chapter (see Figure 1-2), in terms of the organization of the reminder of the thesis chapters.

Chapter 2 provides details of the motivations and importance of this study. It explores the specific research topic in the broader context and draws a link between resource management and the thesis topic of PM2P practice, concerned specifically with the allocation of project managers-to-projects in MPEs and not other types of resources. The chapter concludes with discussions on the need to respond to the research problem.



Note – chapter 4 to 6 cover methods implemented to achieve outcomes, chapters 7 to 11 cover outcomes for respective methods

Figure 1-2 Outline of thesis structure

Chapter 3 provides the theoretical basis for this thesis, in terms of theories surrounding the PM2P practice. It explores and identifies gaps in existing literature, to advance our understanding of the literature associated with the PM2P practice as a decision making process. This chapter concludes with research hypotheses.

Chapter 4 provides an overview of the research methodology. The methods for evaluating existing PM2P practices in MPEs of Botswana and developing a conceptual framework are then presented. The outcomes of implementing these methods are presented in chapters 7 and 8 respectively.

Chapter 5 presents the methods for describing the existing PM2P practice of a specific organization (organization A) in Botswana. It uses the conceptual framework to illuminate a complete picture of this practice. The outcomes from implementing these methods are presented in chapter 9.

Chapter 6 presents the methods for proposing and validating a new approach to improve the existing PM2P practice in organization A, as part of addressing the study aim. The outcomes from implementing these methods are presented in chapters 10 and 11 respectively.

Chapter 7 presents and discusses the findings from an evaluation of existing PM2P practices in Botswana's MPEs. It demonstrates compelling empirical evidence of the ineffectiveness of existing PM2P practices in Botswana's public and private sector, including the negative impact of those practices on performance. This demonstration is consistent with the arguments made in chapters 1 and 2, regarding the need and potential to improve existing PM2P practices. The implications of the findings from Botswana are also discussed, leading into the next chapter.

Chapter 8 discusses the development of a conceptual framework to understand effective PM2P practices in MPEs, as an outcome from implementing the methods described in chapter 4. It provides evidence of the advantage of the developed conceptual framework over existing conceptual frameworks, in the context of comprehensiveness regarding 34 identified factors influencing the PM2P practice.

Chapter 9 presents a complete description of the existing PM2P practice of a specific organization (organization A) in Botswana, as an outcome from implementing the methods described in chapter 5. This chapter provides empirical evidence of the weaknesses identified in organization A's existing PM2P practices, as part of the central argument associated with the need and potential to improve existing PM2P practices from a Botswana context. The implications of the findings are also discussed. These findings set the scene for and inform the development of a new approach to improve the existing PM2P practice in organization A, the subject of the next chapter.

Chapter 10 proposes a new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana, as part of outcomes from implementing the methods described in chapter 6. The process of verifying the proposed new approach is discussed, including evidence of the novelty and superiority of this new approach over existing approaches. These outcomes are part of extending existing knowledge on effective PM2P practices applicable to MPEs.

Chapter 11 validates the proposed new approach, as part of outcomes from implementing the methods described in chapter 6. It explores the validation process for the new approach and provides compelling evidence of the value of the proposed new approach, in terms of its potential to improve organization A's existing PM2P practice. The potential for practitioners to accept the new approach, on the basis of its user-friendliness over existing PM2P approaches is also highlighted.

Chapter 12 brings the entire research to a culmination by revisiting the objectives and their achievement. The contributions, implications and limitations of this thesis are discussed, followed by recommendations for future research.

1.7 Summary

This chapter provided an overview of the entire thesis, in terms of laying a foundation for the research problem associated with the need and potential to improve existing PM2P practices in the context of Botswana. Given this foundation, the thesis continues by providing details to respond to the research problem, starting with the next chapter.

Chapter 2
Project manager-to-project practice in multi-project environments (MPEs)

Given an outline of the contents of this thesis in the previous chapter, the purpose of this chapter is to derive the research problem (knowledge gap) by providing details of the study motivation, in terms of demonstrating the need and potential to improve the existing PM2P practice in the context of Botswana. This purpose is achieved through the following: (1) importance of the PM2P practice in MPEs, (2) study motivations and specific conditions from a Botswana context, (3) importance of need to improve PM2P practices in the context of Botswana, (4) value of improving existing PM2P practices in the context of Botswana, (5) author's anecdotal evidence for the research problem, (6) justification for using Botswana as context, (7) limited literature on PM2P practices in MPEs, (8) locating the research topic in the broader context, (9) building a generic resource management process, (10) managing project managers as a type of resource, and (11) need to respond to the research problem (knowledge gap).

2.1 Importance of the PM2P practice in MPEs

Research into the decision making process of allocating project managers-to-projects (PM2P) reveals that this decision is fundamental to project success (Pinto and Slevin, 1989a; Pinto and Slevin, 1989b; Brown and Eisenhardt, 1995) and hence an important topic to study. This view has been asserted by seminal work of researchers (such as Augustine, 1959; Avots, 1969; Brown and Eisenhardt, 1995; Pinto and Slevin, 1989b; Archibald, 1975) and corroborated by other researchers (see Dainty et al., 2003; Song and Noh, 2006; Sebt et al., 2010; Patanakul, 2013), who are all unified in concluding that the choice of a project manager is one of the critical factors that influence project success. Project management standards and professional institutions (PMBOK, 2008, 2013; PMI, 2004, 2006, 2008; IPMA, 2012) also corroborate this view. The trend in extant literature published from 1959 to 2014 (see Table 2-1) provides compelling evidence that is unified in demonstrating the importance of choice of project manager, as one of the dominant factors influencing project success.

The evidence in Table 2-1, spanning over the last five decades, provides enormous implications for management, in relation to the importance of PM2P practices in MPEs, and the impact on both project and organizational performance (Brown and Eisenhardt, 1995; Patanakul, 2009; Patanakul and Milosevic, 2008; Pinto and Slevin, 1989a).

Table 2-1 Choice of project manager as a critical success factor

Identified success or failure factors	References
Selection of personnel for the project team	Slevin and Pinto, 1986
Project manager in terms of importance to company performance	Archibald, 1975;Beck, 1983;Augustine, 1959
Project manager technical capability and goal commitment	Ashley, 1986
Inappropriate project manager	Payne, 1995; Stewart, 1995
Project manager technical and administrative capabilities	deWit, 1988
Project manager's leadership style and skills	Brown and Eisenhardt, 1995; Song and Noh, 2006
Competency of project manager and project personnel	Kuen et al., 2009
Competency of project manager for selection and project team	Jiang, 1996;PMI, 2008;Gudienė, 2013;Ihuah, 2014
Selection and training of the right person as project manager, choice of project manager	Fricke, 2000;Avots, 1969;Badiru,1996;Birkhead, 2000;Crawford, 1998;Kuprenas, 2000;Pinto, 1988;Sattler, 1998;Spinelli, 1997;Westerveld, 2003
Competent project manager and project team (including project manager allocation)	Hadad, 2012,2013;Patanakul, 2010, 2013;Sebt, 2010

Notwithstanding the establishment of the PM2P practice as one of the key factors contributing to project and organizational performance (Choothian et al., 2009; Patanakul, 2004; Patanakul et al., 2007), there is evidence to suggest that practitioners in project-based organizations across different industries rely predominantly on managerial intuition. For example, LeBlanc et al. (2000) provides empirical evidence of practitioners' reliance on intuition to allocate project managers-to-projects in the construction industry. Raiden et al. (2001, p.139) highlights the use of *"manager's subjective value judgements"* in assessing qualitative attributes such as *"resource capabilities and organizational or project requirements"*, during decision-making processes associated with human resource practices, in the context of UK construction industry. Similarly, empirical evidence of practitioners' use of gut feel in making PM2P allocation decisions is found in high-technology and manufacturing industries (Choothian et al., 2009; Milosevic and Patanakul, 2004, Patanakul et al., 2003). The informal approach, referred to as managerial intuition, is considered sub-optimal (Jansson, 1999; Keeney and Raiffa, 1993; Keren, 1992), in situations where the PM2P decision criteria to be assessed are known and contain elements that can be structured (Shapiro and Spence, 1997).

The ineffectiveness of managerial intuition for aspects of the decision that can be structured, has been demonstrated in (LeBlanc et al., 2000; Milosevic and Patanakul, 2004; Patanakul et al., 2003). Furthermore, Meredith and Mantel (2005) asserts that in the context of MPEs, the PM2P practice is a key challenge facing management, arising from the following reasons: lack of management tools and techniques to guide allocation decisions (Choothian et al., 2009; Patanakul et al., 2007), lack of sufficient information, and lack of time (Kabli, 2009). Whilst managerial intuition is of value as an input into the PM2P practice, there is need to complement intuition, in the context of an effective PM2P practice that is balanced to process both structured and unstructured aspects of the allocation decision. Therefore, intuition alone is considered insufficient in the context of an effective PM2P practice and must be complemented with formal management tools, to yield optimum allocation decisions. Mismatches between project manager competencies and project requirements, in relation to the management of multi-projects, warrant an improvement in existing PM2P practices, as one approach necessary to enhance achievement of Botswana’s strategic plans.

There are cost implications of making erroneous allocation decisions, arising out of a human’s limited capacity for both arithmetic and memory (Adair, 2004; Drummond, 1991; Jennings and Wattam, 1998; Kleindorfer et al., 1993; Triantaphyllou, 2000), as highlighted in section 1.1. Furthermore, the indirect cost implications of ineffective PM2P allocations are also significant. For example, mismatches in allocations negatively impact on employee productivity (Ivancevich, 1979, Patanakul et al., 2007) and ultimately on an organization's bottom line (Adler et al., 1996; Choothian et al., 2009; Lagesse, 2006; Patanakul et al., 2007; Seboni and Tutesigensi, 2014a; Seboni et al., 2013; Shenhar et al., 2001). Additional indirect cost implications of sub-optimal PM2P allocations relate to motivation of project managers (Patanakul et al., 2007), which also impact negatively on both project and organizational performance (Patanakul et al., 2004; Raiden et al., 2006). For example, Raiden et al.’s work (2006) highlights the long-term impact of failure of organizations to balance employee needs with project requirements, in terms of the long-term impact such as employee stress and turnover, arising from issues such as excessive travel that impact negatively on family issues, in the context of human resource deployment within the construction industry.

The PM2P practice becomes more critical to organizational performance in MPEs (Fricke and Shenhar, 2000; Ireland, 1997; Kuprenas et al., 2000; Patanakul and Aronson, 2010; Patanakul and Milosevic, 2009), given presence of clear links between projects and an organization’s strategic goals (Olsson, 2008). A multi-project environment (MPE), sometimes reffered to as portfolio management (Jonas, 2010; Meskendahl, 2010) is defined as the management of multiple concurrent projects, from an organizational perspective (Fricke and Shenhar, 2000; Hashim et al., 2012; Ilincuta and Jergeas, 2003; Ireland, 1997; Milosevic and Patanakul, 2004; Moodley, 2008; Tobis and Tobis, 2002). A MPE is characterized by number of concurrent projects to be implemented as a vehicle to deliver the organization's strategic goals. Several possibilities exist in the management of multi-projects. Examples include:

1. portfolio management - management of a group of projects such that projects in each group may not necessarily be related in terms of goals (Charouz and Ramik, 2010; Cooper et al., 1998; Gareis, 2006; Laslo, 2010; Pennypacker and Dye, 2002; Young and Conboy, 2013);
2. programme management - management of several programmes comprising projects, such that all projects in each respective programme are related in terms of goals (Ferns, 1991; Gray, 1997; Pellegrinelli et al., 2007; Shehu and Akintoye, 2009); and
3. management of a combination of either single projects with portfolios or programmes of projects, which may be referred to as complex multi-projects (Aritua et al., 2009c; Artto and Dietrich, 2004; Blissmass et al., 2004).

2.2 Study motivations and specific conditions from a Botswana context

Botswana is a middle-income country with a high Gross National Income that is about fouth largest in Africa (International Monetary Fund, 2005). Botswana is the world's largest producer of quality diamonds measured by value. Approximately $3.3 billion of the $8.5 billion of annual quality diamonds produced globally come from Botswana (Kitco, 2013). Diamond revenues, which contribute up to 30% to Botswana's national GDP (World Bank Group, 2015), enable policies for free education and health care for all citizens (Botswana Federation of Trade Unions, 2007).

One of the factors impeding achievement of Botswana's National Development Plans is deficiencies in the processes to deliver Infrastructure projects (World Bank Group, 2015; Mwamba et al., 2009). Expert Group Botswana conducted a survey of the status of project management processes in Botswana's public and private sector and reported reliance on both project manager availability and number of years in service, rather than competence (Hughes, 2014; X-pert Botswana, 2011). This finding implies mismatches between project manager competencies and project requirements, in relation to the management of strategic government projects. These mismatches represent deficiencies in existing PM2P practices and are directly linked to project failures that cause significant losses in Government revenues, and warrant an improvement in PM2P practices, as one approach necessary to enhance achievement of the Country's plans.

Mine accidents that result in fatalities, downtime and lost profits in excess of $3 billion per annum have been reported to occur frequently in Botswana's mining industry (Broomes, 2013). Such outcomes arise from existing sub-optimal project management processes (Farole, 2014; Hughes, 2014; Mwamba et al., 2009) and linked directly to ineffective PM2P practices. Evidence in (Mwamba et al., 2009; X-pert Botswana, 2011; Hughes, 2014) suggests that the selection of a project manager is done informally and without proper procedures in terms of consultation, documentation and proper reviews regarding project manager competencies. This selection process is directly related to the PM2P practice.

MPEs are going to become an increasingly important environment in which to deliver projects in Botswana's public and private sector, as part of enhancing achievement of the Country's strategic plans for the period 2010 to 2017 (Botswana Ministry of Finance and Development Planning, 2010). Among the Country's strategic priorities are: (1) improving the productivity of both public and private sector organizations, to enhance their competitiveness, and (2) directing and increasing Government spending to improve infrastructure. If these strategic plans are to be achieved, they require a shift from traditional single project environments to MPEs in terms of project delivery.

The above argument requires building efficient and effective processes to achieve country strategic plans, as per one of the focus areas from the Country's National Development Plan 10 (World Bank Group, 2015; Mwamba et al., 2009). In particular, ineffectiveness and bottlenecks in the delivery of infrastructure projects, including projects to generate and supply electricity, are among the major challenges highlighted (Mwamba et al., 2009). These challenges can benefit from improved PM2P practices to effectively deliver Government projects.

2.2.1 Botswana's public sector and specific conditions

The Government of Botswana's investment spend on infrastructure projects shows an increase since 1995 (World Bank Group, 2015), in line with country strategic plans (Botswana Ministry of Finance and Development Planning, 2010; World Bank Group, 2015). In particular, the investment spend on core infrastructure projects has increased as follows: electricity and water (2.5 to 25%), roads (2.5 to 9%), air transport (0.5 to 4%) and information and communications technology (0.1 to 4%). Given this increasing trend, one of the important areas highlighted to support the country's development efforts in terms of growth is the need for an improvement in processes (Farole, 2014).

The improvement in processes is linked to challenges associated with selection of project personnel and how those projects are managed (Farole, 2014). Specific examples of the Country's recent infrastructure projects in which challenges were experienced are: construction of Francistown stadium, construction of Morupule B power station, North-South carrier water project, and expansion of Sir Seretse Khama International Airport (Farole, 2014; Ofori, 2000).

Evidence of challenges relating to inefficiencies and ineffectiveness of informal project management processes in Botswana's construction industry is reported in Ssegawa and Ngowi (2009). These challenges impede achievement of the Country's strategic plans and represent a need to improve existing processes, in the context of an effective PM2P approach that does not rely on managerial intuition, project manager availability and number of years in service.

2.2.2 Botswana's private sector and specific conditions

In the context of MPEs of Botswana's private sector, the need for enhancing the management of project portfolios is recognized. In particular, some private sector organizations recognize the need for an improvement in project management practices and processes, as part of strategic plans to maximize performance and bottom line profits (Hughes, 2014). A specific example of the conditions that warrant the need for this study can be seen in one of the strategic plans associated with the aspirations of a particular private sector organization (organization A), to shift to a high performance organization. Some of the operational plans to achieve this aspiration are noted as the need for formal approaches that are balanced, standardized and cost effective (Gowens, 2012). Formal approaches are likely to improve existing project management processes in the delivery of an organization's project portfolio, to ensure enhanced business benefits.

The recognition from private sector organizations acknowledges the value in the need to shift from traditional project management processes that are no longer appropriate in the effective management of multi-projects (X-Pert Botswana, 2011) comprising various levels of complexities. The value to be derived from effective practices requires an improvement in the processes associated with the selection of the project manager, along with other project stakeholders, as part of the need to improve existing PM2P practices in the context of Botswana.

2.3 Value of improving existing PM2P practices in the context of Botswana

Given the discussion in section 2.2.2, an improvement in processes is linked to an effective PM2P practice, which has potential to reduce mismatches between project managers and projects, leading to increased organizational performance. In particular, one of the strategic intent of organizations in Botswana is commitment to employees and the community (Botswana Insurance Holding Limited Group, 2013; Murray and Roberts Botswana, 2014), which is linked to the need to improve existing processes, leading to reduction in costs.

There are benefits of introducing a more rational system to improve existing PM2P practices that impact negatively on organizational performance, given the discussions in section 2.2. The real value to an organization associated with the need to improve existing PM2P practices that are affected by the choice of project manager, includes reductions in: senior manager's time spent on rectifying allocation decisions, mismatches between project managers and projects, mine accidents and associated costs, downtime and lost profits. This value may ultimately lead to improved accountability in decision making, improved productivity, increased organizational performance (Choothian et al., 2009; Patanakul et al., 2003, 2004, 2007), economic success and continued free education and health care for all Botswana citizens.

2.4 Author's anectodal evidence for the research problem

The research problem (knowledge gap) associated with the need and potential to improve the existing PM2P practice in the context of Botswana originated from the author's professional experience as a project manager in a financial organization based in Botswana's private sector, which operates in a MPE. A group of project managers were allocated to several projects to lead as part of delivering the organization's strategic goals. Each project manager from a pool of 15 project managers was allocated to manage a minimum of three projects simultaneously, by a Head of projects. The demand from the business was such that the number of projects to be implemented, including those in the pipeline, exceeds the number of project managers. The Head of projects was therefore, tasked with the responsibility of managing the portfolio of projects by making PM2P allocation decisions.

The author's observation, during the four years as project manager, was that the Head of projects used his own opinion, to process all the information (in his head) and make PM2P allocations decisions. For example, the Head of projects used his general knowledge of the project managers, in the absence of formal and effective management tools to substantiate the decision. In some instances, the Head of projects did not have sufficient information and time to make PM2P allocation decisions, due to pressure from the business. Projects came from regional office and had to be implemented urgently, such that the allocation decisions had to be made almost instantly, using tacit knowledge. This complex decision (comprising both structured and unstructured aspects) was made informally, on the basis of predominantly tacit knowledge. There were no formal and standardized procedures used to complement tacit knowledge, in the context of an effective PM2P approach that uses both tacit knowledge (for unstructured aspects of the decision) and formal tools (for structured aspects). There were also no documented project manager profiles that outline project manager competencies to assist in effectively matching project managers to projects. The absence of documentation meant that there were no records or information to inform the allocation decision.

Mismatches in PM2P allocations presented a major challenge to the responsible authority and the organization, in terms of a number of factors such as: project manager performance, project manager motivation, project manager turnover, project performance, recruitment costs for new project managers and training costs for newly recruited project managers. These factors impacted negatively on the overall organization's performance. Based on the above arguments from the author's professional experiences, there was an opportunity to improve the existing PM2P practice in the context of Botswana. This led to a review of relevant literature on studies that specifically report on PM2P practices in MPEs, to ascertain whether the author's experiences were unique.

2.5 Author's independent justification for using Botswana as context

Over and above the issues discussed in sections 1.1, 1.2, 2.1 and 2.2, this study required intensive grounding, fieldwork activities, process, commitment, effort, financial resources and time, to respond adequately to the research problem. The financial resources for all fieldwork travel from England to Botswana were provided for by the research sponsor (University of Botswana), also the author's current employer. It would have been unwise to conduct the research in a country that the author was not familiar with, particularly in view of stringent timelines for a PhD project and the challenges of access to data (Kervin, 1992; Fellows and Liu, 2008). It made sense to conduct research in Botswana, where 100% of the funding came from, to practically contribute to an improved way of allocating project managers-to-projects in a specific organization (organization A).

Besides empirical evidence of performance related factors that are affected by sub-optimal PM2P practices in Botswana's public and private sector, Botswana was a convenient place to go for data collection in the eyes of the author, who was born, bred, studied and worked in Botswana. Botswana was chosen, given the challenges of access to data in research. However, this does not suggest that data collection in Botswana is easy, since the author had to go through bureaucratic but necessary processes regarding to apply for Government research permits, a requirement for conducting research in Botswana. Furthermore, the basis of research is that it must be done within a certain context, particularly if the problem suits that particular context.

2.6 Limited literature on PM2P practices in MPEs

Given the discussions in section 2.5, the next logical step was a critical appraisal of relevant literature to understand this phenomenon (PM2P practice in MPEs). The literature revealed that the PM2P practice in MPEs is a limited research area that is currently underexplored, as highlighted in section 1.2. Although the work in Adams et al. (1979) and Mian and Dai (1999) was found to be important in identifying criteria to be considered in the matching of project managers-to-projects, additional criteria such as the contribution of projects to organizational strategy must be integrated into the PM2P practice (Patanakul et al., 2007). Furthermore, a comprehensive list of criteria that cover both hard and soft issues in the PM2P allocation process must be considered, for a more balanced approach. This reasoning is because a comprehensive list of criteria that takes account of all important factors, substantiates the resulting decision, particularly in a MPE.

Despite the currently underexplored research on PM2P practices in MPEs (Choothian et al., 2009; Hadad et al., 2013; Ogunlana et al., 2002; Patanakul et al., 2003, 2004, 2007; Sebt et al., 2009, 2010), these empirical studies, conducted in the context of other countries and industries, demonstrate that there are benefits to be derived from improving PM2P practices. The absence of empirical studies on PM2P practices from a Botswana context, constitutes an opportunity for improvement, as indicated in section 1.2. This argument is based on originality definitions highlighted in section 1.2. Given the limited empirical studies associated with improving PM2P practices in predominantly one region (North America), country (United States of America), industry (High-technology) and for specific project types (new product development projects), the intent of this thesis was to build on this limited area by extending it to the context of another region (Africa), country (Botswana), industry (mining) and project types (mineral exploration). Therefore, an opportunity exists to improve the PM2P practice in a new context (organization A in Botswana) that has hitherto not been studied. This opportunity is a central argument of this thesis, as it relates to the research problem statement in sections 1.1 and 1.2. The limited empirical studies on PM2P practices applicable to MPEs led to a broadening of this narrowly focussed research area. This approach is consistent with locating the research topic in the broader context, discussed next.

2.7 Locating the research topic in the broader context

It is important that the research topic be located within the broader field in relation to the core discipline and other cognate fields of enquiry (Tinkler and Jackson, 2004). However, this does not imply that extensive literature on all related fields must be examined and included in one research project. Phillips and Pugh (2005) and Tinkler and Jackson (2004) emphasize that the scope of the research has to be defined, to indicate the boundaries (see section 1.5).

In view of locating the research topic to the broader context in terms of literature, resource management was identified as the broader management literature surrounding the research topic. This is because the PM2P practice is a process that is aimed at optimizing the allocation of specific resources (project managers) to projects, leading ultimately to increased organizational performance (Patanakul et al., 2007). The project managers are a type of resource under human resource management (Hoobler and Johnson, 2004, Raiden et al., 2004), which is a subset of a broader field called resource management (Azarmi and Smith, 2007; Fitsimmons, 2009; Othman and Sheehan, 2011; Owusu et al., 2007; Sirmon et al., 2007). This thesis focuses on the need to improve the PM2P practice, which falls under the broader theory of resource management (ibid).

Resource management theory suggests that it is important to examine project managers (as resources) and that they must be managed using effective processes. The management of project managers, in the context of effectively allocating them to projects, is linked to improved organizational performance (Choothian et al., 2009; Patanakul et al., 2004). Despite this theory, representing best PM2P working practices, the literature search revealed no empirical evidence from a Botswana context that demonstrates that project managers are effectively managed in terms of processes for allocating them to projects. This absence of empirical evidence further supports the opportunity to improve the PM2P practice in the context of Botswana, consistent with the discussions in sections 1.1, 1.2, 2.1 to 2.5.

2.7.1 Critique of resource management definitions in organizational studies

Definitions of both resource and resource management are necessary for the purpose of this thesis. Azarmi and Smith (2007) and Owusu et al. (2007) suggest that a definition of both a resource and resource management is infeasible, given the multitude of perspectives that can be taken regarding the meaning of these terms. However, Amit and Shoemaker (1993) and Sheehan (2005) refute the view of an infeasible definition of a resource and suggest that a resource can be defined as an organization's productive element that the organization owns and has control of, such as physical assets, financial and human capital. The implications of these contrasting views are that a fixed definition of a resource is feasible, based on context. The definition suggested in (Sheehan, 2005) and supported in (Amit and Shoemaker, 1993) is adopted because it is consistent with organizational studies, which are relevant to this thesis, from a broader context. Examples of resources include: land, inventory, personnel, time, energy and money (Hartman and Boyd, 1998; Ragsdale, 2015). These resources are limited and hence give rise to important decisions on how to use them efficiently, to achieve organizational strategic goals (Fitsimmons, 2009; Ragsdale, 2015). The resources in this thesis are the project managers, who work for a particular organization, and not other types of resources.

Following an appropriate definition of a resource for the purpose of this thesis, resource management can now be defined. Azarmi and Smith (2007) reject a rigid definition of what constitutes resource management, on the basis that a concrete definition may be insufficient or quickly become obsolete. The views of Azarmi and Smith (2007), in rejecting a rigid definition, are supported by the different definitions of resource management that exist. For example, in habitat conservational studies for natural resources, resource management is the set of approaches that deal with preserving the reliability and existence of natural systems. This practice of management can be exemplified by water and air resource management (Habitat, 2012). However, the interpretation is that, contrary to views of Azarmi and Smith (2007), a firm definition of resource management is practical on the basis of context. Context refers to the multitude of perspectives that can be adopted in relation to a definition of this broad term called resource management.

Therefore, in the context of organizational studies, resource management can be defined as the process of efficiently and effectively deploying an organization's resources, where (location) and when (timeframe) they are needed (Owusu et al., 2007), to achieve strategic goals. This definition is akin to what Raiden et al.'s work (2001, 2004 and 2006) refers to as employee resourcing in the context of the construction industry. Resource management can be viewed as a process with a series of steps such as: predicting the demand for a specified volume of work over a specific time period; translating the prediction into a forecast in terms of the amount of required resources to execute the work; and optimally allocating the resources to the work or tasks (Owusu et al., 2007). This optimal allocation of resources to tasks, as per the principles of resource management, is not being applied in the context of PM2P practices in Botswana. Based on a definition of resource management in organizational studies, a literature search shows no evidence from a Botswana context to suggest efficient and effective processes for allocating project managers-to-projects, in the context of an effective PM2P practice.

Besides rejecting a firm definition of resource management, Azarmi and Smith (2007), instead present the following activities that shed light on what constitutes resource management: the management and supply of resources; the maintenance of inventory of resources; the allocation and/or re-allocation of resources; and, the planning and scheduling of resources. This list of activities is similar to what Owusu et al.'s (2007) work postulates as components of the resource management process that seek to answer several questions such as: (1) what task/job must be completed? (2) what are the available resources? (3) where are they located? (4) what are their profiles or attributes? and (5) when are they available to be deployed? Missing from this list is the question, what are the priorities of the tasks/jobs to be completed? This question is of critical importance in the context of this thesis, from a project prioritization perspective. Owusu et al. (2007) suggest that the resource management process may be split up into the following three steps: (1) determine workload for a particular time period, (2) translate above into a forecast in terms of number of required resources, and (3) create a resource allocation plan regarding who among the available resources should work on what, where and when. Based on these three steps, a literature search revealed no evidence to demonstrate that effective processes are used to allocate project managers to projects in Botswana.

Resource management is viewed in (Sirmon et al., 2007), under three stages of: resource structuring, resource bundling, and resource leveraging. However, in comparison with what constitutes resource management in (Owusu et al., 2007), the component of the job/task demand profiles (the actual job attributes) is missing from the definitions in (Azarmi and Smith, 2007) and (Sirmon et al., 2007). For this reason, Othman and Sheehan (2011)'s suggestion that the resource management process proposed in (Sirmon et al., 2007) is comprehensive, may not be accurate. Another reason may be that it focuses on corporate strategy in terms of building competitive advantage through leveraging the firm's capabilities.

However, the fourth and fifth edition of the Project Management Institute (PMI, 2008; PMBOK, 2013) provide a more holistic picture that can be used as a foundation to build a comprehensive resource management process. This resource management process, particularly the fifth edition which is recent, was used in conjunction with other resource management processes to build a generic resource management process. Justification for adopting ideas from PMI is that it is more comprehensive in comparison to existing resource management processes described in this section.

The series of activities under resource management have specific aims such as: minimizing operational costs, improving customer service delivery and maximizing profits (Azarmi and Smith, 2007). All of these aims are examples of achieving organizational strategic goals. The managerial decisions that have to be made during the resource management processes to achieve these strategic goals are influenced by a number of factors such as: organizational politics and power dynamics (Briner et al., 1996), organizational culture, organization's operating structure in terms of decision making, and project management structures. Several authors discuss these organizational factors under different contexts, in relation to the management of projects, programmes and portfolios (Adams et al., 1979; Aritua et al., 2009c; Ferns, 1991; Gray, 1997; Meskendahl, 2010; Pellegrinelli and Bowman, 1994; Pellegrinelli et al., 2007). While these publications contribute to the understanding of the importance of organizational factors that have an influence on successful management of projects, programmes and portfolios, they are too broad to be examined in great detail for this thesis. However, these organizational factors are acknowledged and linked to this thesis where appropriate. The series of activities under resource management have implications on PM2P practices in Botswana, given absence of empirical studies that report on improving these practices. The implications are associated with high operational costs, poor project delivery and reduced profits, arising out of sub-optimal PM2P practices. It is therefore sensible to seek to improve these PM2P practices, from a Botswana context, to reap the benefits demonstrated in other contexts (see Choothian et al., 2009; Patanakul et al., 2007).

2.7.2 Resource management theories – organizational perspective

The theory of sets (Ferreiros, 2000) is used to illustrate the broader management literature related to the specific thesis topic (Figure 2-1). Ideas in (PMI, 1996, 2008; PMBOK, 2013) were used as a basis to derive the contents of the resource management universal set, from an organizational rather than a project perspective.

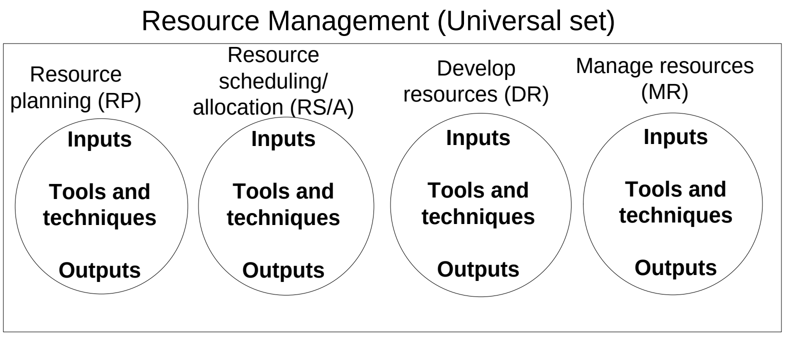


Figure 2-1 Broader management literature related to this thesis

Resource management represents the universal set. It comprises four main processes namely: resource planning, resource scheduling/allocation, developing resources, and managing the resources. Equations 1 and 2 describe the elements in Figure 2-1.

$$\in = RP + RS/A + DR + MR \text{ ––––––––––––––––––––––––––– } (1)$$

$$RP \cup RS/A \cup DR \cup MR = \emptyset \text{ –––––––––––––––––––––––––– } (2)$$

Using ideas in (PMI, 2004, 2008; PMBOK, 2013), the high level inputs to the resource management process, are:

i. identifying the organization's resource needs in relation to delivery and achievement of strategic goals (i.e. part of resource planning process);
ii. developing a resource plan to achieve strategic goals (resource planning);
iii. developing a strategy for resource procurement – process for acquiring required resources to achieve the organization's strategic goals (resource planning);
iv. resource scheduling/allocation; and

v. developing resources – investing in the procured resources in terms of capability for sustainable competitive advantage.

The high level output to the resource management process is achievement of organization's strategic goals (Azarmi and Smith, 2007). Examples of the lower level outputs to the resource management process include: resource plan, resource allocations and calendars, change requests, and resource performance assessments (Owusu et al., 2007; PMI, 2004, 2008; PMBOK, 2013). The mechanisms of converting the inputs to the outputs (ibid) are:

i. resource breakdown structure (RBS);
ii. organizational charts (documentation);
iii. training (for people resources);
iv. enhancements/upgrades and maintenance plans (for physical resources);
v. rewards and recognition programs;
vi. team building activities; and
vii. resource procurement strategies.

Given the above discussions, resource management theory suggests that both the lower level outputs and high level outputs require effective processes in relation to inputs. However, a literature search, including the discussions in section 2.4, suggests absence of evidence that the principles of resource management are applied. This lack of evidence represents a need and opportunity to improve the existing PM2P practice in the context of Botswana.

2.8 Building a generic resource management process

In the absence of a generic and comprehensive resource management process that is applicable to the context of managing any resource types from an organizational perspective, the contents of several concepts (Azarmi and Smith, 2007; Darren et al., 2003; Fitsimmons, 2009; NIMS, 2009; Othman and Sheehan, 2011; Owusu et al., 2007; PMI, 2004, 2008; PMBOK, 2013; Sirmon et al., 2007) were critically reviewed and used to build a generic resource management process (Figure 2-2). This generic resource management process is used simply to demonstrate links between the specific research topic and broader management theories, although this study is focussed on the allocation of specific resources (project managers) and not other types of resources.

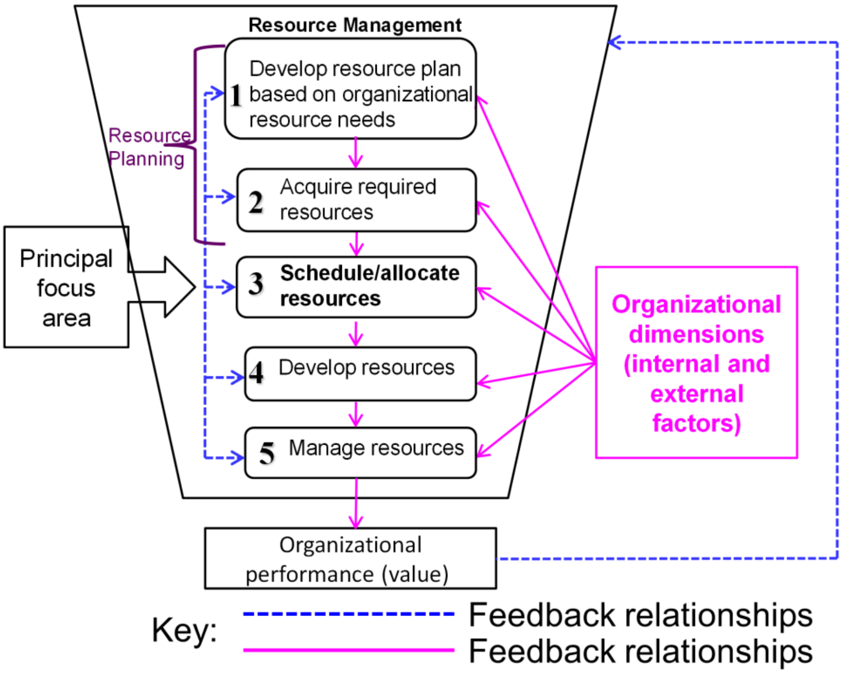


Figure 2-2 A generic resource management process

The structure of the process proposed in (Sirmon et al., 2007) was adapted to present a generic and comprehensive resource management process, illustrated in Figure 2-2. A discussion of the processes that make up the universal resource management set shown in Figure 2-2 is presented.

2.8.1 Resource planning

The theory of resource planning can be defined as the process of identifying and documenting required resource needs as well as how they will be acquired, over a futuristic planning horizon, to achieve the organization's strategic goals (Owusu et al., 2007). The idea of a futuristic view in terms of timelines for planning differentiates resource planning from resource scheduling. In resource planning, the resource needs can be analysed and categorized in terms of profiles (attributes) such as: resource kind, resource quantity, resource type, resource size, resource capacity, resource capability, and resource skills (NIMS, 2009). The aim of resource planning is to enable an organization to maximize resource utilization (PMI, 2008; PMBOK, 2013). This aim can only be achieved if the resource planning process is performed well, such that correct information is fed into resource scheduling/allocation. This argument is akin to an assertion that resource planning is an essential predecessor to successful resource scheduling/allocation (Owusu et al., 2007).

Ideas in (PMI, 2008; PMBOK, 2013) were used to illustrate the theory of organizational resource planning. This organizational resource planning theory is summarized in Figure 2-3, showing both a generic and a specific resource plan applicable to project managers (the resource type for this thesis).

The resource plan comprises three components namely: inputs, tools and techniques and outputs. Figure 2-3 is an exploded view of the resource planning process, which is the first component of the resource management universal set illustrated in Figure 2-1. In the absence of an existing resource planning process that is generic, ideas from different resources (Darren et al., 2003; Fitsimmons, 2009; NIMS, 2009; Owusu et al., 2007), were appraised and used to build the resulting generic resource planning process (Figure 2-3). This generic resource plan was subsequently applied to project managers, as a specific resource type applicable to this thesis.

Generic Resource Plan	Specific Resource Plan (Project Manager resources)
1. Inputs ▪ Task/Job requirements (forecast) ▪ Resource requirements (forecast) ▪ Task/Job priorities ▪ Organizational dimensions (internal & external) ▪ Organizational process related assets (e.g., processes, procedures, policies, guidelines)	1. Inputs ▪ Project requirements (forecast) ▪ Project Manager requirements (forecast) ▪ Project priorities ▪ Organizational dimensions (internal & external) ▪ Organizational process related assets (e.g., processes, procedures, policies, guidelines, lesson learned)
2. Tools & Techniques ▪ Organizational charts ▪ Resource Breakdown Structures (RBS) ▪ Work Breakdown Structures (WBS) ▪ Position descriptions, Work process charts ▪ Resource procurement strategy ▪ Networking activities ▪ Organizational structures (influencing personal relationship characteristics) ▪ Enterprise Resource Planning (ERP)	2. Tools & Techniques ▪ Organizational charts ▪ Resource Breakdown Structures (RBS) ▪ Work Breakdown Structures (WBS) ▪ Project Manager roles and responsibilities ▪ Project Manager resource procurement strategy ▪ Networking activities ▪ Organizational structures (influencing personal relationship characteristics) ▪ Enterprise Resource Planning (ERP)
3. Outputs ▪ Resource Plan	3. Outputs ▪ Project Manager resource Plan

Figure 2-3 Resource planning and link to project manager resources

In essence, the specific resource plan for project manager resources is a version of the generic resource plan. The contents of Figure 2-3 show the sequential flow in relation to the inputs for developing a resource plan. The inputs provide guidance on the organization's resource requirements in relation to the portfolio of work to be completed to accomplish strategic goals. The organizational process related assets such as standard procedures (under inputs to the resource plan) can be used to identify anticipated resource requirements (PMI, 2004, 2008; PMBOK, 2013). Standard procedures may be viewed in the context of effective PM2P practices. For example, the use of management tools and techniques to complement managerial intuition in making effective PM2P allocation decisions, represents standard procedures in relation to best practices.

A literature search, including the author's professional experiences about the existing PM2P practice in the context of Botswana (section 2.4), suggests no evidence of these standard procedures. The mechanisms for converting inputs to outputs are listed under tools and techniques (Figure 2-3). A resource breakdown structure can be used to organize the identified and required resources in a useful hierarchical structure, in terms of resource categories. The output is a resource plan that provides guidelines on resource profiles needed to execute the work demands. Given absence of evidence from a Botswana context, including discussions associated with the author's observations regarding the absence of documented project manager profiles, an opportunity exists to improve the existing PM2P practice in the context of Botswana.

2.8.2 Resource scheduling/allocation

Resource scheduling or allocation involves selecting resources and allocating them to tasks on a day-to-day basis (NIMS, 2009). This process must be done in an effective way to ensure high levels of match between resources and tasks. The day-to-day nature of this process requires more specific and accurate information and differentiates it from resource planning, which involves a forecast of required resource needs. This may explain why enterprise resource planning (under tools and techniques in Figure 2-3) is an appropriate tool for planning and not for scheduling/allocating resources to tasks. Resource allocation is also referred to as resource scheduling by some authors. For example, Owusu et al. (2007) discuss the scheduling of tasks concurrently with the allocation of those tasks.

Resource allocation in project management, viewed as a subset of the broader theory of resource management in this thesis, is a complex hierarchical decision making process (Hartman and Boyd, 1998; Jennings and Wattam, 1998; Keeney and Raiffa, 1993; Kocaoglu, 1984; Patanakul, 2004). This process takes place at different levels in the organization. In the context of this thesis, resource allocation can be viewed at three different levels namely: strategic level, program or portfolio level and project level (see Figure 2-4).

The principal focus of this study is on the middle level (Figure 2-4), where the responsible authority makes PM2P allocation decisions. The intent is to improve these PM2P allocation decisions, from an overall approach that is contextual in Botswana.

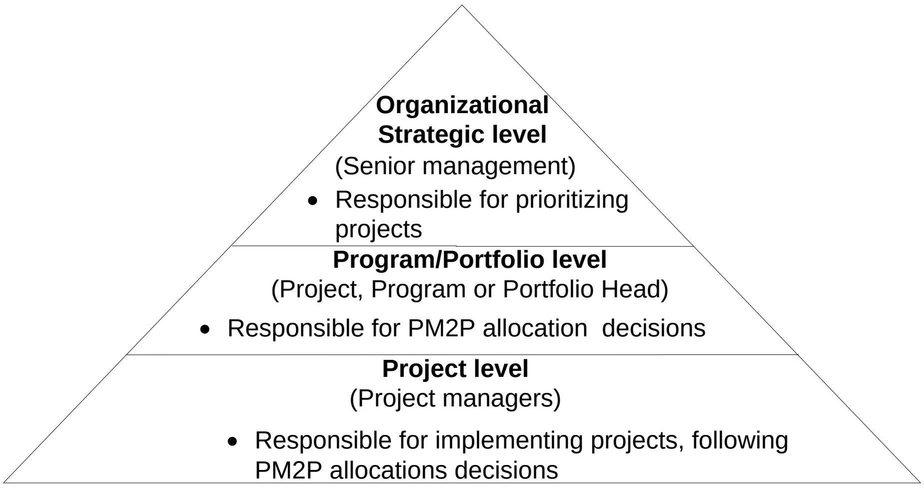


Figure 2-4 Levels of resource allocation decisions

The PM2P allocation decision (as a process) comprises inputs, management tools and techniques, that a decision maker uses to guide his/her decision making about the allocations (output). The responsible authority may have different titles, depending on the specific organization and its hierarchy. The discussion in this section is more comprehensive than other sections, given the emphasis on resource allocation.

Management literature (Adams et al., 1979; Badiru, 1996; Brown and Eisenhardt, 1995) has established that this decision is treated casually by some practitioners, yet it is among the critical factors to performance. The literature findings are consistent with the arguments in section 2.2 about existing PM2P practices from a Botswana context, and section 2.4 about the author's anecdotal evidence. Empirical evidence on PM2P practices in MPEs reveal that this practice has been explored in countries such as USA, in terms of improving working practices and that there has been some value derived from improving those PM2P practices. Given the discussions in sections 1.1, 2.2 to 2.4, there is need to improve the PM2P practice in the context of Botswana, to derive the benefits associated with improved organizational performance**.**

An example of a resource allocation problem is the task of selecting field engineers by identifying their profiles and allocating them to incoming service jobs, to optimize service quality while reducing operational costs (Owusu et al., 2007). The term profiles, refers to the attributes of the resources in terms of their capabilities and location (ibid).

In the case of British Telecoms (BT), the managers responsible for this decision making task use an information system called Work Manager, to aid their decision making process regarding which engineers to allocate to which incoming service jobs (ibid). The relevance of this decision making process at BT can be linked to this study by replacing the engineers with project managers and the incoming service jobs with projects. The intent of this thesis is to practically contribute to allocating project managers-to-projects in a specific organization based in Botswana, given absence of empirical evidence that suggests the use of effective tools and processes to allocate resources, from a Botswana context. In the context of resource allocation, efficient use of these resources is vital to improving productivity for national and international economic competitiveness (ibid).

Hartman and Boyd (1998) propose three theoretical approaches that can be used to examine the motivations, objectives and constraints impacting on a decision-making behaviour. These are: the rational, bureaucratic and political approach. The rational approach attempts to address the question of whether the decision-maker has the knowledge and understanding of the inputs required in the decision making process of allocating resources. The bureaucratic approach emphasizes standard operating procedures, rules and 'fixed' procedures for doing things as pre-determined by senior management (Alison, 1971). The political approach is associated with power, control and self-interest on the part of the decision-maker (Hartman and Boyd, 1998). These three theoretical approaches may be used to characterize the contextual factors faced by the decision-makers' resource allocation process (ibid). Therefore, the link between these theoretical approaches to this study lies in their role in influencing or constraining the motivations and objectives on the decision maker's behaviour, in terms of his/her PM2P allocation decisions.

The decision making process of allocating resources to utilize them effectively, within the confinements of organizational constraints, is fundamental to organizational performance (Patanakul et al., 2007; PMI, 2008, 2013). The constraints in which this decision making process is made require an understanding of the organizational structures, on the part of a decision maker (Hartman and Boyd, 1998). These organizational structures, which may include internal and external influences, have an impact on the constraints faced by the decision maker, in a PM2P practice context.

The contents of the resource allocation process, for both generic and specific project manager resources, are outlined in Figure 2-5. The generic resource allocation process (left-hand side) can be applied to the PM2P practice, in the context of project managers as a type of resource (right hand side in Figure 2-5). Examples of the inputs to the generic resource allocation process are: organization’s mission, strategic goals and the portfolio of work to be carried out to deliver the business strategy (Patanakul et al., 2007; PMI, 2006, 2008). The mechanisms for converting these inputs to outputs include: reports on past resource performance, multi-criteria decision making techniques, and improvement plans for current resources to upgrade their capabilities. An example of a significant output is effective utilization of resources (left hand side in Figure 2-5). This effective utilization implies high levels of match between project managers and projects, arising from optimum PM2P practices. However, the discussions in sections 2.1 to 2.6 suggests low levels of match between project managers and projects, in the context of Botswana’s existing PM2P practices. There is therefore, an opportunity to improve the existing PM2P practice in the context of Botswana.

Resource allocation

1. Inputs
- Organizational Mission & strategic goals
- Resource lists, profiles (e.g., available capacities, quantities, skill levels)
- Current Job demands/portfolio & location
- Job attributes (e.g., complexity)
- Resource availability (e.g., current workload)
- Organizational dimensions (internal & External)
- Decision maker’s personal preferences

2. Tools & Techniques
- Deliverables
- History of Performance of resources (reports)
- Scoring models & rating techniques
- Delphi
- Multi-Criteria Decision Making Techniques (e.g., Analytic Hierarchy Process)
- Rewards & recognition (people resources)
- Performance improvement programs
- Training (people resources)
- Discarding non-performing resources
- Investment in new resources with required capabilities

3. Outputs
- Effective utilization of resources
- Updates to Organizational processes/procedures, plans
- Increased Organizational performance

Resource allocation (Project Manager resources)

1. Inputs
- Organizational Mission & strategic goals
- Project Manager competencies, levels of existing competencies
- Current Project portfolio & geographic locations
- Project requirements/attributes (e.g., complexity)
- Project Manager availability & personal limitations, Project team strength & availability
- Organizational dimensions (internal & External)
- Decision maker’s personal preferences

2. Tools & Techniques
- Project Manager roles and responsibilities (deliverables)
- Previous Project Manager Performance appraisals
- Scoring models & rating techniques
- Delphi
- Project Manager Lay-offs (non-performing) and recruitment of those with required competencies for complex project portfolios
- Multi-Criteria Decision Making Techniques (e.g., Analytic Hierarchy Process)
- Project Manager Training
- Rewards & recognition

3. Outputs
- Effective utilization of Project Managers
- Organizational process updates (e.g., staffing management plans, lessons learned)
- Increased Organizational performance

Figure 2-5 Resource allocation process and link to this thesis

2.8.3 Develop resources

Developing resources is a process that involves making improvements by maintaining resource capabilities up to date, in the face of changing conditions (PMI, 1996, 2008; PMBOK, 2013). Resource capabilities can also be improved beyond maintaining capabilities by upgrading them through enrichment and enhancements, with a view to attain increased organizational performance (Sirmon et al., 2007). In the case of people resources, this process involves improving competencies through activities such as training and team-building. This may include motivating people by rewarding and recognizing their performance, in addition to improving overall organizational climate (PMI, 2008; PMBOK, 2013). Given the author’s observations (section 2.4) and the absence of publications associated with PM2P practices in Botswana’s MPEs, there is no evidence to suggest effective processes for managing project managers.

In the case of other resource types such as physical resources, developing the resources can include investing in technological enhancements, maintaining or servicing and upgrading machines, discarding non-productive resources and replacing them. The contents of this process, under the broader resource management theory, are outlined in Figure 2-6.

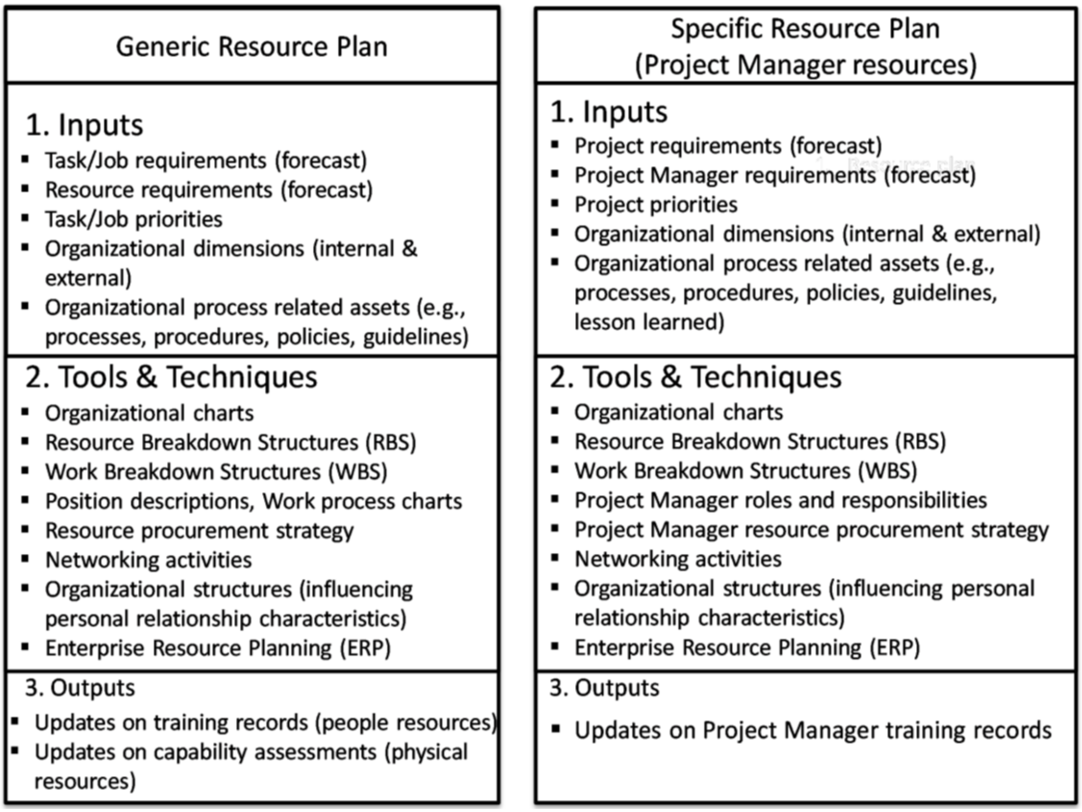


Figure 2-6 Resource development and link to specific resources

Examples of the inputs, tools and techniques and outputs to the process of developing resources, for both generic resources and project manager resources, are illustrated in Figure 2-6.

2.8.4 Manage resources

Managing resources is the last process under the broader resource management process. From a generic context, the process of managing resources is the same in terms of principles followed, regardless of resource type. It involves documenting resource needs, profiles, management plans, and conducting productivity assessments to determine which resources need to be improved as part of achieving the organization's strategic goals. The absence of documented project manager resource profiles was highlighted in section 2.4, in relation to the existing PM2P practice from a Botswana context.

There are various strategies to be considered in improving performance of resources such as discarding non-performing resources and investing in new resources that possess required capabilities to handle changing conditions (PMI, 2008; PMBOK, 2013; Sirmon et al., 2007). The contents of this process are presented in Figure 2-7, for the management of both generic resources and specific project manager resources. Given the discussions in sections 2.8.1 to 2.8.4, an opportunity exists for applying the universal process for resource management to this thesis, in the context of the PM2P practice.

Manage Resources	Manage specific resources (Project Manager resources)
1. Inputs ▪ Documented resource lists and profiles ▪ Resource management plan (e.g., resource needs – quantities, capability, training plans, improvement plans, etc) ▪ Productivity assessments ▪ Productivity reports ▪ Organizational processes/procedures & policies	1. Inputs ▪ Documented Project Manager lists and profiles ▪ Project Manager training plans ▪ Project Manager performance assessments ▪ Project Manager performance reports ▪ Organizational processes and policies (e.g., limits on working hours due to labour laws and Unions)
2. Tools & Techniques ▪ Work Breakdown Structure and deliverables ▪ Performance appraisals ▪ Conflict management ▪ Discarding non-performing resources and replacements (e.g., procuring new resources, outsourcing work) ▪ Discarding non-core operations and business units(e.g., procuring new resources, outsourcing work)	2. Tools & Techniques ▪ Project Manager roles and responsibilities (deliverables) ▪ Project Manager Performance appraisals ▪ Conflict management ▪ Project Manager Lay-offs (non-performing) and recruitment of those with required competencies for complex project portfolios
3. Outputs ▪ Organizational process updates (e.g., organizational standards) ▪ Change requests (e.g. new equipment, staff, outsourcing) ▪ Resource management plan updates	3. Outputs ▪ Organizational process updates (e.g., lessons learned) ▪ Updates to Project Manager staffing plan

Figure 2-7 Managing resources and link to specific resources

2.9 Managing project managers as a type of resource

The identified theories from the broadening of the literature surrounding the PM2P practice in MPEs are linked to managing project managers. Project managers must be managed effectively, to maximize performance. The management of project managers is linked to the effectiveness of decision-making processes associated with allocating them to projects. This decision making process requires an assessment of important attributes, such as project requirements, competencies and organizational requirements, in the context of achievement of an organization's strategic goals (Choothian et al., 2009; Patanakul et al., 2007, Raiden et al., 2004). Competencies are also referred to as resource capabilities by some researchers (such as Bower, 2013 and Raiden et al., 2004). Resource management theory suggests an important need to use effective processes for managing and allocating project managers-to-projects, leading to improved organizational performance. A literature search, including the evidence in section 2.2, suggests that these effective processes are absent in existing PM2P practices from a Botswana context. The absence of evidence from a Botswana context, further supports the idea regarding opportunities to improve existing PM2P practices in MPEs of Botswana.

2.10 Need to respond to the research problem (knowledge gap)

Given the discussion in sections 2.1 to 2.9, there is need to respond to the research problem, to improve the existing PM2P practice in the context of Botswana. The benefits derived from improving PM2P practices in USA, and the evidence of informal and sub-optimal PM2P practices from a Botswana context (Farole, 2014; Hughes, 2014), demonstrate that there is need and opportunity to improve existing PM2P practices in Botswana (the main argument in this thesis).

The importance of studying and improving PM2P practices in a new context that is hitherto unknown in existing knowledge cannot be overemphasized, given the significance of globalization of working practices (which include PM2P practices). This argument is supported by empirical evidence from other countries and industries (Choothian et al., 2009; Patanakul and Milosevic, 2006; Patanakul et al., 2007), demonstrating the value of improving the PM2P practice. Therefore, the aim and objectives outlined in section 1.3, are a sensible and robust response to the research problem.

2.11 Summary

This chapter has demonstrated the importance of the need to improve the existing PM2P practice in the context of Botswana's MPEs, in terms of the likely benefits to be derived from improved working practices. The arguments made in this chapter show that improving the PM2P practice is among the crucial factors to increased organizational performance. The lack of effective PM2P practices from a Botswana context warrants the need for an improved way of allocating project managers-to-project, in terms of potential to increase organizational performance. The issue of drawing from several theories and demonstrating their link to the specific topic of PM2P practice in MPEs, extends our understanding of existing knowledge. For example, the broadening of the literature surrounding the thesis topic addresses a gap in existing empirical studies reported in (El-Sabaa, 2001; Hadad et al., 2013; Ogunlana et al., 2002; Patanakul, 2004; Sebt et al., 2010).

Chapter 3

Decision making and optimization approaches to the PM2P practice

The previous chapter justified the basis for this study, from a Botswana context. This chapter provides a review of literature regarding theories surrounding the PM2P practice, with a view to establish the conceptual basis for this study. The following sections fulfil the purpose of this chapter: (1) literature streams and categorization of conceptual frameworks for the PM2P practice, (2) critique of existing conceptual frameworks and identified gaps in existing literature, (3) approaches to resource allocation problems, (4) decision making and theories, and (5) Selection of research variables, propositions and associated hypotheses.

3.1 Literature streams and categorization of conceptual frameworks for the PM2P practice

The discussions in sections 2.2 to 2.4 were used as a basis to significantly broaden the limited and specific literature that directly propose conceptual frameworks for the PM2P practice. The aim was to encapsulate cognate fields of inquiry in terms of theories related to this limited literature, using broader management theories. This attempt resonates with ensuring that a conceptual framework can be proposed for this study, such that it is comprehensive and well-grounded in management literature from various authors that support each component. This means that the resulting conceptual framework can be said to be both comprehensive and generic in nature, in terms of key components that influence effective PM2P practices. The literature to propose a conceptual framework was categorized into 8 streams, covering both the depth and breadth of management literature surrounding the thesis topic. The term ‘allocation’ is preferred over ‘assignment’ because it resonates with resource management theory (Owusu et al., 2007; Hartman and Boyd, 1998; PMI, 2008; PMBOK, 2013), identified as the broader theory surrounding the thesis topic. Table 3-1 is a summary of the 8 identified literature streams, with references supporting each stream. A brief discussion of these identified literature streams, critically reviewed in the context of identifying and supporting key components of a conceptual framework for the PM2P practice, is presented.

Table 3-1 Identified literature streams under resource management

Literature streams	References
Stream 1:PM2P practice and organizational environments	Aritua et al., 2009c; Boyatzis, 2007; Clegg, 2000; Cooke and Slack, 1991; Fiedler and Chermers, 1974
Stream 2:Multi-project environment and management of projects, programs and portfolios	Aritua, 2009; Artto and Dietrich, 2004; Blismas et al., 2004; Caniels and Bakens, 2012; Dietrich et al., 2002; Gareis, 1991, 2006; Hagan et al., 2011; Ireland, 1997; Laslo, 2010; Patanakul, 2009; Payne, 1995; Pellegrinelli, 2002; Platje and Seidel, 1993
Stream 3:Project complexity within a multi-project management environment	Williams, 1999; Turner and Cochrane, 1993; Baccarini, 1996; Aitken and Crawford, 2007a; Cooke-Davies and Patton, 2008; Geraldi and Adlbrecht, 2007; Geraldi, 2009; Tatikonda and Rosenthal, 2000; Richardson et al., 2005; Hagan et al., 2011; Cicmil et al., 2009; Pellegrinelli, 2002
Stream 4:Project manager competencies for managing single projects	Stevenson and Starkweather, 2010; Hauschildt et al., 2000;Archibald, 1975; Dulewicz and Higgs, 2005; Fricke and Shenhar, 2000; Karz, 1955; Madter et al., 2012; PMI, 1996, 2007; Crawford, 2006, 2007b; Müller and Turner, 2007,2010; Pettersen, 1991a; Shenhar and Thamhain, 1994; Waller, 1997; Posner, 1987; Patanakul and Milosevic, 2009
Stream 5:Project manager competencies for managing multiple concurrent projects	Aritua et al., 2009c; Blissmass et al., 2004; Fricke and Shenhar, 2000; Ireland, 1997; Olsson, 2008; Shenhar and Thamhain, 1994; Thamhain, 1991; Tobis and Tobis, 2002
Stream 6:Project critical success factors	Archibald, 1975; Gudienė et al., 2013; Ihuah et al., 2014; Slevin and Pinto, 1986
Stream 7:Implied conceptual frameworks for PM2P practice	Archibald, 1975; Frame, 1999; Augustine, 1959; Ilincuta and Jergeas, 2003; Pettersen, 1991a
Stream 8:Explicit conceptual frameworks for PM2P practice applicable to multi-project environments	Adams et al., 1979; Choothian et al., 2009; Hauschildt et al., 2000; Mian and Dai, 1999; Patanakul et al., 2003, 2004, 2007; Patanakul and Milosevic, 2006, 2009; Patanakul, 2009

3.1.1 PM2P practice and organizational environments

Various literature sources under this stream were reviewed and grouped under the term ‘organizational dimensions’ (both internal and external) that influence the PM2P practice. The concepts under this stream include: organizational politics and power dynamics, culture and leadership, organization's physical resources and structures in relation to management of projects. The dynamic interplay between the organizational dimensions (Aritua et al., 2009c) is acknowledged as an influencing factor in the PM2P practice. This means that the responsible authority, in his/her role of making PM2P allocation decisions, must understand and deal with these organizational dimensions in the context of his/her organizational environment (Harrison, 1981; Jennings and Wattam, 1998). For example, the responsible authority must handle the organizational culture, linked to the organization's strategy, processes and people (Aritua et al., 2009a) in his/her role. The interplay between the various organizational dimensions of the socio-technical system, are demonstrated in Figure 3-1, in the context of linking them to components of the conceptual framework for understanding PM2P practices in an organizational setting.

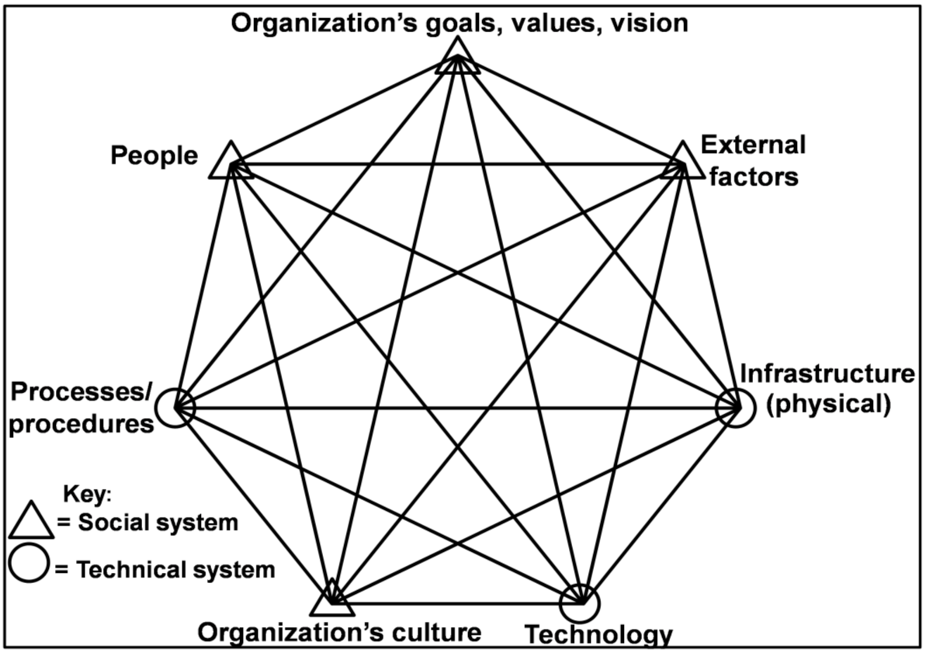


Figure 3-1 Interactions between organizational dimensions. Source: Aritua et al. (2009)

The influence of these organizational dimensions are acknowledged in Cooke and Slack (1991), as the social pressures and issues felt by the decision maker in his/her role and acting in the presence of other stakeholders within an organization's internal climate. Fiedler and Chermers (1974) support the concept of organizational dimensions by using the term 'organizational climate' in relation to *"organizational constraints and redtape"* (p. 57) faced by the decision maker.

External factors may fall under both social and technical system and include: legal, economic, financial, political, environmental and religious conditions within a specific country in which an organization is operating. Boyatzis (2007) refers to these external factors as:

"…….aspects of the economic, political, social, environmental, and religious milieu surrounding the organization." (p.6).

The interpretation is that external factors may influence the PM2P practice. For example, both internal and external stakeholders such as clients, customers and suppliers (who are users of the project's output), can influence the PM2P allocation decision. The interplay between the various organizational dimensions and their influence on the PM2P allocation decision is implied at each process within the overarching PM2P practice, made up of three processes namely: project prioritization, project manager-to-project (PM2P) matching, and recognition of constraints.

In project prioritization, organizational dimensions such as culture, leadership and politics are at play in terms of decisions on project priorities. Similarly, in the PM2P matching process, organizational dimensions such as politics and power dynamics (House et al., 2004), are at play in terms of influencing PM2P allocation decisions. These organizational dimensions include both internal and external factors that may have an influence on the PM2P practice. However, existing literature on PM2P practices (Adams et al., 1979; Choothian et al., 2009; Hauschildt et al., 2000; Patanakul et al., 2007) do not explicitly acknowledge these organizational dimensions, present in management practices of today's organizational environments.

This thesis will respond to this gap by explicitly incorporating organizational dimensions into the development of a conceptual framework for effective PM2P practices, whilst acknowledging the issue of context. For example, it would be impractical to develop a conceptual framework that can be used across countries, industries, organizations and project types; due to variations in contextual factors. Evidence from the GLOBE research project on the relationship of culture to conceptions of leadership across 62 countries, measured at different levels of industry and organization reveals that views on the importance and value of leadership varies considerably across countries; due to cultural forces at play in each specific country (House et al., 2004). Therefore, the contents of the conceptual framework may be influenced by contextual factors and hence applicable to a specific context, due to the above variations. Explicit recognition of these contextual factors is important, in the context of an effective PM2P practice.

This explicit recognition represents an addition to existing literature on conceptual frameworks for the PM2P practice in MPEs.

3.1.2 MPEs and management of projects, programs and portfolios

The discussions in section 2.1 regarding definitions and possibilities of a MPE are expanded in this section. Ideas in (Patanakul and Milosevic, 2009), supported by several authors (such as Blismas et al., 2004; Elonen and Artto, 2003; Engwall and Jerbrant, 2003; Geraldi, 2008; Pellegrinelli, 2002; Aritua et al., 2009c), were adopted to illustrate a potential representation of the management of projects, programmes and portfolios within an organizational setting (see Figure 3-2). The term potential is used to acknowledge the different organizational project management structures that exist in relation to the management of projects, programmes and portfolios.

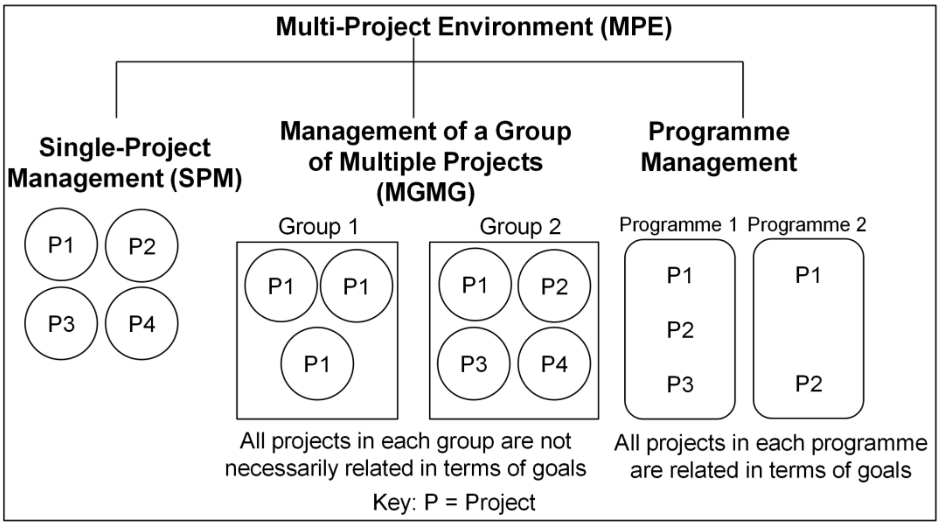


Figure 3-2 Representation of a MPE environment within an organization. Source: Patanakul and Milosevic (2009)

In the management of single projects, each project manager leads one project at a time. However, in the management of multi-projects and at project manager operational level, a project manager can lead either one project or more than one project concurrently (Payne, 1995; Patanakul and Milosevic, 2008; Patanakul and Milosevic, 2009; Caniels and Bakens, 2012). Though each project manager competes and shares a pool of limited resources with the other project managers, the benefit lies in efficient utilization of scarce resources. There is reduction in resource idle time from the sharing of know-how possessed by project team members from different functional departments. Furthermore, clear links between projects and organizational strategy exist (Olsson, 2008) in MPEs (as discussed in section 2.1). This may be due to clustering of projects, with a view to facilitate effective management and most importantly, achieve delivery of the organization's strategic goals (Meskendahl, 2010; Patanakul and Milosevic, 2009).

An important distinction between portfolio and program management is that, unlike in program management where all the projects in each program have common goals, all projects in each group of a portfolio are not necessarily related in terms of goals (Pellegrinelli, 2002; Pellegrinelli et al., 2007; Pennypacker and Dye, 2002). This means that the projects within a portfolio may not necessarily be directly related in terms of goals (Ireland, 1997).

The management of projects is also influenced by the adopted project management structure. Several project management structures are possible within an organization. The chosen structure is dependent on a number of factors such as how senior management views the benefits of using a preferred project management structure, probably to be approved by the board. The chosen structure will dictate the approach to be used in implementing the various projects, on the basis of how the projects sit within the organization and their relationships to existing business processes (Patanakul, 2013; Pellegrinelli and Bowman, 1994). These relationships represent some of the factors that may have an influence on the PM2P practice. These factors are incorporated into the development of a conceptual framework for this thesis.

3.1.3 Project complexity within a MPE

The concept of project complexity is discussed by numerous authors under different contexts (Baccarini, 1996; Tatikonda and Rosenthal, 2000; Vidal and Marle, 2008; Aitken and Crawford, 2007b; Cicmil et al., 2009; Geraldi, 2009; Hatcher et al., 2013). Project complexities, in the context of characteristics, are more notable in a MPE, characterized by uncertainties and risks due to a dynamic environment. These complexities have implications on project manager competencies required to cope with the management of different projects types (Crawford and Nahmias, 2010; Crawford, 1997; Muller and Turner, 2007, 2010). The required competencies in turn have an influence on the PM2P allocation decision. Aspects of project complexity were explored from critical appraisal of management literature, in the context of influence on the PM2P practice. The results of this critical appraisal, in terms of a content (Krippendorff, 2004) and thematic analysis (Bazeley, 2009a) of the literature on characteristics of project complexity within a MPE, revealed eleven key aspects (see Table 3-2).

Table 3-2 Key aspects of project complexity within a MPE

Key: DSS = decision support system

Resources & People	Company Structure	DSS	Planning & Controlling	Strategic Goals &	Synchronization	Numerous interfaces	Communication and Stakeholders sophistication	Managing Risk	Processes	Distributed or co-located resources	References
						1		1			(Williams, 1999)
1			1								(Platje and Seidel, 1993)
1			1								(Platje et al., 1994b)
1						1	1		1	1	(Baccarini, 1996)
1	1						1				(Gray, 1997)
2	1		1	1	1	1			1		(Turner and Cochrane, 1993; Payne, 1995; Payne and Turner, 1999)
						1		1		1	(Richardson et al., 2005; Cicmil et al., 2009)
3	1	1	1		2						(Pellegrinelli, 2002; Pellegrinelli et al., 2007)
								1			(Hans et al., 2007)
				1		1	1				(Cooke-Davies and Patton, 2008)
1			1			1					(Platje et al., 1994b; Vidal and Marle, 2008)
	1			1							(Van Der Merwe, 1997)
1			1								(Gareis, 2006)
2					1	1					(Laslo and Goldberg, 2008)
						2	1	2	1		(Leijten, 2008)
						1	1	2			(Aitken and Crawford, 2007a)
						2		2	1		(Geraldi and Adlbrecht, 2007; Geraldi, 2009)
		1				1					(Meskendahl, 2010)
						1		2			(Tatikonda and Rosenthal, 2000)
13	**4**	**2**	**6**	**3**	**4**	**14**	**5**	**10**	**4**	**2**	

The numbers within the cells indicate the number of citations or the number of times that a particular theme of project complexity has been referred to by authors (represented in the column labelled ‘references’). The total number of citations for each theme is shown in the last row. The results reveal that the concept of many interfaces (both internal and external) is a dominant factor that characterizes the concept of project complexity, in the context of MPEs defined by unanticipated changes. This is followed by the concept of resources and people, including the need to manage uncertainty and risk. These characteristics of project complexity are recognized on the basis that they play a role in the PM2P practice, in terms of required project manager competencies for leading different project types with varying levels of complexities (Müller and Turner, 2007; Geraldi and Adlbrecht, 2007; Müller et al., 2012).

3.1.4 Project manager competencies for managing single projects

Conventionally, project manager competencies have long been conceptualized on the basis of management of single projects (PMBOK, 2008; PMI, 1996, 2008), despite the growing body of literature on multi-projects. The concept of a project manager’s competencies in leading single projects is widely discussed (implicitly) by numerous authors under different context (Archibald, 1975; Pettersen, 1991a; Pettersen, 1991b; Shenhar and Thamhain, 1994; Hauschildt et al., 2000; Crawford, 2007a; Crawford, 2006; Dulewicz and Higgs, 2005; PMI, 2007; Muller and Turner, 2010; Stevenson and Starkweather, 2010). Drawing from the work of these authors, this stream is particularly useful, given that the management of multiple simultaneous projects also requires competencies for leading individual projects, all of which play a role in the PM2P practice. The streams of literature on project manager competencies for managing single projects and multiple concurrent projects is brought to bear on key components of a conceptual framework for understanding the PM2P practice.

In view of extensive literature reviewed in relation to project manager competencies across different industries (Ahadzie et al., 2008; Archibald, 1975; Cheng and Dainty, 2005; Crawford and Nahmias, 2010; Dainty et al., 2003; Dulewicz and Higgs, 2005; Duncan, 1999; Fricke and Shenhar, 2000; Muller and Turner, 2007, 2010; Patanakul and Milosevic, 2009), an interesting observation is that all of these publications do not explicitly mention the ability of the project manager to work effectively within a diverse team. Diverse team is used in the context of cultural backgrounds. For example, Madter et al. (2012) identify a comprehensive list of twenty-nine construction project manager competencies, in the context of career development, but do not explicitly include the ability of the project manager to work in a multi-cultural diverse workforce; particularly since globalization is recognized by these authors in relation to managing the risk of organizational collapse. However, this ability of the project manager may be implied under competencies such as: communication skills, conflict management, negotiation skills and relationship management. Notwithstanding, Yasin et al. (2000) acknowledge the importance of understanding cultural differences and identify cultural sensitivity, among the desirable competencies of a project manager. Müller and Turner (2007) corroborate the view of cultural sensitivity by stating *"knowledge of the local language and legal system"* (p.25). These authors also specifically identify cultural understanding as an *"entry ticket"* of a project manager to be selected for managing projects in which the following conditions exist: regular contact with other cultures, clients hosted from abroad, involvement of "external territories" (ibid). The criticism of Muller and Turner's paper (Müller and Turner, 2007) is the implication that for organizations conducting projects in their home countries, the project managers are not required to have an understanding of cultural differences. This may be true only if all employees of that particular organization are from the same culture, a rather rare occurrence given issues of globalization in today's business environments. Project Management Institute states: *"Today project managers operate in a global environment and work on projects characterized by cultural diversity"* (PMI, 2008, p.230). Therefore, this statement has implications on the competencies of a project manager in terms of his/her ability to work effectively in a multi-cultural diverse team of professionals, who are either project stakeholders or project team members.

3.1.5 Project manager competencies for managing multiple projects

The distinction between a project manager's competencies for managing single versus multiple projects was contended in (Patanakul et al., 2004; Patanakul, 2013; Patanakul and Aronson, 2010), as a contribution to existing literature on MPEs, in the context of additional competencies for managing multiple concurrent projects. These competencies were identified as: experience in managing multiple simultaneous projects, multi-tasking among different projects, managing interdependencies and interactions across different concurrent projects, and switching contexts to manage project teams for different concurrent projects. However, multi-tasking is not a unique competency for managing multiple concurrent projects. Instead, the level of multi-tasking across different concurrent projects is higher than for single project management, given that a project manager leading a single project must also multi-task by coordinating different activities of the same project. To this effect, the competencies of a project manager in leading multiple simultaneous projects are particularly relevant on the basis of an influence on the PM2P practice. This stream of literature is brought to bear on the identification of key factors that influence the PM2P practice.

The nature of roles and challenges for managing single versus multiple concurrent projects may also be used as a basis to indicate the distinction between project manager competencies required for managing single projects (SPM) and those required for managing multiple simultaneous projects (MPM). Table 3-3 is an illustration of this distinction, at the project manager operational level.

Table 3-3 Role distinctions between SPM and MPM

Single Project Manager (SPM)	**Multiple Project Manager (MPM)**
No need to link multiple concurrent projects since SPM leads only one project at a time	Link multiple simultaneous projects (Patanakul, 2013; Patanakul and Milosevic, 2009)
Lead a single team for one project, with one goal, at a time (Patanakul and Milosevic, 2009)	Lead multiple teams for several concurrent projects and simultaneously manage each project's specific goal (Patanakul and Milosevic, 2009)
No switch-over time loss (Fricke and Shenhar, 2000; Patanakul and Milosevic, 2009)	Switch-over time loss by changing gears from one project in one phase to another in a different phase, on a daily basis (Fricke and Shenhar, 2000; Patanakul and Milosevic, 2009)

3.1.6 Project critical success factors

The discussions in section 2.1 demonstrated that the choice of project manager is one of the major factors influencing project success (Fortune and White, 2006; Pinto and Slevin, 1987; Pinto and Slevin, 1989a; Wit, 1988). However, a distinction must be made between the success of the project management activity and the success of the actual project, implemented through project management activities. For example, Wit (1988) states:

"…one must make a distinction between project success and the success of the project management effort, as the two although related, may be very difference." (p. 164).

This statement implies that although good project management practices can enhance the likelihood of project success, they do not necessarily guarantee project success. Conversely, project success without necessarily good project management is possible. The intent of the literature review under this stream is not to comment on or critique the various sets of success factors by numerous authors, in terms of the lack of agreement regarding the factors that influence project success (Fortune and White, 2006). The intent is to relate extensive literature on success factors to the thesis topic, in terms of the need to improve the existing PM2P practice of a specific organization (organization A) in Botswana.

Pinto and Prescott (1987) conducted an empirical study on project critical success factors, which reveals that the relative importance of success factors change considerably over the life of a project, depending on what stage the project is in. The relevance of critical project success factors, in the context of developing a conceptual framework for this thesis, can also be articulated in terms of a project manager's performance (Gudienė et al., 2013), which is a function of his/her competencies in managing projects of varying complexities. Several studies (such as Müller and Turner, 2007, 2010; Müller et al., 2012) have confirmed the link between a project manager's leadership style and project success. Reviews of this identified stream of literature were incorporated into the identification of key components of a comprehensive conceptual framework, supported by evidence from literature and industry practice.

3.1.7 Implied conceptual frameworks for PM2P practice

Numerous authors discuss several concepts such as project manager attributes (Archibald, 1975; Gaddis, 1959; Pettersen, 1991a; Frame, 1999; Ilincuta and Jergeas, 2003) and leadership competencies of project managers (Crawford, 1997, 2000, 2007b; Muller and Turner, 2007, 2010; Thamhain, 1991; Aritua et al., 2011), under different contexts. For example, Crawford (2007b); Muller and Turner (2010), and Aritua et al. (2011), discuss project manager attributes in the context of developing programs for professional development of project managers and improving project delivery capability, but not in the context of conceptual frameworks for allocating project managers to projects. The terms conceptual framework and model are used for different things, both associated with the PM2P practice. The term model is used in this thesis in the context of mathematical programming or optimization.

Similarly, literature on desirable attributes for successful project managers in different industries and for different project types exist (Archibald, 1975; Gaddis, 1959;

Pettersen, 1991a; Müller and Turner, 2007), including literature on project manager competencies and how they are developed and implemented (Boyatzis, 2007; Frame, 1999; Madter et al., 2012). While this literature is crucial to the understanding of the project management body of knowledge, it was identified and reviewed on the basis of its relevance under implied conceptual frameworks for the PM2P practice. A review of this extensive literature reveals that different project manager competencies are appropriate for different industries and project types (Boyatzis, 2007; Frame, 1999; Madter et al., 2012; Shenhar et al., 2001). Among the literature on project manager attributes, Ilincuta and Jergeas (2003) and Pettersen (1991a, 1991b) discuss project manager attributes that may be used as criteria for selection of project managers. These project manager attributes represent implied conceptual frameworks for the PM2P practice.

The above literature surrounding project manager attributes and competencies were reviewed in the context of implied conceptual frameworks for the PM2P practice, given the emphasis on assessing project manager competencies in relation to matching them to project requirements. The lists of identified project manager competencies applicable to management of projects, were used as components that influence the PM2P practice. Thus, the work of these numerous authors was recognized and incorporated into the development of a conceptual framework for understanding PM2P practices, on the basis of confirming its contents with management literature from a wide range of sources.

3.1.8 Explicit conceptual frameworks for the PM2P practice in MPEs

Discussions in section 2.6 have demonstrated evidence of the limited literature (currently underexplored) that directly propose conceptual frameworks for the PM2P practice. The existing conceptual framework in (Patanakul et al., 2003, 2004, 2007), identified as the most comprehensive (as at January 2012) and directly relevant to the PM2P practice in MPEs, was used as a basis to develop a conceptual framework for this thesis. Other studies that propose conceptual frameworks for the PM2P practice were not comprehensive, in comparison to the conceptual framework in Patanakul (ibid). For example, Adams et al. (1979) recommend three basic steps in terms of their conceptual framework for the PM2P practice, which can be summarized as: (1) assess the project’s characteristics to identify its requirements, (2) assess the project managers in terms of their capability to meet the identified project requirements, and (3) select the project manager who matches the identified project requirements in terms of his/her capability. This proposed conceptual framework in (Adams et al.,1979) represents seminal work on which other researchers, such as Patanakul, built on and hence does not incorporate a comprehensive list of important criteria to be considered in effective PM2P practices.

The most comprehensive conceptual framework (Patanakul, 2004, 2009; Patanakul and Milosevic, 2006; Patanakul et al., 2007) was therefore, critiqued and modified on the basis of broader reviews of management literature (incorporating the 8 streams of literature identified in section 3.1), with a view to significantly broaden the foundation, in the context of developing a conceptual framework for this thesis. The 8 literature streams are bounded by resource management (Azarmi and Smith, 2007; Hoobler and Johnson, 2004; Othman and Sheehan, 2011; Owusu et al., 2007; PMBOK, 2013; PMI, 2008; Sirmon et al., 2007), identified as the broader management theory, which incorporates theories discussed in section 2.7.2. Drawing significantly from the 8 identified literature streams, gaps were identified in existing literature in the context of developing the most comprehensive and up to date conceptual framework, to contribute to the understanding of existing knowledge on PM2P practices. The identified gaps are presented in the next sub-section.

3.2 Critique of existing conceptual frameworks and identified gaps in existing literature

Following critical reviews of both the depth and breadth of management literature associated with the PM2P practice (sections 2.6, 2.7, 2.8 and 3.1), six gaps were identified. These gaps are: (1) lack of explicit consideration of organizational dimensions, (2) narrowly focussed literature in existing conceptual frameworks for the PM2P practice, (3) lack of comprehensiveness in existing conceptual frameworks for the PM2P practice, (4) absence of feedback loops in existing conceptual frameworks for the PM2P practice, (5) inappropriate use of symbols consistent with process modelling, and (6) inconsistent use of terminology. An expansion of these identified gaps, along with the actions to address them, is presented next.

3.2.1 Lack of explicit consideration of organizational dimensions

Existing conceptual frameworks on the PM2P practice applicable to MPEs do not explicitly consider organizational dimensions that have potential to influence the PM2P practice, on the basis of context (Cook and Slack, 1991; Fiedler and Chermers, 1974; Kew and Stredwick, 2010). These organizational dimensions, which cover both internal and external factors that may vary on the basis of country, industry, organization and project types (Boyatzis, 2007; Briner et al., 1996; Ferns, 1991; Hartman and Boyd, 1998; Pellegrinelli and Bowman, 1994; Yasin et al., 2000) have not been discussed in existing conceptual frameworks for the PM2P practice. The potential role played by these organizational dimensions, in relation to contextual elements of the PM2P practice, needs to be explicitly recognized. This explicit recognition is an addition to existing conceptual frameworks, to further the understanding of existing knowledge on PM2P practices in MPEs.

3.2.2 Narrowly focussed literature in existing conceptual frameworks for the PM2P practice

Although the conceptual framework for the PM2P practice proposed in (Patanakul et al., 2004; Patanakul and Milosevic, 2006; Patanakul, 2004) represents a foundation for this thesis in terms of being comprehensive, it does not incorporate and discuss broader management theories surrounding the PM2P practice. In an attempt to close this gap, resource management (Azarmi and Smith, 2007b; Fitsimmons, 2009; Hartman and Boyd, 1998; Hoobler and Johnson, 2004; Othman and Sheehan, 2011; Owusu et al., 2007; Sirmon et al., 2007) was identified as the broader management theory, used as a reference point to identify key components of a more comprehensive and up to date conceptual framework (in comparison to existing frameworks). The comprehensive conceptual framework developed for this thesis is well- grounded in both depth and breadth of management literature.

3.2.3 Lack of comprehensiveness in existing conceptual frameworks for the PM2P practice

Existing conceptual frameworks on the PM2P practice in MPEs (see Patanakul et al., 2004; Patanakul and Milosevic, 2006; Patanakul, 2004; Choothian et al., 2009) lack comprehensiveness in terms of identification of factors that influence the PM2P practice. This gap may be a result of a narrowly focussed literature as per gap 2 (section 3.2.2).

3.2.4 Absence of feedback loops in existing conceptual frameworks for the PM2P practice

Existing conceptual frameworks for the PM2P practice applicable to PMEs (see Patanakul et al., 2003, 2004; Choothian et al., 2009) are characterized by absence of feedback loops. The inclusion of feedback loops is viewed to improve the current understanding among project management researchers and practitioners, in terms of both comprehensiveness and relevance of a PM2P allocation decision to industry practice, to enable continuous flow of information about the effectiveness of PM2P practices. For example, the inclusion of feedback loops provides practitioners with opportunities for identifying gaps to continuously improve the PM2P practice, on the basis of outcomes of PM2P allocation decisions, particularly in a dynamic MPE.

3.2.5 Inappropriate use of symbols consistent with process modelling

Existing conceptual frameworks for the PM2P practice do not use appropriate symbols consistent with process modelling theory, in the schematic representation of the components of the conceptual framework. Drawing on a process-based approach in terms of business process modelling techniques (Aguilar-Savén, 2004; Ahoy, 2013), this gap was addressed by using appropriate symbols, in the schematic representation of components of the conceptual framework. The reason for closing this gap lies in improving the understanding of existing but limited literature on conceptual frameworks for the PM2P practice in MPEs.

3.2.6 Inconsistent use of terminology

Existing but limited studies that report on the PM2P practice in MPEs (Choothian et al., 2009; Patanakul and Milosevic, 2006, 2009; Patanakul et al., 2004, 2007) use the terms "project assignments" and "project manager assignments" interchangeably. The use of these terms implies that the task of assigning a project to a project manager is the same as that of assigning a project manager to a project. These two tasks are distinct on the following basis: (1) when assigning projects to project managers, the decision maker assesses which projects can utilize the available project manager competencies, given the limitations of the available project managers in the firm, (2) however, when assigning project managers to projects, the decision maker seeks for suitable project managers to lead those projects, which opens up opportunities to search for the required project manager competencies not necessarily within the constraints of the pool of project managers in the firm. In this thesis, the term "allocation" is preferred over the term "assignment" for reasons given in section 3.1. A distinction is made between the two tasks, to avoid confusion and add to the understanding of knowledge on PM2P practices. For example, the phrase *PM2P allocation* is used consistently and not interchanged with *project allocation.*

3.3 Approaches to resource allocation problems

Various approaches for solving resource allocation problems exist. These approaches can be categorized as informal and formal, as discussed next.

3.3.1 Informal approaches

Informal approaches include: managerial intuition, typical resource loading process, and use of staffing levels based on comparisons with similar projects implemented previously (LeBlanc et al., 2000). Empirical evidence of the popularity of managerial intuition by practitioners in fields such as new product development (Patanakul et al., 2003, 2004, 2007; Choothian et al., 2009) and construction management (LeBlanc et al., 2000) exist. For example, LeBlanc et al. (2000 , p. 105) state:

"the use of intuition or gut feeling when assigning managers is very prevalent in construction management (and probably in other fields)"

The implication is that practitioners in construction management predominatly use managerial intuition to allocate project managers to construction projects. Although commonly used to allocate project managers-to-projects, managerial intuition alone may be subjective and inadequate (LeBlanc et al., 2000; Patanakul et al., 2007), in the context of processing structural aspects of complex multi-criteria decision making problems. Intuition may be unreliable and prone to errors, owing to limited cognitive ability (Adair, 2007; Jansson, 1999; Keren, 1992) to concurrently process a large number of criteria. Typical resource loading process requires detailed information about all project tasks, in relation to managing such a project (LeBlanc et al., 2000). This approach seems to be limited as regards unsuitability for projects with a large number of tasks (ibid). For example, it is rather cumbersome to get detailed information about all tasks of a large project. The use of comparisons with similar projects done previously to determine staffing requirements, poses challenges associated with problematic assumptions (ibid). For example, current and future projects have elements that are unique and hence require different staffing requirements, in comparison to previous projects. Given the limitations inherent in the use of informal approaches, these approaches were considered unsuitable as possible solutions in the development of a new approach to improve the PM2P practice in organization A.

3.3.2 Formal approaches

The most widely used formal approach to solve resource allocation problems is mathematical modelling, as an optimization approach to improve resource allocation problems (Conway and Ragsdale, 1997; Ragsdale, 2011, 2015; Triantaphyllou, 2000). Optimization is a field of operations research concerned with finding the optimum utilization of limited resources, to accomplish specific organizational objectives (ibid). Reviews of literature on mathematical modelling justify its use in different application areas, including resource allocation problems (ibid). Mathematical modelling has been applied in several industries and application examples, from a global industry classification perspective (GICS, 2008). Examples of applications of mathematical modelling include: determination of product mix in agriculture (Ragsdale, 2003, 2004), determination of optimum routes to transfer products in rail and road (Powell, 1988), and determination of optimum allocation of tickets to customers in leisure, equipment and products (Grandine, 1998; Ribeiro, 2005).

3.3.3 Justification for mathematical modelling

Mathematical modelling stands out in terms of superiority to informal approaches, on the basis of capability to handle a large number of decision variables concurrently. This optimization-based approach yields a less subjective and more optimized decision that considers all variables in less time (Mason, 2011; Meerschaert, 2007; Meindl and Templ, 2013). It brings about increased accuracy, timeliness and reduced subjectivity, by quantifying the large number of decision criteria (factors) in a consistent and standardized manner (Berry and Houston, 1995; Edwards and Hamson, 2001; Murthy et al., 1990).

Given the above considerations, mathematical modelling was chosen as a suitable approach (among alternatives discussed in sections 3.3.1 and 3.3.2) to facilitate a proposal to improve the PM2P practice in organization A. It brings together all the relevant factors in an effective manner that is robust, systematic and promotes fairness in the process. Whilst there are benefits with optimization-based approaches that use spreadsheets alone, critical analysis of the use of spreadsheets proposed in (LeBlanc et al., 2000; Ragsdale, 2015), reveals problems of lack of flexibility associated with having to make changes in different parts of the spreadsheet, which is cumbersome. Mathematical modelling, using algebraic functions in conjunction with optimization software, addresses these limitations and produces solutions in less time, compared to the use of spreadsheets alone (Mason, 2011; Meindl and Templ, 2013).

3.4 Decision making and theories

A decision may be defined as making a choice, when faced with several options under a specific context (Adair, 2007; Drummond, 1991; Jennings and Wattam, 1998). Apart from reference to a moment in time, this definition is consistent with that in Harrison (1981, p.348), which states "*A moment of choice in an on-going process of evaluating alternatives with a view to selecting one or some combinations of them to attain the desired end."* Both of these definitions imply the concept of a process.

The term decision is differentiated from a decision-making process in that it focuses on the moment of making a choice, whilst a decision making process extends beyond that moment, to shape the future (Drummond, 1991). In the context of this thesis, the PM2P practice (a decision making process), once made, will shape future events in terms of the success or failure of a project, and the performance of an organization. From an organizational viewpoint, decision making lies at the core of management and all organizational actions stem from managerial decision making (Cooke and Slack, 1991; Jennings and Wattam, 1998).

3.4.1 Characteristics and types of decision theories

The literature on decision making reveals three types of decision theories namely: descriptive, normative, and prescriptive (Bell et al., 1988; Keren, 1992; Edwards et al., 2007; Kleindorfer et al., 1993; Triantaphyllou, 2000). Firstly, descriptive decision theory deals with the way in which decisions are actually made (ibid). Secondly, normative decision theory is the way in which people should make decisions (Trianphyllou, 2000), rather than how they actually make decisions in practice. Kleindorfer et al. (1993) corroborates this view and suggests that normative theories involve the use of abstract representations that act as theoretical benchmarks, in relation to how decisions must be made. Normative decision theory is aimed at finding the optimal solution to a decision problem (Keren, 1992), irrespective of how such decisions are made in practice. This normative theory assumes an 'ideal' decision maker, in the absence of constraints noted in section 3.3.1.

Lastly, prescriptive decision theory is aligned with a human's limitations in processing information*, and "may take into account emotional, motivational, and other potential nonrational effects"* (Keren, 1992, p.28). The implication is that a human decision maker is likely to make errors associated with changes in emotional conditions that might impact the decision. This definition is consistent with that in (Edwards et al., 2007), which acknowledges the limitations in human judgement, under a prescriptive viewpoint. Both normative and prescriptive decision theories are aimed at optimizing decisions, except that normative decision theory assumes an ideal decision maker, while a prescriptive theory accommodates a human's cognitive limitations. Kleindorfer et al. (1993) supports the idea that prescriptive theories are aimed at assisting a human decision maker to improve his/her decision making, given the constraints and complexities of real-life situations. The idea of a human's limitations to process information is echoed in (Jansson, 1999), as regards potential for disastrous consequences. These consequneces are a result of vulnerability to changes in emotions.

In the context of the main argument in this thesis, associated with the need and potential to improve the existing PM2P practice in the context of Botswana, the most appropriate type of decision theory is the prescriptive theory. The reasons are: (1) it is aimed at optimization but accommodates reality, in terms of a human decision maker's limitations, and (2) it requires establishing clear guidelines (hence prescriptive) upon which decisions will be based, prior to making decisions.

3.4.2 Nature of decision making

Decision makers must have an understanding of the context within a decision problem (Harrison, 1981; Jennings and Wattam, 1998), consistent with the discussions in section 3.1.1. This context is shaped by the nature of the decision problem and the organizational environment in which the decision ought to be made (Cooke and Slack, 1991; Kleindorfer et al., 1993), and forms part of the responsibility of a decision maker seeking to make optimal decisions. Triantaphyllou (2000) discusses the normative and prescriptive decision theories from the perspective of making an optimal decision in a given situation, which implies context. Ragsdale (2015) asserts that the essence of decision analysis is to assess alternatives and choose the best action. Decision analysis is necessitated by complexities facing decision makers, due to data-intensiveness and competitive nature of today's dynamic changes in the business landscape. These dynamic changes are corroborated in (Jennings and Wattam, 1998) as the reasons affecting the complexity of a decision process. Organizational politics are implied, particularly if the decision to be taken will impact different stakeholders across the organizational hierarchy. For this reason, the politics surrounding the decision making process must be accommodated (ibid).

3.4.3 Operations research and common optimization modelling techniques

There are several optimization modelling techniques, in the context of decision making. These techniques fall under the discipline of operations research (Cushing, 1970; Ragsdale, 2003, 2011, 2015). The most common techniques are linear programming (LP), integer linear program (ILP), goal programming (GP) and non-linear programming

(NLP). The first three involve modelling problems in which the objective function and constraints can be expressed as linear combinations of the decision variables, while the last involve problems in which the objective function and constraints cannot be expressed as linear combinations of the decision variables (Cushing, 1970; Ragsdale, 2015).

The distinction between LP and ILP lies in restricting some or all the decision variables to integer values, given that an optimum solution to a LP problem may give non-integer values that do not strictly represent reality. For example, the scheduling of employees in an organization requires determination of an optimum number of employees to be allocated to different shifts (ibid). This scheduling problem, if formulated as a LP problem, may give an optimum solution that suggests allocating fractional numbers of employees to different shifts, which is problematic. The problem is that employee numbers are better expressed as integers in reality. For this reason, ILP was developed as an advancement of LP by Ralph E. Gomory (Cushing, 1970), to address majority of real-life business problems by restricting some or all of the decision variables to integer values. ILP has since gained popularity and used to solve many business optimization problems (Duffuaa and Al-Sultan, 1999; Furusaka and Gray, 1984; Glover, 1969; Ribeiro and Urrutia, 2005).

Unlike LP and ILP, Goal progming (GP) is an optimization modelling technique concerned with solving problems comprising more than one goal (Conway and Ragsdale, 1997; Ragsdale, 2011, 2015). GP involves soft constraints as opposed to hard constraints that are common in LP and ILP problems. A soft constraint can be violated under certain circumstances, while a hard constraint cannot be violated, irrespective of the circumstances.

3.4.3.1 Benefits of mathematical models in decision making

Although the main benefit of using mathematical models in decision making is to optimize decision making (Ragsdale, 2015), other benefits include: reduction in costs due to opportunity to analyse a decision problem prior to committing funds, timeliness of decisions, feasibility in terms of enabling analysis of concepts that would otherwise be impossible in reality, and gaining deeper insights of the problem to be solved (Conway and Ragsdale, 1997; Jensen and Bard, 2003; Ragsdale, 2003, 2015).

3.4.3.2 Multi-criteria decision making problems and approaches to solve them

Multi-criteria decision making (MCDM) is one of the renowned branches of decision making (Drummond, 1991;Triantaphyllou, 2000). It is concerned with the assessment of the best alternative, given a set of alternatives and decision criteria. Alternatives are the different options available to a decision maker in terms of action, while criteria are the different extents to which alternatives can be assessed (Triantaphyllou, 2000). An individual MCDM problem comprises multiple criteria. The complexity of MCDM problems stems from these multiple criteria, which may be structured into a hierarchy with different levels, particularly if the number of criteria is large. Triantaphyllou (2000) defines large in the context of more than 12 decision criteria. Given the large number of decision criteria to be assessed in the PM2P allocation decision, making it a complex decision problem, there is need for optimization based approaches to complement managerial intuition. This argument is an addition to the discussions in sections 2.2.1, 2.2.2, and 2.4, regarding justification for a formalized PM2P approach. Furthermore, a single major criterion may be associated with several sub-criteria. Similarly, a sub-criterion may be associated with several sub-sub criteria, which brings about the concept of a decision matrix (ibid). Given the complexity of such a MCDM problem, managerial intuition alone cannot effectively process this amount of information and all at the same time, to arrive at an optimum deicision. The reasons were highlighted in section 3.3.1.

The challenge faced by decision makers in organizations lies in how to assess a finite set of alternatives by taking account of all the decision criteria (and not just some of them) concurrently (Triantaphyllou, 2000), to arrive at an optimum decision. Drummond (1991) asserts that managerial intuition may be problematic in solving structured aspects of MCDM problems. Furthermore, assumptions made on the basis of guesswork may be unreliable.

The issue of complexity and the unreliability of managerial intuition in assessing structured aspects of decisions, bring about the suitability of business analytics. Business analytics is a discipline that uses data, statistics, mathematics and computers, to solve problems (Ragsdale, 2015). Business analytics act as tools to complement the human decision maker's limited capacity for arithmetic and memory (Adair, 2007; Drummond, 1991; Jennings and Wattam, 1998; Kleindorfer et al., 1993), in making optimal decisions (Ragsdale, 2011; Triantaphyllou, 2000). Jennings and Wattam (1998) assert that the people involved in the decision making process "*often* *fail to perceive how the decision was made*" (p.1) for various reasons. This implies a lack of accountability in decision making. Adair (2007) provides an explanation for this failure in the context of the human mind's limited capacity to store and retrieve information.

3.4.3.3 Types of Multi-criteria decision making techniques

Multi-criteria decision making (MCDM) can be categorized into two types namely: multi-objective decision making (MODM), and multi-attribute decision making (MADM). MODM is concerned with decision problems where the solution space is continuous (Triantaphyllou, 2000). Mathematical programming problems involving multiple objective functions represent a typical example of MODM (ibid). A specific example is goal programming. MADM is concerned with decision problems in which the solution space is discrete and characterized by a predetermined set of decision alternatives (Triantaphyllou, 2000). In the context of this thesis, MADM is the appropriate type on the basis that the alternatives are predetermined and can take the form of discrete values. For example, the candidate projects and project managers are predetermined and can take the form of binary variables.

3.4.3.4 Multi-criteria decision making (MCDM) techniques

MCDM techniques are diverse (Triantaphyllou, 2000). The most popularly used MCDM techniques in solving MCDM problems are: analytic hierarchy process (AHP), ELECTRE and TOPSIS (ibid). Belton (1986) reveals that AHP is equally as valid as the other techniques, from both a theoretical and practical viewpoint. Forman and Gass (2001) have also conducted a study involving the principle of these techniques and concluded that although each technique is different, they are both valid. However, Shoemaker and Waid (1982) assert that people have found AHP to be more insightful. AHP offers a clear and formal structuring of the decision problem, such that human perceptions can easily be obtained (Rogers, 2001; Saaty, 1980, 2008). In fact, Shoemaker and Waid (1982) and Sato (2004) agree that AHP is a superior method of measuring human perception. Furthermore, AHP is the most popular approach for selection problems, particularly when integrated with other techniques such as linear programming and goal programming (Ho et al., 2010). For these reasons, AHP was used only to visualize the decision hierarchy for the PM2P allocation problem. AHP was integrated with linear programming but not applied in terms of pairwise comparisons, which require significant time from practitioners.

Besides diversity of MCDM techniques, a common denominator for majority of them lies in the notion of alternatives and decision criteria (Triantaphyllou, 2000). A common classification scheme for MCDM techniques is on the basis of: (1) data types (e.g., deterministic or stochastic), and (2) number of decision makers involved in the decision process. This thesis focuses on the 'single decision maker deterministic MCDM technique.' There are two critical steps in dealing with any MCDM problem namely: (1) define the problem, and (2) estimate the relevant data required to solve the problem (Belton, 1986; Triantaphyllou, 2000). These steps are briefly discussed.

3.4.3.4.1 Define the problem

Defining the problem involves understanding and formulating the decision problem, in terms of the information required to inform decision making (Belton, 1986; Triantaphyllou, 2000). It requires input from experts, to ensure correct definition of the problem, given that this step may be *"more relevant to the art than the science of MCDM"* (Triantaphyllou, 2000, p.23). This argument is consistent with the discussions in sections 3.1.1, 3.2.3, 3.4, and 3.4.2, regarding an understanding of the context (organizational environment or contextual factors) in which the decision is made.

3.4.3.4.2 Estimate the relevant data required to solve the problem

Given the need but difficulty of accurately estimating the required data, Triantaphyllou (2000) acknowledges the challenge involved in this step by stating *"it is difficult, if not impossible, to quantify"* (p. 23) qualitative attributes, which explains why *"many decision making methods attempt to determine the relative importance, or weight, of the alternatives in terms of each criterion in a given MCDM problem."* This statement implies that it is easier to quantify data required to solve a MCDM problem in relative terms rather than absolute terms, particularly if the data involves qualitative attributes that are often intangible. The assumption is that a decision maker can express his/her opinion regarding the performance of each individual alternative, with respect to each alternative. A brief discussion of the possible solution approaches under a prescriptive decision theory is presented, in the context of facilitating development of a new approach to improve the existing PM2P practice in organization A.

3.4.4 Choice of solutions to decision problems – prescriptive theory

The possible solution approaches under a prescriptive decision theory are: intuitive, mathematical programming, decision support system and decision analysis (Kleindorfer et al., 1993). These solution approaches depend on the decision problem context as well as the availability of resources (e.g., computers, historical data records and time). Firstly, intuition is rejected on the basis of reasons given in section 3.3.1. Secondly, mathematical modelling is embraced, given the discussion in section 3.3.3. The central aim of this thesis is to develop a new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana, which is consistent with the use of mathematical programming to optimize decision making. Thirdly, a decision support system is also appropriate, on the basis of complementing managerial intuition to improve the PM2P practice. A decision support system provides a basis for developing a new apoproach that can be used directly by industry practitioners to improve the existing PM2P practice. Lastly, decision analysis is embraced to fully understand the research problem in this thesis and then develop a solution that addresses the research problem, given that an understanding of the decision problem is paramount to its solution (Kleindorfer et al., 1993).

3.4.5 Chosen approach – mathematical modelling and basic principles

The discussion on principles of mathematical models in relation to their classifications and types, is used as a basis to articulate the nature of the PM2P allocation problem in terms of formulation. There are two main classifications of mathematical models in the context of programming namely non-linear and linear (Conway and Ragsdale, 1997; Jensen and Bard, 2003). Further to the definitions of linear and non-linear models given in section 3.4.3, a linear model comprises three key elements namely: decision variables, objective function and constraints.

Decision variables represent a measure of the quantities of resources to be utilized. Examples include: people, funds, and raw material products (ibid). An objective function is an equation that is expressed in relation to the decision variables (ibid). It can either be a minimisation or maximisation function. For example, the objective could either be to minimize costs or to maximize profit, by maximizing raw material usage. Constraints of an optimization problem are the limits, whose objective is to restrict the values that the decision variables can assume (ibid). The nature of the PM2P allocation problem in this thesis is such that it comprises relationships which can be expressed by linear equations, and hence can be modelled using linear programming concepts. On this basis, non-linear programming is considered unsuitable to model the PM2P allocation problem.

Alternative programming techniques such as integer programming (IP) and mixed integer programming (MIP) are used to address difficulties such as giving unrealistic solutions to real-life business problems, as discussed in section 3.4.3. These alternative techniques may be referred to as variations of linear programming (Cushing, 1970). Integer programming implies that either some or all values in the solution to the problem are restricted to integers (Abara, 1989; Ragsdale, 2003; Cushing, 1970). Integer programming can be divided into two classifications namely: (1) *all integers,* and (2) *mixed integers* (Cushing, 1970). The first classification means that all the variables in the integer programming problem can only be integers. The second classification means that the variables in the problem are not restricted to all integer values but rather, a mixture of integers and continuous values (Meindl and Templ, 2013). Within the *mixed integers* classification, it could be that the solution variables are small but must also be restricted to either 0 or 1 (binary). In this situation, the IP is referred to as dichotomous-integer (Ragsdale, 2003). The nature of the PM2P allocation problem fits this condition, where a 0 and 1 represent no allocation and allocation respectively.

3.4.6 Types of mathematical models

The general nomenclature on mathematical models can be described in relation to the following characteristics: (1) deterministic versus stochastic (Edwards and Hamson, 2001; Murthy et al., 1990); (2) dynamic versus static (Meerschaert, 2007); (3) equation types involved (Meerschaert, 2007; Murthy et al., 1990), and (4) quantitative versus qualitative (Saaty and Alexander, 1981).

Firstly, in the context of deterministic versus stochastic, the simplest classification lies in whether the problem being investigated can be planned with certainty or difficult to plan due to uncertainties (Duffuaa and Al-Sultan, 1999). A deterministic approach was chosen over a stochastic approach, on the basis of aspects of certainty in estimations, as opposed to a stochastic approach characterized by uncertainties due to randomness (Murthy et al., 1990). For example, production scheduling activities involve elements of certainty (Duffuaa and Al-Sultan, 1999) and hence classified under deterministic models. The PM2P allocation problem has elements of certainties in terms of estimations such as: known workloads, known time periods, known project priorities, and known competencies of project managers at the beginning of each planning period (Patanakul et al., 2007). By definition, these elements suggest a deterministic model. A deterministic approach is consistent with existing mathematical models (see Choothian et al., 2009; Patanakul et al., 2007) on this type of allocation problem, although not explicitly stated in these existing models.

Secondly, assumptions of a static system in relation to assessing project managers and projects at a snapshot in time (ibid), makes the use of a dynamic system unsuitable. Thirdly, static systems are synonymous with algebraic equations in the mathematical formulation over other equation types (integral, differential, and difference), on the basis of suitability of algebraic formulations for static systems. Murthy et al.'s (1990) work advocates for static and algebraic expressions in the formulation of deterministic models. Lastly, given that the purpose of the chosen mathematical modelling technique (section 3.4.5) is to quantify the PM2P allocation decision in a systematic manner, as a way to reduce subjectivity and promote fairness, a quantitative approach is more appropriate over a qualitative approach (Saaty and Alexander, 1981).

3.5 Research hypotheses development

The literature reviews in chapters 2 and 3 were used as a basis to develop research hypotheses. These literature reviews build on existing but limited empirical studies on the PM2P practices in MPEs, published between 2003 and 2013. The research variables, propositions and associated hypotheses are discussed next.

3.5.1 Selection of research variables, propositions and associated hypotheses

The variables used in this study are defined as expressions of concepts associated with a measure of something that varies across cases (Kervin, 1992). 8 key variables were identified, following reviews of literature in chapters 2 and 3. These were:

1. extent of formality (variable 1);
2. extent of objectivity (variable 2);
3. extent of match between project manager and project (variable 3);
4. extent of comprehensiveness (variable 4);
5. impact on project manager motivation (variable 5);
6. impact on project manager performance (variable 6);
7. impact on project success (variable 7); and
8. impact on project manager rewards (variable 8).

Propositions and associated hypotheses were then derived. Given a number of articles that looked into improving project management practices in the context of the PM2P allocation decision, leading to a key finding that the PM2P practice is linked to both project and organizational performance (Brown and Eisenhardt, 1995; Patanakul and Milosevic, 2006; Pinto and Slevin, 1989a), the work in these articles is notable because it justifies the significance of the improving the PM2P practice in terms of its influence on both project and organizational performance. However, existing and relevant studies (LeBlanc et al., 2000; Patanakul et al., 2007; Shapiro and Spence, 1997) examined project management practitioners' PM2P decision making approach. The evidence from these studies is unified in revealing that practitioners in project based organizations rely on intuition to make PM2P allocation decisions. Therefore, the first proposition associated with nature of the PM2P practice was constructed as below.

3.5.1.1 Proposition 1 and associated hypothesis

The nature of PM2P practice is such that allocation decisions are made casually, despite their impact on the performance of the project manager, project and organization (Patanakul and Milosevic, 2006; Patanakul et al., 2007). Four hypotheses to this proposition, made up of two competing and simple statements (null and alternative hypothesis) that cover the sample space (Field, 2005; Gray and Kinnear, 2012) are:

i. **H1** – the PM2P practice is informal (null hypothesis, denoted by H_0). By definition, the alternative hypothesis (H_1) is that the PM2P practice is formal;
ii. **H2** – the PM2P practice is not objective;
iii. **H3** – the PM2P practice is such that there is lack of a good match between the project manager and the project; and
iv. **H4** – the PM2P practice is not comprehensiveness.

Several studies demonstrated a link between PM2P practices and performance of the project manager, project and organization (Adler et al., 1996; Badiru, 1996; Brown and Eisenhardt, 1995; Brown et al., 2007; Forseberg et al., 2000; Kuprenas et al., 2000; Patanakul et al., 2004, 2007). Therefore, two proposition and associated hypotheses were constructed.

3.5.1.2 Proposition 2 and associated hypothesis

The extent of match between a project manager and a project is most likely to be associated with project manager motivation and performance (Adler et al., 1996; Badiru, 1996; Balachandra and Friar, 1997; Brown and Eisenhardt, 1995; Forseberg et al., 2000; Kuprenas et al., 2000; Patanakul et al., 2004, 2007; Shenhar, 2001). Based on this proposition, hypotheses 5 (H5) and 6 (H6) were stated as:

i. **H5** – extent of match between a project manager and a project is associated with project manager motivation; and

ii. **H6** – extent of match between a project manager and a project is associated with project manager performance.

3.5.1.3 Proposition 3 and associated hypothesis

The extent of match between a project manager and a project is expected to be associated with project success (Adler et al., 1996; Badiru, 1996; Brown and Eisenhardt, 1995; Forseberg et al., 2000; Kuprenas et al., 2000; Patanakul et al., 2004, 2007). Based on proposition 3, hypothesis 7 (H7) was stated as:

i. **H7** – extent of match between a project manager and a project is associated with project success.

Empirical studies established a link between the concepts; good match between project manager and project, and organizational performance (Choothian et al., 2009; Patanakul et al., 2003, 2004, 2007). For example, considering a good match between a project and a project manager has a positive impact on both business success and reward for performance (Patanakul, 2009). Business success is linked to project performance by other researchers (see Hauschildt et al., 2000; Kuprenas et al., 2000). Considering similarities among projects has a positive impact on career advancement (referred to in this thesis as project manager rewards) and resource productivity (Patanakul, 2009). Therefore, proposition 4 (P4) and the associated hypothesis were constructed as presented below.

3.5.1.4 Proposition 4 and associated hypothesis

The extent of match between a project manager and a project is linked to project manager rewards (ibid). The associated hypothesis was stated as **H8** – extent of match between a project manager and a project is associated with project manager rewards.

A link between the effectiveness of the PM2P practice and performance of both the project and the organization was found (Adler et al., 1996; Brown and Eisenhardt, 1995; Kuprenas et al., 2000; Patanakul and Milosevic, 2006; Patanakul et al., 2003, 2004). Effectiveness is viewed in terms of constituents such as: (1) use of formal guidelines such as documentation, management tools and techniques, (2) standardization in the context of reducing subjectivity, and (3) comprehensiveness in relation to important factors to be considered in the decision (Choothian et al., 2009; Patanakul et al., 2007). Other studies revealed a link between business success and project success (Hauschildt et al., 2000; Kuprenas et al., 2000; Patanakul, 2009). Patanakul (2009) concluded that considering similarities among projects in the PM2P practice has a positive impact on resource productivity and career advancement. Career advancement is linked to project manager rewards (Patanakul, 2009). For the purpose of this thesis, rewards include opportunities for promotions, performance bonus and career advancement. Resource productivity is linked to project manager motivation, leading to project manager performance (Patanakul, 2009). Therefore, three propositions (P5, P6 and P7) were constructed, along with the associated respective hypotheses (H9, H10 and H11).

3.5.1.5 Proposition 5 and associated hypothesis

The extent of formality in the PM2P practice is linked to project manager rewards. The hypothesis associated with proposition 5 was stated as **H9** – extent of formality is associated with project manager rewards.

3.5.1.6 Proposition 6 and associated hypothesis

The effectiveness of the PM2P practice is linked to the following: resource productivity (Patanakul, 2009), performance of projects (Archibald, 1975; Augustine, 1959; Beck, 1983; Patanakul, 2013; Patanakul et al., 2003), performance of the project manager, and ultimately organizational performance (Choothian et al., 2009; Patanakul et al., 2007). The associated hypothesis was stated as **H10** – extent of objectivity is associated with project manager performance.

3.5.1.7 Proposition 7 and associated hypothesis

The extent of comprehensiveness in the PM2P practice is expected to be linked with project manager rewards (Patanakul, 2009), which is linked to resource productivity, project performance and hence project success (Patanakul, 2009, 2013). The associated hypothesis was stated as **H11** – extent of comprehensiveness is associated with project success.

3.5.2 Hypothesized relationships

A summary of the hypothesized key relationships between nature of PM2P practice (independent variables) and performance of the PM2P practice (dependent variables) was developed (see Figure 3-3). Hypotheses H1 to H4 are associated with descriptive statistics for nature of the PM2P practice variables. Hypotheses H5 to H11 are associated with correlations (Gray and Kinnear, 2012) that indicate the relationships between variables, in terms of performance of the PM2P practice.

This means that hypotheses H1 to H11 were measured, as part of evaluating PM2P practices in MPEs of Botswana, in the context of independent variables that define the nature of PM2P practices (H1 to H4), and dependent variables that define the performance of those practices (H5 to H11). The measurement of all identified key variables (both dependent and independent) give an indication of the status of existing PM2P practices in Botswana. This indication is a starting point to address the research problem.

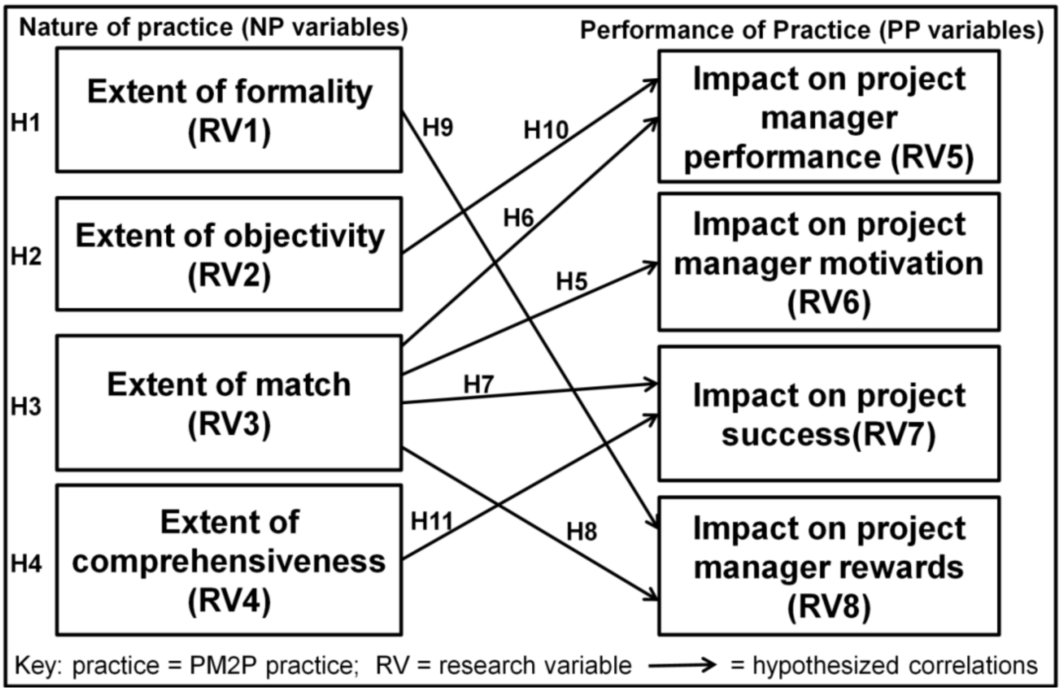


Figure 3-3 Hypothesized relationships

3.6 Summary

This chapter has established the theoretical basis for this thesis, in terms of theories surrounding the PM2P practice. It has advanced the understanding of the literature on PM2P practices by identifying gaps in existing literature and drawing links between approaches to resource allocation problems and decision making theories. The literature review was used to guide the development of research variables, propositions and associated hypothesis.

Chapter 4

Overview of research design, methodology and methods to evaluate existing PM2P practices in MPEs of Botswana and develop a conceptual framework

Following derivation of the research problem and the study motivations in the previous chapter, the purpose of this chapter is to present an overview of the research design and methodology for the entire study. Details of the methods implemented to evaluate existing PM2P practices in MPEs of Botswana and methods to develop a conceptual framework are then discussed. The following sections fulfil the purpose of this chapter: (1) overview of research methodology for entire study, (2) justification of chosen methodology for entire study, (3) outline of overall approach, (4) outline of methods, (5) methods, techniques and instruments for evaluating existing PM2P practices in MPEs of Botswana, (6) methods, techniques and instruments for developing a conceptual framework, and (7) summary.

4.1 Overview of research methodology for entire study

The term *research methodology* is used in this study to refer to the rationale, principles, processes and assumptions that provide an overall direction to the conduct of a study (Creswell, 2014; Mertens, 2015; Newby, 2014; Smyth and Morris, 2007). Three common research methodologies were identified as possibilities to address the overall study aim. These three possibilities are quantitative, qualitative and mixed methods. The three methodological choices are influenced by factors such as the nature of the research problem and research objectives (Creswell, 2009). A brief discussion of each is presented next.

4.1.1 Quantitative approach

A quantitative approach is generally associated with hypothesis testing, by measuring variables and then examining the relationships between them, using statistical analysis methods (Creswell, 2009, 2014). Researchers who advocate for a quantitative approach assume a positivist view that is agreeable to scientific procedures and are therefore, against a qualitative approach, which they deem subjective (Fellows and Liu, 2008). This approach is described as deductive (Borrego et al., 2009) and regarded as a means to provide the opportunity for objectivity, on the basis of use of scientific methods.

However, Bryman and Bell (2007) provide arguments against adopting a quantitative approach, on the basis that relationships between measured variables generate a somewhat simplistic perspective to a study of social life that is detached from informants' lived experiences that are rather subjective. Whilst there are merits associated with adopting a quantitative approach (on its own) in a study on how managers make PM2P allocation decisions in the context of Botswana, there are also weaknesses in terms of failure to account for informants' subjective experiences in their study context. These arguments provide evidence of why a quantitative approach, on its own, is not sufficient to study different aspects of the PM2P practice in the context of Botswana.

4.1.2 Qualitative approach

This type of approach, also referred to as a relativist approach to research (Jupp, 2006), is generally characterized by collecting and analysing textual data, to provide rich descriptions by examining the meanings of real life issues in the context in which they occur (Borrego et al., 2009; Jupp, 2006). It is applicable to a study of elements of real world issues and linked to subjective experiences of people and not exactly open to measurements using scientific quantitative procedures. Given the various perspectives of these real world issues, this approach calls for procedures that focus on uncovering meanings of those real world issues in their specific contexts.

Researchers who assume a positivist view that is agreeable to a quantitative approach, are against a qualitative approach. Patton (2002) suggests that a qualitative approach uses different types of data collection methods such as: direct observations, interviews, documents and artefacts. A qualitative approach is generally associated with creating new theory from analysis of collected data. Examples of the types of qualitative approaches to research include case studies (Mertens, 2015) and grounded theory (Glaser and Strauss, 1967). Creswell (2009) suggests that a qualitative approach is suitable in situations where existing findings cannot be applied to the specific group being studied and when the research topic has not been studied using the group, sample or context in question. The absence of empirical studies that report on PM2P practices in MPEs of Botswana, is consistent with arguments in (Creswell, 2009), regarding the suitability of a qualitative approach. For example, the findings from limited empirical studies on the PM2P practice conducted in the context of USA, may not be applied to the context of Botswana. Notwithstanding, a qualitative approach on its own, is insufficient to uncover a complete understanding of the existing PM2P practice, given the different aspects surrounding this practice. This argument leads to the need for a mixed methods approach.

4.1.3 Mixed methods approach

Mixed methods involve combining both a quantitative and qualitative approach. Although it is described as the third methodological movement (Teddlie and Tashakkori, 2003), this description may pose problems relating to debates associated with paradigms. The intent of a mixed methods approach is on uncovering a more complete understanding of the phenomenon being studied, than either approach on its own (Creswell, 2014; Stockman, 2015). Newman and Benz (1998) and Creswell (2014), view the three research approaches to be existent on a continuum, with a mixed methods approach positioned in the middle of a quantitative and qualitative approach, since it encompasses elements of both.

Researchers (such as Cohen et al., 2011; Creswell and Clark, 2011; Eisenhardt, 1989; Fellows and Liu, 2008; Jick, 1979; Loosemore et al., 1996; Stockman, 2015; Teddlie and Tashakkori, 2003) agree that the motivations of using a mixed methods approach should be based on the need to obtain a complete and rich understanding of the phenomenon being studied, to best accomplish the research aim. These researchers also argue that the use of a mixed methods approach is appropriate in underexplored areas where no or little previous studies have been done, to improve assurance in the study results by obtaining a more balanced and full understanding of the different facets of the phenomenon being studied. This assurance may be viewed in terms of a sound authentication of constructs examined and increased reliability and validity, based on combining approaches. The use of mixed methods also provides potential to uncover things that would otherwise not be uncovered by use of a single approach (Fellows and Liu, 2003, 2008). The limitations of using either a quantitative or qualitative approach brought about the popularity of mixed methods, owing to the advantages over a single approach (Bazeley, 2012; Creswell and Clark, 2011; Greene and Caracelli, 1997; Luck et al., 2006).

4.2 Justification of chosen methodology for entire study

Whilst several researchers (such as Creswell, 2009; Mertens, 2015) contend that no single methodology is better than another, there is more support for a mixed methods approach, in the context of improving research quality (Creswell, 2014; Teddlie and Tashakkori, 2003). The need and potential to improve the existing PM2P practice in the context of Botswana, warrants a mixed methods design. This argument is substantiated by the absence of empirical studies on the PM2P practice from Botswana, a new context that has hitherto not been explored. Given that the PM2P practices in this new context is not known in existing literature, it seemed logical to use a mixed methods approach, as part of the need to ilucidate a more complete understanding that expands existing knowledge. The use of different data types, arising from the different sequential stages of the study, was vital to gain this complete understanding (Stockman, 2015). Furthermore, the research topic of PM2P practices in MPEs is currently underexplored and warants a mixed methods approach. A mixed methods approach was considered appropriate to adequately address the overall study aim, through three sequencial stages of data collection. This approach was also chosen to offset integral biases involved in employing either a quantitative or qualitative approach on their own (Creswell, 2009). The PM2P practice is a real-life industry problem, and the different issues surrounding this problem call for a multi-dimensional approach to fully address this problem. Furthermore, addressing the overall study aim (comprising five identified objectives conducted in sequence) required different approaches, appropriate for the different sequencial stages of the research.

In a given research project, it is possible to have one research method to address all objectives, which taken together, accomplishes the overall study aim. However, this approach is not always possible in all situations (Bazeley, 2003). This means that sometimes (as in the case of this study) more than one research method may be required to address research objectives. The author had to opt for a mixed methods approach in terms of use of different research methods to address all five objectives. The key issue is that the five objectives are tightly linked together by the need to adequately accomplish the overall study aim. There is a logical sequence in terms of the work conducted to address the five objectives. Although the main emphasis of this research was on a specific organization (organization A) in Botswana, in terms of an in-depth study to uncover the existing PM2P practice, followed by proposing a solution and validating it in organization A, the research had to start with a broader view in relation to evaluating existing PM2P practices in Botswana, given absence of empirical studies that report on the status of existing PM2P practices in the context of Botswana. Once this first objective was addressed, using a survey approach, the research could then proceed by narrowing down on a specific organization (organization A) in Botswana, in terms of a case study approach that seeks to uncover details of organization A’s PM2P practice, outcomes of which could then be used to inform the next objective. This next objective involved developing a bespoke solution to the existing PM2P practice in organization A, followed by validating the proposed solution.

4.3 Outline of overall approach

A mixed methods approach was chosen to address the aim and objectives, as per the discussions in sections 4.1.3 and 4.2. Three stages of fieldwork activities were conducted sequentially (section 1.4), to address objectives 1, 3 and 5, while objectives 2 and 4 were addressed through literature reviews. The link between objectives 1 to 5 was maintained throughout the research, in terms of an overall mixed methods study that focuses on a specific problem pertaining to the context of Botswana. The overall approach taken is contextual to the specific conditions in Botswana, whilst the emphasis is on a specific organization based in Botswana (organization A), in terms of developing a new approach to improve the PM2P practice that pertains to that organization. This new approach was operationalized and customized to improve the PM2P allocation problem in organization A.

Whilst an organizational perspective was adopted to optimize the PM2P allocation decision (a decision making process) from inclusion of both senior level executives and project heads in the validation of the proposed new approach (fieldwork 3), the employee's perspective was also considered, given involvement of the project managers in the evaluation of existing PM2P practices in Botswana (fieldwork 1). The project managers were engaged to give input because they are directly impacted by PM2P allocation decisions. This approach was part of encouraging buy-in from not only the project heads (representing the organization in terms of managerial buy-in) as users of the new approach but also the project managers, who must also be informed on how the new approach works such that they can have trust in it. Given that the new approach represents some change in management processes, it was important that all stakeholders (including those that the new approach will affect) are engaged for endorsement, such that stakeholders feel that they have contributed to the process of developing the proposed new approach in terms of giving input to it (if it were to be implemented).

An overview of the research design and methodology, pertaining to accomplishment of objectives is depicted in Figure 4-1. These objectives represent contributions to knowledge from this thesis. A brief description of the three fieldwork stages is presented in sections 4.3.1 to 4.3.3.

Key: PM2P = project manager-to-project; RO1 – RO5 = research objectives; 1 – 5 = key outputs/contributions from this thesis; MPEs = multi-project environments; MCDM =Multi-criteria decision making

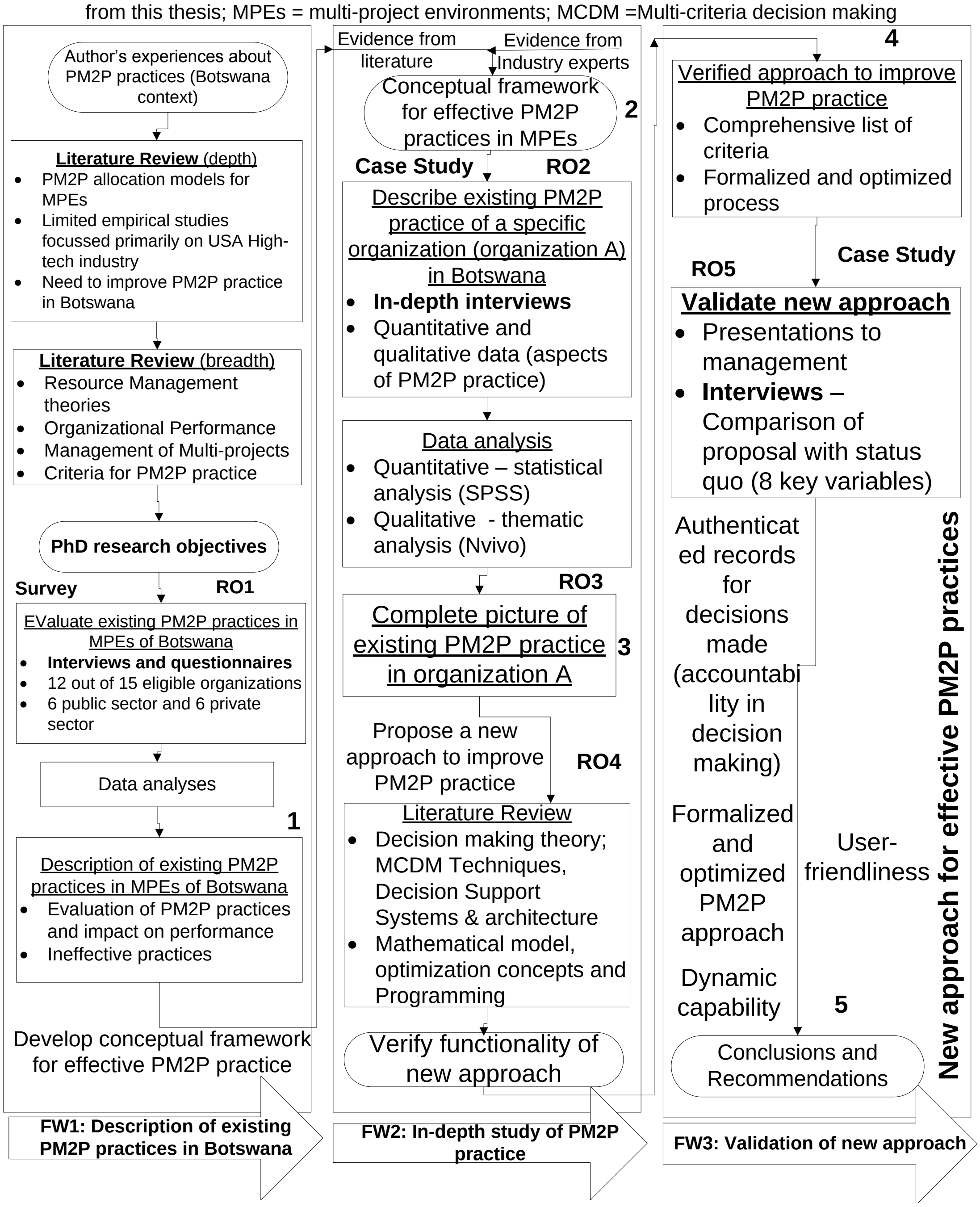


Figure 4-1 Research design and methodology overview

4.3.1 Fieldwork 1 – evaluation of existing PM2P practices in Botswana

Fieldwork 1 was a survey involving 12 out of 15 eligible organizations in Botswana's public and private sector. The intent was to evaluate existing PM2P practices in Botswana, and the impact on performance, as the first response to the research problem. At the country level, the 12 organizations represent the individual cases from which data were collected. The major unit of analysis is therefore, the individual organizations that form a body to which the research problem pertains (Fellows and Liu, 2003a, 2008; Kervin, 1992). This argument is based on the following attributes used for selection: project organizations, multi-project management environments and multiple project managers. At the organization level, data were collected from inside informants, the embedded unit of analysis. The data provided by the group of inside informants consisted of attributes of the PM2P practice in a particular organization.

4.3.2 Fieldwork 2 – in-depth study of existing PM2P practice in organization A

Fieldwork 2 involved a case study approach (single case study) to illuminate the existing PM2P practice in organization A, using a conceptual framework as a lens through which the PM2P practice in organization A could be described. Complete elucidation of the PM2P practice included identification of strengths and weaknesses in working practices. In-depth semi-structured interviews were conducted with two groups of interviewees (4 project heads and 11 senior level executives). Relevant organizational documents were reviewed to complement the evidence from interviews, including meetings held with various informants across three geographic locations. The use of case nodes was suitable since each informant or case could be linked to a number of documents, as asserted in (Gibbs, 2002). Analysis of data from this in-depth study addressed objective 3 and used to inform the development of a new approach to improve the existing PM2P practice in organization A (objective 4).

4.3.3 Fieldwork 3 – validation of the proposed new approach

A case study approach was used to validate this new approach. The validation process involved measuring the perceived change the new approach would bring to the PM2P practice in organization A. In-depth semi-structured interviews with a total of twenty-one informants from five business units were conducted. Analysis of data collected from this validation addressed objective 5.

4.4 Outline of methods

An outline of the methods, techniques and instruments used to achieve each objective is presented in Table 4-1. Table 4-1 should be viewed from an overall research perspective, which is a mixed method study conducted in series, with a view to develop a new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana. The research objectives are used as a reference point, in the context of details of the methods to address each of the five identified objectives, which collectively accomplish the study aim. This approach is embraced to link achievement of the five objectives, as a way to adequately accomplish the aim, using an overall mixed methods approach.

Table 4-1 Outline of methods to achieve each objective

Research objectives	Methods	Techniques and instruments
To evaluate existing PM2P practices in MPEs of Botswana (objective 1)	**Survey** (interviews and questionnaires)	(1) Bristol online survey (2) Index and computations (3) Response bias (4) Binomial tests (5) Correlation analysis
To develop a conceptual framework for understanding effective PM2P practices in MPEs (objective 2)	Literature review	(1) Literature searching strategies (2) Really Simple Syndication feeds and publication alerts (3) Systematic and linear note taking strategy (4) Mind-mapping (5) Endnote
To describe the existing PM2P practice of a specific organization (organization A) in Botswana (objective 3)	**Case study research** (single case study) - In-depth semi structured **interviews**	(1) Interview schedule (derived from conceptual framework contents) (2) Statistical analysis - quantitative data (SPSS) (3) Framework method (4) Thematic and content analysis - qualitative data (NVivo) (5) Cross case analysis
To propose a new approach to improve organization A's PM2P practice (objective 4)	Literature review	(1) Mathematical modelling (2) Optimization modelling (3) Decision Support Systems (4) Programming - Visual Basic for Applications (VBA)
To validate the new approach (objective 5)	**Case study research** (single case study) - semi-structured **Interviews**	(1) MS Powerpoint and MS Excel (2) VBA (3) OpenSolver (4) Interview schedule

Key: VBA = Visual Basic for Applications, MS = Microsoft

4.5 Methods, techniques and instruments for evaluating existing PM2P practices in MPEs of Botswana

Six main research methods in engineering management (Bryman, 1989; Bryman and Bell, 2007; Cook and Campbell, 1979; Denscombe, 2007; Fellows and Liu, 2008, Kervin, 1992; Newby, 2014; Yin, 1994; 2009) were identified. These were: laboratory experiments, field experiments, available data studies, observational studies, case studies and surveys. The six research methods are briefly described, in the context of demonstrating their consideration to evaluate existing PM2P practices in Botswana, followed by justification of the chosen research method.

Laboratory experiments employ a non-naturally occurring setting (Kervin, 1992), which implies manipulating the study setting and hence unsuitable. Although field experiments employ a natural setting as opposed to a manipulated setting, they are characterized by the need to treat groups (treatment and comparison) differently, which introduces the risk of one group modifying their behaviour, leading to distorted results (Cook and Campbell, 1979). Field experiments were considered unsuitable given that evaluating the PM2P practice can best be studied without manipulating variables and testing their effects. Available data studies involve existing or archival data (Kervin, 1992), in different forms such as: organizational and government documents, records, and questionnaires from previous research. Given that little was known about the existing PM2P practices in the context of Botswana, available data studies were unsuitable. Observational studies are concerned with discerning cause-and-effect relationships between variables, in situations where the researcher does not have control over assignment of informants to categories nor have control over which treatment each informant should receive (Cochran and Chambers, 1965; Kervin, 1992). These were unsuitable for an evaluation of existing PM2P practices for the following reasons: the intent was on establishing associations between variables rather than cause-and-effect, the researcher has control over assignment of informants to categories and has control over which research instrument to administer to which informant group. Case studies involve an in-depth study of contemporary issues of the phenomenon of interest, in a real-life context and using one or a few cases (Bryman, 1989, 1995; Yin, 2009). Case studies were considered unsuitable, given that the intent to evaluate the existing PM2P practice was not to uncover details about the practice but rather, obtain valid inferences of the nature of those practices across Botswana's public and private sector, as part of empirical evidence to justify the author's anecdotal observations about the need to improve existing PM2P practices from a Botswana context. Surveys involve covering *"a large number of instances",* (Denscombe, 2007, p.36) of the sample population of interest, without manipulating the study setting, with a view to draw conclusions about the population. A survey approach was considered appropriate to evaluate existing PM2P practices in Botswana, as discussed below.

4.5.1 Survey approach and justification

The need to cover a large number of organizations, in terms of breadth rather than depth, consistent with evaluating existing PM2P practices in Botswana, suits a survey approach (Bryman and Bell, 2007; Denscombe, 2007; Fellows and Liu, 2008; Kervin, 1992). A survey approach was required to provide a robust and reasonable response to the research problem, in the context of representativeness. The decision to adopt a survey approach also meant that there was potential to generalize findings (Bryman, 1995; Bryman and Bell, 2007) regarding PM2P practices to multi-project organizations in Botswana, although the findings may not be claimed to be representative of the entire country. This argument is corroborated by several researchers (see Creswell, 2007; Fellows and Liu, 2008; Gill and Johnson, 2002, 2010; Johnson and Clark, 2006), who are unified in asserting that surveys are generally characterized by taking a sample of the study subjects from the population of interest, to address certain characteristics.

4.5.2 Context for research design

In terms of deriving eligible organizations that form the population of interest, there were a total of 46 organizations listed to be operating in Botswana (Botswana Government Ministry of Trade and Industry, 2012), as at March 2012. In the public sector, there were a total of 16 organizations, of which only 6 operate in a MPE and hence eligible to participate in the study. In the private sector, there were a total of 30 organizations, of which only 9 were eligible. Enumeration was used to select eligible organizations, hence no sampling. Justification for enumerating the eligible organizations is that their number is small. The population of eligible organizations was therefore 15. However, 12 participated, given the practical challenges of access to data (Bryman, 1989, 2008; Bryman and Bell, 2007; Denscombe, 2007; Kervin, 1992).

4.5.3 Research design for evaluating existing PM2P practices in MPEs of Botswana

Following the context described in section 4.5.2, the research design for evaluating existing PM2P practices in Botswana’s MPEs is discussed. The discussion comprises: (1) selection of cases, and (2) selection of data sources (Kervin, 1992).

4.5.3.1 Selection of cases

The selection of cases is discussed under the following: (1) unit of analysis, (2) basic research design, (3) specific research design, and (4) sample design (Fellows and Liu, 2003b).

4.5.3.1.1 Unit of analysis

The unit of analysis was a body of organizations that pertain to the PM2P practice (phenomenon being studied) and upon which data were collected. A group of individuals within each organization represented one case. Therefore, each of the 15 eligible cases (MPEs) had a group of individuals who represented attributes of the respective cases (Fellows and Liu, 2008; Kervin, 1992), in the context of evaluating existing PM2P practices in Botswana. The individual potential informants were identified on the basis of categorization into 3 groups namely: (1) senior level executives responsible for strategic decisions, (2) project heads responsible for making PM2P allocation decisions, and (3) project managers impacted by the allocation decisions. This categorization is consistent with previous studies on PM2P practices in MPEs (Choothian et al., 2009; Patanakul et al., 2003, 2004, 2007). However, only project heads and project managers, who fall within the immediate scope of the project management function, were selected for participation to evaluate existing PM2P practices in Botswana. The project heads represent the organization’s perspective while the project managers represent the employee’s perspective, as discussed in section 4.3.

4.5.3.1.2 Basic research design

The basic design of fieldwork 1 is considered non-experimental, given absence of manipulated independent variables and no random assignment of cases to groups (Fellows and Liu, 2008; Kervin, 1992). The absence of manipulated independent variables is based on the intent to study the existing PM2P practice by interacting with organizations and informants in their natural setting, consistent with elements of a qualitative approach. Similarly, the intent was to assign each informant to the appropriate group, instead of random assignments. Appropriate assignment of informants to each group was important for the non-experimental design (Fellows and Liu, 2008; Kervin, 1992), such that the appropriate research instrument could be administered to each informant group. For example, a questionnaire survey designed for project managers could not be administered to project heads and vice versa.

4.5.3.1.3 Specific research design

The number of groups of eligible organizations was only 15, given the context described in section 4.3.2. The groups of eligible organizations were formed on the basis of two selection criteria namely: (1) organizations that operate in a MPE and (2) organizations that have a team of project managers, who implement a portfolio of projects and report to a project head. Cross-sectional measurements were made among eligible organizations, concerning an evaluation of existing PM2P practices in Botswana, as part of building a foundation to begin to address the research problem.

4.5.3.1.4 Sample design

A convenience sample was used for interviews, given considerations regarding constraints of time and cost (Denscombe, 2007; Fellows and Liu, 2008; Kervin, 1992). However, the population of eligible informants was enumerated for questionnaires. A link to the online questionnaire was sent via e-mail to the research custodian in each organization, to forward the link to all eligible informants within each organization as a case. The questionnaire was designed using Bristol online survey, such that incomplete responses could not be submitted, whilst allowing saving and completing the questionnaire at a later time.

4.5.3.2 Selection of data sources

Several possibilities were considered in terms of types of data sources to be used in evaluating existing PM2P practices in Botswana, namely: available data, outside observers, researcher observations and inside informants (Kevin 1992). Inside informants were chosen over alternatives, for the following reasons: (1) absence of existing studies that report on PM2P practices in Botswana means that there are no available data, (2) unavailability of outside observers who are knowledgeable about the existing PM2P practices in all eligible organizations in Botswana, given item 1, (3) views regarding existing PM2P practices in Botswana cannot be measured using researcher observations, which are also time-consuming, and (4) the availability and accessibility of multiple inside informants who can provide rich information about all key variables associated with the existing PM2P practice in Botswana, to lay a foundation for addressing the research problem. The choice of data sources was also made on the basis that potential inside informants are capable of providing complete information about most of the key variables, such that the outcome truly represents the existing PM2P practices in Botswana. This argument is supported by the informants' different levels in each organization, which ensures incorporation of variations in views.

4.5.4 Preparation for data collection and procedures to address reliability in measurements

The following preparatory activities were completed in line with best practices for conducting research (Bryman, 1989, 2008; Bryman and Bell, 2007; Denscombe, 2007; Fellows and Liu, 2003b, 2008;Kervin, 1992): (1) development of fieldwork 1 research instruments, (2) acquisition of research ethics approval, (3) pilot testing of fieldwork 1 research instruments, (4) construct validity issues, (5) internal validity issues, and (6) external validity issues.

4.5.4.1 Development of fieldwork 1 research instruments

Among existing but limited literature on ideas for the PM2P practice in MPEs, the most cited is the work in (Patanakul et al., 2007). This work was also the most comprehensive in terms of the list of factors that influence the PM2P practice, in comparison to other work (Hadad et al., 2012, 2013;Ogunlana et al., 2002; Sebt et al., 2009, 2010), as at January 2012. This may explain why the work in Patanakul et al. (2007) won an award for the best paper in the IEEE Transactions on Engineering Management journal (Farris, 2008). The work in (Patanakul et al., 2007) was used as a basis to inform the development of fieldwork 1 research instruments, given that it incorporated the contents of other researchers' work.

The research instruments (appendix B) contained questions that were focussed on two characteristics namely: (1) nature of existing PM2P practices and (2) performance of those practices, consistent with the hypothesized relationships in Figure 3-1.

4.5.4.2 Acquisition of research ethics approval

Yin (2009) asserts that once the research design is finalized and prior to data collection, researchers are obligated to demonstrate ethical considerations in the conduct of their research, owing to a study of *"contemporary phenomenon in its real-life context"* (p.73). Denscombe (2007) corroborates this view by suggesting that accessing informants, company documents and sites, are all associated with ethical issues in terms of confidentiality. These views are consistent with the thesis topic involving how managers make PM2P allocation decisions in MPEs, a sensitive and confidential issue.

The following ethics procedures were completed, to evaluate existing PM2P practices in Botswana: (1) acquiring research permits from relevant government of Botswana ministries, (2) obtaining official authorizations for data collection from relevant authorities in each of the eligible organizations, (3) obtaining consent from informants,

(4) obtaining fieldwork risk assessment approval from the University of Leeds, and (5) obtaining ethical approval from the University of Leeds, in line with the requirements for conducting research involving human subjects. Items 1 to 4 were used as inputs to item 5 (see appendix I). The research instruments were also reviewed by the University of Botswana ethics committee, in line with requirements for conducting research involving human subjects in Botswana.

4.5.4.3 Pilot testing of fieldwork 1 research instruments

The research instruments were pretested, to obtain comments on the measures and procedures (Kervin, 1992). Whilst the rigorous ethical review process provided an initial opportunity to address measurement error in terms of potential difficulties in question wording, pretesting of instruments was necessary to address the measurement error that has potential to affect interview and particularly questionnaire surveys, due to lack of the prospect to clarify seemingly unclear questions (ibid). Useful feedback from pre-testing was received and used to improve the final instruments, consistent with fundamental aspects of addressing research quality (Kervin, 1992).

4.5.4.4 Construct validity issues

Construct validity is generally associated with the extent to which the procedures used to operationalize the variables are appropriate and actually reflect the variables and concepts they are supposed to measure (Cook and Campbell, 1979; Fellows and Liu, 2008; Kervin, 1992; Yin, 2009). In the context of evaluating existing PM2P practices in Botswana, construct validity issues were addressed through the following:

i. collecting data from informants in different organizational levels, to provide multiple perspectives about the constructs being measured (Fellows and Liu, 2008; Silverman, 2013), and
ii. collecting data from different organizations, representing more than one source of evidence (Yin, 2009).

4.5.4.5 Internal validity issues

Internal validity is related to the extent to which an observed effect is actually a consequence of an identified effect, as opposed to a false effect (Fellows and Liu, 2008). Approaches to address internal validity include: (1) use of triangulation as well as comparing cases (Silverman, 2013), and (2) use of pattern matching (Yin, 2009).

In the context of evaluating existing PM2P practices in Botswana, within case comparisons were conducted as part of the measures to address internal validity. For example, appropriate statistical tests were conducted to ascertain whether there were similarities or differences between existing PM2P practices in the public and private sector.

Triangulation was used in the context of administering both questionnaire and interview surveys to address internal validity issues in measured variables (Fellows and Liu, 2008; Silverman, 2013). The use of both quantitative and qualitative data collection techniques to evaluate existing PM2P practices in Botswana, makes the findings more convincing than when using a single techniques (Denscombe, 2007; Denzin, 1970;Fellows and Liu, 2008; Kervin, 1992). Furthermore, issues of reliability were addressed through the following:

i. use of self-administered questionnaires containing exactly the same questions and administered in a consistent manner; and
ii. use of an interview schedule, including use of the same procedures for interviewing.

4.5.4.6 External validity issues

External validity is broadly concerned with the extent to which conclusions drawn from a study about a particular group can be generalized beyond that study (Bryman, 2008; Bryman and Bell, 2007; Fellows and Liu, 2003b, 2008). In terms of approaches that can be taken to address external validity issues, Silverman (2013) proposes comparing cases while Fellows and Liu (2008) propose careful comparison of the sample and the population from which it was drawn, with other populations, including conditions for the two populations. However, both Mook (1983) and Fellows and Liu (2008) assert that while external validity may be important, it is not generally an essential consideration, given that results of a specific study are to a large extent subject to context. The arguments in (Mook, 1983) and (Fellows and Liu, 2008) may have been made in the context of a case study approach, where generalization of findings must be made with prudence. On this note, generalizations from a survey approach to evaluate existing PM2P practices in Botswana's MPEs (context) may be made, to shed light on these existing practices (hitherto unknown in existing knowledge).

4.5.5 Measurement of constructs

Participant information sheets were used in conjunction with both the questionnaire survey and interview survey, to collect primary data about key variables discussed in section 3.5.1. The actual questionnaire and interview survey questions measured specific items on a 5 point Likert scale. These items formed components of an index for each of the 8 key variables (see appendix B).

Only positively worded questions were included to form components of an index, although negatively worded questions were also used to form a pair of questions designed specifically to measure response bias (appendix C). The concept of a scale and reliability was rejected in favour of an index for the following reasons:

i. implementation of a scale during data exploration resulted in dropping a lot of measured variables, which may represent valuable information on collected data;
ii. the nature of the existing PM2P practice and its impact on performance are different constructs that cannot be combined into one underlying variable; and
iii. the use of statistical tests for analysis, suits the concept of an index (Campbell and Fiske, 1959; Kervin, 1992).

4.5.6 Analysis of quantitative data

Several possibilities, such as SPSS, Bristol online survey (Field, 2005; Gray and Kinnear, 2012), MS Excel, SAS and R (Galili, 2011; Muenchen, 2012), were considered. SPSS was chosen because it is more robust for analysis of quantitative data than these competing alternatives, in addition to its popularity. Preliminary statistical analysis explored differences between the two groups (public and private sector), on the basis of descriptive statistics, from both project heads and project manager data sets. This initial analysis was vital to establish whether there were significant differences between public and private sector, an outcome of which was then used to inform correlation analysis. This approach is consistent with a systematic approach to scientific data analyses that seeks to establish new knowledge, given the absence of empirical evidence of the status of existing PM2P practices in Botswana.

Several concepts of factor analysis were explored with a view to identify clusters of variables and reduce them to a small number of underlying variables, while retaining as much of the collected data as possible (Field, 2005). Factor analysis concepts were discarded on the following basis: (1) Kaiser-Meyer-Olkin statistic for measuring sampling adequacy was below the recommended threshold of 0.5 (Kaiser, 1974), (2) Bartlett’s Test of Sphericity was non-significant, with a significant value greater than 0.05 (Field, 2005), and (3) the determinant of the correlation matrix was greater than the recommended threshold of 0.0001 (ibid).

4.5.7 Analysis of qualitative data

The qualitative data were analysed using NVivo. The reason for choosing NVivo over competing alternatives such as QDA and NUD*IST lies in flexibility to be used with many analytic techniques and capability to systematically interrogate the data to extract emerging themes, whilst demonstrating transparency in the process of analysis. The interviews measured the same variables as questionnaires, for the purpose of establishing research validity (Gibbs, 2002). The analysis focussed on themes that indicate the nature and performance of existing PM2P practices in MPEs of Botswana.

4.5.8 Index and computation of constructs

Two new variables were created in SPSS to implement the concept of an index. The first variable was created to compute the average scores for the items that form components of the index for each case (informant). The second variable was created to compute an index score for each case (see appendix B). In terms of nature of existing PM2P practice variables (i.e., independent variables labelled RV1 to RV4 in appendix B), the higher the index score, the more effective the existing PM2P practice. Similarly, the lower the index score, the least effective the existing PM2P practice. Index scores of 100% indicate an ideal situation in terms of nature of existing PM2P practice. In terms of performance of the existing PM2P practice variables (i.e., the dependant variables labelled RV5 to RV8 in appendix B), the higher the index score, the better the performance of the existing PM2P practice. The variations in the measurement of these variables was used for correlation analysis.

An example to illustrate the computation of an index score, using the variable ‘extent of formality’ (labelled RV1 in appendix B) is given. The index score for this variable was computed by summing up the scores for all three measured items that form components of the index RV1, using only positively worded questions as noted in section 4.5.5. The sum of scores was then divided by 15, which is the maximum possible sum of score for these three items, measured on the 5 point scale used.

The degree of departure from the phenomenon being studied (existing PM2P practices in Botswana), can be expressed in different ways. Expressing it as a percentage was considered useful in that it introduced some generalization in terms of a common measurement unit, irrespective of the variable under consideration and the number of items that form a particular index. The percentage value was used to indicate the degree of departure between ideal index score (100%) and the observed index score. The implementation of an index rather than a scale represents novel data analysis techniques, to further the understanding of existing knowledge on PM2P practices in MPEs, and is consistent with ideas in (Chileshe, 2005; Dunleavy, 2003; Phillips and Pugh, 2005; Tinkler and Jackson, 2004).

An example of the computation of a percentage index score for the latent variable, extent of formality (labelled RV1 in appendix B) is given by equation 3;

$$RV1\ index\ score = \frac{\text{observed sum of scores for the 3 items}}{15} * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots.. (3)$$

The outcome is a percentage score that indicates the extent to which the PM2P practice is formal. Given the generalization introduced by multiplying the composite scores for each latent variable by 100, it follows that the general formula to compute an index for the 8 latent variables (RV1 to RV8) is given by equation 4;

$$RV_x index = \frac{\text{observed sum of scores for n items}}{\text{y}} * 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where x represents the latent variable under consideration (x = 1, 2, 3,…., 8), n represents the number of items that form components of that specific latent variable or index, and y represents the maximum sum of score for the n items. A discussion of the procedures used to determine the following two aspects in the measured variables is presented: (1) threshold for level of presence of nature of existing PM2P practice, and (2) presence or absence of nature of existing PM2P practice.

4.5.8.1 Threshold for level of presence of natute of existing PM2P practice

In the absence of a recommended threshold to indicate the level of presence of nature of existing PM2P practice, several scenarios were performed to determine the cut-off point for the proportion of index scores that can be classified as: formal and informal (RV1 index), objective and not objective (RV2 index), match and no match (RV3 index), comprehensive and not comprehensive (RV4 index).

4.5.8.2 Presence or absence of nature of existing PM2P practice

Four new variables were created in SPSS, to determine the presence or absence of nature of existing practice, using binomial tests (Gray and Kinnear, 2012). These variables were labelled: (1) RV1 binomial, (2) RV2 binomial, (3) RV3 binomial, and (4) RV4 binomial. For these four variables, index scores of 74% and below were awarded a 1, indicating the following: (1) an informal PM2P practice (i.e. success), (2) not objective PM2P practice, (3) no match between project manager and project and (4) not comprehensive. Conversely, index scores of 75% and above were awarded a 0, indicating the following: (1) a formal PM2P practice (i.e. failure), (2) an objective PM2P practice, (3) match between project manager and project and (4) comprehensive PM2P practice. The K-S tests for normality in relation to the dichotomized nature of practice binomial variables indicated that these one sample distributions were non-normal.

The variable *extent of formality (RV1)* is used as an example to demonstrate determination of its presence or absence, on the basis of a binomial test. The two hypotheses for this binomial test were stated as:

i. H_0: the proportion of the two categories, informal (i.e. success) and formal (i.e. failure) occur with some hypothesized probability to be determined from the binomial test trials; and
ii. H_1: the proportion of the two categories, informal (i.e. success) and formal (i.e. failure) do not occur with the hypothesized probability.

The aim was to test the null hypothesis in terms of the proportion of responses in the success group and then make a conclusion for or against the null hypothesis, using a 95% confidence interval. It follows that If $p \leq 0.05$, the null hypothesis must be rejected. This condition means that there is sufficient evidence to conclude that the proportion of responses in the success group is less than the hypothesized probability. Conversely, if $p > 0.05$, the null hypothesis must be accepted. This condition means that there is compelling evidence to conclude that the proportion of responses in the success group is equal to the hypothesized probability of success.

Binomial test trials were performed for responses to the non-parametric one sample distribution, RV1 binomial. The same procedure described above (using RV1 as an example) was used to run binomial tests for the one sample non-parametric distributions associated with the remaining variables RV2 to RV4.

4.5.9 Measurement of response bias

A new variable was created in SPSS to compute response bias index scores for each case. This new variable became one distribution on which a significance test could then be performed to test the hypothesis that the difference between the index scores (for both positively and negatively worded questions) is zero.

In the project manager and project heads (appendix C) data set, there were a total of seven and two pairs of questions used to measure response bias respectively. These pairs of questions were included in the questionnaire and interview instruments as part of the design, with a view to measure response bias, as part of additional procedures to address reliability in measurements.

Following careful examination of the histograms, skewness and kurtosis statistics, as well as K-S tests for normality, data transformations involving logarithm, square root and inverse (Tabachnick and Fidell, 2013) were explored and discarded on the basis that the transformations did not help to convert the one sample non-parametric distributions to normal. The variables RB1 to RB7, and RB1 and RB2, associated with measuring response bias from the two data sets were dichotomized (ibid).

Response bias scores were computed by taking the difference between the scores on the pair of questions designed to measure response bias (see equation 5).

Response bias = |observed score on positively worded question – observed score on negatively worded question|…………………………..………………………………….(5)

Prior to computing a response bias score, the scale for the negatively worded question was first reverse coded, in line with measurement consistency. A resultant score of 0 represents no difference between the 2 questions used to measure response bias, which indicates no bias. Scores of 1, 2, 3 and 4 indicate different levels of bias.

The outcomes from response bias scores were organized into two complementary events, biased or not biased. The emphasis was not on the level of bias but rather, on establishing whether a respondent is biased or not biased. The next step was to determine whether there is enough evidence to make a conclusion regarding the statistical significance of the presence or absence of bias. The basis of this type of analysis was to test the hypothesis that the proportion of ‘no bias’ is significant while that of ‘bias’ is insignificant, using a binomial test (Gray and Kinnear, 2012). Cohen’s effect size index (*g)* for the binomial test (Cohen, 1988, 2008; Gray and Kinnear, 2012) was also computed and used as an additional statistical inference for the presence or absence of bias. The outcome of response bias scores were coded as either 0 or 1, based on the following assumptions (Gray and Kinnear, 2012):

i. there are a fixed number of identical responses or trials (i.e., 34 responses for project manager questionnaires and 19 responses for project manager interviews);
ii. the outcome of every response can be dichotomized into two categories namely: 0 (no bias) and 1 (bias), and these two categories are treated as complementary and mutually exclusive ;
iii. the outcomes of the responses are independent; and

iv. the probability of no bias represents success and can be represented as p (no bias).

Therefore, the series is a set of Bernoulli trials and a binomial probability distribution can be used (Gray and Kinnear, 2012), since there is a finite number of responses ($n = 34$ for questionnaire responses and $n=19$ for interview responses), and the probability of getting no response bias (coded as 0s) is independent. Similarly, the probability of getting a response bias (coded as 1s) is also independent.

However, the probability of getting a score of 0 is not known. Several binomial test trials were performed to set the p-value for success (no bias), in relation to response bias. The aim was to search for the highest p-value for success and check the binomial test result, in terms of whether there is compelling evidence for no response bias. An initial p-value of 0.99 for no bias (success) was set, with a defined success cut-off point of 0 (success is less than or equal to zero) to start the binomial test trials. The two hypotheses are stated below.

1. Null hypothesis (H_0) - the proportion of the two categories, not biased (success) and biased (failure), occur with probabilities of 0.99 and 0.01 respectively. This means that the proportion of responses in the success group is equal to the hypothesized probability, in this case 0.99; and
2. Alternative hypothesis (H_1) - the proportion of the two categories, not biased (success) and biased (failure), do not occur with probabilities of 0.99 and 0.01 respectively.

The aim was to test the null hypothesis in relation to the proportion of responses in the success group and make a conclusion for or against the null hypothesis, using a 95% significance level commonly preferred in relatively small sample sizes (du Prel et al., 2009). It follows that if $p \leq 0.05$, the null hypothesis must be rejected. Conversely, if $p > 0.05$, the null hypothesis must be accepted.

4.6 Methods, techniques and instruments for developing a conceptual framework

The term conceptual framework was defined in the context of this thesis under the list of terms and definitions. Critical reviews of both the depth and breadth of literature surrounding the PM2P practice were conducted and used as a basis to develop a conceptual framework. Justification for using literature review is that it was the most readily available method to build on existing knowledge. Given the absence of primary data collection to develop a conceptual framework, research methods discussed in section 4.5 were not applicable as alternatives.

4.6.1 Techniques and instruments to develop a conceptual framework

Literature review strategies such as setting up RSS feeds and publication alerts (via e-mail) for relevant peer reviewed journal articles were implemented. The intent was to stay up to date with current issues in and around the thesis topic. The initial literature review conducted (see section 3.1) focused mainly on annual reviews of journal articles that are relevant to the general research topic. This approach was invaluable to start the process of obtaining a quick and broader understanding of the foundations of existing body of knowledge. The literature review process then focused on specific sources in relation to the research topic.

A systematic and linear note taking strategy was implemented to compile a summary of reviewed literature that is closely relevant to the research topic, using ideas in (Divan, 2009. The summary document was treated as work in progress and updated on a continuous basis, as more publication alerts were received and relevant papers reviewed. The note-taking strategy was combined with a visual alternative by creating a mind-map on A3 paper, for the identified literature streams. Different coloured pens were used to add different keywords to the branches as more articles were reviewed. The note-taking strategy was associated with reviews of both specific and related literature surrounding the PM2P practice in terms of breadth (sections 3.3 and 3.4), as part of addressing the overall study aim.

4.6.2 Overview of approach to develop a conceptual framework

The approach to develop a conceptual framework for this thesis is summarized in Figure 4-2. This approach incorporated evidence from both theory and industry practice. The evidence from theory included critical appraisal of the depth of management literature directly relevant to PM2P practices in MPEs (sections 2.6, 3.1 and 3.2), as well as cognate fields of inquiry (Tinkler and Jackson, 2004) surrounding the thesis topic (sections 2.7, 2.8, 3.3 and 3.4).

The inclusion of broader theories surrounding the thesis topic represents an enrichment to existing conceptual frameworks on PM2P practices in MPEs (Choothian et al., 2009; Patanakul, 2004; Patanakul et al., 2007). The evidence used to support the conceptual framework development included the following: (1) the author's experiences about the nature of existing PM2P practices in the context of Botswana,

(2) evidence from existing but limited empirical studies on PM2P practices, predominantly focussed to the context of the United States of America, (3) empirical evidence from the evaluation of existing PM2P practices in Botswana, and (4) broader reviews of literature and industry expert reviews. All of this evidence was brought to bear on the developed conceptual framework.

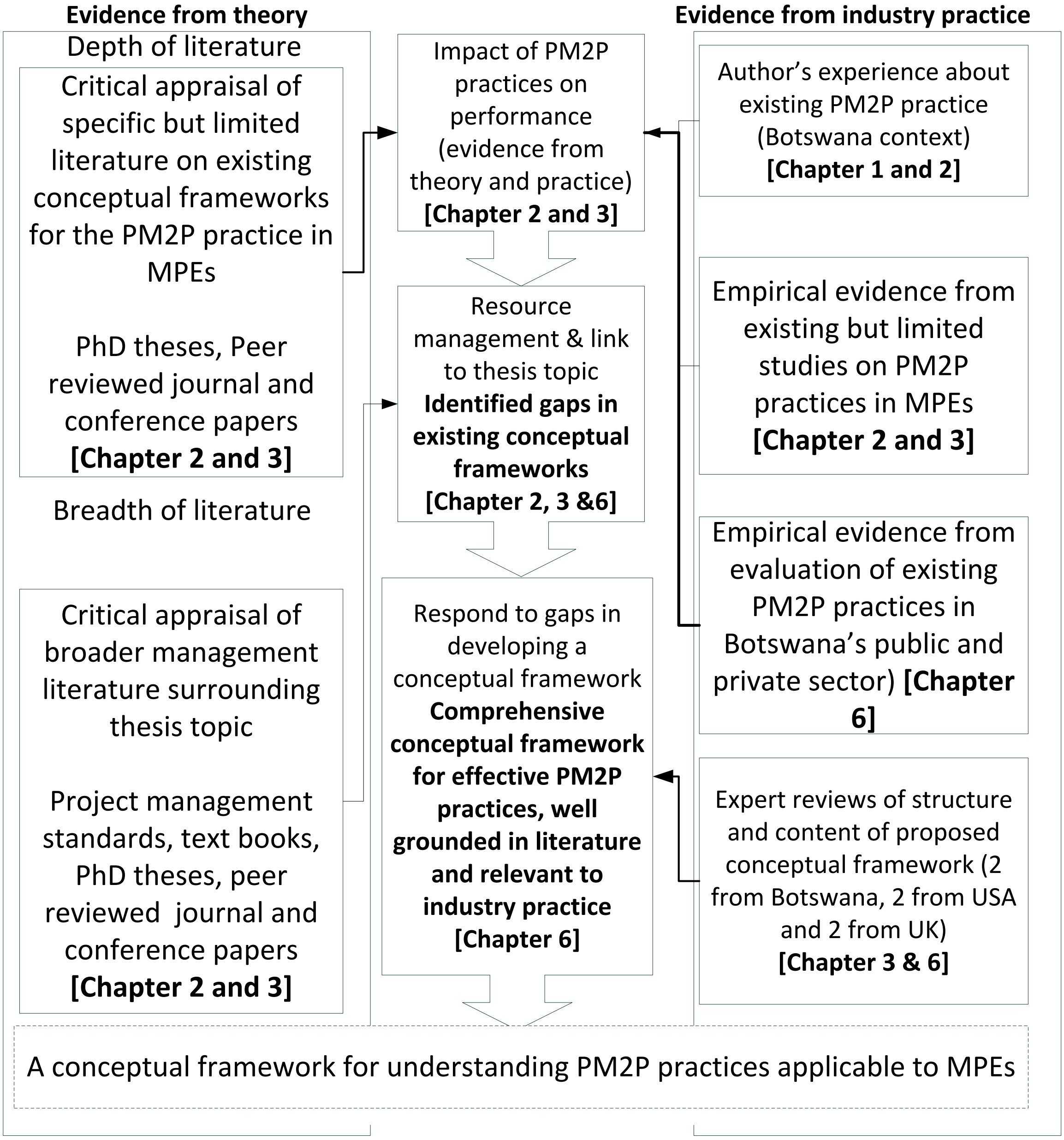


Figure 4-2 Approach to develop a conceptual framework

4.7 Summary

This chapter has provided an overview of the research methodology for this study, in the context of demonstrating how the five objectives are linked together in terms of an overall story that seeks to address the research problem and aim, consistent with the discussions in sections 1.2, 1.3, 4.2 and 4.4. It has also discussed details of the methods implemented to evaluate existing PM2P practices in MPEs of Botswana, and develop a conceptual framework. The methods to evaluate existing PM2P practices in Botswana (new context to existing studies), using the concept of an index rather than a scale, used in prior studies, represent methodological advances and contribute to improved measurement quality.

The robustness of methods described in sections 4.5 and 4.6, based on evidence from both literature and industry practice, provides a solid foundation that facilitates addressing the overall study aim. The evaluation of PM2P practices in Botswana and the development of a conceptual framework, are consistent with the need to propose a new approach. This evaluation is part of practical contribution to an improved way of allocating project managers-to-projects in a specific organization (organization A) based in Botswana. The outcomes of implementing these methods are presented in chapters 7 and 8 respectively. The discussion of methods to evaluate existing PM2P practices in Botswana and methods to develop a conceptual framework lead into the next chapter, associated with methods to describe the existing PM2P practice in organization A, using the developed conceptual framework.

Chapter 5

Methods for describing the existing PM2P practice of a specific organization (organization A) in Botswana

Given a discussion of methods to evaluate existing PM2P practices in Botswana and methods to develop a conceptual framework in chapter 4, the purpose of this chapter is to discuss details of methods implemented to describe the existing PM2P practice of a specific organization (organization A) in Botswana, the main focus of this thesis in terms of addressing the research problem. The following sections fulfil this purpose: (1) research methods for using the conceptual framework to illuminate the existing PM2P practice in organization A, (2) case study approach and justification, (3) design of case study research in using the conceptual framework to illuminate the existing PM2P practice in organization A, and (4) summary.

5.1 Research methods for using the conceptual framework to illuminate the existing PM2P practice in organization A

Six possibilities (see section 4.5) were identified in relation to research methods for using the conceptual framework as a lens through which the existing PM2P practice in organization A can be described. Laboratory experiments were considered unsuitable for an in-depth study of the existing PM2P practice in organization A, which require a naturally occurring setting as opposed to a non-naturally occurring one (Kervin, 1992). Field experiments were considered unsuitable, given that the existing PM2P practice can best be studied without manipulating variables and testing their effects. For example, all informants need to be treated in the same way, using measurement procedures that are the same for all informants. Available data studies were considered unsuitable for illuminating the existing PM2P practice of a specific organization (organization A) in Botswana, which was unknown prior to this thesis. Observational studies were considered unsuitable because examining cause-and-effect relations (Cochra and Chambers, 1965) is not consistent with the intent to uncover a rich description of the existing PM2P practice in organization A. Surveys were deemed unsuitable because the intent of using a conceptual framework was not to cover a large number of instances of the sample population but rather, on richness of descriptions about the existing PM2P practice in organization A. This leaves a case study approach, which suits the need to uncover a complete description of the existing PM2P practice.

5.2 Case study approach and justification

The need to obtain a complete and rich description of the different issues surrounding the existing PM2P practice in organization A suits a case study approach, characterized by an in-depth study of contemporary issues of the phenomenon of interest, in a real-life context and using one or a few cases (Bryman, 1989, 995; Yin, 2009). A key feature of case studies that suits a complete description of the existing PM2P practice in organization A lies in a focus on one specific instance of the phenomenon being studied, such that an in-depth explanation of the PM2P processes that exist in that specific instance (organization A's PM2P practice) can be obtained (Denscombe, 2007). Fellows and Liu (2003b, 2008) assert that case studies can be conducted for different purposes such as provision of a description, which is consistent with the need to uncover a complete description of the existing PM2P practice in organization A. Denscombe (2007) argues that case studies are usually associated with no random selection of subjects under study, given intentional and thoughtful choices to be made, particularly in the context of a single case. This argument makes a single case study approach suitable for addressing the research problem in this thesis, given that careful choices were made about the selection of the eligible case study organization, including selection of the groups of inside informants. The use of a single case study was preferred over multiple case studies, given the intent to examine the existing PM2P practice of a specific organization (organization A) in Botswana, such that a solution can be proposed and customized to improve the existing PM2P practice in that specific organization.

The need to obtain a complete understanding of organization A's existing PM2P practice required collecting both quantitative and qualitative data. This need is akin to a suggestion made in (Bryman, 1989, 1995; Fellows and Liu, 2003b, 2008), regarding collecting different combinations of data, as a common characteristic of a case study approach. The use of a conceptual framework for an in-depth study of the existing PM2P practice in organization A is consistent with one of the key defining features of case studies, on the basis that a good case study approach must be theory-led, except in grounded theory research (Glaser and Strauss, 1967, Strauss, 1990). In the context of a single case study, the complexity of the case (Fellows and Liu, 2003a) as regards hierarchy of the units of analysis (e.g., organization A as a major unit of analysis versus inside informants as embedded unit of analysis) is another key defining feature of a case study approach that makes it a suitable research method for describing the existing PM2P practice in organization A. The next section discusses the design of case study research to describe the existing PM2P practice in organization A.

5.3 Design of case study research in using the conceptual framework to illuminate the existing PM2P practice in organization A

The literature on case study research designs is well documented (Bryman, 2008; Denscombe, 2007; Eisenhardt, 1989; Fellows and Liu, 2003b, 2008;Simons, 2009; Stake, 1995; Yin, 2009). Yin (2009) argues that case study design is invaluable under circumstances where the research area or topic is underexplored, such as is the case in this thesis. A predominant feature, which numerous researchers have unity about, is the need to pay attention to the procedures to be employed in the design of case study research. These procedures, which represent key considerations in terms of six steps to ensure good case study research design, are presented in the context of examining the research problem in more depth.

5.3.1 Step 1: Define the research problem and questions

The research problem associated with the need and potential to improve the existing PM2P practice in the context of Botswana, informed the specific research questions for uncovering a complete description of the existing PM2P practice in organization A. The use of a case study approach enabled flexibility to use a combination of data collection techniques, consistent with an overall mixed methods approach adopted in this thesis. Two specific research questions were constructed as follows:

1. to what extent do managers in organization A consider the list of 34 factors contained in the conceptual framework, in their existing PM2P practices?; and
2. what are the strengths and weaknesses of organization A's existing PM2P practices, on the basis of the conceptual framework contents?

The first research question required quantitative data to capture descriptive statistics about the existing PM2P practice in organization A. This first research question was used to measure a total of 34 important variables (representing factors that influece the PM2P practice) on a 1 to 9 scale that has been used in similar studies (Patanakul et al., 2003, 2004, 2007; Patanakul, 2009). The second research question required qualitative data to capture descriptions of the issues surrounding organization A's existing PM2P practice, with a view to uncover strengths and weaknesses.

Analysis of responses to these two questions formed the basis to describe the existing PM2P practice in organization A, using an overall mixed methods approach. The importance of applying this approach, in terms of collecting both quantitative and qualitative data, lies in the need to fully uncover a complete understanding of the existing PM2P practice in organization A.

5.3.2 Step 2: Select the cases or case

Whilst multiple case studies are broadly considered more beneficial over single case studies (Simons, 2009; Yin, 2009), they are likely to possess distinct and independent features (ibid). A multiple case study design was rejected for the following reasons:

i. the impracticality of in-depth studies of PM2P practices of multiple organizations and then developing solutions to the PM2P problems pertaining to each of those organizations, which are distinct and independent cases; and
ii. it would have been unwise to conduct cross-case comparisons to develop a solution that addresses the PM2P problems across multiple cases, given potential to weaken essential features of each case and hence affecting reliability (Stoecker, 1991).

A single case study approach was therefore, considered appropriate. It involved using the conceptual framework as a lens through which the existing PM2P practice of a specific organization (organization A) could be described, outcomes of which were used to address the overall study aim. Procedures to guide selection of the “case” are presented next.

5.3.2.1 Procedures to guide selection of case

In the context of a single case study approach, two possibilities exist as procedures to guide which case to select namely: random and theoretical sampling (Bryman and Bell, 2007; Yin, 2009). Random sampling was rejected on the following basis: (1) it is generally associated with statistical analysis techniques; (2) it is inappropriate for use in the context of a case study approach, which seeks in-depth and full descriptions of the existing PM2P practice (Eisenhardt, 1989), and (3) the number of eligible cases (15 organizations that operate in a MPE) from which to select, was not necessarily large (Fellows and Liu, 2008). Theoretical sampling was deemed appropriate on the basis of the need to make conscious and deliberate choices about which case to select. Organization A was selected as the “case,” to be studied. This decision is akin to the assertion made in Yin (2009), regarding the suitability of a single case study design, when the same study subjects are contacted more than once over time. Denscombe (2007) suggests that decisions on selecting a particular case must be provided in the context of: (1) key features of the “case”, and (2) relevant details about those significant features. These two factors constitute selection criteria for the “case”, to be explicitly stated, as part of an important component of methodology (Fellows and Liu, 2008). The essential features used as selection criteria for the ‘case’ were:

1. types of organizations – project based organizations that operate in a MPE, as defined in section 2.1, using relevant literature on multi-projects to support this essential feature (Denscombe, 2007); and
2. size of PMO office in terms of the number of project heads and project managers – the size of the PMO office was an important feature to determine which case to select, on the basis of comparison with other eligible cases from a Botswana context. Beyond the Botswana context, existing literature on PM2P practices in MPEs (Choothian et al., 2009; Patanakul et al., 2007) suggests that the size of the PMO office in project-based organizations is such that there is on average, one project director, leading a team of six project managers.

Based on the above criteria, which represent a ‘broader’ category of the phenomenon being studied, it may be argued that the selected case has similarities with other organizations that operate in a MPE, and hence typical of the essential features used as selection criteria. The selected organization is therefore, one instance of the types of organizations that operate in a MPE (Denscombe, 2007; Ragin and Becker, 1992; Yin, 1994, 2009). Furthermore, the selected case is a multi-national organization, with presence in other regions of the world such as Australia, Canada, United States of America and South Africa, although it has features that are unique to Botswana. Beyond the two selection criteria discussed above, practical considerations associated with access to data (Denscombe, 2007; Fellows and Liu, 2008), also played a role in the selection of the eligible ‘case’ to be studied.

5.3.2.2 Justification for choosing organization A as a case study and its context

The reasons for choosing organization A (among eligible organizations in Botswana) for an in-depth examination of the research problem were: commitment, cooperation and willingness to be used as a case to proceed with the research, following evaluation of existing PM2P practices in Botswana’s MPEs. Given issues regarding access to data and significant interest demonstrated by organization A in this study, convenience sampling was used to select the ‘case.’ Convenience sampling was therefore, an additional criterion for the decision to select among equally suitable cases. This additional criterion is akin to an assertion made in Denscombe (2007), regarding the appropriateness of convenience sampling, when deciding between equally suitable alternatives and not in its own right.

In terms of context, organization A is a global leader in the mining industry, as regards annual value and quality of minerals produced. The estimated value of minerals produced, as at 2013, was over £0.96 billion (Kitco, 2012). The core activities in relation to projects are underground mineral explorations involving operations such as geotechnical drilling, blasting, hauling and processing of the extracted minerals to world class finished products. The portfolio of projects implemented per year is typically 34 to 47, and range in budget and duration from £100 m to over £400 m and 12 to 48 months respectively. There are three project management offices in different locations, with a total of 18 project managers, each managing between one to five projects (small projects), and one to two projects (large projects). Typical small projects include resource assessment to sustain existing mine business and give confidence to the investment community, regarding the types of mineral resources mined. Typical large projects include strategic expansion projects, such as building a new underground mining plant or increasing the capacity of an existing plant. The selection criteria for informants are discussed next.

5.3.2.3 Selection criteria for informants

A relevant population of 15 eligible informants, who represent the embedded unit of analysis, was identified on the basis of the following selection criteria:

i. hierarchy of unit of analysis (organization), in relation to appropriate business functions within and outside the immediate scope of the project management function;
ii. ability to provide the required data relating to a description of the existing PM2P practice in organization A; and
iii. willingness to participate in the study, as per research ethics requirements.

The selection criteria for eligible informants within the immediate scope of the project management function were based on direct involvement and experience in making PM2P allocation decisions. Outside the immediate scope of the project management function, the selection criteria were based on direct involvement and experience in making strategic decisions on project prioritization, in terms of determining project priorities.

Initial meetings were held with the research custodian, following logging (see appendix D) and reviewing of organization documents. The purpose was to determine eligible informants, on the basis of the identified selection criteria. A total of four project heads and eleven senior level executives were identified as the target population. Initial decisions on whether or not to sample, based on factors such as target population size and required resources for an in-depth study of the research problem, led to a decision to enumerate this population (Kervin, 1992), given its manageable size. There was no sampling. The 15 informants in two organizational levels, represent the entire population in the context of organization A (the major unit of analysis).

5.3.3 Step 3: Make choices on appropriate techniques for data collection and analysis

Given that this thesis subscribes to a mixed methods approach discussed in section 4.1.3, multiple techniques for data collection and analysis were employed, to examine the research problem in more depth. The need to illuminate a complete description of the existing PM2P practice in organization A, was used to guide appropriate choices about data collection and analysis techniques to be used. A case study approach enabled the use of multiple: data collection, data analysis techniques and data sources, to enable representativeness, in relation to collective views from different informants (Denscombe, 2007).

5.3.4 Step 4: Make the necessary preparations to collect data

In the context of an in-depth study of the research problem, certain procedures were conducted to prepare for data collection, in line with best practices (Kervin, 1992; Yin, 2009). These procedures were: (1) development of research instruments, (2) research ethics, and (3) pilot testing. These procedures are presented below.

5.3.4.1 Development of research instruments

The contents of the conceptual framework discussed in section 4.6 were used in developing research instruments for an in-depth study of the existing PM2P practice in organization A. Given that the conceptual framework was supported by both literature sources and industry expert reviews, including a publication (Seboni and Tutesigensi, 2014a) that demonstrates its up to date nature and relevance to the PM2P practice, it was used to guide the development of research instruments for an in-depth study of the existing PM2P practice in organization A. The intent was to fully describe organization A’s existing PM2P practice, using the conceptual framework contents. The research instrument (appendix E) contained both quantitative and qualitative questions, as discussed in section 5.3.1. The questions were structured into four themes.

Theme 1 focused on measuring the importance score the managers in organization A give to each of the 34 decision criteria in their PM2P practice, making it a complex MCDM problem as highlighted in section 3.4.3.2. A 1 to 9 Likert scale (1 = not important, 5 = average importance, and 9 = very important) was used to measure importance scores the managers attach to each of the PM2P decision criterion. Theme 2 examined a reflection of the given importance scores to determine how each decision criterion is taken into account in the existing PM2P practice. This theme was based on the reasoning that it is one thing to say something is very important and quite another to demonstrate how that importance score manifests itself in the existing PM2P practice in reality (Yin, 1994). Theme 3 examined the outputs to the existing PM2P decision making practice, under 3 processes within the overarching PM2P practice namely: (1) project prioritization, (2) PM2P matching, and (3) recognition of constraints. Theme 4 examined how the output to each of the three processes is used in reality. The four themes represent different aspects of the issues surrounding the existing PM2P practice in organization A, that when combined with the quantitative measures, illuminate a complete understanding of organization A's existing PM2P practice. For this reason, both quantitative and qualitative data were required and used concurrently for an in-depth study of the research problem.

5.3.4.2 Research ethics

The research instruments were subjected to the same ethical review procedures described in section 4.5.4.2. The only difference in the context of methods for describing the existing PM2P practice in organization A, was an amendment letter from the University of Leeds research ethics committee (see appendix I).

5.3.4.3 Pilot testing

The same procedures described in section 4.5.4.3 were used to pilot test the research instruments used to illuminate organization A's existing PM2P practice in. Pilot testing was used for interview schedules, participant information sheets and consent forms.

5.3.5 Step 5: Collect and manage data to facilitate analysis

Multiple sources of data are usually collected, using a variety of techniques (Bryman, 2008; Denscombe, 2007; Fellows and Liu, 2008). In the context of an in-depth study of the research problem, a discussion on collecting and managing data to facilitate analysis is presented under the following: (1) interviewing, (2) measurement of variables, (3) data collection log, (4) data management/reduction techniques, and (5) overview of *‘framework method.’*

5.3.5.1 Interviewing

Interviews were used to collect data, in conjunction with the research instruments discussed in section 5.3.4.1. Interviews were considered suitable, given the need to provide a complete and rich description of the existing PM2P practice in organization A, including the sensitivity of the research topic involving how managers make decisions (Denscombe, 2007).

The literature on interviewing is well documented (Bryman, 2008; Bryman and Bell, 2007; Fellows and Liu, 2008; Yin, 2009). Among the three types of interviews (Frey and Oishi, 1995; Oishi, 2003; Robson, 2002; Sekaran, 2000; Yin, 2009), a semi-structured interview (at a mid-point between structured and unstructured) was deemed appropriate and used to collect data about the different aspects of the issues surrounding the existing PM2P practice in organization A. The choice for semi-structured interviews was based on the need to strike a balance between flexibility and rigidity, while enabling probing for additional insights, where appropriate (Fellows and Liu, 2008; Gray, 2004).

The duration of all interviews was 60 minutes maximum, as per participant information sheets provided to informants prior to interviews, consistent with guidelines in Kervin (1992). The fact that interviews did not go over the stipulated durations proved invaluable in collecting useful information from busy professionals. The collected data from an in-depth study of the existing PM2P practice in organization A, created voluminous data. This volume of data necessitated the need for a systematic process to log, sort and retrieve it, using appropriate tools.

5.3.5.2 Measurement of variables

A 1 to 9 Likert scale (Saaty, 1980, 2008) was used to measure key variables that influence the PM2P practice, under the three processes within the overarching PM2P practice. Although empirical studies surrounding the PM2P practice in MPEs (Choothian et al., 2009; El-Sabaa, 2001; Ogunlana et al., 2002; Patanakul et al., 2007) used different scales, the 1 to 9 scale was preferred for the following reasons: (1) ability to capture the absence of the variable being measured, (2) absence of vagueness in the median score, and (3) presence of three anchor points that helps to improve measurement accuracy. The 1-9 scale was also used in (Patanakul et al., 2007), to quantify certain parameters associated with the PM2P practice.

5.3.5.3 Data collection log

A data collection log (appendix D) was created to systematically capture collected data. This data included field notes and organization documents.

5.3.5.4 Data management/reduction techniques

A number of techniques exist to facilitate data analysis. These techniques serve the purpose of managing collected data by handling it, such that it is in an appropriate form to be analysed. The technique for achieving this process is termed data management or data reduction (Blaikie, 2000), applicable to quantitative data, qualitative data or both.

5.3.5.4.1 Quantitative data reduction techniques

In the management of quantitative data, the following techniques were considered: developing coding categories, codebook, post-coding and rearranging coding categories and Likert scales.

A codebook was developed for management and reduction of the quantitative data. The codebook contained instructions to be used in facilitating data analysis, as part of data management/reduction. A Likert scale was used, along with the code book, to develop coding categories, based on pre-determined themes. Coding categories were rearranged from pre-determined themes, as appropriate. Post-coding was rejected on the basis of existence of pre-determined themes.

5.3.5.4.2 Qualitative data reduction techniques

Data management/reduction techniques also apply to qualitative data, although it becomes difficult to make a clear distinction between data management/reduction and analysis, in the context of qualitative data. This is because data collection, management/reduction and analysis is an iterative process (Blaikie, 2000), in the context of qualitative data. This may explain why some researchers (Gale et al., 2013; Ritchie and Lewis, 2003) refer to certain data management/reduction techniques, such as *'framework method,'* as a data management and analysis technique, although in reality, there is precisely little data analysis conducted. *'Framework method'* is a data management/reduction technique used to reduce voluminous qualitative data, by creating summaries contained within the cells of the built matrices or grids (Ritchie and Lewis, 2003).

'Framework method' was considered appropriate for managing and reducing the volume of data from an in-depth study of the research problem. The rationale for choosing '*Framework method'* over alternative techniques was based on flexibility to be used with many qualitative data analysis approaches (e.g., content analysis and thematic analysis) seeking to generate themes, without worrying about which philosophical perspective underpins the adopted approach or which particular discipline is aligned with that approach. For example, whilst alternative qualitative approaches such as Grounded Theory are concerned specifically with generation of theory (inductive) in the context of say thematic analysis, '*Framework method'* is flexible for use with an inductive thematic analysis and a deductive thematic analysis, or a combined approach (Gale et al., 2013). A complete description of the existing PM2P practice in organization A, involves both an inductive (generating meaning from the data) and deductive (using pre-existing theories as regards the conceptual framework) approach, which suits the use of 'Framework method.'

'Framework method' was used in conjunction with the following procedures:

i. coding – to shape ideas in terms of identifying major themes;
ii. developing themes – identifying patterns in the data, by reading of text segments and linking them to appropriate themes;
iii. constructing explanatory illustrations – using NVivo to generate visual illustrations that assist in explaining relationships between developing themes; and
iv. re-arranging coding categories – re-arranging themes as appropriate, following more coding of data, in terms of further exploring emerging themes associated with a complete description of the existing PM2P practice in organization A.

Given that *'framework method'* was identified as a suitable technique for the management and reduction of qualitative data collected from an in-depth study of existing PM2P practices in organization A, the next section provides an overview of this chosen technique.

5.3.5.5 Overview of *'framework method'*

'Framework method' was developed by researchers at the UK National Centre for Social Research (Ritchie and Spencer, 1994; Ritchie and Lewis, 2003). It has been widely used as a valuable technique to facilitate the management and analysis of

qualitative data for different applications, since its inception in the 1980s. '*Framework method'* was used to manage and reduce voluminous data, to facilitate analysis. Summaries were created, followed by building *'framework matrices'*, as part of data management necessary to reduce large amounts of text from open-ended responses concerning illumination of the existing PM2P practice in organization A.

Applications of *'framework method'* have gained popularity from initially social sciences and applied policy research (Gale et al., 2013; Ritchie and Lewis, 2003; Ritchie and Spencer, 1994) and most particularly management studies (Denzin and Lincoln, 2000; Srivastava and Thompson, 2009). *'Framework method'* is based on two key principles namely: (1) data reduction, and (2) maintaining the richness of the qualitative data being analysed, to create summaries. Firstly, qualitative data are managed by organizing and grouping them into key themes and concepts, represented in a hierarchical structure. This hierarchical structure groups the data into several key themes that are split into related sub-themes. The key themes and sub-themes, containing the qualitative text (subjective) about the existing PM2P practice in organization A, represent the columns of the matrix or grid. Secondly, this subjective aspect of the qualitative data was combined with the objective aspect (e.g., demographic data about each case), which represent the rows of the matrix. Lastly, the resulting matrix display contains two pieces of information namely: (1) key themes and sub-themes in the columns of the matrix, and (2) cases (along with their demographic data) in the rows of the matrix. The cells in the matrix contain appropriate summaries created from the data, to allow insights to be made about similarities and differences between themes for each case or across cases, during subsequent analysis (Gale et al., 2013; Ritchie and Lewis, 2003).

The *'framework method'* was used to facilitate data analysis, following creation of summaries about the issues pertaining to the existing PM2P practice in organization A, during data reduction. Case and theme-based approaches were combined to categorize the different aspects of the issues surrounding the existing PM2P practice. Themes were identified by looking along one or more columns and across rows (cases), with a view to contrast and compare them as part of conceptualizing themes and cases (NatCen, 2010a,b; Ritchie and Lewis, 2003), to uncover a full understanding of organization A's existing PM2P practice.

The two key elements of the *'framework method'* described above are consistent with the principle of a specific feature within the NVivo software called '*framework matrices'*

(QSR, 2012a). These were used, on the basis of facilitating the crucial need to retain a link between the created summaries in the cells of the matrix and the original data, through a linking feature that is similar in functionality to a hyperlink (NatCen, 2010a,b).

5.3.5.5.1 Justification for '*framework method'*

The '*framework method'* is particularly appropriate for adoption in situations where a descriptive account of the phenomenon being examined, in relation to divergent views and experiences of individuals, groups of individuals or cases from the whole data, is required (Gale et al., 2013). Various types of data formats are suitable for management/reduction using '*framework method'*. These data types include: textual data from semi-structured interviews, minutes of meetings; entries from research journal and diaries from fieldwork activities and other company documents (ibid). The nature of data collected to illuminate the existing PM2P practice in organization A, suits these requirements, hence its use for the data management and reduction process.

5.3.5.5.2 Critique of '*framework method'*

Although '*framework method'* is discussed by several authors (Gale et al., 2013; Ritchie and Lewis, 2003; Ritchie and Spencer, 1994) as a qualitative data analysis technique, it is not strictly a data analysis technique but rather a data management technique, with the objective of reducing large amounts of qualitative data to facilitate analysis. This argument is made on the basis that there is significant data management/reduction involved in application of '*framework method'* and little data analysis as noted in section 5.3.5.4.2. For example, unlike data analysis techniques, application of '*framework method'* does not provide descriptive and explanatory accounts of the existing PM2P practice, or in fact strategies for making analytic decisions during analysis (Bazeley, 2009a; Brewer and Hunter, 2006). While there are no silver bullets in the use of qualitative data analysis techniques, '*framework method'* may not be classified under the same category as qualitative data analysis techniques.

5.3.6 Step 6: Analyse and interpret data to draw conclusions

Procedures for analysis of quantitative and qualitative data, tools and techniques used to integrate both data sets, as well as issues to address reliability, are presented. These procedures are discussed in the context of methods for describing the existing PM2P practice in organization A, the focus for this study in terms of addressing the research problem.

5.3.6.1 Procedures for analysis of quantitative data

The procedures for preparation and analysis of the quantitative data, using SPSS, included the following: creation of SPSS data files, creation of coding instructions, screening data files and correcting errors, and data analysis. The reasons for choosing SPSS over competing alternatives were discussed in section 4.5.6.

Two data sets were created in SPSS; one for senior level executives and the other for project heads. The variables for each data set were defined, followed by data entry into SPSS. A codebook was prepared for both data sets and used as part of the instructions during data entry into SPSS. Both data files were screened and errors corrected, prior to conducting the appropriate statistical analyses. Given the nature of collected quantitative data, univariate descriptive analysis, appropriate for analysis of quantitative data, was used to illuminate the strengths and weaknesses in organization A’s existing PM2P practices, in the context of measures of central tendency. These measures were associated with the 34 factors (conceptual framework contents) that are indicative of best practice regarding effective PM2P practices in MPEs.

5.3.6.2 Overview of computer assisted qualitative data analysis (CAQDA) software

An overview of CAQDA software is presented, with a view to demonstrate consideration of alternative software packages in terms of advantages and disadvantages, leading to justification for choice of software. In general, the use of computer software to analyse qualitative data is geared towards taking advantage of its capability to record, sort, match and link data in a manner that is thorough, while maintaining the context from which that data has come (Bazeley, 2007). Computer software can facilitate exploration of data in a manner that cannot be done manually, because the human mind has limitations. However, learning from the data by working manually was not displaced by the use of computer software (Bazeley, 2007).

Some of the CAQDA software include: NUD*IST, Weft QDA, cassandre (Bazeley, 2006), MAXqda, ATLAS ti, and NVivo (Coffey et al., 1996; Lewins and Silver, 2007). The question of which software is the best for managing and analysing qualitative data is difficult to answer (Lewis and Silver, 2007). This question may be answered in relation to a number of factors such as: nature of the data, unique features of each software that can support certain tasks, and how the software is taught (ibid). Other factors such as software accessibility and support may play a role.

Several books on the use of CAQDA software (Bazeley, 2007; Bazeley and Jackson, 2013; Bazeley and Richards, 2000; di Gregorio and Davidson, 2008; Edhlund, 2011; Gibbs, 2002; Lewins and Silver, 2007; Richards, 1999; Silver and Lewis, 2010) were reviewed. This review included conference papers and journal articles (Albar and Jettera, 2013; Bazeley, 2002; Crowley et al., 2002; Fielding and Lee, 2002; Gilbert, 2002; Ishak and Abu Bakar, 2012; Rich and Patashnick, 2002; Richards, 2002a,2002b; Tagg, 2002), including PhD theses (Albar, 2013; Aritua, 2009; Bringer, 2002; O'Neill, 2013; Raiden, 2004). Additional sources were reviewed from a general methodological standpoint regarding techniques and approaches for analysis of qualitative data (Bazeley, 2013; Frost and Stablein, 1992; Maxwell, 2004; McLellan et al., 2003; Richards, 2005, 2009), including ideas on coding (Hruschka et al., 2004; MacQueen et al., 1998) and specific techniques for identifying themes (Ryan and Bernard, 2003). The advantages and disadvantages of the use of CAQDA are presented.

5.3.6.2.1 Advantages and disadvantages of the use of CAQDA software

The main advantages of using CAQDA software are closeness to data and flexibility. Closeness to data arises from gaining easy access to all the project data in a dynamic manner (Lewis and Silver, 2007). Flexibility arises from the interactive nature of the software tools, although the degree of interactivity may vary from one software to the next (Lewis and Silver, 2007).

Much of the drawbacks of using these software packages are centred on the trap of being consumed by the features and tools of the software and losing sight of the analytic concepts that are mainly done by the researcher, away from a computer. However, features within certain CAQDA software help in this analytic process.

5.3.6.2.2 Choice of CAQDA software and justification

Among the early CAQDA software packages, NVivo stands out for the following reasons (Bazeley and Jackson, 2013):

i. increased flexibility to adapt to demands of today's research projects;
ii. capability to query the data by posing questions to the data within the NVivo database, such that query results are returned and saved, to allow further interrogation; and
iii. transparent reporting from the data, using contents of NVivo database.

5.3.6.3 NVivo procedures – data management and analysis

NVivo was used for management and analysis of the qualitative data. A summary of procedures for managing and analysing the qualitative data, to illuminate a complete description of the existing PM2P practice in organization A, is shown in Figure 5-1.

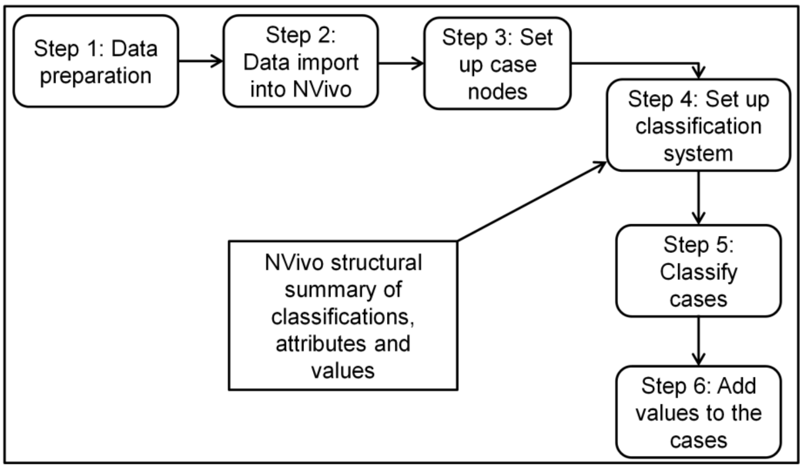


Figure 5-1 Procedures for qualitative data management and analysis

Data preparation involved formatting documents using textual and heading styles as appropriate, following interview transcription. The data was then imported into the NVivo database, followed by setting up case nodes for each informant by creating classification nodes. This set up enabled a systematic record of informants and their respective raw data. Attributes were assigned to created classification nodes and values assigned to each attribute. Appropriate values were added to the cases, to enable automatic tracking of what each informant (case) said under each thematic node, as well as providing demographic information about that specific informant, from the assigned attributes and values. Demographic information was used in NVivo's coding queries to interrogate the data, since the software would have linked the demographic details of each informant to their respective case nodes (Edhlund, 2011), as per the created classification system.

5.3.6.4 Research journal and memos

A research journal was created (appendix G) to enable various entries, during data management and analysis (Bazeley and Jackson, 2013). Summaries were created within NVivo's '*framework matrices*' as noted in section 5.3.5.5. Links for various journal entries were created, to enable instant access to data during analysis. Various memos were written during the iterative processes of data management and specifically analysis, as part of journal entries to facilitate analysis (Miles and Huberman, 1984).

5.3.6.5 Approaches to analysis of qualitative data and NVivo tools

In light of the diversity of qualitative approaches as regards analytic styles available for analysing qualitative data, a decision was made not to rely on one specific approach but instead employ combinations of them, consistent with a mixed methods approach used in this thesis (section 4.1.3). The use of NVivo, which is not designed to suit a particular approach but can be used in a way that supports the multitudes of qualitative approaches (Gibbs, 2002), also suits the approach of combining analytic styles.

A choice of NVivo tools and features for analysis processes was made, on the basis of which tools were directly applicable to facilitate a full description of the existing PM2P practice in organization A. For example, analytic memos (appendix F) were used with NVivo software, as part of qualitative data analysis processes that provide transparency. An example of an analytic memo used to facilitate a discussion of the weaknesses in organization A's existing PM2P practices, is depicted in Figure 5-2.

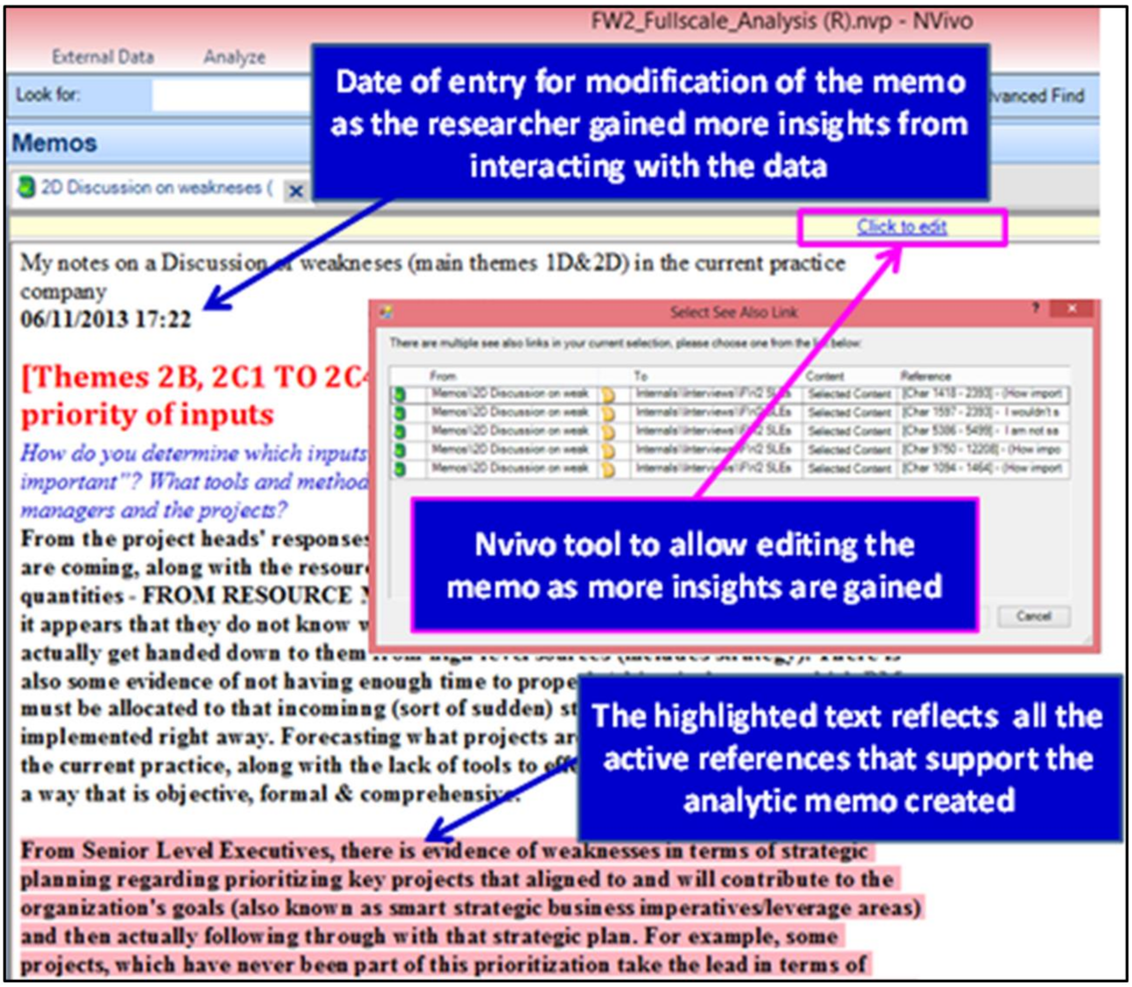


Figure 5-2 Analytic memo for theme regarding weaknesses

The memos were subsequently grouped into different categories, to distinguish the purpose of each category, in light of data management and interpretation. A total of four categories of memos (appendix F) resulted from this grouping namely: operational, conceptual, analytic and visual displays (Bringer, 2002).

The quality of the analysis process and the credibility of both the data analysis and the study outcomes can be ascertained through audit trails of the NVivo software, in line with transparency (Fielding and Lee, 1998), unlike manual processes.

5.3.6.6 Overview of qualitative data analysis methods

There are a multitude of qualitative data analysis methods in existence. Majority of these methods are linked to particular disciplines of enquiry and bounded by certain philosophical perspectives, which inform the analysis process (Crotty, 1998; Gale et al., 2013; Titscher et al., 2002). The similarities lie in a search for patterns in the data, which can ultimately be used to generate descriptive and explanatory accounts of the phenomenon being examined. Most of these methods use an analysis concept that has its roots in grounded theory (Crotty, 1998; Gale et al., 2013; Glaser and Strauss, 1967) known as the 'constant comparative method'. This concept involves comparing the data across different cases in a step-by-step manner, during growing understanding of emergent themes (Boeije, 2002; Gale et al., 2013; Glaser and Strauss, 1967).

Despite the popularity of grounded theory in the analysis of qualitative data, grounded theory was rejected on the basis that a conceptual framework was used to illuminate the existing PM2P practice in organization A, which implies use of pre-existing notions. The intent was not to generate abstract theory (Strauss and Corbin, 1990) but rather, to build on existing theories surrounding the PM2P practice. Content analysis (Busha and Harter, 1980; Krippendorff, 2004) and thematic analysis (Braun and Clarke, 2006; Bryman, 2008; Miles and Huberman, 1984; Riessman, 2008; Ritchie and Lewis, 2003; Ritchie and Spencer, 1994; Saldana, 2011) were used for analysis of qualitative data, for the following reasons:

i. a systematic analysis of the actual features contained within communication (Busha and Harter, 1980), is consistent with content analysis of different types of collected data (Berg, 2007), to uncover a complete understanding of the existing PM2P practice in organization A;
ii. the intent to derive meanings, explanations and a rich description of the existing PM2P practice from different informants' divergent views in relation to their individual words in a mass of data (Saldana, 2011), is consistent with both content and thematic analysis; and
iii. the need to identify, analyse and report patterns in the data, to provide a full description of the existing PM2P practice in organization A, is consistent with thematic analysis (Braun and Clarke, 2006), which is among the most popular methods of analysing qualitative data (Riessman, 2008).

An important categorization of qualitative data analysis methods is on the basis of how the data are sorted, particularly during the data management/reduction process. There are three different approaches of sorting the data namely: (1) case-based, (2) theme-based, and (3) case and theme-based approaches (Gale et al., 2013; Ritchie and Spencer, 1994). All three were adopted because of the need to uncover a complete description of organization A's existing PM2P practice. These approaches are briefly discussed.

5.3.6.6.1 Case-based approaches

Case-based approaches focus on examining the data within particular cases, to determine how views, experiences and attitudes are different or similar, within those cases. For example, the emphasis may be on the views of a particular case across various themes. In the context of '*framework method'* used to uncover a description of the existing PM2P practice in organization A, a case-based approach involves looking across one or more rows of the matrix to examine what a particular case or cases say about different themes. The themes are associated with organization A's existing PM2P practice, in the columns of the matrix (Gale et al., 2013). NVivo 10, along with '*framework matrices,'* were used as part of the procedure to operationalize this case-based approach, in view of the following examples: creating summaries of each case across the various themes, using cell coding, creating hyperlinks between the created summaries and the original data, creating annotations and memos for a transcript belonging to a specific case, and creating visual illustrations to analyse possible relationships and using 'See also links' to explore the various links within each case.

5.3.6.6.2 Theme-based approaches

These are concerned with sorting the whole data on the basis of themes. The emphasis is not on examining how the views of particular cases differ across the various themes but rather, on overall views about certain themes. In the context of '*framework method'*, a theme-based approach involves looking down one or more columns of the matrix, to determine overall views of all cases to that particular theme (Gale et al., 2013). A theme-based approach was operationalized in a number of ways, through the use of '*framework analysis'* and NVivo. For example, the coding processes used within NVivo 10, represents procedures to operationalize the theme-based approach, as opposed to manual processes of sorting the data using coloured pens and markers (Bryman, 2008; Miles and Huberman, 1984).

5.3.6.6.3 Case and theme-based approaches

These involve sorting the whole data by case and themes, to analyse data by combining both approaches. This combination was achieved using '*framework method'*, allowing a combination of these two approaches by looking across both the rows (cases) and columns (themes) of the matrix. The intent was to determine two things: views of a particular case or cases across all the themes, and overall views about a particular theme or themes (Gale et al., 2013).

5.3.6.7 Qualitative data preparation and analysis procedures

The procedures used during the data management and analysis of qualitative data are summarized in Table 5-1. The stages of the '*framework method'* (Table 5-1) are briefly described.

Table 5-1 Summary of procedures for analysis of qualitative data

Analytic (Richie & Lewis, 2003; Krippendorf, 2004)	Framework method and stages	NVivo 10 procedures	Purpose
Nature of data	**Stage 1. Data transcription** Convert audio from interviewees' verbatim into written text, to gain closeness to data	Format transcripts using heading styles	Data management
Research questions and objectives	**Stage 2. Data familiarization** Listen to audio, write reflective notes and observations made during interviews	Data import into NVivo, Create research journal, annotations & initial memos (operational & conceptual)	Data management
Research questions and objectives	**Stage 3. Coding** Develop code book, label data segments, and link memos	Code by pre-defined themes, Auto-coding, in Vivo coding, Create memos for cases	Data management
Research questions and objectives	**Stage 4. Develop analytic lens** Arrange nodes into hierarchies as per research questions and objectives	Merge similar nodes and re-arrange nodes	Data management
Research questions and objectives	**Stage 5. Apply analytic lens** Phase 2 coding	Phase 2 coding - shift from mere labels to analytic themes, Explore data using queries	Data analysis
Research questions and objectives	**Stage 6. Generate Framework matrices** Create summaries that retain data context, Conduct Case and Theme-based analyses	Create summaries for framework matrices, create links to original data, Create links for annotations, memos and journal entries, Conduct Case and Theme-based analyses	Data analysis
Explore patterns across whole data (cases and themes)	**Stage 7. Data interpretation** Internalize whole data from record of growing understanding of ideas, concepts and reflective thoughts	Categorize memos based on themes, Intellectualize matrix coding qury results for patterns	Descriptive and explanatory accounts

5.3.6.7.1 Stage 1. Data transcription

Interview transcription was conducted verbatim. The transcripts were then imported into NVivo, which was used in conjunction with the '*framework method'*. The reasons were to maximize NVivo tools and features, and closeness to data (Bazeley, 2007), in line with good research practices (Frost and Stablein, 1992).

5.3.6.7.2 Stage 2. Data familiarization

Familiarization with the collected data was achieved through the following: verbatim transcription, use of NVivo tools such as creating annotations and different types of memos (appendix F) during review of data, and creation of links between various project items, to facilitate identification of relationships. Data familiarization formed an important aspect of gaining an overall view of the whole data (Ritchie and Spencer, 1994), to facilitate interpretation (Gale et al., 2013).

5.3.6.7.3 Stage 3. Coding

A code book was developed and used during initial coding involved with close reading of informants' text segments, making judgements about which text segments belong to which pre-defined themes (nodes in the context of NVivo) and grouping the various text segments to those themes. This coding process is referred to as deductive coding, since it is based on pre-existing themes informed by existing theory (Bazeley and Jackson, 2013). An NVivo feature called 'Coding stripes' was used for checking coding consistency, to confirm that the labelling of the various text segments across the collected data is done in a consistent manner.

5.3.6.7.4 Stage 4. Develop analytic lens

A complete analytic lens used to represent the entire data, in terms of all the ideas and concepts arising from informants' views, was identified. Themes were re-arranged into hierarchies and grouped according to similarity of concepts, exhausting all themes that cover the whole data in terms of indexing informants' verbatim. While pre-existing themes were used to guide the issues emerging from the data, the data was not forced to those existing themes (Ritchie and Spencer, 1994). For example, additions were made to the analytic lens, arising from collected data. Refinements to the analytic lens were made on the basis of a growing understanding of the important issues arising from subsequent coding and indexing of text segments, bounded most importantly by the need to uncover a full description of the existing PM2P practice in organization.

5.3.6.7.5 Stage 5. Apply analytic lens

Subsequent interview transcripts were indexed by identifying the remaining text segments and applying them to the analytic lens that has been confirmed to cover the entire data. There were no additions to the analytic lens at this stage, except for further refinement of the node hierarchical structure geared to illuminate organization A's existing PM2P practice. Node reference numbers were assigned to identify key themes.

5.3.6.7.6 Stage 6. Generate *'framework matrices'*

The indexed text segments from stage 5 were used to generate framework matrices containing data summaries from those indexed segments, in preparation for both case and theme-based analysis. An attempt was made to retain the original expressions of the informants' verbatim, while reducing it into corresponding thematic summaries (Gale et al., 2013; Ritchie and Spencer, 1994; Srivastava and Thompson, 2009). 'F*ramework matrices'* for each theme were created within NVivo, containing data summaries by theme, from each case. Hyperlinks were used to retain links between data summaries and the original data, as part of transparency. Various links to other items such as different categories of memos (appendix F) and annotations of text segments, were created using NVivo tools, to facilitate analysis.

5.3.6.7.7 Stage 7. Data interpretation

Various NVivo tools were used, along with the created '*framework matrices'* containing the data summaries, to facilitate the mapping and interpretation of the data. The aim was to produce rich descriptions of organization A's existing PM2P practice that cover the whole data and representative of informants' divergent views and beliefs (ibid). Given collection of both quantitative and qualitative data, procedures for integrating analysis of both strands are discussed next, in the pursuit of describing the existing PM2P practice in organization A.

5.3.6.8 Procedures for integrating analysis of both quantitative and qualitative data

Following separate analysis of each strand, the outcomes of each analysis were integrated for further analysis, on the basis of dimensions related to uncovering a complete description of organization A's existing PM2P practice. Several analytic strategies for integrating both data types were explored. These analytic strategies are (Bazeley, 2009b; Brewer and Hunter, 2006; Creswell and Clark, 2011; Greene, 2007):

i. creating a matrix to facilitate comparison of the quantitative results with the qualitative results;
ii. transforming the results of either the quantitative or qualitative data type into the other data type, and integrating them by comparing the transformed data; and

iii. integrating the quantitative and qualitative data in terms of a combined analysis, to obtain a complete understanding of the existing PM2P practice.

The first two strategies were considered inappropriate, given that the aim was not to compare the two data types but rather to uncover a complete understanding of the existing PM2P practice in organization A, by integrating each data type in a complementary manner. The different aspects of the PM2P practice uncovered, could not be compared with each other, since they were different. For example, the research instrument was aimed at addressing two research questions (section 5.3.1), which required both different answers and different aspects of the answers.

This leaves the third analytic strategy of combining the two strands, based on integrating analysis of both data types, to obtain a complete picture of the existing PM2P practice in organization A, as opposed to the first two analytic strategies involving data comparisons and appropriate for similar aspects. Bazeley (2009b), incorporates this third analytic strategy, in a comprehensive coverage of analytic strategies for integrating data during analysis rather than when making conclusions to a mixed methods study. This analytic strategy, supported in (Brewer and Hunter, 2006; Greene, 2007), is unique but useful to uncover new insights. It was considered appropriate to illuminate the existing PM2P practice in organization A, for reasons given in section 5.3.1.

The quantitative and qualitative data represent different aspects of the existing PM2P practice, which cannot be compared but rather, can be integrated together, to illuminate a complete understanding of the different aspects and issues surrounding the existing PM2P practice. The outcome was a more accurate description of the existing PM2P practice in organization A. On this basis, the third analytic strategy was adopted for further integration of the outcomes of each data analysis (see Figure 5-3).

The integrated analysis was performed in a complementary manner (treating each data type equally) at both micro and macro-level, during analysis. Micro-level analysis focussed on the individual criteria in the conceptual framework, while macro-level analysis was concerned with summaries of the findings. Interpretation of the combined analysis followed, to provide a complete and more accurate understanding of organization A's existing PM2P practice.

The left hand side (Figure 5-3) depicts procedures used in quantitative data collection and analysis, including the outcomes related to descriptive statistics such as rating scores, mean and standard deviations. The right hand side (Figure 5-3) depicts procedures used in qualitative data collection and analysis, including outcomes such as strengths and weaknesses in the existing PM2P practice. The integrated results from combined analysis were finally interpreted, resulting in a complete understanding of organization A's existing PM2P practice. This integration revealed new insights.

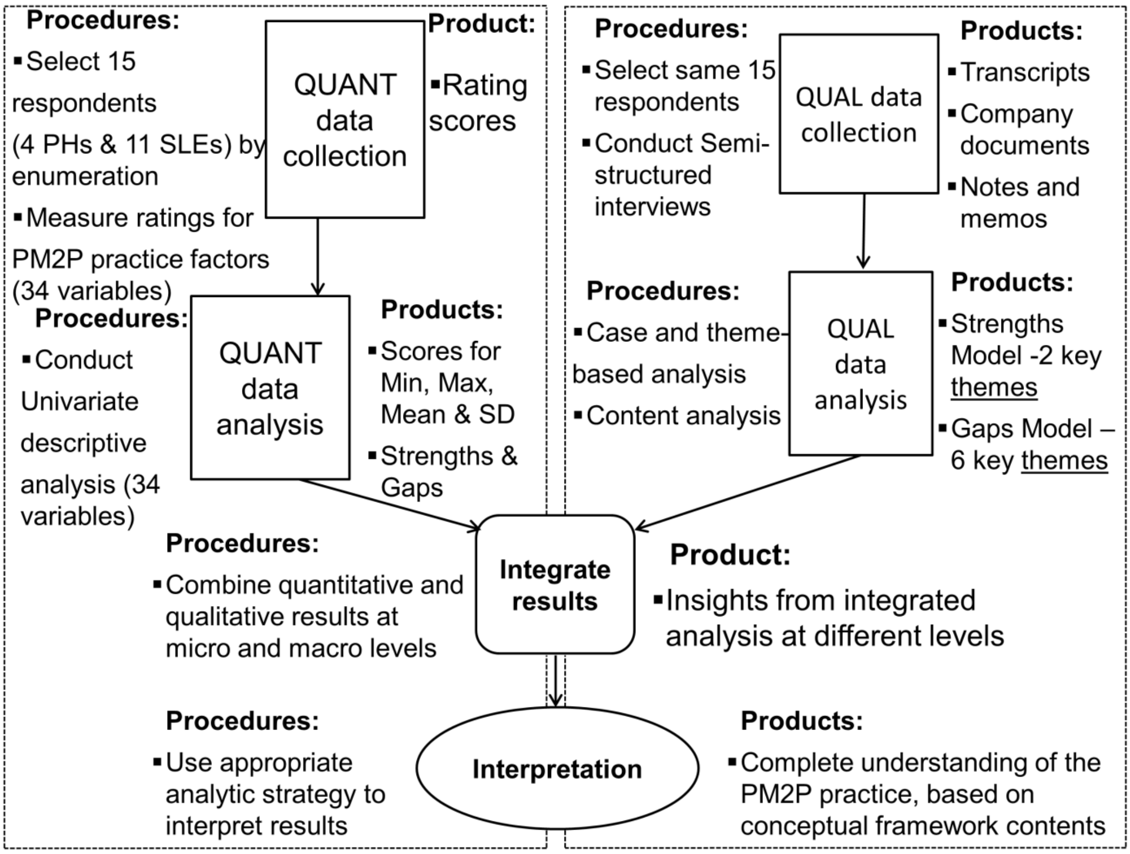


Figure 5-3 Procedures for integrating the two strands

5.3.6.9 Construct validity issues

Measures taken to address construct validity issues, in the context of a case study approach to describe the existing PM2P practice in organization A are: (1) use of multiple sources of evidence (Eisenhardt, 1989) associated with semi-structured interviews, (2) organizational document reviews to supplement evidence from interviews, (3) use of field notes, and (4) use of informants from different organizational levels, to gain multiple perspectives about the issues surrounding the existing PM2P practice in organization A.

5.3.6.10 Internal validity issues

Within case comparisons were used as measures to address internal validity issues in describing the existing PM2P practice of a specific organization in Botswana. These comparisons were associated with examining themes across the whole data, as discussed in section 5.3.6.7.4. Triangulation was another measure taken to address internal validity, vital in obtaining insights for making interpretations about the results (Creswell and Clark, 2011; Denscombe, 2007; Fellows and Liu, 2008).

However, a disadvantage of the use of triangulation is noted by Denscombe (2007), who state *"data analysis becomes more complex"* (p.139), given the need to use more than one type of analysis, including "*the need to compare, contrast,……..or integrate the findings"* (p.139), which is more challenging than when dealing with one technique. However, this argument did not ditter the author from using triangulation, in the persuit of uncovering a complete description of organization A's existing PM2P practice.

5.3.6.11 Reliability and assessing quality in quantitative and qualitative data analysis methods

Given that research reliability and validity are associated with an assessment of research quality, a brief discussion on assessing research quality, in relation to the quantitative-qualitative dichotomy is appropriate and briefly discussed. The emphasis is on demonstrating quality in analysis of qualitative data associated with a description of the existing PM2P practice in organization A, given that assessing quality in analysis of quantitative data is more salient than analysis of qualitative data.

In the context of illuminating a full description of the existing PM2P practice in organization A, reliability was achieved and demonstrated through transparency in terms of tracing findings back to their original data sources (Eisenhardt, 1989), as per discussions in section 5.3.6.7.6. A comparison between criteria for assessing research, in terms of the quantitative and qualitative dichotomy is summarized in Table 5-2, using ideas reported in (Bringer, 2002; Lincoln and Guba, 2000; Marshall and Rossman, 1995; Sparkes, 2001).

This comparison is based on extending quantitative criteria to corresponding qualitative criteria and is referred to as the *parallel perspective* (Sparkes, 2001), in terms of extending criteria for assessing quantitative methods to equivalent criteria for qualitative methods. The approach of comparing quantitative and qualitative methods in parallel is adopted because it is appropriate for an in-depth study of the research problem, which employed a mixture of methods associated with data collection, management and analysis techniques. Mixed methods studies adopt the same approach with regard to parallel perspective (Greene and Caracelli, 1997).

Table 5-2 Comparison of quantitative versus qualitative methods

Quantitative criteria	**Qualitative criteria**	**Methods to achieve qualitative criteria for in-depth study of existing PM2P practices**
Internal validity*	Credibility/truth value*	Analysis of the whole data for all cases, using Framework method and NVivo 10
Internal validity#	Credibility#	Audit trails from framework matrices and NVivo data movement entries (e.g., research journal entries, memos, matrix displays)
External validity	Transferability/Applicability*	Detailed description of research processes and procedures
External validity	Transferability#	NVivo output reports, Framework Matrix outputs
Reliability*	Dependability/replicability/ consistency*	Same interview schedule for each group of informants
Reliability#	Dependability/ trustworthiness#	Explicit statement of assumptions and acknowledgement of limitations
Objectivity*	Confirmability/unbiased/ neutrality*	NVivo output reports as audit trail of research project – track record of when ideas emerged (NVivo's date & time stamp) and how they were developed
Objectivity#	Confirmability/plausibility/ conceivability#	Framework Matrix outputs and links to original data

Key: * = Marshall and Rossman, # = Lincoln and Guba (2000), Sparkes (2001) and Bringer (2002)

5.4 Summary

This chapter has discussed details of the methods implemented to describe the existing PM2P practice of a specific organization in Botswana, the emphasis of this thesis in terms of addressing the research problem introduced in chapter 1 and explored further in chapter 2. The arguments in this chapter are geared towards the need to improve the existing PM2P practice in organization A, by developing an improved way of practically contributing to the allocation of project managers to projects in organization A. The outcomes of implementing these methods are presented in chapter 9.

Chapter 6
Methods for proposing and validating a new approach to improve the existing PM2P practice of organization A in Botswana

The previous chapter discussed details of the methods used to describe the existing PM2P practice in organization A. The purpose of this chapter is to discuss details of the methods implemented to propose and validate a new approach to improve the PM2P practice of a specific organization (organization A) in Botswana. These details are associated with addressing the overall study aim, through the following sections: (1) methods, techniques and instruments for proposing a new approach to improve the PM2P practice in organization A, (2) methods, techniques and instruments for validating the new approach, (3) internal validation of the DSS – discussion of four test cases, (4) internal validation by direct comparison with existing approach, and (5) summary.

6.1 Methods, techniques and instruments for proposing a new approach to improve the PM2P practice in organization A

Literature review was considered a suitable method to propose a new approach to improve the PM2P practice in organization A, in the absence of primary data collection, for the same reasons given in section 4.6. These reviews (see sections 3.3 and 3.4), were internalized and integrated in a creative manner, using concepts from different disciplines such as mathematics, operations research, computer science and project management. Detailed discussions of the methods associated with the development of the new approach are presented.

6.1.1 Steps in developing a new approach to improve the PM2P practice

Figure 6-1 is used to facilitate a discussion of the development of a new approach to improve organization A's existing PM2P practice, consistent with the study aim. It comprises steps taken in the process of developing the new approach, as part of addressing the study aim. Steps 1 to 8 are consistent with basic principles of mathematical modelling and optimization (Conway and Ragsdale, 1997; Ragsdale, 2003, 2011, 2015) of multi-criteria decision making problems (Triantaphyllou, 2000). Steps 9 to 11 have been added to extend the usefulness of mathematical optimization modelling to industry applications, to address the research problem and identified gaps

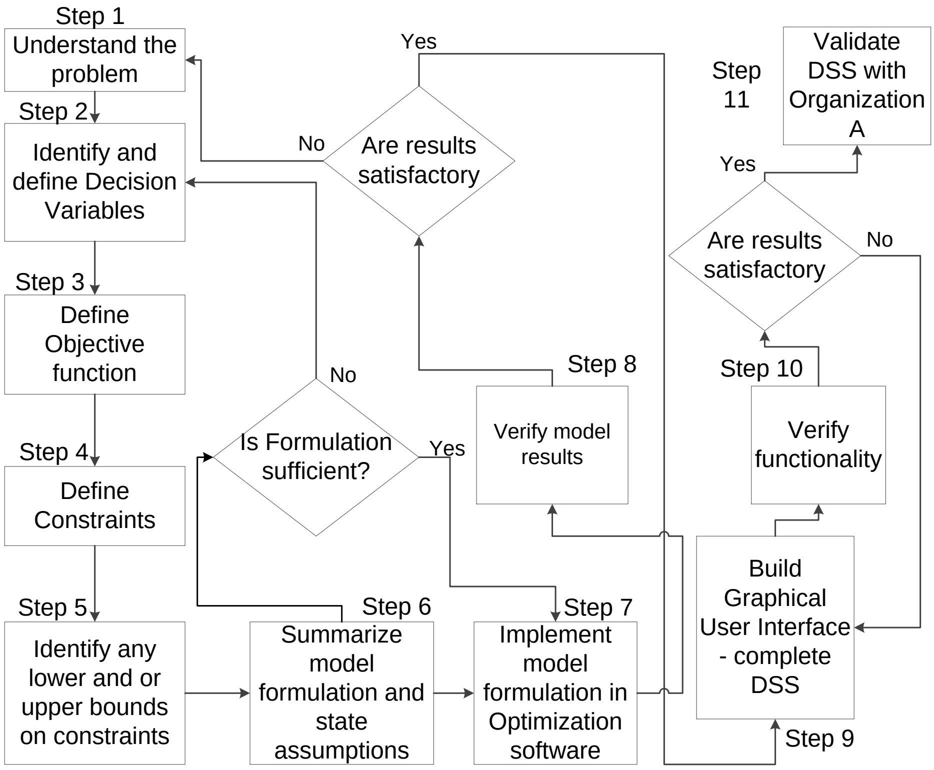


Figure 6-1 Flowchart in development of a new approach to improve the PM2P practice

in existing mathematical models for the PM2P allocation problem (see Choothian et al., 2009; Patanakul et al., 2007). Although the main approach is contextual to a specific organization in Botswana, it also addresses identified gaps in extant literature on PM2P practices in MPEs.

There are three iterative processes in the development of a new approach. The first iterative process involves the mathematical formulation of the PM2P allocation problem (steps 1 to 6). The second iterative process involves the implementation of the physical details of the mathematical model in an optimization software (step 7); in relation to verifying that the optimization model results are satisfactory (step 8). The last iterative process involves the development of a GUI, using visual basics for applications (VBA), to ascertain that the integrated decision support system is functioning correctly. Details of the development of the new approach, steps 1 to 10, are the subject of methods to propose a new approach to improve the existing PM2P practice in organization A. Step 11 is the subject of methods to validate the new approach and hence not discussed here. The 11 steps can be thought of as three distinct phases that when taken together, represent a robust response to the research problem. Phase 1 involves steps

1 to 6, associated with the mathematical modelling of the PM2P problem. Phase 2 involves steps 7 to 8, associated with implementing the mathematical model in an optimization software and verifying the results. Phase 3 involves steps 9 to 11, associated with the following: building a GUI and verifying its functionality, and validating the new approach. The three components of the new approach, in the form of an integrated DSS, are described next, to demonstrate how everything fits together at high level. This description is followed by a discussion of the methods for the three phases.

6.1.1.1 DSS architecture

Figure 6-2 depicts the DSS architecture, to be used in facilitating a discussion of the new approach. There are three main components in the DSS architecture namely: (1) mathematical formulation, (2) implementation in an optimization software, and (3) graphical user interface (GUI). The three components are briefly described.

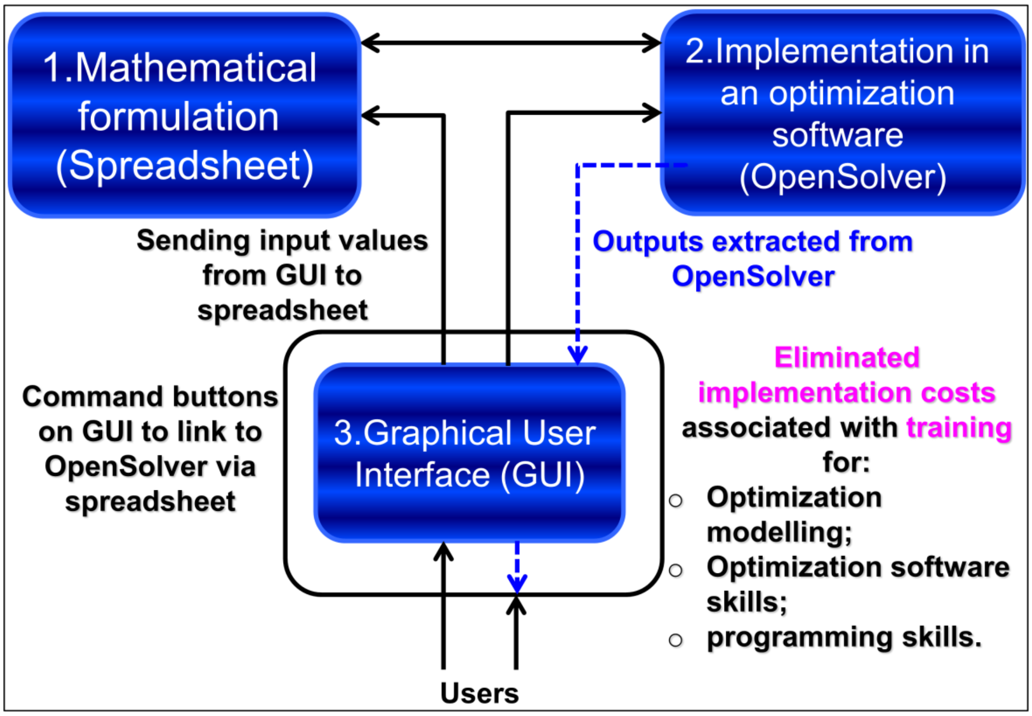


Figure 6-2 DSS architecture

6.1.1.1.1 Mathematical formulation (Spreadsheet)

This component focuses on the mathematical formulation of the PM2P allocation problem, using concepts of generalized assignment problems (GAP) in the field of operations research (Burghes and Wood, 1980; Ragsdale, 2003). The formulation was then implemented into a spreadsheet.

6.1.1.1.2 Implementation in an optimization software (OpenSolver)

This component is concerned with the implementation of the details of the mathematical model formulation in a chosen optimization software called OpenSolver (Mason, 2011; OpenSolver, 2011). It involves running the algorithm, sitting on a spreadsheet, using an optimization engine.

6.1.1.1.3 Graphical User Interface (GUI)

This is the last component of the DSS, built using VBA to integrate the first two components, providing a platform for users to interact with the first two components. This was achieved through command buttons to send instructions to both components, without exposing users to complex details of these components, unlike existing mathematical models for the PM2P allocation problem. The methods for the three phases can now be presented.

6.1.1.2 Phase 1 – steps 1 to 6 associated with the mathematical modelling of the PM2P problem

The methods associated with phase 1 were described in section 6.1, in terms of critical appraisal of relevant literature. In the context of building physical details of the mathematical model formulation in a spreadsheet environment, several alternative packages exist, other than a spreadsheet. These alternative packages include Xpress-Mosel (Gueret et al., 2002; Fico, 2012) and SolverStudio (Mason, 2013; Ragsdale, 2015). Whilst sophisticated to handle relatively large resource allocation problems, these alternative packages pose problems in terms of upfront investments associated with commercial licensing costs (Meindl and Templ, 2013). Complexity and unfamiliarity with these packages is another issue for users, particularly in the absence of a GUI. On this basis, a spreadsheet environment was chosen to build and host details of the mathematical model formulation (implemented in an optimization software), as part of the chosen optimization-based approach discussed in section 3.4.5.

The use of spreadsheets (on their own) to solve PM2P allocation problems was highlighted as a limitation in existing optimization-based approaches (section 3.3.3). However, a spreadsheet environment, when used in conjunction with optimization software and a GUI, is beneficial. Firstly, the managers in organization A (for which the optimization model was primarily developed) are familiar with spreadsheets and use it extensively in their day-to-day operations. Secondly, on a broader context, a spreadsheet environment was chosen on the basis of its simplicity and familiarity to industry practitioners (Conway and Ragsdale, 1997; Ragsdale, 2003, 2015). Lastly, in the absence of a GUI, the use of alternative packages such as Xpress-Mosel (Gueret et al., 2002; Fico, 2012), poses problems of user-friendliness to practitioners.

However, although Conway and Ragsdale (1997) and LeBlanc et al. (2000) advocate for the simplicity of making modifications within a spreadsheet environments, the use of spreadsheets (on their own) poses challenges, as discussed in section 3.3.3. For this reason, a GUI provides a solution to these challenges and addresses identified gaps in existing mathematical models on PM2P allocation problems.

6.1.1.3 Phase 2 – steps 7 to 8 associated with implementing the mathematical model in an optimization software and verifying results

Various optimization software packages exist in relation to implementing the physical details (formulation) of the mathematical model. Some of these packages are commercial while others are non-commercial (Meindl and Templ, 2013), as discussed next.

6.1.1.3.1 Commercial optimization software

Examples of commercial packages include: Xpress-Mosel (Gueret et al., 2002; Fico, 2012), Gurobi (Gurobi, 2015; Meindl and Templ, 2013) and SolverStudio (Mason, 2013; SolverStudio, 2015). Xpress-Mosel and SolverStudio require significant programming expertise in terms of formulating the PM2P allocation problem, in addition to significant licencing costs to use the software (Frontline Solvers, 2014). Commercial packages are generally more powerful and sophisticated to handle larger optimization problems, although all optimization software packages have a practical limit in terms of the number of variables to be processed (Meindl and Templ, 2013). There are also practical limits associated with other issues such as computer random-access memory (RAM) and processing power, in terms of central processing unit (CPU) time required to solve an optimization model. RAM and CPU time are dependent on the size of the mathematical model, which is a function of the number of variables involved (FrontlineSystems, 2015). However, these practical limits are better than human limitations noted in section 3.4.1. Commercial packages were rejected on the basis of upfront investments associated with purchasing commercial licenses, particularly since open source packages were available to handle the demonstration project.

6.1.1.3.2 Non-commercial optimization software

Examples of open source packages include: Solver (FrontlineSystems, 2015) and OpenSolver (Mason, 2011;OpenSolver, 2011). Solver is a Microsoft Excel add-in developed by Frontline Systems for Microsoft and limited to solving allocation problems of up to 800 decision variables (Fylstra and Lasdon, 1998; LeBlanc et al., 2000). OpenSolver is an advanced Microsoft Excel add-in and can handle more than 800 decision variables, unlike Solver. It is an algebraic modelling language developed by COIN-OR (COIN-OR, 2007).

6.1.1.3.3 Justification for choosing OpenSolver over competing alternatives

OpenSolver was chosen to implement the mathematical model on the basis of reasons given below.

i. It does not require significant programming to write the code to build the physical details of the mathematical model formulation, unlike competing packages such as SolverStudio (SolverStudio, 2015).

ii. It is open source and yet capable of handling a relatively large number of variables (Mason, 2011).

iii. It has flexibility to be used with other software programs such as Microsoft Excel (Microsoft, 2015) and VBA.

6.1.1.3.4 Limitations of OpenSolver

The limitations of OpenSolver are: (1) practical limit on the number of variables to be handled, and (2) chance of not finding an optimal solution. These limitations are discussed next.

6.1.1.3.4.1 Practical limit on the number of variables to be handled

Similar to most optimization software packages, including commercial packages, there is a practical limit (Meindl and Templ, 2013) on the number of variables that the OpenSolver engine can handle. The word “handle” is used in the context of addressing the issue of whether the software can give an optimal solution and within a reasonable time, on the basis of the number of variables to be considered. For example, in the context of the PM2P allocation studied, variables beyond the problem size parameters of four organizational goals, six projects and six project managers, cannot be handled by the OpenSolver engine. In this situation, the OpenSolver engine crashes and displays an error message that indicates that it is unable to handle the addition of any more variables. The observed limitation of OpenSolver is made not only on the basis of the error message displayed but also on the approach taken to build the optimization model incrementally. For example, variables were added incrementally and the optimization model solved with each increment, until an optimum solution could not be found.

6.1.1.3.4.2 chance of not finding an optimal solution

Based specifically on the developed DSS, there is a 1% chance that the optimization software will not find an optimal solution, given a set tolerance of 1% that works best for the PM2P problem size studied. The decision to set the tolerance at 1% followed from the process presented below.

6.1.1.3.5 Procedure to determine appropriate OpenSolver tolerance

Whilst there is a default OpenSolver tolerance of 10% (Mason, 2011; OpenSolver, 2011), justification for using a 1% tolerance arose from testing the impact of default values on the solution outputs for 2 different scenarios, using the same input data. Iterations were performed in terms of setting different tolerance values, solving the optimization model using the same input data and comparing the resulting solutions. The two scenarios were as follows:

i. scenario 1 - solution space of a 2 by 2 matrix (i.e., 2 projects, 2 project managers and 2 organizational goals); and

ii. scenario 2 - solution space of a 6 by 6 matrix. Scenario 2 was the master file.

Using a default OpenSolver tolerance of 10% and the same input data for both scenarios, the outputs were slightly different.

6.1.1.3.6 Verification of OpenSolver results (step 8)

The results of implementing the mathematical formulation in OpenSolver were examined and iterations conducted to verify the OpenSolver results. In a situation where the results were not satisfactory, on the basis of intuitive checks on certain expectations, the procedure involved going back to step 1 (see Figure 6-1) and executing all the 8 steps in succession and going through several iterations until the results were satisfactory.

6.1.1.4 Phase 3 – steps 9 to 11 associated with building a GUI

The methods associated with developing a GUI as part of the last component that enables users to interact with the entire DSS started with reviews of relevant literature.

The same techniques and instruments for literature searching strategies described in section 4.6 were used. The literature review included programming languages and application development (Albright, 2012; Bovey et al., 2009). Whilst there are several programming packages available such as c, c+, VB.net, VBA (Walkenbach, 2010) and Xpress Mosel (Fico, 2012), VBA was chosen on the basis of its availability to be used without incurring extra costs. For example, VBA comes pre-installed within Microsoft Excel, requiring only an activation of the developer tab to enable application development.

The methods associated with all 3 phases (sections 6.1.1.2 to 6.1.1.4) are taken together to address the overall aim of this thesis.The next section discusses the design of components of the GUI, to build an integrated DSS that represents a new approach to improve the PM2P practice in organization A.

6.1.1.5 Design considerations

The design considerations in the development of the GUI, as part of an integrated DSS included user-friendliness, robustness, and modifiability. Design consideration decisions for user-friendliness, an important aspect of the DSS, involved seamless data input that enables saving at any point as well as integrated command buttons.

6.1.1.6 Design of user forms (tabs or pages)

10 user forms were developed independently, with fields for input data associated with important factors that play a role in the PM2P allocation process. The development of these user forms followed conventions associated with application development, as expected by users (Bovey et al., 2009; Harris, 1997; Walkenbach, 2010). The 10 user forms were then combined into a multi-page form with 10 tabs that constitute the GUI.

6.1.1.7 Design of command buttons

Different command buttons were developed, enabling the user to navigate through the GUI and send the appropriate instructions to the relevant components of the integrated DSS. The design of command buttons such as: Open, Save, Save As, Close, Print, were done by adhering to the basic requirements associated with application development, to enable user-friendliness in terms of conventions that users expect from major windows applications (Albright, 2012; Bovey et al., 2009; Harris, 1997; Walkenbach, 2010). The most complex command buttons involved those that would communicate with the optimization software by sending instructions to activate the algorithm associated with searching for an optimum PM2P allocation decision, on the basis of input data into the GUI controls.

6.1.1.8 Design of dialog boxes

Dialog boxes were created to enable the user to execute the appropriate option, associated with the need to work on a new or existing PM2P allocation. Programming code was written for all components of the GUI, such that the appropriate user selections, entries and commands are invoked (Harris, 1997; Walkenbach, 2010). Troubleshooting of errors in the programming was completed throughout application development process (as part of verification), to ascertain that the DSS is functioning correctly.

6.2 Methods, techniques and instruments for validating the new approach

It is useful to define the term validation, prior to a discussion of the methods for validating the new approach. Whilst the term validation has different conceptions and may be used in different ways (Miser and Quade, 1988), it is used in this thesis in the context of an external process (Boehm, 1981) that seeks to assess or test that the DSS addresses the intended users' needs, in terms of potential to improve the existing PM2P practice in organization A. The purpose of this validation was to measure the perceived improvement (positive or negative) that the new approach would bring to organization A's PM2P practice, on the basis of intended users' perceptions about 8 key variables associated with the proposed system's suitability to improve the allocation of project managers-to-projects. Validation in terms of actual acceptance of the system's fitness for purpose in the context of implementation is out of scope for this thesis, for reasons given in section 1.5. The criteria for system's acceptance include: robustness, user-friendliness and usefulness (Papamichail and French, 2005).

6.2.1 Validation process for the DSS

For the purpose of this thesis, the intended users are the project heads. Other key stakeholders are senior management. These two groups constitute the teams of experts used to validate the DSS. Team 1 experts included project heads from project management office. Team 2 experts included senior management from strategy and business process improvement, Mineral management and Human resource. Team 3 experts included executives from the CEO's office, who were independent from teams 1 and 2 experts. All three teams of experts were from organization A, given the need to validate a DSS that is custom-made for a specific PM2P problem in organization A.

6.2.2 Categories and aspects of validation

There are different categories of validation of DSSs, such as prospective validation. Prospective validation is conducted before the system is released for use, with the aim of confirming that the system's features are functioning as appropriate and that those features meet the needs of users. This category of validation was conducted in this study, in the context of a single case study of Organization A. Similarly, there are different aspects of validation. Examples include: accuracy and precision, reproducibility, repeatability, and system suitability. System suitability involves testing a system's robustness with an organization (Martinsons et al., 1999; Volkner and Werners, 2000), consistent with the validation in this thesis.

6.2.3 Methods to validate DSSs

Validating the new approach is represented by step 11 (see Figure 6-1). Several possibilities exist in terms of methods for validating the new approach to improve the existing PM2P practice in organization A. These methods are consistent with decision science literature (Papamichail and French, 2005), and include: performance validation techniques, panel-based validations, direct assessment, focus groups, Delphi technique, case studies (include questionnaires and interviews). A brief discussion of each is presented, in the context of selecting an appropriate method.

Performance validation techniques – these involve field tests (Boreinsten, 1988), where the system is installed within an organization and users given the opportunity to use it. Usually, users interact with the system and navigate through its features, to solve the intended problem for a specified period, as part of field test validation. The field test validation process may produce minor improvements or alterations to the system design, including major redesign of the system in some cases (ibid), following users' practical feedback over the test period in which the system was put to use. Performance validation techniques also involve validating a DSS, not only in the context of perceived usefulness by intended users, but also, fit with the organization and its environment. Fit with the organization include alignment with the organizational strategic objectives and structures (Papamichail and French, 2005; Sharma et al., 1991). In this validation technique, certain factors may influence the DSS's performance, on the basis of its fit or lack of fit with existing organizational strategic objectives, culture and structures (Sharma et al., 1991). Performance validation techniques also include use of technical methods such as conducting sensitivity analysis, using several criteria such as completeness, consistency and precision. The sensitivity analysis reports may increase the user's belief of the outputs from the system (Papamichail and French, 2005). Performance validation was rejected on the basis of timelines for the PhD project, given the need to perform field tests of the proposed DSS over time and obtain feedback from users, after having used it for a specified test period.

Panel-based validations – these are common in validating DSSs (particularly expert systems) using Delphi method, especially in situations where the issues in question are generic. In these situations, the use of third parties to validate such systems is beneficial (Papamichail and French, 2005; Ram and Ram, 1996). However, the use of the same experts for which the system is developed and not third-parties, is not uncommon, even for generic systems (Boritz and Wensley, 1992). Panel based validations were rejected because the proposed DSS is bespoke to the specific environment of Organization A. It would have been unwise to solicit input from experts, who are outside organization A (or Botswana) and hence have no specific knowledge of the working PM2P practice in Organization A. The validation exercise involved direct comparison between organization A's existing PM2P practice and the proposed new approach. This condition justifies the use of internal experts within organization A, who are familiar with the status quo, for eligibility to participate in the validation of a bespoke system. Furthermore, potential limitations of the use of other validation methods such as Delphi (Dalkey and Helmer, 1963) include: difficulty in selecting appropriate experts, compromising anonymity and challenges of bringing together all required respondents to physically convene in a certain venue and interact with each other, face-to-face. These limitations provide further justification for rejecting panel based validations.

Direct assessment – these involve intended users, directly assessing the DSS's performance, in terms of its utility. Utility includes usefulness (applicability), appropriateness, outputs quality and user level of confidence in the resulting output from the DSS. In such validation, intended users may be asked to give input (qualitative feedback) to the DSS during its development cycle, with a view to improve the DSS interface (Papamichail and French, 2005; Cliburn et al., 2002). Given the difficulty of engaging users (who are busy professionals) throughout the development cycle, as a result of challenges of direct access to all users on a regular basis, the use of direct assessment was rejected as a validation method in this thesis.

Focus groups – focus groups are useful in soliciting input from discussions with carefully selected individuals, into a facilitated session, with all members present.

These were rejected on the basis that strong individuals are likely to dominate the validation discussions, thereby losing out on valuable input from reserved individuals (Kelly et al., 2004). The difficulty of bringing together all identified informants, in terms of their different levels and busy schedules, into a focus group meeting, was also a factor associated with the unsuitability of focus groups.

Delphi technique – it is used to solicit reliable opinions from a group of experts through a series of questionnaires, especially in situations where group consensus is required (Azani and Khorramshahgol, 1990; Chaw et al., 2001; Dalkey And Helmer, 1963; Ludwig, 1997). This method was considered unsuitable for two reasons. Firstly, the developed new approach is a bespoke solution to the PM2P allocation problem in organization A. The opinions of an independent group of experts from other organizations within or outside Botswana, would not be useful, since those independent experts would be unfamiliar with details of a bespoke proposal. Secondly, it would be unethical to validate a bespoke solution for organization A's existing PM2P practice with external parties, in terms of confidentiality agreements between organization A and the author. This confidentiality extents to alignment with granted Government of Botswana research permits.

Case studies - They can be conducted for different purposes such as: provision of a description, validation and prediction (Fellows and Liu, 2003c, 2008; Paparachi and French, 2005). Evidence from decision science literature (see Martinsons et al., 1999; Paparachi and French, 2005; Volkner and Werners, 2000) suggests the use of case studies, as a valid method for validating a DSS. These case studies include the use of questionnaires and interviews, to measure the perceived user-friendliness and usefulness of a DSS, from the perspective of users. This validation is geared towards establishing the attitudes of intended users to the proposed DSS. Interviews were deemed appropriate and preferred over questionnaires, given the need to obtain rich information about the proposed DSS.

6.2.4 Discussion of case study approach to validate the new approach

In the context of methods, a series of presentations were delivered, using a case study approach (single case study), to demonstrate the functionality of the new approach as a proposal to improve the existing PM2P practice in organization A. Semi-structured interviews with each informant then followed. The validation of the proposed new approach was conducted in direct comparison with organization A's existing PM2P practice, as discussed in section 6.2.

6.2.5 Design of case study research

The same procedures described in section 5.3 were used in the design of case study research, to validate the proposed new approach. However, given that the variables measured to validate the new approach were different from those described in section 5.3, details of the methods for describing the existing PM2P practice in organization A are presented.

6.2.5.1 Methods to validate the new approach

The validation of the developed new approach, in the form of an integrated DSS to improve organization A's existing PM2P practice, was guided by fieldwork 3 interview schedule (appendix H). The research instrument captured two aspects in relation to the validation of the proposed DSS namely: (1) technical solution to the PM2P problem and (2) practical solution to the PM2P problem.

Presentations of the proposed DSS were made to a total of twenty-one eligible informants from five business units within organization A namely: Project management office, Strategy and Business improvement, Mineral Resource Management, Human Resource and CEO's office (section 6.2.1). Given the challenges of bringing together busy executives into one presentation, several presentations involving between three to four informants were made. The worst case scenario was a presentation involving a maximum of two informants, particularly in the case of senior level executives from the CEOs office.

In the presentations, the author outlined the new approach and its background in terms of context, in addition to the interview schedule containing a summary of the PhD research project. Informants were given the opportunity to learn what the proposed new approach is in light of the identified gaps in organization A's existing PM2P practice, such that they are in a position to participate fully in the validation process. The presentations were concerned with outlining the proposed DSS as a demonstration project (application), to illustrate its value in comparison with organization A's confirmed status quo. The value was demonstrated in terms of features, functionality, utility and potential benefits of the proposed new approach.

The actual validation exercise followed, through individual semi-structured interviews with each informant, using a consistent interview schedule. A bipolar scale from -5 (maximum negative improvement) through 0 (no improvement) to +5 (maximum positive improvement) was used in the validation. The bipolar scale was used in the context of a comparative measure between organization A's existing PM2P practice, versus the proposed new approach.

6.2.5.2 Technical solution to the problem

Informants were asked specific questions under technical solution to the problem (appendix H), using the bipolar scale. Analysis of responses to both the rating exercise and the open-ended questions about which approach is more effective, formed part of the validation.

6.2.5.3 Practical solution to the problem

Informants were asked specific questions, aimed at testing implementation issues (appendix H). An example of a specific question under practical test for implementation issues was "what problems do you envisage in implementing the proposed system (both during and after implementation)?" Actual implementation of the proposed new approach, including issues of change management, is out of scope for this thesis (see section 1.5).

6.2.5.4 Research ethics

The same ethics procedures described in section 4.5.4.2, were used in validating the proposed new approach. An amendment letter was obtained from the University of Leeds ethics review committee (see appendix I), in addition to the ethics procedures described in section 4.5.4.2.

6.3 Internal validation of the DSS – discussion of four test cases

The difficulty of finding suitable test cases as part of validating a DSS by making comparisons is highlighted in (Papamichail and French, 2005). On this note, input data from existing but secondary sources were used as suitable test cases for comparisons. In particular, four test cases were used as follows:

i. test case 1 – existing case study in construction industry, to allocate project managers to construction projects (LeBlanck et al, 2000);
ii. test case 2 - existing case study in high technology industry, to allocate project managers to new product development projects (Patanakiul et al, 2007);
iii. test case 3 - existing case study in manufacturing industry, to allocate project managers to projects (Choothian et al, 2009);
iv. test case 4 - existing case study in financial industry, to allocate change managers to projects (unpublished).

Secondary data from the four different test cases were used to validate the developed DSS, using an Excel environment and OpenSolver, to implement the mathematical model formulation. All test cases involved the allocation of six project managers to six projects, for direct comparisons of the developed DSS, using different scenarios. Following these four test cases, the validation of the DSS in organization A is discussed next.

6.4 Internal validation by direct comparison with existing approach

Internal validation of the new approach was conducted in direct comparison with the existing PM2P practice in organization A, for reasons given in section 6.2. This validation process sought to establish if there are inherent gaps with the developed new approach, from the perspective of intended users. It involved assessing the potential of the DSS to improve organization A's existing PM2P practice, using interviews with the relevant stakeholders, as part of a single case study approach. Interviews and case studies were discussed in section 6.2.3, as valid methods to validate DSSs. The validation was therefore, conducted by assessing respondents' attitudes regarding an indication of the practicality of the new approach, as an improved way of allocating PM2P in organization A. The assessment criteria for this validation included utility, system suitability in terms of robustness, under both technical and practical solution to the PM2P allocation problem. This validation exercise was important for both the technical and practical solution to improving a real-life PM2P industry problem, as a means to demonstrate usefulness of the new approach to industry practice.

6.5 Summary

This chapter has discussed details of the methods implemented to propose and validate a new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana, as part of addressing the overall study aim. The outcomes of implementing these methods are presented in chapters 10 and 11 respectively. The implementation of these methods is geared towards making a practical contribution to an improved way of allocating project managers to projects in a specific organization (organization A) in Botswana, consistent with the study aim. The next chapter demonstrates that existing PM2P practices in MPEs of Botswana require improvement, progressing the central argument made in chapters 1 to 4 regarding the need and potential to improve the existing PM2P practice in the context of Botswana.

Chapter 7
Existing PM2P practices in MPEs of Botswana

The previous three chapters discussed the methods implemented to accomplish the five identified objectives, all of which facilitate achievement of the overall study aim. The purpose of this chapter is to present and discuss the results of the evaluation of existing PM2P practices in Botswana's MPEs, and the impact of those practices on organizational performance, based on methods described in section 4.5. The following sections are used to achieve this purpose: (1) outcomes from determination of a threshold for level of presence of nature of practice variables, (2) outcomes from measurement of response bias, (3) results and discussion from evaluation of existing PM2P practices in MPEs of Botswana, (4) implications of findings from evaluation of existing PM2P practices in MPEs of Botswana, and (5) summary.

7.1 Outcomes from determination of a threshold for level of presence of nature of PM2P practice variables (independent variables)

The results of the project manager data set, showing sum, average and index scores from the measurement of these four independent variables (see Table 7-1), were used to facilitate determination of a cut-off point. This cut-off point indicates the level of presence of these measured variables (as highlighted in section 4.5.8.1). The four independent variables are important in effective PM2P practices, as supported by a wide range of literature sources discussed in section 3.5.1.

The index for the variable 'extent of formality' (RV1 index) is used as an illustration to determine a cut-off point for the level of presence of this variable. Four scenarios were performed to determine the cut-off for level of presence of formality in the PM2P practice, using RV1 index scores in Table 7-1, from all 53 project managers. These four scenarios are briefly outlined. The four scenarios are based on the assumption that the original measurement scale can be interpreted as follows: 1.Never = 0%, 2.Seldom = 25%, 3.Sometimes = 50%, 4.Often = 75%, and 5. Always = 100%, in terms of index scores (percentages). On this basis, the four scenarios performed are presented.

Scenario 1: If 100% is the cut-off point (average score of 5), then the proportion of formal and informal = 0 (0%) and 53 (100%). 0 represents the number of RV1 index scores (Table 7-1) that are equal to or above the cut-off point of 100%. Similarly, 53 represent the number of RV1 index score (Table 7-1) that are below the cut-off point of 100%. 0% is the percentage of RV1 index scores that is below the set cut-off point of 100%, from 53 measurements. Similar interpretations were made for scenarios 2 to 4.

Table 7-1 Index scores for level of presence of independent variables

Case number	RV1 sum of scores	RV1 average	RV1 Index	RV2 sum of scores	RV2 average	RV2 Index	RV3 sum of scores	RV3 average	RV3 Index	RV4 sum of scores	RV4 average	RV4 Index
1	9	0.60	60.0	11	0.73	73.3	6	0.60	60.0	19	0.42	42.2
2	6	0.40	40.0	5	0.33	33.3	6	0.60	60.0	20	0.44	44.4
3	5	0.33	33.3	6	0.40	40.0	6	0.60	60.0	23	0.51	51.1
4	6	0.40	40.0	5	0.33	33.3	5	0.50	50.0	19	0.42	42.2
5	4	0.27	26.7	5	0.33	33.3	8	0.80	80.0	16	0.36	35.6
6	7	0.47	46.7	8	0.53	53.3	4	0.40	40.0	24	0.53	53.3
7	7	0.47	46.7	5	0.33	33.3	8	0.80	80.0	23	0.51	51.1
8	8	0.53	53.3	11	0.73	73.3	2	0.20	20.0	28	0.62	62.2
9	10	0.67	66.7	10	0.67	66.7	8	0.80	80.0	28	0.62	62.2
10	10	0.67	66.7	13	0.87	86.7	10	1.00	100.0	34	0.76	75.6
11	7	0.47	46.7	9	0.60	60.0	4	0.40	40.0	20	0.44	44.4
12	9	0.60	60.0	15	1.00	100.0	6	0.60	60.0	35	0.78	77.8
13	12	0.80	80.0	12	0.80	80.0	8	0.80	80.0	30	0.67	66.7
14	6	0.40	40.0	12	0.80	80.0	6	0.60	60.0	25	0.56	55.6
15	9	0.60	60.0	14	0.93	93.3	8	0.80	80.0	33	0.73	73.3
16	9	0.60	60.0	8	0.53	53.3	6	0.60	60.0	24	0.53	53.3
17	11	0.73	73.3	9	0.60	60.0	10	1.00	100.0	21	0.47	46.7
18	4	0.27	26.7	7	0.47	46.7	4	0.40	40.0	12	0.27	26.7
19	9	0.60	60.0	8	0.53	53.3	6	0.60	60.0	28	0.62	62.2
20	10	0.67	66.7	10	0.67	66.7	8	0.80	80.0	34	0.76	75.6
21	7	0.47	46.7	13	0.87	86.7	10	1.00	100.0	15	0.33	33.3
22	8	0.53	53.3	14	0.93	93.3	8	0.80	80.0	37	0.82	82.2
23	8	0.53	53.3	10	0.67	66.7	6	0.60	60.0	19	0.42	42.2
24	5	0.33	33.3	3	0.20	20.0	2	0.20	20.0	17	0.38	37.8
25	5	0.33	33.3	7	0.47	46.7	4	0.40	40.0	19	0.42	42.2
26	6	0.40	40.0	12	0.80	80.0	8	0.80	80.0	29	0.64	64.4
27	6	0.40	40.0	7	0.47	46.7	8	0.80	80.0	25	0.56	55.6
28	10	0.67	66.7	12	0.80	80.0	8	0.80	80.0	37	0.82	82.2
29	9	0.60	60.0	8	0.53	53.3	6	0.60	60.0	17	0.38	37.8
30	7	0.47	46.7	10	0.67	66.7	6	0.60	60.0	19	0.42	42.2
31	5	0.33	33.3	8	0.53	53.3	6	0.60	60.0	19	0.42	42.2
32	7	0.47	46.7	9	0.60	60.0	4	0.40	40.0	21	0.47	46.7
33	8	0.53	53.3	9	0.60	60.0	4	0.40	40.0	17	0.38	37.8
34	5	0.33	33.3	10	0.67	66.7	6	0.60	60.0	18	0.40	40.0
35	10	0.67	66.7	6	0.40	40.0	2	0.20	20.0	16	0.36	35.6
36	4	0.27	26.7	5	0.33	33.3	4	0.40	40.0	9	0.20	20.0
37	10	0.67	66.7	10	0.67	66.7	8	0.80	80.0	18	0.40	40.0
38	4	0.27	26.7	6	0.40	40.0	6	0.60	60.0	10	0.22	22.2
39	9	0.60	60.0	6	0.40	40.0	4	0.40	40.0	13	0.29	28.9
40	7	0.47	46.7	4	0.27	26.7	4	0.40	40.0	11	0.24	24.4
41	4	0.27	26.7	12	0.80	80.0	6	0.60	60.0	14	0.31	31.1
42	9	0.60	60.0	6	0.40	40.0	6	0.60	60.0	21	0.47	46.7
43	7	0.47	46.7	11	0.73	73.3	6	0.60	60.0	13	0.29	28.9
44	9	0.60	60.0	10	0.67	66.7	6	0.60	60.0	15	0.33	33.3
45	7	0.47	46.7	10	0.67	66.7	4	0.40	40.0	13	0.29	28.9
46	9	0.60	60.0	9	0.60	60.0	6	0.60	60.0	15	0.33	33.3
47	9	0.60	60.0	8	0.53	53.3	4	0.40	40.0	16	0.36	35.6
48	5	0.33	33.3	9	0.60	60.0	4	0.40	40.0	14	0.31	31.1
49	8	0.53	53.3	7	0.47	46.7	4	0.40	40.0	14	0.31	31.1
50	8	0.53	53.3	7	0.47	46.7	8	0.80	80.0	14	0.31	31.1
51	9	0.60	60.0	6	0.40	40.0	4	0.40	40.0	10	0.22	22.2
52	8	0.53	53.3	11	0.73	73.3	4	0.40	40.0	16	0.36	35.6
53	6	0.40	40.0	10	0.67	66.7	6	0.60	60.0	15	0.33	33.3

Scenario 2: If 75% is the cut-off point (i.e. average score of 4), then the proportion of formal and informal = 0 (0%) and 53 (100%).

Scenario 3: If 50% is the cut-off point (i.e. average score of 3), then the proportion of formal and informal = 27 (50.9%) and 26 (49.1%).

Scenario 4: If 25% is the cut-off point (i.e. average score of 2), then the proportion of formal and informal = 53 (100%) and 0 (0%)

Although there was no change in the outcome from scenario 1 to 2, in relation to the proportion of formal and informal index scores, the cut-off was set at 75%. This was because scenario 3 and 4 were considered too strict and lenient respectively, given the original measurement scale (1.Never = 0%, 2.Seldom = 25%, 3.Sometimes = 50%, 4.Often = 75%, 5.Always = 100%). It follows that index scores of 74% and below (average scores of 3, 2 and 1 on the 5 point Likert scale used) are considered as informal PM2P practice while those from 75% and above (average scores of 4 and 5 on the scale used) are considered formal PM2P practice. The same procedure for determining the cut-off for the remaining three nature of practice variables: extent of objectivity (RV2), extent of match (RV3) and extent of comprehensiveness (RV4), yielded a cut-off of 75% across all 4 nature of practice variables.

7.2 Outcomes from measurement of response bias

The variable, RB1, associated with measuring response bias from the project manager data set is used as an example to present the results, based on the methods described in section 4.5.9. The histogram in Figure 7-1 depicts the project managers' response bias scores for RB1. There are several outcomes with scores of zero (i.e., no bias), 1 (minimum level of bias) to 3 (maximum level of bias in the responses to RB1). The maximum level of bias was a score of 3, for both questionnaire and interview data sets. A score of 4, representing the highest level of response bias, is absent in Figure 7-1. The results demonstrate that the respondents' answers to both questionnaire and interview questions are not biased.

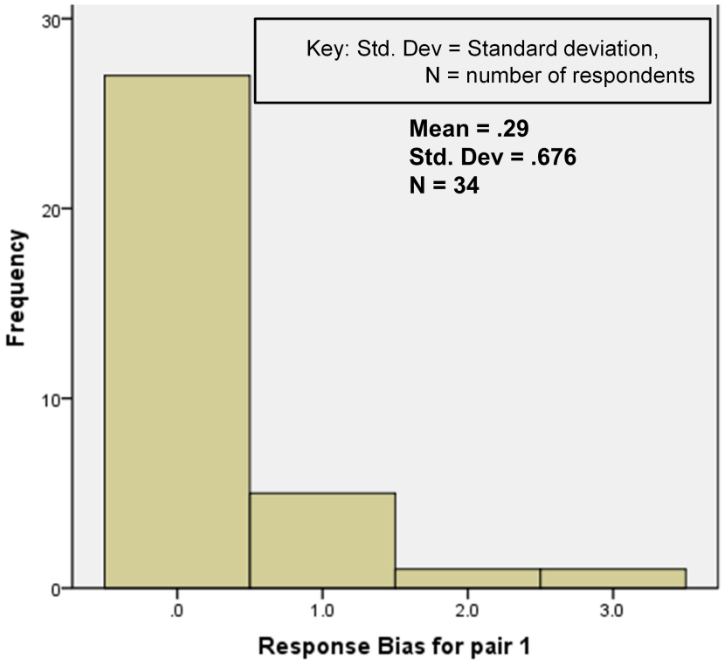


Figure 7-1 Project manager's response bias scores for RB1

7.3 Results and discussion from evaluation of existing PM2P practices in MPEs of Botswana

The results concerning the nature of PM2P practices in Botswana and the impact of those practices on performance are presented on the basis of the following: (1) differences between public and private sector, (2) nature of PM2P practices and hypotheses H1 to H4, and (3) correlations between variables (hypotheses H5 to H11).

7.3.1 Differences between public and private sector

Differences between public and private organizations were explored for all measured variables (RV1 to RV8), among both project managers and project heads data sets. For example, differences among the groups (factored by public or private sector organization), in relation to 8 key variables (section 3.5.1) for the project manager data set and the same 8 key variables for the project heads data set (making a total of 16 variables), were explored as part of preliminary statistical tests. For the sake of context regarding providing sufficient evidence for testing the significance of the difference between public and private organizations (out of 16 eligible public organizations at country level), the achieved sample was 9. This sample represents 56.3% of the population of eligible public organizations at country level. Similarly, out of 9 eligible private organizations at country level, 6 was the achieved sample, representing 66.7% of the population of eligible private organizations. The disproportionality in the percentage split between public and private sector organizations is not a concern because this translates to a ratio of 1.000:1.185. Similarly, the disproportionality of the two achieved samples (i.e. 9 public organizations vs. 6 private organizations) is also not a concern since the ratio of public to private organizations is 1:0.67. In the context of individual project manager informants, 26 project managers were from public sector while 27 were from private sector. These numbers represent a ratio of 1:1.04, which is again not a concern in terms of making comparisons. As regards project head informants, 10 were from public sector and 10 from private sector, translating into a ratio of 1:1.

The objective was to test the statistical significance of the difference between the mean scores of informants from public and private sector, in relation to the variables RV1 to RV8. Since the data were non-parametric, a Mann-Whitney U test was deemed appropriate (as opposed to an independent samples t-test) and performed, to establish whether the difference between public and private sector is not simply due to random causes (Gray and Kinnear, 2012). Further justification for Mann-Whitney U test as an appropriate non-parametric statistical test lies in the fact that the sample was small and contained a few outliers and extreme values (ibid). The independent samples t-test (an alternative to the Mann-Whitney U test) was rejected since the data did not meet the parametric assumptions of normality and homogeneity of variance (ibid). These comparisons were deemed necessary to explore the differences between the 2 groups, in relation to the mean scores that indicate the perceptions of the informants, as regards the nature of the PM2P practice and its impact on performance variables.

The results of the non-parametric Mann-Whitney U test (following K-S tests for normality) are presented in Table 7-2 for each data set, in terms of the two groups, for all 8 key variables. These results revealed no differences between public and private sector in 15 out of a total of 16 pairs of variables. Only 1 significant difference between the 2 groups was found for the variable “extent of match between project manager and project” (RV3), in terms of the project heads data set.

Table 7-2 Mann-Whitney U tests for differences between the 2 groups

VARIABLES	PROJECT MANAGERS	PROJECT HEADS
Extent of formality (RV1)	**No significant differences**	**No significant differences**
	Significance value = .33	Significance value = .68
	Mean:26.5(private),27.5(public)	Mean:11.1(private),9.9(public)
Extent of objectivity (RV2)	**No significant differences**	**No significant differences**
	Significance value = .07	Significance value = .77
	Mean:30.7(private),23.1(public)	Mean:10.2(private),10.9(public)
Extent of match (RV3)	**No significant differences**	**Significant differences**
	Significance value = .69	Significance value = .04
	Mean:27.8(private),26.2(public)	Mean:13.3(private),7.8(public)
Extent of comprehensiveness (RV4)	**No significant differences**	**No significant differences**
	Significance value = .11	Significance value = .13
	Mean:30.2(private),23.6(public)	Mean:12.2(private),8.8(public)
Project manager performance (RV5)	**No significant differences**	**No significant differences**
	Significance value = .78	Significance value = .97
	Mean:27.6(private),26.4(public)	Mean:10.6(private),10.5(public)
Project manager motivation (RV6)	**No significant differences**	**No significant differences**
	Significance value = .20	Significance value = .03
	Mean:29.7(private),24.3(public)	Mean:8.0(private),13.0(public)
Project success (RV7)	**No significant differences**	**No significant differences**
	Significance value = .41	Significance value = .65
	Mean:25.3(private),28.8(public)	Mean:11.0(private),10.0(public)
Project manager rewards (RV8)	**No significant differences**	**No significant differences**
	Significance value = .08	Significance value = .28
	Mean:30.6(private),23.3(public)	Mean:11.9(private),9.1(public)

7.3.2 Discussion of differences between public and private sector

Although the results of the Mann-Whitney U tests (Table 7-2) indicated one significant difference between the groups public and private sector, in relation to the variable “extent of match between project managers and projects” (RV3), this difference was assumed to be insignificant and ignored for the following reasons: (1) there was a small sample size of only 10 project heads from each group, consistent with assertions made in (Gray and Kinnear, 2012) regarding the need to be careful of interpretations associated with results from Cohen’s g, when the sample size is small, and (2) test results for differences between the two groups for 15 out of 16 variables from both project managers and project heads data set revealed no significant differences between public and private sector. These results imply that the PM2P practices in Botswana’s public sector is not significantly different to that in the private sector. This interpretation is consistent with the arguments in sections 2.2.1, 2.2.2 and 2.3 regarding the ineffectiveness of PM2P practices in Botswana’s public and private sector, arising out of reasons such as: reliance on project manager availability rather than project manager competence, and reliance on managerial intuition alone. Based on the above two reasons regarding the statistical insignificance of differences between public and private sector, it was not worth investigating the different PM2P practices between public and private sector. The two groups were thus considered together as one data set, such that the distribution of the data sets *public and private organizations* was treated to be the same in all the categories. Subsequent statistical analyses were performed, based on treatment of both public and private sector as one data set. The following two sets of results are presented next: (1) binomial test results regarding response bias, and (2) binomial test results regarding nature of PM2P practice.

7.3.3 Binomial test results for response bias

Based on the procedures described in section 4.5.9, the binomial test results for response bias among both project managers and project heads data sets indicate sufficient evidence to conclude that the proportion of observed successes (not biased) are statistically significant. Computed values of Cohen’s effect size index (g) for the binomial test (Gray and Kinnear, 2012; Cohen, 1988), all indicate large effects. This result means that the degree to which the phenomenon being examined (i.e. not biased) is established, is of a large magnitude. This finding corroborates that of the binomial test results and provides additional statistical inference, over and above significance tests. These two findings (significance test and Cohen’s effect size index) lead to the inference that the information obtained from administering the research instruments (questionnaires and interviews) is not biased. This inference leads to the conclusion that the questionnaire and interview responses associated with a description of PM2P practices in Botswana are reliable.

7.3.4 Binomial test results for nature of existing PM2P practice

Based on the methods described in section 4.5.8.2, the binomial test results are presented in Figure 7-2. The criteria for probability of success was based on a pre-determined cut-off point of 75% as determined through scenario analysis, in terms of the proportion of index scores in the success and failure categories. The results indicate that the hypothesized p-value of 0.906 (i.e. 90.6%) is the highest p-value for which there is no compelling evidence against the null hypothesis.

The significance value p is 0.051, which is greater than 0.05, at a 95% confidence interval. The inference is to accept the null hypothesis that the proportion of informal (success) and formal (failure) index scores of RV1 occur with probabilities of 0.906 and 0.094 respectively.

	Null Hypothesis	Test	Sig.	Decision
1	The categories defined by RV1 Dichotomy occur with the specified probabilities.	One-Sample Binomial Test	.014	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

	Null Hypothesis	Test	Sig.	Decision
1	The categories defined by RV1 Dichotomy occur with the specified probabilities.	One-Sample Binomial Test	.020	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

	Null Hypothesis	Test	Sig.	Decision
1	The categories defined by RV1 Dichotomy occur with the specified probabilities.	One-Sample Binomial Test	.029	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

	Null Hypothesis	Test	Sig.	Decision
1	The categories defined by RV1 Dichotomy occur with the specified probabilities.	One-Sample Binomial Test	.042	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

	Null Hypothesis	Test	Sig.	Decision
1	The categories defined by RV1 Dichotomy occur with the specified probabilities.	One-Sample Binomial Test	.061	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 7-2 Binomial test results for project manager responses

The results indicate compelling evidence to conclude that the proportion of informal index scores for the whole sample of 53 project managers (irrespective of organization sector) is significant. The results associated with nature of PM2P practices and all four hypotheses H1 to H4 (described in section 3.5.1.1) can now be presented.

7.3.5 Nature of existing PM2P practices and hypotheses H1 to H4 – binomial test results for H1 to H4

Descriptive statistics for hypotheses tests H1 to H4 were performed, informed by outcomes from preliminary tests for differences between the groups (sections 4.5.6 and 7.3.1). All four hypotheses are important and must be considered together, in the context of independent variables that characterize an effective PM2P practice, as per the dicussions in section 3.5.1.1. A binomial test (Field, 2005;Gray and Kinnear, 2012) was used to test each of the four hypotheses in relation to the nature of the PM2P practice. The objective was to establish, with some level of confidence, whether the nature of the PM2P practice can be described as: (1) informal or formal (RV1), (2) objective or not objective (RV2), (3) characterized by a match or no match between project managers and projects (RV3), and (4) comprehensive or not comprehensive (RV4) in terms of influencing factors to an effective PM2P practice, based on the proportion of informants' responses for the whole study sample (irrespective of whether the informants were from public or private sector). A summary of the binomial test results for the four hypotheses tests (H1 to H4) that indicate the nature of PM2P practice, from both project managers and project heads data set, are presented in Table 7-3.

The binomial test results for the four hypotheses indicate that the nature of PM2P practices from both project managers and project heads (based on 12 out of 15 eligible MPEs in Botswana) are: informal, not objective, not comprehensive and characterized by no match between project managers and projects. Based on the results in Table 7-3, H1 to H4 were accepted.

Table 7-3 Summary of hypotheses tests H1 to H4

Hypotheses	Nature of PM2P practice	Project managers	Project heads
H1 – the PM2P practice is informal	Extent of formality (RV1)	Informal (Sig .061)	Informal (Sig .998)
H2 – the PM2P practice is not objective	Extent of objectivity (RV2)	Not objective (Sig .122)	Not objective (Sig .046)
H3 – the PM2P is such that there is lack of a good match between project manager and project	Extent of match between project manager and project (RV3)	No match (Sig .079)	No match (Sig .071)
H4 – the PM2P practice is not comprehensive	Extent of comprehensiveness (RV4)	Not comprehensive (Sig .062)	Not comprehensive (Sig .120)
Key – RV = research variable			

7.3.5.1 Discussion of Nature of existing PM2P practices and hypotheses H1 to H4

Binomial test results for descriptive statistics associated with hypotheses tests (Table 7-3) regarding nature of PM2P practice variables (independent variables) provided compelling evidence to conclude that all null hypotheses (i.e. H_0) for H1 to H4 can be accepted. Results of these four hypotheses tests are briefly discussed.

7.3.5.1.1 H1 – PM2P practice is informal

The results across all 12 MPEs in Botswana indicated compelling evidence to accept the null hypothesis that the PM2P practice is informal. These results were based on the proportion of informal index scores (on the 5 point Likert scale used), which were significant at a 95% confidence interval for both project managers and project heads data sets. Based on a definition of formality, in terms of components of the index RV1 (see appendix B), the interpretation is that the PM2P practices across the 12 MPEs in Botswana are: (a) not prescribed and (b) characterized by a low extent of usage of documentation, management tools and techniques to guide the PM2P practice. Items a and b imply a PM2P approach characterized by the following: (1) significant inconsistencies everytime an allocation decision is made, given absence of standardization for assessing all project managers, (2) inability to justify allocation decisions in terms of suitability of project managers to given projects, and (3) lack of transparency in terms of indicating why certain project managers were not allocated to specific projects, given absence of documentation and output reports that demonstrate a transparent process for arriving at the allocation decisions. The findings regarding informal PM2P practices in Botswana's MPEs from this study corroborate evidence of reliance on managerial intuition alone, considered insufficient and sub-optimal for structured aspects of the decision (LeBlanc et al., 2000; Patanakul et al., 2007; Jansson, 1999; Keren, 1992). In particular, the findings from this study are in agreement with those from a survey of the status of project management processes in Botswana's public sector, as per the discussions in sections 1.1, 2.2 and 2.3. The interpretation for items a and b also confirms evidence from existing empirical studies on PM2P practices (Patanakul et al., 2003, 2004, 2007; Patanakul and Milosevic, 2006; Choothian et al., 2009). The informal PM2P practices call for formal management tools to complement intuition, given the implications of mismatches between project managers and projects as discussed in sections 1.1 and 2.2.

7.3.5.1.2 H2 – PM2P practice is not objective

The results indicated compelling evidence to accept the null hypothesis that the PM2P practice across all 12 organizations is not objective, based on the proportion of index scores that fell under the category of not objective. The proportion of these index scores was significant at a 95% confidence interval, for both project managers and project heads data sets, based on a definition of this index (i.e. RV2), in terms of its components (see appendix B). The interpretation is that PM2P practices are characterized by a high level of subjectivity, given the absence of a standardized approach in making PM2P allocation decisions. This finding is consistent with the discussions in section 1.1 and 2.1 regarding the need to improve the PM2P practice in the context of Botswana. However, the single result for RV2 in relation to the project heads data set (see Table 7-3) is surprising because the binomial test suggests that the null hypothesis for the proportion of *not objective* should be retained, despite a significance value of 0.046.

One must question why the single result for RV2 suggests that the hypothesis (PM2P practice is not objective) should not be accepted, in the case of the project manager data set. This result implies that the PM2P practice in MPEs of Botswana, as per analysis of responses from the project heads data set, is objective. There may be some differing perceptions about the level of objectivity in the PM2P allocation decision, on the basis of organization sector (public or private) in which the project heads work, although the differences in practices between public and private sector was insignificant and hence not worth invesitigating. Alternatively, whilst a survey response rate of 40.4% is within acceptable limits (Fellows and Liu, 2008), it may be that the small sample size as regards specifically the project heads data set, including non-participation from the remaining 3 MPEs in Botswana, is an influencing factor. However, the impact of this influencing factor on the results from this study is estimated to be minimal, given participation from 12 out of 15 (i.e. 80%) MPEs in Botswana. Notwithstanding, it may be that further studies involving larger sample sizes regarding project head informants and more MPEs in Botswana are needed to test the hypothesis that the PM2P practice is not objective.

7.3.5.1.3 H3 – PM2P practice is such that there is no match between project manager and project

The results indicated compelling evidence to accept the null hypothesis that the PM2P practice is characterized by no match between project managers and projects. This lack of match is based on the proportion of index scores, which fell under the category of no match and were significant at a 95% confidence interval, for both project managers and project heads data sets. A definition of a match between a project manager and a project was derived on the basis of components of the index RV3 (refer to appendix B). The interpretation is that the PM2P practices across the 12 organizations in Botswana are characterized by a lack of good match between project manager’s competencies and project's characteristics. The lack of match means poor fit between project manager competencies and project demands, which may translate into the following: less chances for project managers to be succeful in delivering their allocated projects, increased project failures, demotivation of project managers, reduced performance levels and hence rewards. The discussions in sections 1.1, 2.2 and 2.3 are consistent with the finding from this study, in relation to the mismatches between project managers and projects. Given the time and cost implications of unsuitability of project managers to projects (discussed in sections 1.1, 2.1 and 2.2), there is need to introduce a formal PM2P approach.

7.3.5.1.4 H4 – PM2P practice is not comprehensive

The results indicated compelling evidence to accept the null hypothesis that the PM2P practice is not comprehensive, based on the proportion of index scores that fell under the category of not comprehensive. This proportion was significant at a 95% confidence interval for both data sets and across all 12 MPEs in Botswana. A definition of this index (i.e. RV4), was derived on the basis of components of the index (see appendix B). The interpretation of these results is that PM2P practices across the 12 MPEs in Botswana are not comprehensive, in relation to consideration of all the important factors that influence the PM2P allocation decisions. These results imply that managerial intuition alone, whilst valuable, is insufficient to process (in a consistent manner) not just a handful of influeicing factors but a comprehensive list of factors that influence an effective PM2P approach. This interpretation is consistent with the discussions in sections 1.1, 2.1, 2.2 and 2.4. Furthermore, the finding regarding lack of comprehensiveness confirms evidence from existing empirical studies (Patanakul et al., 2004, 2007; Patanakul and Milosevic, 2008; Choothian et al., 2009).

Overall, the results of the four hypotheses tests that provided compelling evidence to accept all four null hypotheses were consistent in relation to both data sets, across all 12 MPEs in Botswana. The findings from these four hypotheses tests also corroborate the evidence presented in sections 2.2 and 2.4 regarding specific conditions that warrant this study and require a formal approach.

7.3.6 Correlations between variables (hypotheses H5 to H11)

Correlation analysis in terms of associations between nature of PM2P practice variables (independent) and performance variables (dependent) were explored, using the methods described in section 3.5.2. All three measures of associations (i.e. Pearson correlation, Spearman rank correlations and Kendall’s tau statistics) between the variables were explored (Field, 2005; Gray and Kinnear, 2012). Careful examination of the scatterplots (which were not elliptical) for the bivariate distributions of the continuous variables under investigation, including the K-S tests for normality, provided compelling evidence to reject the Pearson correlation as a suitable approach for measuring the degree of association between the variables. This left only two options (Spearman rank correlations and Kendall's tau statistics) that lend themselves to non-parametric data. Based on these two non-parametric correlations, Spearman rank was considered appropriate since it is not confined to ordinal data (ibid). However, all 3 correlation types were performed and yielded the same conclusions regarding significant correlations between variables. Using the hypothesized relationships depicted in Figure 3-3, the correlations between variables are presented in Figure 7-3.

Six significant correlations were found between the variables (highlighted in colour in Figure 7-3), as outcomes from measuring hypothesis H1 to H11. Only significant relationships at a confidence level of 95% minimum were extracted and shown in Figure 7-3. From these results, the following hypotheses were supported: H6, H7, H8, H9, H10 and H11. These results are the bivariate correlations, using Spearman rank (r_S) for non-parametric data. For the 8 variables being examined, a positive correlation means that when the nature of PM2P practice (independent) variable increases, the corresponding performance variable (dependent) also increases.

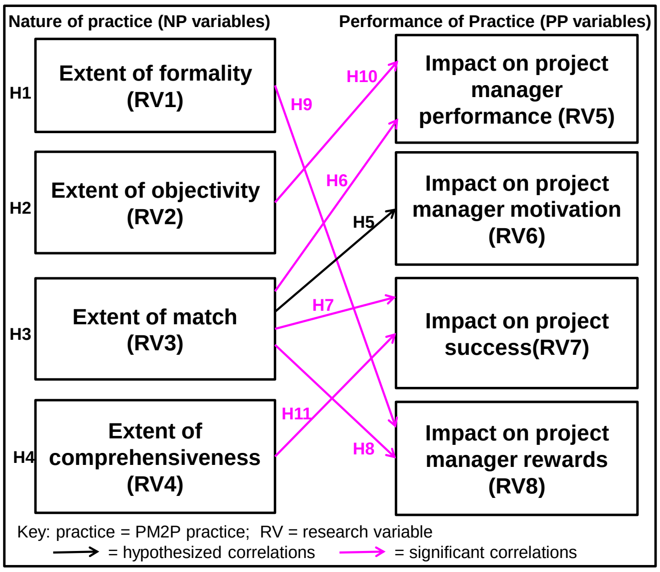


Figure 7-3 Correlations between NP and PP variables (H5 to H11)

Similarly, when the nature of PM2P practice variable decreases, the corresponding performance variable also decreases. This relationship can be described as monotonic (Gray and Kinnear, 2012). The results indicate positive correlations. The absence of negative correlations implies that there are no instances where one independent variable increases while the dependent variable decreases or vice versa.

Figure 7-3 reveals 6 significant correlations between the following independent and dependent variables: (1) extent of formality (RV1) and project manager rewards (RV8), (2) extent of objectivity (RV2) and project manager performance (RV5), (3) extent of match between project managers and projects (RV3) and project manager performance (RV5), (4) extent of match between project managers and projects (RV3) and project success (RV7), (5) extent of match between project managers and projects (RV3) and project manager rewards (RV8), and (6) extent of comprehensiveness (RV4) and project success (RV7). The correlation between the nature of PM2P practice variable, extent of match between project managers and projects (RV3), and the performance variable, project manager rewards (RV8), was significant beyond the 99% level for both the project managers and project heads data sets.

7.3.7 Discussion of correlations between variables

Correlational analysis results (using spearman rank correlations to test the hypothesized relationships shown in Figure 7-3) indicated 6 significant and positive correlations between nature of PM2P practice variables and performance variables. A brief discussion of these results is presented on the basis of hypotheses tests for H6 to H11.

7.3.7.1 H6 – extent of match between a project manager and a project is associated with project manager performance

The results of the spearman rank correlations indicated compelling evidence to accept the null hypothesis that the extent of match between a project manager and a project is associated with project manager performance. A positive and significant relationship was found between these two variables. This relationship has 3 important characteristics: (1) the association is significant at the 99% level, (2) the association has the highest correlation coefficient of all the correlations, and (3) the association has the highest effect size index. The interpretation from these three important characteristics is that there is a strong relationship between the two variables in question, which suggests that the extent of match between a project manager's competencies and project requirements significantly influence the performance of the project manager. In addition to significance testing, a high effect size index (Cohen, 1988) suggests that the degree to which the relationship between these two variables is present is of a large magnitude. This result implies that practitioners involved with the

PM2P practice in MPEs of Botswana, must ensure that there is a good match between a project manager's competencies and project demands, to attain higher levels of project manager performance and ultimately project and organizational success. This finding is supported by existing studies (Adams et al., 1979; Badiru, 1996; Brown and Eisenhardt, 1995; Forseberg et al., 2000; Mian and Dai, 1999; Patanakul et al., 2007; Pinto and Slevin, 1989a), discussed in chapters 1 and 2.

7.3.7.2 H7 – extent of match between a project manager and a project is associated with project success

The results of the spearman rank correlations indicated compelling evidence to accept the null hypothesis that the extent of match between project manager and project is linked to project success. This is based on a positive and significant correlation found between these 2 variables (Figure 7-3), in relation to the whole data set across 12 organizations in Botswana. The interpretation is that a good match between a project manager's competencies and a project's characteristics influence project success. The implications for practitioners in Botswana is that PM2P practices can be improved by ensuring a good match between project managers and projects, leading to project success. This finding concurs with those from existing studies (Brown and Eisenhardt, 1995; Patanakul et al., 2007; Pinto and Slevin, 1989a; Pinto and Slevin, 1989b).

7.3.7.3 H8 – extent of match between a project manager and a project is associated with project manager rewards

The results indicated compelling evidence to accept the null hypothesis that the extent of match between project manager and project is linked to project manager rewards. A positive and significant relationship between these variables was found. This relationship was significant at the 99% level for both project managers and project heads data sets, which implies a strong relationship. The implications for practitioners across the 12 organizations in Botswana is that increasing the extent of match between a project manager's competencies and project requirements in turn increases the project manager's rewards. Rewards are likely to arise from suitability of a project manager to project demands and hence higher levels of performance. This finding is consistent with that found in (Patanakul, 2009; Patanakul et al., 2003), regarding a strong relationship between degree of match between a project manager and a project and career advancement.

7.3.7.4 H9 – extent of formality is associated with project manager rewards

The results indicated compelling evidence to accept the null hypothesis that extent of formality is associated with project manager rewards. The positive and significant relationship found between these two variables, was significant at the 95% level for both data sets. In particular, these results imply that increasing the extent of formality in turn increases project manager rewards.

The implications for PM2P working practices among the 12 organizations in Botswana are that practitioners must not solely rely on informal practices such as managerial intuition but rather, complement those approaches with formal approaches. Formal approaches incorporate use of documentation, management tools and techniques to complement intuition and improve the effectiveness of the PM2P allocation decisions.

7.3.7.5 H10 – extent of objectivity is associated with project manager performance

The results indicated compelling evidence to accept the null hypothesis that extent of objectivity is associated with project manager performance. A positive and significant relationship was found between these two variables, based on the project manager data set. The implication for practitioners across the 12 organizations in Botswana is that increasing the extent of objectivity in the PM2P allocation decision results in a corresponding increase in project manager performance. This may be linked to a likely increase in the project managers' perceptions of fairness in the allocation decision, if there was a standardized and less subjective process used to allocate them to projects. The established links between these variables is an extension of existing body of knowledge, to further the understanding of effectiveness in the PM2P practice.

7.3.7.6 H11 – extent of comprehensiveness is associated with project success

The results indicated compelling evidence to accept the null hypothesis that extent of comprehensiveness is associated with project success. A positive and significant relationship was found between these two variables, based on evidence from the project manager data set. This relationship has 3 important characteristics: (1) it is significant at the 99% confidence level, (2) it has the second highest correlation coefficient of all the correlations, and (3) it has the second highest effect size index. Based on these characteristics, there is a strong relationship between the two variables. The implication for practitioners among the 12 organizations in Botswana is that increasing the extent of comprehensiveness in the PM2P practice results in a corresponding increase in project success.

7.3.7.7 Summary of quantitative findings – existing PM2P practices in Botswana

Overall, the results provided compelling evidence to conclude that the existing PM2P practices among the 12 MPEs in Botswana are: informal, not objective, not comprehensive, and characterized by a lack of good match between project managers and projects. Correlational analyses revealed three key findings: (1) when the extent of match between a project manager and a project is increased, the level of project manager performance also increases, when the extent of match between a project manager and a project is increased, the level of project success also increases, and when the extent of match between a project manager and a project is increased, the level of project manager rewards also increase, (2) extent of formality and extent of objectivity in the PM2P allocation decision have a significant and positive impact on project manager rewards and project manager performance, respectively, (3) when the extent of comprehensiveness in the factors that influence the PM2P practice is increased, the level of project success also increase. However, these results do not suggest causation but rather, associations between independent variables (nature of PM2P practice) and dependent variables (performance of the PM2P practice).

The above findings justify the need for this study, as per the discussions in sections 1.2, 2.2 to 2.3. The need for a formal and objective approach to improve existing PM2P practices in Botswana is corroborated by the following findings: strong association between comprehensiveness in consideration of factors influencing the allocation decisions and the positive impact on project success; strong association between objectivity in making allocation decisions and positive impact on project manager performance; strong association between formality in the PM2P practice and positive impact on project manager rewards. The findings regarding the relationship between nature of PM2P practice variables and performance variables are also consistent with those in existing studies (Adams et al., 1979; Badiru, 1996; Brown and Eisenhardt, 1995; Mian and Dai, 1999; Patanakul et al., 2007; Pinto and Slevin, 1989a,b).

7.3.8 Results from analysis of qualitative data – FW1 interviews

Following analysis of qualitative data (from 27 interviews), using the methods described in section 4.5.7, the results are presented. The 27 interviews comprise 8 project heads and 19 project managers. Qualitative data from both cases (project heads and project managers across 12 organizations in Botswana’s public and private sector) were used to uncover words and phrases that are indicative of nature of PM2P practices (4 themes) and performance of the practices (4 themes). Analysis of qualitative data shed light on PM2P practices in Botswana. Figure 7-4 is an output from NVivo's matrix coding query, in relation to a content analysis of themes associated with PM2P practices and the impact on performance.

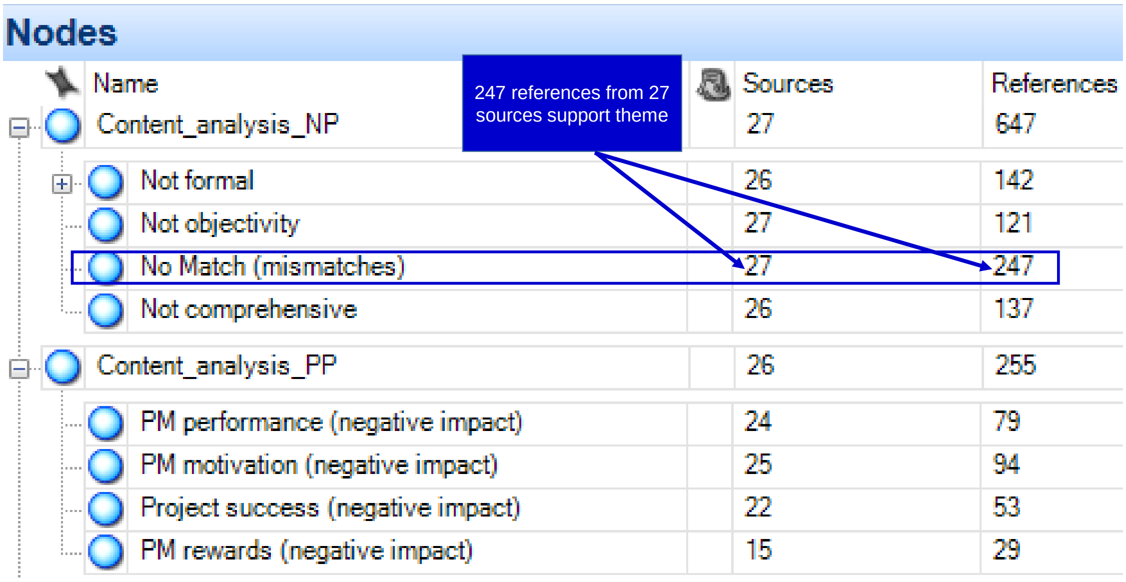


Figure 7-4 Matrix coding query for PM2P practices and impact on performance

In the context of nature of PM2P practices, the most dominant theme was the lack of good match between project managers and projects, which provides evidence of the need to improve existing practices in Botswana. For example, documentation to guide PM2P allocation decisions is rarely used in both public and private sector. The reasons given is that the project heads know their project managers, although the project heads acknowledged this approach to be ineffective in the case of them changing roles or leaving the organization. 247 text references from 27 primary data sources support the core theme of mismatches between project managers and projects. This dominant theme was linked to absence of formal management tools and techniques (theme 2) to help improve the allocation process, in terms of increased levels of match. Some project heads revealed that their existing PM2P approach is ineffective on the basis of absence of a specific tool to standardize the allocations. Others acknowledged the inconsistency and probable variation in the PM2P allocations, arising out of an unstructured process (in the absence of a formal management tool to complement decision-making). The project heads also revealed that their changing roles within the organization may be a reason for inconsistencies in the allocation decisions that are “*subject to human error”,* particularly in the absence of a standardized approach, since each incoming project head uses their own approach.

This acknowledgement by project heads provides evidence of the need to introduce a formal approach, for which the project heads view as an area for improvement. The text search query in Figure 7-5 substantiates the need for a formal and objective PM2P approach, on the basis of 87 coding references from 15 sources.

Nodes

Name	Sources	References
Importance of Formality_text_search	15	87

<Internals\\PH_Interviews\\Hubcoordinator> - § 7 references coded [3.15% Coverage]

Reference 1 - 0.25% Coverage

because the right decisions were not made.

Reference 2 - 0.38% Coverage

the fact that there is no procedures doesn't rest well with me.

Reference 3 - 0.52% Coverage

we need to have some form of procedure and some form of tool that we can use to do it.

Reference 4 - 0.50% Coverage

I am not going to be here forever and somebody needs to be able to do it when I go

Reference 5 - 0.41% Coverage

And if there is no proper way of doing, there is gonna be problems.

Reference 6 - 0.53% Coverage

the reason I am saying god helps me is that you don’t really know the people first hand.

Reference 7 - 0.56% Coverage

I don’t use any management tools. Maybe you project [change of phrase] research will help us.

Figure 7-5 Text search query results for importance of a formal approach

The absence of formalized tools may explain the lack of comprehensiveness (third dominant theme) in consideration of important criteria that influence the PM2P practice, followed by lack of objectivity in the allocation process. The lack of comprehensiveness was more pronounced in the public sector than private sector. In particular, it emerged that the system within the public sector focuses more on a project managers’ number of years in government service in terms of loyalty than other important criteria such as level of match between project manager competencies and project requirements.

However, analysis of responses from project managers in both public and private sector revealed that the PM2P practice is based predominantly on availability of a project manager at the time of the allocation, than any other factors. This finding is consistent with the findings from a survey reported in (Hughes, 2014), as discussed in sections 2.2 and 2.3.

As regards impact of existing practices on performance, the most dominant theme was negative impact on project manager motivation. Project managers are unified in highlighting the negative impact of existing PM2P practices on their motivation, arising from several reasons such as mismatches between their competencies and projects requirements. Another major reason for negative project manager motivation, in Botswana's public and private sector, was the lack of consideration of a project manager's marital status, in terms of allocations to projects requiring frequent and long travelling distances to and from the project site. This occurrence impacts on a project manager's finances and family issues, which provides evidence of the need to improve existing PM2P practices in Botswana, in relation to consideration of a project manager's marital status.

Some project heads also acknowledged the frustrations from project managers and linked the negative motivation of project managers to mismatches in allocations, although they stressed that projects have to be done as part of a business need, which takes priority over project manager preferences and needs. The negative impact on project manager motivation may explain the impact on their performance in managing projects for which they are not well matched, which in turn impacts negatively on both project success and project manager rewards. For example, some project heads in the public sector revealed instances of project failures, arising out of allocation decisions based on a project manager's number of years in service (as per the emphasis on the public system's PM2P practice). The lesson learnt was that this approach is not working and requires improvement, in terms of consideration of other important criteria.

7.3.9 Comparison of results from analysis of quantitative and qualitative data

A comparison of the results from both quantitative and qualitative data analysis reveals a consistent message regarding the nature of existing PM2P practices in Botswana's MPEs and the negative impact of those practices on performance related variables. In particular, the quantitative analysis revealed that the nature of PM2P practices is characterized by no match between project managers' competencies and project requirements. Similarly, the qualitative analysis (content analysis) revealed no match between project managers and projects, as a dominant theme under nature of existing practices. The qualitative analysis revealed more insights about the issues surrounding this theme. For example, it emerged that the lack of match is linked to the absence of formal management tools, as per analysis of the project heads open ended responses. Furthermore, the project heads recognized the need for a formal management tool to standardize the PM2P allocations in terms of a structured process, given the reality of their business environment such as changes in roles.

As regards performance related variables, the quantitative analysis revealed three key findings: (1) an increase in the extent of match between a project manager and a project will in turn increase a project manager’s performance, project manager’s rewards and project success, (2) an increase in the extent of formality and objectivity will in turn increase a project manager’s rewards and project manager’s performance respectively, (3) an increase in the extent of comprehensiveness associated with influencing factors to the allocation decision will in turn increase project success. These findings are supported by the qualitative analysis, which revealed that the nature of existing practices have a negative impact on project manager performance and predominantly a project manager’s motivation. The reason for the negative impact on a project manager’s motivation was linked to mismatches in the allocations, lack of consideration of a project manager’s marital status. It emerged that the bussines need takes priority over project manager preferences, at the expense of a good match between project managers and projects, given reliance on availability of a project manager (at the time of the allocation) than any other factors such as project manager competence. The finding regarding reliance on project manager availability over competence is consistent with the survey findings reported in (Hughes, 2014), concerning the status of project management processes in Botswana’s public sector.

7.4 Implications of findings from evaluation of existing PM2P practices in MPEs of Botswana

The findings from the 12 organizations in Botswana (which include organization A) are significant in view of the established importance of this topic and the need to respond to the established gap in existing PM2P working practices. The consequences of these findings on existing PM2P practice are significant in terms of potential financial and non-financial losses arising out of the following:

i. potential direct financial losses arising from ineffectiveness of PM2P practices, in relation to mismatches between project manager competencies and project requirements. This argument is evidenced in (Skabelund, 2005), in terms of annual costs amounting to $105 billion, lost on rectifying mismatches in allocations that arise from unsuitability of employees to tasks (section 1.1);

ii. indirect financial losses associated with potential non-value added activities regarding correcting mismatches in PM2P allocations. This argument is supported by an empirical study (Skabelund, 2005) that reported a 27% annual loss in a senior manager's time, spent on rectifying mismatches in allocations;

iii. indirect financial loses involving potential employee dissatisfaction with existing PM2P practices that impact negatively on employee motivation, supported in (Patanakul et al., 2007; Raiden et al., 2006).

The implications for research are demonstrated in the resulting publication (Seboni et al., 2013), associated with reporting findings from evaluation of PM2P practices from another geographic region and country (Botswana), other than United States of America. Therefore, future research on PM2P practices in MPEs will need to account for and draw upon the findings reported in this thesis, including the publication (ibid), disseminated within the relevant academic community.

7.5 Summary

This chapter has demonstrated compelling empirical evidence of the ineffectiveness of existing PM2P practices in Botswana’s public and private sector, and the negative impact of those practices on performance. This evidence, hitherto unknown in existing body of knowledge, represents a contribution to knowledge on PM2P practices and extends the limited empirical studies on this topic to a new context (Botswana), other than USA and North America. This argument is akin to Phillips and Pugh’s (2005) definition of an original contribution to knowledge, in relation to conducting an empirical study in a country or locality that has only been done in other countries. This originality definition, representing an essential element of one of the criteria for the award of a doctoral degree, is also supported in (Dunleavy, 2003; Fellows and Liu, 2008; Tinkler and Jackson, 2004). The contribution made in this chapter is treated to be incremental, in the context of an overall mixed methods approach (section 4.1.3) to sufficiently accomplish the study aim.

The implications of these findings, in terms of financial losses (both direct and indirect) demonstrate the need and potential to improve existing PM2P practices in the context of Botswana, consistent with the central argument in this thesis. A plan to improve existing PM2P practices must first focus on identifying and understanding the influencing factors to effective practices. On this basis, the findings from a Botswana context led to the need to develop a conceptual framework to understand effective PM2P practices in MPEs, the subject of the next chapter.

Chapter 8
Conceptual framework

Given the findings presented in the previous chapter that demonstrated compelling empirical evidence of the need to improve PM2P practices in the context of Botswana, the next logical step was the development of a conceptual framedwork to understand effective PM2P practices in MPEs, the subject of this chapter. This chapter presents and discusses the results of methods described in section 4.6, associated with the development of a conceptual framework, as a guideline to facilitate development of a new approach to improve the PM2P practice in organization A. The literature reviews in sections 3.1 and 3.2 were also used to address the purpose of this chapter.

8.1 Proposed conceptual framework for effective PM2P practice

The discussion of the theoretical base for this thesis (chapters 2 and 3), and the methods described in section 4.6, was brought to bear on the developed conceptual framework presented in this chapter. The broadening of the literature surrounding the PM2P practice (section 2.7), and the discussions in sections 2.8, 3.2 and 3.4, resulted in a total of 12 new additions under factors or criteria that form important components of effective PM2P practices. These 12 new additions have not been included in previous studies on PM2P practices in MPEs and incorporated into the proposed conceptual framework for this thesis. The inclusion of these additional criteria constitutes significant additions to existing conceptual frameworks, on the basis of broader literature reviews surrounding the PM2P practice.

The conceptual framework represents a revised thinking in terms of understanding PM2P practices in MPEs, consistent with ideas in Kuhn (1970), from the perspective of potential for other researchers to use this revised thinking to study PM2P practices in other contexts. The key components of the conceptual framework, categorized under three processes, are considered as important factors to effective PM2P practices that are well grounded in literature. Given expert reviews used to confirm the structure and content of the proposed conceptual framework, the developed conceptual framework is relevant to industry practice. The conceptual framework is presented in the next two sub-sections. The first sub-section is an overview of the proposed conceptual framework in relation to key components. The second sub-section provides a summary of details of the identified components, to demonstrate theoretical grounding of the contents of the conceptual framework, as important factors that influence the PM2P practice.

8.1.1 Proposed conceptual framework – overview of key components

An overview of the proposed conceptual framework for understanding effective PM2P practices comprises six major components namely: (1) contextual factors, (2) project prioritization process, (3) project manager-to-project (PM2P) matching process, (4) recognition of constraints process, (5) effective PM2P practice, and (6) project and organizational performance (see Figure 8-1). The emphasis is on the first four components, considered the main components that form the basis for this conceptual framework.

The conceptual framework, representing a process for resource management in general, can be applied when considering any resource, or a version of which can be applied to organizational resources. In the context of the broader definition of resources, there is a resource in terms of project management called a project manager. This resource falls under the category of personnel resources, as discussed in sections 2.7.1 and 2.8.

The conceptual framework signifies the relationships between inputs, processes and outputs, including feedback loops and boundaries that define the scope of the PM2P practice for this thesis. For example, the content of the proposed conceptual framework shows components that are within the scope of this thesis, representing the boundaries in relation to elements where data were collected for an empirical study of PM2P practices in MPEs. These boundaries are denoted by a dotted rectangle.

The general theme of inputs labelled A, B and C is influenced by 1, which represents the contextual factors in the PM2P practice. In view of addressing the gap identified in existing conceptual frameworks (section 3.2.1), internal and contextual factors that play a role in influencing the general theme of inputs in A, B and C, are explicitly recognized and represented by the input labelled 1, as an addition to existing conceptual frameworks for the PM2P practice. In particular, the inputs A, B, and C, fall under the general theme of inputs to processes labelled 2, 3, and 4 (respectively). For example, the inputs in block A, B and C form important criteria to be considered in the project prioritization process, recognition of constraints process and PM2P matching process respectively. The numbers 1 to 6 represent the visual flow of information, such that what comes out of each component becomes an input feeding into the next component.

The two feedback loops (from component 6 to 5 and 5 to the general theme of inputs under A, B and C) are part of the additions made to existing conceptual frameworks, as part of addressing identified gaps and contributing to the understanding of extant knowledge on PM2P practices in MPEs. The feedback loops address gap 4, discussed in section 3.2.4. The inclusion of feedback loops represents an enrichment to existing conceptual frameworks on PM2P practices applicable to MPEs, in terms of explicit recognition of the important need to provide opportunities for continuous improvements in the PM2P practice.

Unlike existing conceptual frameworks for the PM2P practice (Patanakul et al., 2003, 2004, 2007; Patanakul, 2004, 2009; Patanakul and Milosevic, 2006), appropriate symbols consistent with process mapping (Aguilar-Savén, 2004; Ahoy, 2013) have been incorporated into the development of the conceptual framework for this thesis. The use of appropriate symbols addresses gaps highlighted in section 3.2.5. The general theme of inputs (A, B and C) to each process is represented by rounded rectangles while processes (components 2, 3 and 4) are represented by rectangles, consistent with the theory behind process mapping.

Four types of arrows are used to demonstrate different aspects regarding the logical flow of information in the PM2P practice. Firstly, the arrow from 1 to the general theme of inputs in A, B and C, depicts the influence of contextual factors on the inputs of the conceptual framework. Secondly, three arrows from the inputs in A, B and C to processes 2, 3 and 4, demonstrate primary relationships between the general theme of inputs and processes. Thirdly, two arrows (one from component 4 to 5 and the other from component 5 to 6) demonstrate links to performance concepts. For example, the PM2P matching process (labelled 4) influences the effectiveness of the PM2P decision-making process labelled 5, which in turn influences project and organizational success (Adler et al., 1996; Kuprenas et al., 2000; Patanakul et al., 2007).

8.1.2 Proposed conceptual framework – summary of details

A summary of the details of the proposed conceptual framework are presented, including exploded views of the high level components. Prior to presenting exploded views of each key component, a summary of the conceptual framework, in relation to all identified components that represent important criteria or factors to be considered in effective PM2P practices is illustrated in Figure 8-1. These identified factors were verified through literature sources (see chapters 2 and 3), industry expert reviews and the resulting publication (Seboni and Tutesigensi, 2014).

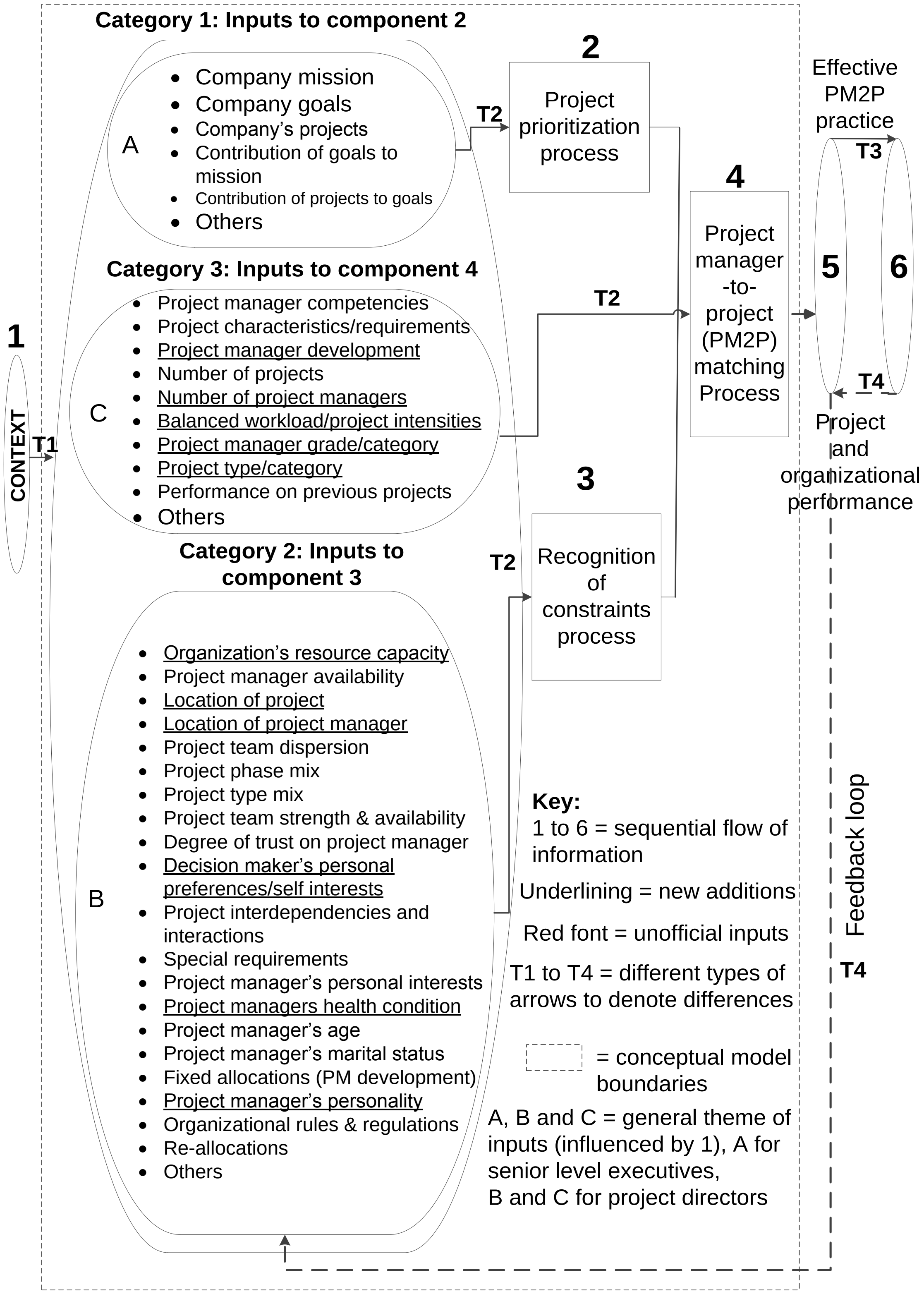


Figure 8-1 Summary of conceptual framework for the PM2P practice

The contents of the conceptual framework for understanding the PM2P practice (Figure 8-1) were brought together and displayed under three categories of a total of 34 identified criteria (labelled A, B and C) considered important in effective PM2P practices. These 34 criteria are consistent with the discussions in section 6.1.1.6, associated with design of user forms to capture information concerning these criteria in the PM2P practice. A full description of these identified criteria is discussed under exploded views of each component.

The four arrows T1 to T4 represent the flow of information from contextual factors to project and company success (forward loop) and back to the three categories of criteria that are inputs to each of the three processes under the overarching PM2P process. T1 denotes the influence of context on the inputs to each of the three categories of criteria. T2 denotes the influence of inputs to each of the three processes. T3 represents the influence of an effective PM2P practice on project and company success. T4 denotes an important starting point for a feedback loop in terms of an indication of the effectiveness of the PM2P practice and the level of project and company success, on the basis of all the inputs considered.

The proposed conceptual framework is intended to contribute to an understanding of existing knowledge on the PM2P practice in MPEs, in relation to effective decision-making. It is generic in nature, given that it was developed by drawing from broader reviews of literature, unlike existing conceptual frameworks. This conceptual framework may be used by project management practitioners and researchers, subject to contextual factors that influence the identified criteria, to guide effective PM2P practices. The word “others”, under each of the three categories of inputs (Figure 8-1) was used to appreciate scope for inclusion of additional criteria that may emerge from deploying the conceptual framework in practice. Further discussions of the details of the conceptual framework are presented next, to demonstrate theoretical grounding of each identified criterion on the PM2P practice.

8.1.3 Exploded views of key components of the conceptual framework

As part of demonstrating the evidence from various literature sources to support each identified criterion or factor, considered important in effective PM2P practices, four exploded views of the developed conceptual framework are outlined in the next sub-sections. These exploded views are associated with four main components that form the overall structure of the conceptual framework, labelled 1 to 4 in Figure 8-1.

8.1.3.1 Exploded view of the context

An exploded view of the organizational dimensions (Kew and Stredwick, 2010; Pellegrinelli et al., 2007; Ferns, 1991), identified in this thesis as contextual factors that vary on the basis of context (Aritua et al., 2009c; Pettersen, 1991a; England, 1967; Cook and Slack, 1991; Fiedler and Chermers, 1974) is illustrated in Figure 8-2. The associated references that support the inputs to the contextual factors are presented in Table 8-1. These contextual factors influence the PM2P practice and include the following aspects in terms of the PM2P practice: a specific country, industry, organization and project types.

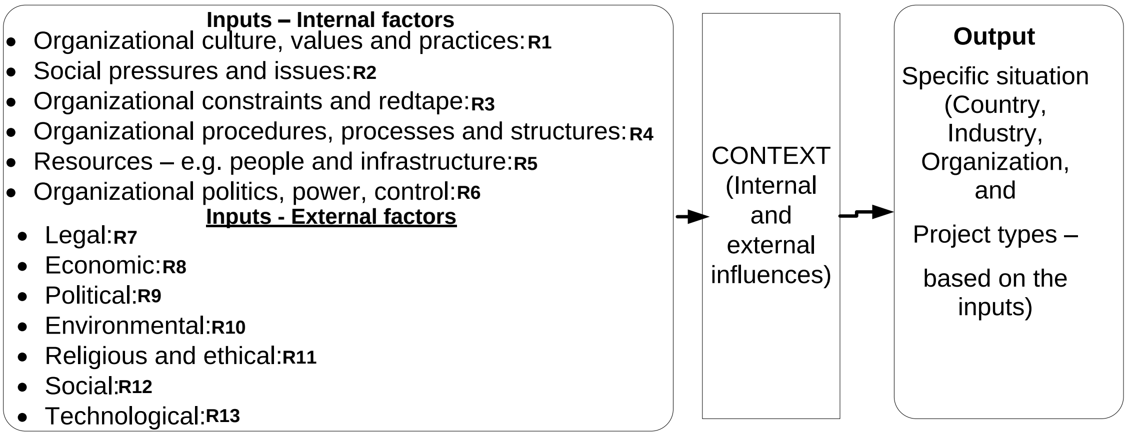


Figure 8-2 Exploded view of organizational dimensions

Table 8-1 References for inputs to context

Input	References
R1	Aritua et al., 2009c; England, 1967; Hauschildt et al., 2000; House et al., 2004; Müller and Turner, 2007; Ogunlana et al., 2002; Patanakul and Milosevic, 2006; Pellegrinelli and Bowman, 1994; Yasin et al., 2000
R2	Cook and Slack (1991)
R3	Fiedler and Chermers, 1974; Ferns, 1991
R4	Alison, 1971; Aritua, 2009; Ferns, 1991
R5	Aritua et al., 2009a; Hartman and Boyd, 1998; Owusu et al., 2007; Pellegrinelli et al., 2007
R6	Briner et al., 1996; Hartman and Boyd, 1998; Pellegrinelli and Bowman, 1994
R7	Briner et al., 1996
R8	Boyatzis, 2007; Briner et al., 1996; Hartman and Boyd, 1998
R9	Boyatzis, 2007; Briner et al., 1996; Hartman and Boyd, 1998
R10	Boyatzis, 2007; Briner et al., 1996; Yasin et al., 2000; Ives et al., 1993; Tractinsky and Jarvenpaa, 1995
R11	Boyatzis, 2007; Kew and Stredwick, 2010
R12	Boyatzis, 2007; Briner et al., 1996
R13	Briner et al., 1996; Kew and Stredwick, 2010

Explicit recognition of these contextual factors (Briner et al., 1996; Hartman and Boyd, 1998; Pellegrinelli and Bowman, 1994; Boyatzis, 2007; Yasin et al., 2000) represents an addition to existing studies on conceptual frameworks for the PM2P in MPEs, in the context of a generic approach relevant to industry practice. However, the main approach is contextual in Botswana, on the basis of the need to develop a new approach that is of value to practically contribute to allocating project managers-to-projects in a specific context that has not been explored prior to this thesis.

These contextual factors have not been previously discussed in existing conceptual frameworks for the PM2P practice, and their inclusion addresses the identified gap discussed in section 3.2.1, arising from drawing on critical reviews of literature such as the nature of decision making (section 3.4.2) in terms of an understanding of context. The addition of contextual factors represents a contribution to the understanding of existing knowledge on PM2P practices.

A multitude of studies discuss numerous issues, classified in this thesis under internal and external factors (see Figure 8-2 and Table 8-1). These studies represent various sources of evidence from management literature that support the concept of contextual factors influencing the PM2P practice on the basis of context. This implies, for example, that internal factors such as organizational culture (Aritua et al., 2009c; England, 1967; House et al., 2004; Pellegrinelli and Bowman, 1994), and politics (Briner et al., 1996; Hartman and Boyd, 1998; Pellegrinelli and Bowman, 1994), as well as external factors such as environmental (Boyatzis, 2007; Yasin et al., 2000), political (Boyatzis, 2007; Briner et al., 1996), and economic factors (Boyatzis, 2007; Briner et al., 1996; Hartman and Boyd, 1998), will have varying levels of influence on the PM2P practice, based on context. In their empirical studies, (Patanakul et al., 2003, 2004, 2007) acknowledge that the proposed conceptual framework in their work needs to be extended to other countries, industries and project types, to address limitations of unknown or unreported PM2P practices in other countries and industries. This acknowledgement is consistent with the view that the factors to be considered in the PM2P practice are based on context. Crawford (1998) highlights the importance of project management context (environment), in relation to customizing global project management standards, to assess project management competence, on the basis of regulations and cultural issues specific to each country. Although the development of these standards may be generic and geared to assess project management competence across national boundaries, industries and organizations, the implications of Crawford's (Crawford, 1998) recognition for the need to customize standards at local levels is consistent with the concept of contextual factors in the proposed conceptual framework for this thesis. Other sources of evidence from management literature supporting the concept of context are studies on corporate globalization, which discuss issues of global versus local, in relation to global projects seeking to provide consistent products and services to customers across Countries (Ives et al., 1993; Tractinsky and Jarvenpaa, 1995).

In summary, these studies demonstrate and warrant the need to explicitly recognize the internal and external factors that play a role in the PM2P allocation practice, based on the conditions and situations of a particular country, industry, organization and project types (represented by component 1). This means that the decision maker must deal with these factors as inputs to the decision making process, as part of the importance of understanding the decision making context (Harrison, 1981; Jennings and Wattam, 1998; Keren, 1992; Orasanu and Connolly, 1993).

8.1.3.2 Exploded view of the project prioritization process

Based on the logical flow of elements in the developed conceptual framework depicted in Figure 7-3, the next process in the overarching PM2P allocation process is the project prioritization process. In this process, which is outside the immediate scope of the project management function, senior management determine the relative priority of projects in relation to impact on strategic business imperatives. This process addresses questions such as which projects will make the biggest impact to an organization's bottom line? The relevance of this process to the PM2P practice lies in determining which project managers must be allocated to which projects, on the basis of the strategic impact of those projects. Figure 8-3 is an exploded view of the project prioritization process (component 2), showing the identified key inputs that play a role in the PM2P practice.

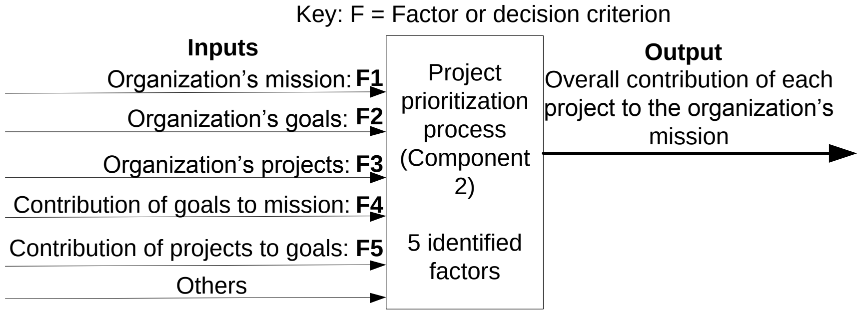


Figure 8-3 Exploded view of project prioritization process

The theoretical grounding of the inputs is presented in Table 8-2, in terms of the associated references supporting each input. Existing literature highlights the importance of project prioritization in terms of project management success, particularly portfolio management (Fricke and Shenhar, 2000; Elonen and Artto, 2003; Cooper et al., 1998). Portfolio management is linked with project prioritization in relation to making strategic resource allocation decisions.

Table 8-2 References for inputs to the project prioritization process

Input	References
F1	Patanakul et al., 2003, 2004, 2007
F2	Eisenhardt and Brown, 1998; Choothian et al., 2009; Patanakul and Milosevic, 2006
F3	Choothian et al., 2009; Patanakul and Milosevic, 2006
F4	Patanakul et al., 2003, 2004, 2007; Choothian et al., 2009
F5	Choothian et al., 2009; Patanakul et al., 2003, 2007

However, the literature on project prioritization is focused mainly on product development. The literature on project prioritization in terms of activities such as idea screening and project selection (Ayag and Ozdemir, 2009; Campos et al., 2010; Russell and Tippett, 2008), to decide which projects should be given funding is not in scope for this thesis, given that the PM2P practice is concerned specifically with making PM2P allocation decisions, once the projects have been given funding, following completion of activities related to idea screening and project selection. Organizational strategic business imperatives are well documented in existing literature (Adler et al., 1996; Asosheh et al., 2010; Dickinson et al., 2001; Eisenhardt and Brown, 1998), in the context of project selection.

Notwithstanding the popularity of organizational strategic business imperatives in terms of enhancing organizational performance, there is limited literature regarding organizational strategic business imperatives in the context of improving the PM2P practice (Patanakul and Milosevic, 2006). The assumption in this thesis is that projects have already been appraised, selected, given funding by senior management and awaiting resources (i.e., project managers) to implement them. The emphasis is on prioritizing funded projects by assessing their relative contribution to the organization's strategic leverage areas, such that appropriate decisions can be made regarding effective PM2P allocation decisions. The output of the project prioritization process is knowledge of the contribution of each project to the accomplishment of each organization's strategic goal, which informs the PM2P allocation decisions. A brief discussion of each of the identified 5 factors, under the project prioritization process

(Figure 8-3) is provided, as part of substantiating each factor with evidence from literature. The input labelled ‘Others’ represents scope for inclusion of additional criteria and applies to all three processes within the overarching PM2P process.

8.1.3.2.1 Organizational mission (F1)

An organization’s mission represents the reason for existence, in relation to the organization’s mission and vision statements that get cascaded down into specific strategic goals to be executed at operational level in the form of projects (Patanakul et al., 2003; Patanakul et al., 2004; Patanakul et al., 2007; PMBOK, 2013).

8.1.3.2.2 Organizational goals (F2)

An organization’s goals are the organizational level factors representing a breakdown of the organization’s mission. These organizational level factors constitute the strategic business imperatives such as financial indicators (affected by issues such as market demands and competition). The implications of these organizational level factors lies in the role played by each project (relative contribution) to the accomplishment of these organizational goals and therefore, which project managers are better suited to manage those projects in relation to the PM2P practice (Eisenhardt and Brown, 1998; Choothian et al., 2009; Patanakul and Milosevic, 2006).

8.1.3.2.3 Organization’s projects (F3)

An organization’s projects are the vehicle through which the organization’s strategic goals are achieved (PMBOK, 2008, 2013; PMI, 2004; Williams, 2002). The contribution of each project (relative to other projects) to the achievement of the organization’s strategic goals, influence the choice of project manager to lead a particular project (Choothian et al., 2009; Patanakul and Milosevic, 2006).

8.1.3.2.4 Contribution of goals to mission (F4)

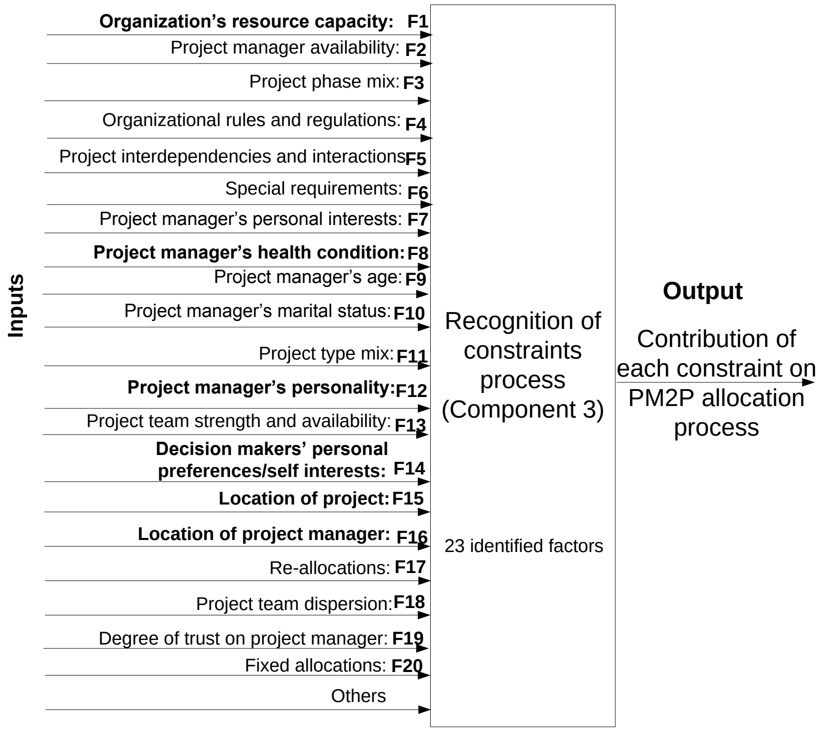
This input is concerned with addressing the question, what is the relative contribution of each identified organizational goal to the mission. An answer to this question will ultimately influence the PM2P allocation decision, in relation to optimizing the level of match between a project manager’s competencies and the project requirements, as part of achievement of strategic goals and hence mission (Patanakul et al., 2003; Patanakul et al., 2004; Patanakul et al., 2007; Choothian et al., 2009).

8.1.3.2.5 Contribution of projects to goals (F5)

The contribution of projects addresses the question of which projects make the biggest strategic impact to the organization's bottom line in terms of goals (i.e. what is the relative priority of projects in relation to their bottom line impact on the organization's strategic goals). The answer to this question informs the PM2P allocation decision, in terms of matching the project manager's competencies to the various projects, based on the relative priority of each project in relation to bottom line impact (Choothian et al., 2009; Patanakul et al., 2003; Patanakul et al., 2004; Patanakul et al., 2007).

8.1.3.3 Exploded view of the recognition of constraints process

The next process within the overarching PM2P practice is the recognition of constraints that influence the PM2P allocation decisions. An exploded view of the recognition of constraints process is presented in Figure 8-4.



Key: F = Factor or decision criterion; inputs in bold font = new additions to existing framework

Figure 8-4 Exploded view of the recognition of constraints process

The theoretical grounding of the inputs to this process, is presented in Table 8-3, in relation to references supporting each input. A total of 23 key inputs or criteria that play a role in the recognition of constraints process have been identified from critical reviews of a wide range of literature sources (chapters 2 and 3). These reviews include the identified literature streams discussed in section 3.1. Out of these 23 key inputs, 8 inputs highlighted in bold font (Figure 8-4) have not been included in existing conceptual frameworks on PM2P practices in MPEs.

These 8 key inputs represent new and significant additions to existing frameworks and therefore, a contribution to the understanding of existing knowledge on PM2P practices. The 8 additional inputs warrant a brief discussion of each, on the basis that they represent new additions and hence revised thinking to existing frameworks.

Table 8-3 References for inputs to recognition of constraints process

Input	References
F1	Adler et al., 1996; Azarmi and Smith, 2007; Harris and McKay, 1996; Owusu et al., 2007; Sebt et al., 2010; Bower, 2013
F2	KapurInternational, 1993; Rubinstein et al., 2001; Adler et al., 1996; Azarmi and Smith, 2007; Choothian et al., 2009; Harris and McKay, 1996; Kuprenas et al., 2000; Owusu et al., 2007; Patanakul and Milosevic, 2006; Patanakul, 2013
F3	Patanakul and Milosevic, 2006; Choothian et al., 2009
F4	Alison, 1971; Patanakul et al., 2007
F5	Pellegrinelli, 2002; Patanakul and Milosevic, 2006; Choothian et al., 2009; Platje and Seidel, 1993; Platje et al., 1994
F6	Patanakul and Milosevic, 2006; Choothian et al., 2009
F7	Patanakul and Milosevic, 2006; Patanakul, 2013
F8	Bockerman et al., 2011; Citoni et al., 2012
F9	Ogunlana et al., 2002
F10	Ogunlana et al., 2002
F11	Choothian et al., 2009; Patanakul and Milosevic, 2006
F12	Ogunlana et al., 2002; Mustapha and Naoum, 1998; Adobor, 2004
F13	Patanakul and Milosevic, 2006
F14	Hartman and Boyd, 1998; Patanakul and Milosevic, 2006
F15	Kuprenas et al., 2000
F16	Owusu et al., 2007
F17	Patanakul et al., 2007
F18	Patanakul et al., 2007
F19	Einsiedel Jr, 1987; Patanakul et al., 2004
F20	Patanakul and Milosevic, 2006, 2009; Patanakul et al., 2004, 2007

8.1.3.3.1 Organization’s resource capacity (F1)

Although resource capacity is discussed by Patanakul et al. (2007), in the context of a project manager’s availability to be allocated to additional projects without an impact on his/her productivity, the concept of an organization’s resource capacity in relation to assessing the capability of the existing pool of project managers, has not been discussed in existing conceptual frameworks for the PM2P practice. Organization’s resource capacity, is linked to addressing both current and future project delivery capability (Bower, 2013), including project manager development (Pettersen, 1991a;

Zimmerer and Yasin, 1998; Birkhead et al., 2000) to up-grade competency levels. Therefore, this input represents a new addition and hence a contribution to the understanding of existing frameworks on PM2P practices in MPEs, in terms of implications on an assessment of the skills gap of existing pool of project managers, the outcome of which will influence the PM2P allocation decisions.

8.1.3.3.2 Project manager's health condition (F8)

The concept of an employees' physical and mental status, in the context of ability to perform a job, is discussed by (Bockerman et al., 2011; Citoni et al., 2012). However, this concept has not been discussed specifically in relation to criteria to be considered in the PM2P practice. The implication of these broader reviews of management literature lies in the implicit role of a project manager's health condition, in terms of the PM2P allocation decision, hence its inclusion.

8.1.3.3.3 Project manager's personality (F12)

A project manager's personality relates to ability to execute a high profile project by leveraging on his/her stakeholder management skills, in relation to issues such as 'political sensitivity' (Ogunlana et al., 2002; Mustapha and Naoum, 1998). This ability is also contended in (Adobor, 2004), in terms of use of the phrase *"political skills"* (p. 165), to highlight the importance of a project manager's cultural fit in successful management of projects. In a similar vein, Birkhead et al. (2000) discuss the personality traits of a project manager in their empirical study of core competencies required of project managers in the context of South Africa's information technology, construction and engineering industries. Patanakul and Aronson (2010) found that organizational culture (a related concept to project manager's personality/cultural fit) has a significant and direct impact on project success. Although the concept of cultural fit may well be classified under a project manager's competencies, it has been identified as an independent inclusion in the proposed conceptual framework to explicitly recognize the ability to work across and adapt to different cultures, values and beliefs, given globalization issues in today's business dynamics.

8.1.3.3.4 Decision maker's personal preferences/self-interests (F14)

A decision maker's personal preferences are associated with his/her personal prejudices in assessing project managers for different projects. Decision makers have personal interests which are likely to affect delivery (either success or failure) of certain projects (Hartman and Boyd, 1998). The implications of this view lies in the need to recognize the role played by decision maker's personal preferences or self-interests, in the context of an influence on PM2P allocation decisions, on the basis of organizational politics, power and control (Briner et al., 1996; Hartman and Boyd, 1998; Pellegrinelli and Bowman, 1994).

8.1.3.3.5 Location of project (F15)

Kuprenas et al. (2000) discuss the geographic location of a project as a factor that affects project delivery and success. In addition, Owusu et al. (2007) discuss the need to know the location of the work to be completed, in relation to the location of the required resources to be deployed, in the context of resource planning and scheduling (under the broader theory of resource management). Although these studies do not discuss the location of a project in the context of PM2P practices, the implications of these studies lie in the influence of location of a project on PM2P allocation decisions, on the basis of distances between project sites and project managers to be allocated to projects in those sites. For example, the distances between project sites and project managers plays a role in communication effectiveness and quality of project delivery, both of which are likely to influence PM2P allocation decision.

8.1.3.3.6 Location of project manager (F16)

The importance of information regarding the location of required resources to be deployed, in relation to resource planning and scheduling, under the broader theory of resource management, has been discussed (Owusu et al., 2007). The view regarding location of resources is supported in (LeBlanc et al., 2000) in terms of the varying levels of management effort required to manage a project, on the basis of project managers' travelling times to various project sites. Although not previously discussed in the context of conceptual frameworks for the PM2P practice, the implication of travelling times between resource locations and project sites is that the location of a project manager is an important consideration in the PM2P practice.

8.1.3.4 Unofficial inputs under recognition of constraints process

Three inputs fall under the general theme of inputs that play a role in the PM2P allocation decision but classified as unofficial, in the context of human resource (HR) related issues such as regulations to protect employee rights. Depending on context, these inputs may violate HR practices in terms of constraints but still play a role (implicitly) in the allocation decision. These inputs are: (1) project manager's age, (2) marital status of project manager, and (3) project manager's health condition. These three inputs are briefly discussed below.

A project manager's age may influence allocation decisions (Zavadskas et al., 2008; Adobor, 2004; El-Sabaa, 2001; Mustapha and Naoum, 1998), and therefore, an important consideration in the PM2P practice. A project manager's age is supported in (El-Sabaa, 2001), in terms of enhancing the selection, training and performance of effective project managers in the context of Egypt.

Marital status of project manager (Ogunlana et al., 2002) may influence decisions, on the basis of issues such as work-life balance or more specifically the need to balance employment and family responsibilities (Citoni et al., 2012; Berg, 1999). The interpretation is that a project manager's marital status may implicitly be considered as a factor influecing the PM2P allocation decision, in the context of best practices.

Bockerman et al. (2011, p.589), state *"sickness absences cause a substantial reduction in working time."* This statement suggests that a project manager's health condition can be linked to ability to manage projects on a continuous basis, without interruptions from illnesses and absenteeism. This interpretation is confirmed in (Citoni et al., 2012). The implication is that a project manager's health condition may affect his/her ability to lead projects on a continuous basis due to sickness absenteeism, leading to an impact on project delivery, particularly if it occurs at critical project phases when he/she is most needed. These issues are implicitly considered by the decision maker in PM2P allocation decisions.

8.1.3.5 Other inputs to the recognition of constraints process

A total of 13 out of 20 inputs to the recognition of constraints process have already been discussed in existing frameworks on the PM2P practice. These inputs are presented next.

8.1.3.5.1 Project manager availability (F2)

Project manager availability refers to the effective capacity of a project manager in terms of how much time is actually committed to performing project activities (Patanakul et al., 2007) and not non-value added time such as time spent on carrying out administrative work or other non-project work, including holiday (Harris and McKay, 1996; Rubinstein et al., 2001; KapurInternational, 1993). The availability of a project manager indicates workload.

8.1.3.5.2 Project phase mix (F3)

Project phase mix is related to the ability of a project manager to effectively lead concurrent projects simultaneously, that are in different phases (Patanakul et al., 2004; Patanakul et al., 2007). Project management effort required of a project manager varies on the basis of project life cycle in terms project phase and hence influence the PM2P allocation decision.

8.1.3.5.3 Organizational rules and regulations (F4)

Several authors discuss the concept of an organization's rules and regulations dictated by senior management, under different context (Beck, 1983; Payne and Turner, 1999; PMBOK, 2008; PMI, 2008). This concept includes issues such as organizational processes and procedures (e.g., project management processes and support structures), all of which affect the delivery of projects (OGC, 2003; PMI, 2004, 2008; Pinto and Prescott, 1987; Pinto and Kharbanda, 1996). These issues affect agreements on recruitment and outsourcing in terms of thresholds, number of projects that can be taken on board for implementation (related to budget constraints). The implications on this thesis lies in the role played by organizational rules and regulations in the PM2P practice.

8.1.3.5.4 Project interdependencies and interactions (F5)

The concept of project interdependencies and interactions is associated with inter-relationships between projects. It relates to the possibility that certain projects, which have strong overlaps (Platje et al., 1994; Payne, 1995; Platje and Seidel, 1993), should be managed by the same project manager (Patanakul, 2004) to improve effectiveness in project delivery.

8.1.3.5.5 Special requirements (F6)

The literature on PM2P practices suggests that certain projects require project managers with specialist competencies to handle delivery of those projects (Patanakul and Milosevic, 2006; Patanakul and Milosevic, 2009; Patanakul et al., 2004; Patanakul et al., 2007). The implications are that possession of specialist competencies to handle demands of projects with 'special' characteristics, plays a role in the PM2P practice.

8.1.3.5.6 Project manager's personal interests (F7)

The need to accommodate a project manager's personal preferences in the PM2P allocation decision is discussed in (Patanakul and Milosevic, 2006; Patanakul, 2013).

This need is associated with a project manager's developmental needs. However, little has been said about how the PM2P allocation process reported in (Patanakul and Milosevic, 2006; Patanakul, 2013) can be used to build a fit between the project managers' competencies and the requirements of the projects (i.e., organizational needs). The proposed conceptual framework in this thesis addresses this gap.

8.1.3.5.7 Project manager's age (F9), and marital status (F10)

These two inputs fall under the three unofficial criteria (section 8.1.3.4) that play a role in the PM2P practice but not openly discussed by practitioners. A project manager's age (Adobor, 2004; El-Sabaa, 2001; Mustapha and Naoum, 1998; Zavadskas et al., 2008), and marital status (Ogunlana et al., 2002), are related to the concept of work-life balance. Work-life balance is associated with the need to balance employment and family responsibilities (Berg, 1999; Citoni et al., 2012; Raiden et al., 2006). El-Sabaa (2001) supports consideration of a project manager's age, in terms of enhancing the selection, training and performance of effective project managers in the context of Egypt. A project manager's age is also linked to *"experience in similar projects"* (Ling, 2003, p.139).

8.1.3.5.8 Project type mix (F11)

Project type mix refers to the variations in projects that are concurrently managed by a certain project manager. Different project manager competencies are appropriate for different types of projects with varying levels of complexities (Geoghegan and Dulewicz, 2008; Müller et al., 2012; Müller and Turner, 2007; Müller and Turner, 2010). The implication is that the type of projects in relation to their concurrent management is a factor that influences choice of project manager, in the context of the PM2P practice.

8.1.3.5.9 Project team strength and availability (F13)

The project management effort required of a project manager varies on the basis of the strength and availability of the project team (Patanakul, 2004). The contention is that a project manager's productivity may increase, if leading a project in which the project team is available and strong to deal with project issues, since the project manager will be freed from managing details.

8.1.3.5.10 Re-allocations (F17)

Patanakul et al. (2004, 2007) and Choothian et al. (2009) argue that different project managers will have varying levels of competencies, in terms of their ability to take over an existing project from another project manager (following a re-allocation) and continue its delivery without a discontinuity in its delivery. This situation influences the PM2P practice.

8.1.3.5.11 Project team dispersion (F18)

Project team dispersion defines the nature of the project management team set-up in terms of geographic distribution of the project team, also referred to as ‘distributed or co-located project team’ (Patanakul et al., 2004; Patanakul et al., 2007). This input or criterion affects efficiency of both communications and project delivery in the context of an impact on PM2P allocation decisions.

8.1.3.5.12 Degree of trust on project manager (F19)

Einsiedel Jr (1987) discusses the level of trust that stakeholders have on the credibility of a project manager in terms of leading projects to success. (Patanakul, 2004; Patanakul and Milosevic, 2006; Patanakul et al., 2004) corroborate this view, in the context of an influence on the PM2P practice.

8.1.3.5.13 Fixed allocations (F20)

Certain situations require a decision maker to recognize and accommodate the project manager’s personal preferences in terms of choice of project, which is linked to the concept of a project manager’s motivation (Patanakul and Milosevic, 2006; Patanakul and Milosevic, 2009; Patanakul et al., 2004; Patanakul et al., 2007). This concept is also related to special allocations in which the decision maker considers a project manager’s development (i.e., to fulfil training needs) as part of on-the-job training, which represents a strategy to upgrade the project manager’s competencies in preparation for promotions in terms of both project manager role and capability to manage more complex projects (Patanakul et al., 2007). Following consideration of both the project prioritization and recognition of constraints processes, the PM2P matching process can now be presented, consistent with the logical flow of information in the conceptual framework presented in Figure 8-1.

8.1.3.6 Exploded view of the PM2P matching process

An exploded view of the PM2P matching process, within the overarching PM2P process, is depicted in Figure 8-5. The theoretical grounding of the inputs to this process, in terms of references supporting each input, are presented in Table 8-4. A total of 10 key factors or inputs that play a role in the PM2P matching process were identified, following critical reviews of literature streams discussed in section 3.1, along with the literature discussed in chapter 2. Out of these 10 key inputs, 4 inputs (highlighted in bold font) have not been included in existing frameworks on PM2P practices in MPEs. These 4 key inputs represent new additions to existing frameworks and therefore, a contribution to the understanding of existing knowledge on PM2P practices. For example, these 4 additions are discussed in existing literature under different context but have not been included in existing conceptual frameworks as criteria to be considered in PM2P practice.

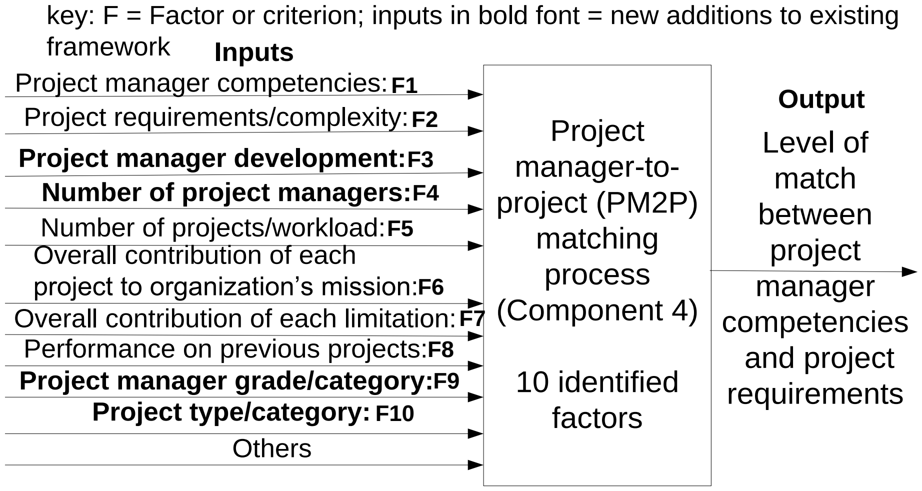


Figure 8-5 Exploded view of the PM2P matching process

Table 8-4 References for inputs to PM2P matching process

Input	References
F1	Aritua et al., 2011; Ballesteros-Pérez et al., 2012; Crawford, 1997,1998, 2005, 2007a; Crawford and Nahmias, 2010; El-Sabaa, 2001; Hoobler and Johnson, 2004; Patanakul et al., 2007; Patanakul, 2013; Sebt et al., 2010; Vergne, 2012; Wetterling, 2012; Zavadskas et al., 2008; Madter et al., 2012; Hadad et al., 2012, 2013
F2	Adams et al., 1979; Ballesteros-Pérez et al., 2012; Birnberg, 1997; Duncan, 1999; El-Sabaa, 2001; Hadad et al., 2012, 2013; Patanakul et al., 2007; Platje and Seidel, 1993; Platje et al., 1994; Shenhar, 2001
F3	Pettersen, 1991a,b; Jiang et al., 1998; Zimmerer and Yasin, 1998; Birkhead et al., 2000
F4	Azarmi and Smith, 2007
F5	Azarmi and Smith, 2007; Owusu et al., 2007; Patanakul et al., 2007
F6	Patanakul et al., 2007; Choothian et al., 2009
F7	Patanakul et al., 2007
F8	Hadad et al., 2012, 2013
F9	Müller and Turner, 2007
F10	Müller and Turner, 2007

A brief discussion of these four inputs, representing new additions to existing frameworks under the PM2P matching process is presented next.

8.1.3.6.1 Project manager development (F3)

Birkhead et al. (2000) discuss employee development as part of effective human resource management practices of training, up-skilling and retaining talent, with the aim of building an organization's 'competitive advantage'. Godbout (2000) supports the view of building competitive advantage in the context of *"knowledge assets"* (p.81). The concept of project team development and its importance in relation to project manager competencies is discussed in several studies (Jiang et al.,1998; Pettersen, 1991a; Zimmerer and Yasin, 1998). These studies have implications on project manager development, in the context of the PM2P practice.

8.1.3.6.2 Number of project managers (F4)

The number of project managers is an important consideration in PM2P practices, on the basis of an organization's resource capacity (Bower, 2013), which is likely to have an impact on project manager availabilities (Patanakul et al., 2007).

8.1.3.6.3 Project manager grade/category (F9)

The literature on leadership competency profiles of project managers, in the context of ability to lead different types of projects with varying levels of complexities (Crawford, 1997; Crawford, 2003; Draganidis and Gregoris, 2006; Patanakul and Milosevic, 2008; Geoghegan and Dulewicz, 2008; Müller et al., 2012; Müller and Turner, 2007; Müller and Turner, 2010) is well documented. However, these studies do not discuss project manager grade (i.e., seniority) in the context of extent of capability to manage projects of varying complexities, by utilizing skills and experience (including experience of managing similar projects). The contention is that a project manager's grade is likely to influence the PM2P practice.

8.1.3.6.4 Project type/category (F10)

The need to match a project manager's leadership style to project type is discussed (Müller and Turner, 2007). The type of project is related to project complexity (Geraldi, 2008; Müller et al., 2012), which influences the category of project manager to be chosen to lead certain projects. The implication is that the type or category of project will influence the PM2P practice.

8.1.3.7 Other inputs to the PM2P matching process that have already been discussed in existing frameworks

Details of the other inputs or criteria that influence the PM2P practice, under the PM2P matching process, are presented. These inputs have been discussed in existing literature, under different context.

8.1.3.7.1 Project manager competencies (F1)

The concept of project manager competence is broad and discussed by numerous authors under different context. For example, Crawford (1998) discusses it in the context of project management standards across different countries to asses project management competence (includes “Qualifications and Experience”), based on ideas from PMI regarding PMP Certification (PMI, 1996; Crawford, 1997). Partington (2005) discusses project manager competence in the context of its importance to capability of both project managers and program managers, in large organizations that implement projects with a *“technological dimension”* (p. 87). The concept of project manager competency is also discussed in several other studies (Müller et al., 2012; Muller and Turner, 2010; Müller and Turner, 2007) in the context of leadership styles, appropriate for different types of projects. Patanakul and Aronson (2010) discuss the competency of a project manager in terms of direct impact on project success in a MPM setting.

In the context of a conceptual framework to match project managers to construction projects, (Ogunlana et al., 2002) include criteria such as project manager’s performance on previous projects, qualifications and management capability. The performance of the project manager on previous projects, is related to the project manager’s competencies, which influences his/her, performance.

These concepts are covered in the proposed conceptual framework under project manager competencies, on the basis that they are components of a project manager competency. This concept of competence incorporates another concept referred to as domain knowledge, which is a sub-set of a project manager’s competence. Different authors use different terms to refer to the concept of domain knowledge. For example, El-Sabaa (2001) uses the term ‘technical skills’ and describes them as: *“relevant experience/knowledge of the technology required by the project,” “specialized knowledge and analytical ability in the use of the tools and techniques of the specific discipline”* (p. 2). The work of Ogunlana et al. (2002) uses the phrases; *“technical credibility”* (p. 391), “*specialised experience for specific projects”* and *“construction industry experience”* (p. 392) to assert the importance of the concept of domain knowledge. Similarly, the phrase ‘technical competence and industry knowledge’, is used in (Adobor, 2004), while the term ‘job-task competencies’ is used in (Cheng and Dainty, 2005). All these studies agree and highlight the importance of an understanding of the job content in which the project is based, in the context of required project managers competencies. Furthermore, domain knowledge is referred to with phrases such as *“technical competence”* and *“technical skills”* (Zavadskas et al., 2008, p. 471) and described as *“an understanding of, and proficiency in, a specific kind of activity, particularly one that involves methods, processes, procedures or techniques”* (Zavadskas et al., 2008, p. 471). Experience in similar projects is also implied in these studies’ descriptions. The implications in these studies is that a project manager’s domain knowledge is a component of his/her competency (captured in the conceptual framework), which is a broader concept that incorporates domain knowledge (El-Sabaa, 2001; Ogunlana et al., 2002; Adobor, 2004; Cheng and Dainty, 2005; Zavadskas et al., 2008). Rowe (1995) asserts that there are 3 application areas of competence namely: (1) skill assessment, (2) recruitment and (3) development. An important point to underscore is that these numerous studies demonstrate evidence of the importance of a project manager’s competency, as an input to the PM2P practice within the developed conceptual framework.

8.1.3.7.2 Project requirements/complexity (F2)

Project complexity is discussed in numerous publications under different contexts and was discussed in section 3.1.3. For example, Birnberg (1997) and Duncan (1999) highlight different ‘project characteristics’ such as project size, budget, number of interfaces, extent of technological uncertain (Cooke-Davies and Patton, 2008), which brings about issues of uncertainty and risk. Other aspects of project complexity include number, diversity and difficulty of stakeholders (e.g. clients, customers) involved with the project. A content analysis of the identified literature stream on characteristics of project complexity, was discussed in section 3.1.3. The content analysis results are linked to an understanding of the requirements of a project to the usefulness in terms of project prioritization, which informs choice of project manager (Patanakul et al., 2004). Blismas et al. (2004) assert that an understanding of *“project requirements or characteristics”* (p. 358) is important to enable project success. Ireland (1997) supports this view by suggesting that categorizing projects into different types helps to determine what resources and effort would be required to execute those projects.

Several authors use different terms or keywords to refer to the same concept (i.e., project requirements). For instance, Ogunlana et al. (2002), Patanakul et al. (2007), Raiden et al. (2004), and Choothian et al. (2009) use the term “project requirements” to describe the demands of the projects, which dictate the required competencies of the candidate project manager. Other authors use the term ‘project complexity’ (Sun and Luo, 2010), to refer to the concept of project requirements. All of these issues, geared towards addressing particular business needs, characterize project complexity as it relates to the concept of project requirements, which in turn, influence the PM2P allocation decision.

8.1.3.7.3 Number of projects/workload (F5)

The number of projects to be implemented (may also include projects in the pipeline) is a function of demand from the perspective of an organization and translates to workload in the context of project managers, who are the resources required to deliver those projects to achieve strategic goals (Azarmi and Smith, 2007; Owusu et al., 2007; Patanakul, 2004; Patanakul et al., 2007).

8.1.3.7.4 Overall contribution of each project to the company’s mission (F6)

The concept of project priorities in the context of determining the contribution of each project to accomplishment of an organization’s strategic mission, is an influencing factor to the PM2P practice (Choothian et al., 2009; Patanakul, 2004, 2007). For example, different projects have varying levels of contribution to the achievement of a company’s mission, which in turn dictates choice of project manager.

8.1.3.7.5 Overall contribution of each Limitation (F7)

Different constraints on the PM2P practice exist. Some of these constraints are associated with the individual candidate project manager while others are associated with the organization. A determination of the impact of each of these constraints constitutes an important exercise in the context of effective PM2P allocation decisions (Choothian et al., 2009; Patanakul, 2004; Patanakul et al., 2007).

8.1.3.7.6 Performance on previous projects (F8)

The performance record of a project manager on previous projects is contended by Ogunlana et al. (2002), as an important consideration in the selection of a project manager. It addresses questions such as: what portfolio of projects has the project manager led in the past? and what is their performance rating on those projects? Hadad et al. (2013) support the view of performance on previous projects by highlighting the importance of feedback on the project manager's performance from other stakeholders, as part of assessing project managers. The implications of these studies are that the performance of a project manager on previous projects is an important criterion to be considered in effective PM2P practices.

In summary, critical reviews of a wide range of literature sources from various studies (spanning different contexts) that discuss and support the issues and concepts surrounding the PM2P practice were brought to bear on the development of a conceptual framework for this thesis. Exploded views of the proposed conceptual framework were provided to demonstrate the validity of each criterion with supporting references, as part of the important criteria to be considered in effective PM2P practices. The development of a conceptual framework for the PM2P practice consolidates the relevant managerial theories discussed in chapters 2 and 3 (e.g. sections 2.6, 2.7.2, 3.1 and 3.4), yielding a comprehensive and generic conceptual framework to be used subsequently in examining the research problem in more depth. This consolidation is synthesized in the context of the following four high level components of the conceptual framework:(1) assessing project priorities from an organizational strategic perspective, (2) assessing project characteristics or requirements, (3) assessing required project manager competencies in the context of project characteristics, and (4) assessing limitations in the PM2P allocation decision from the perspective of both organizational and project manager level. The inputs to these four key components were also drawn from reviews of relevant literature discussed in chapters 2 and 3.

8.2 Summary

This chapter discussed the development of a conceptual framework for this thesis (considered most up to date and comprehensive), to understand effective PM2P practices in MPEs. The conceptual framework was substantiated with two sources of evidence namely: broader reviews of management literature in terms of theoretical grounding of the constituent elements, and industry expert reviews to confirm the structure and content of the conceptual framework.

A total of 34 factors influencing the PM2P practice were identified and brought together in a systematic manner, using business process modelling techniques (Aguilar-Savén, 2004). These 34 factors may be referred to as the critical success factors that influence effective PM2P practices and ultimately increased organizational performance as discussed in section 1.1.

Gaps in existing conceptual frameworks for the PM2P practice were identified, using broader reviews of literature. Modifications of existing conceptual frameworks were then made, on the basis of broader reviews of literature, to develop a conceptual framework for this thesis. A total of 12 new and significant additions (8 under recognition of constraints and 4 under the PM2P matching process) were made to existing conceptual frameworks in relation to important factors influencing effective PM2P practices. Contextual factors (internal and external), were also added to represent revised thinking on conceptual frameworks for the PM2P practice. These additions have not been previously included in existing conceptual frameworks and hence represent contributions to further the understanding of knowledge on PM2P practices in MPEs. A publication (Seboni and Tutesigensi, 2014) associated with the development of this conceptual framework, provides further justification of the robustness of the proposed conceptual framework, which can be used to guide effective PM2P practices in PMEs. Therefore, this publication represents further evidence of the robustness of the developed conceptual framework, as scholarly work that has stood up to scrutiny, in terms of contribution. Other project management researchers may benefit by drawing on the proposed conceptual framework to study PM2P practices in other contexts (Kuhn, 1970), subject to contextual factors.

The contribution discussed in this chapter, builds on that discussed in chapter 7, in terms of an incremental contribution arising from an overall mixed methods approach that adequately accomplishes the study aim. Besides contributing to knowledge by furthering the understanding of existing PM2P practices, the additions made to existing conceptual frameworks broadened the scope of measures to be examined in an in-depth study to describe the existing PM2P practice of a specific organization in Botswana, the subject of the next chapter.

Chapter 9

Existing PM2P practice of a specific organization (organization A) in Botswana

Following the development of a conceptual framework to understand effective PM2P practices in the previous chapter, a sensible approach is to use the developed conceptual framework to uncover a complete description of the existing PM2P practice of a specific organization (organization A) in Botswana, the subject of this chapter. The purpose of this chapter is to present the outcomes from implementing the methods discussed in chapter 5, associated with describing the PM2P practice in organization A (as a building block to accomplish the study aim). The following sections are used to achieve this purpose: (1) findings from analysis of quantitative data, (2) findings from analysis of qualitative data, (3) findings from integrated analysis of both data types and discussion of findings regarding PM2P practice in organization A, (4) implications of findings from PM2P practice in organization A, and (5) summary.

9.1 Findings from analysis of quantitative data

The results from univariate descriptive analysis of the quantitative data related to the extent to which the managers consider the list of 34 factors contained in the conceptual framework are presented and discussed in this section. These results are presented and discussed under the three processes within the overarching PM2P allocation process namely; project prioritization, recognition of constraints and project manager-to-project matching. This approach is consistent with the role of the developed conceptual framework (chapter 8) used to examine the PM2P practice in organization A, in terms of the extent to which the managers consider each of the influencing factors to the allocation decision.

9.1.1 Project prioritization process

Based on the methods described in sections 5.3.1, 5.3.4 and 5.3.5.2, the results are displayed in Table 9-1, in relation to measures of central tendency (i.e., minimum, maximum and mean scores for continuous variables). These results are based on quantitative data collected from all 11 eligible data sources (i.e., senior level executives) or inside informants (Kervin, 1992), who represent the unit of analysis in relation to their role in the project prioritization process, which is a component of the PM2P allocation process. For the variable ‘importance of company mission’, (Table 9-1) the range of scores measuring the extent to which this variable is considered, in the project prioritization process, (on a 1 to 9 scale) is from 6 to 9. The mean score is 8.00. This indicates that the extent to which the senior level executives consider the company's mission as an input in prioritizing projects is high. The mean is used to interpret these results because it is the most common and "*useful measure of central tendency"* (Blaikie, 2003, p. 71) in this situation, in terms of the type of measurement scale used (i.e., continuous).

Table 9-1 Descriptive statistics for criteria under project prioritization

Criteria/Factors	N	Min	Max	Mean
Company mission	11	6	9	8.00
Company goals	11	6	9	8.00
Company's projects	11	5	9	8.27
Contribution of goals to mission	11	5	9	7.91
Contribution of projects to goals	11	4	9	7.27
Valid N (listwise)	11			

Note: scores from 11 senior level executives

A similar interpretation is made for the other three variables namely; importance of company goals, importance of company's projects and importance of contribution of goals to mission. In totality, the extent to which the senior level executives consider four out of the five continuous variables is relatively high. This may indicate a strength in the existing PM2P practice as regards prioritization process, in the context of recognition of the importance of these factors. The phrase 'recognition of the importance' is used to indicate that the quantitative results do not provide a complete picture of the existing PM2P practice when considered alone. This implies that the integration of the analysis of both the quantitative and qualitative results will need to be conducted to provide a complete picture.

Notwithstanding, the mean scores from the individual quantitative data provide some kind of trend in terms of the extent to which the senior level executives consider the importance of these variables in their existing prioritization process, as a component of the PM2P allocation process. This trend gives an indication of the strength in organization A's PM2P practice, as regards practitioners' recognition of the importance of the projects' strategic alignment, given the high mean scores for all five variables under the project prioritization process.

9.1.2 Recognition of constraints process

On the basis of methods described in section 5.3, the results are presented in Table 9-2. These results are from all four project heads in relation to the extent to which they consider the list of 20 factors (out of 34) that influence the PM2P allocation decision, under the recognition of constraints process.

Table 9-2 Descriptive statistics for recognition of constraints inputs

Criteria/factors	N	Min	Max	**Mean**
Organization's resource capacity	4	7	9	**8.25**
Project manager availability	4	5	9	**8.00**
Location of project	4	2	5	**4.25**
Location of project manager	4	1	5	**2.50**
Project team dispersion	3	1	4	**2.00**
Project phase mix	3	7	7	**7.00**
Project type mix	3	2	9	**6.00**
Project team strength & availability	3	5	9	**7.33**
Degree of trust on project manager	4	4	9	**6.25**
Decision maker's personal preferences/self-interests	4	1	5	**4.00**
Project interdependencies & interactions	4	5	7	**6.25**
Special requirements	4	5	8	**7.00**
Project manager's personal interests	4	1	5	**3.75**
Project manager's health condition	4	1	3	**1.50**
Project manager's age	4	1	3	**1.50**
Project manager's marital status	4	1	5	**2.00**
Fixed allocations	4	1	5	**2.50**
Project manager's personality	4	2	9	**6.25**
Organizational rules & regulations	4	2	5	**3.75**
Re-allocations	4	2	5	**3.75**
Valid N (listwise)	4			
Note: scores from 4 project heads (PHs)				

The results reveal that 11 out of 20 criteria under the recognition of constraints process, have mean scores of less than 5. Given a mean score of 5 and above as being adequate in relation consideration of a certain criterion that influence the PM2P practice, the results suggest that the extent to which managers consider the list of criteria in their recognition of constraints process, as part of the PM2P practice, is not adequate. This provides an initial opportunity to identify weaknesses in organization A's PM2P practice. Red font is used to indicate the 11 criteria with mean scores below 5.

However, the remaining 9 criteria have mean scores above 5. The mean scores above 5 suggest that the extent to which the project heads consider these 9 criteria in their PM2P allocation decisions is adequate, at least in terms of recognizing the importance of these criteria as important inputs to the recognition of constraints within the PM2P process. The implication is that the extent to which these 9 criteria are considered by the project heads may represent a strength in existing PM2P practice.

9.1.3 PM2P matching process

Based on the methods described in section 5.3, the results from all four project heads are displayed in Table 9-3.

Table 9-3 Descriptive statistics for the PM2P matching process

Criteria/factor	N	Min	Max	Mean
Project manager competencies	4	7	9	8.25
Project characteristics/requirements	4	7	9	8.25
Project manager development	4	5	9	**6.75**
Number of Project Managers (supply)	4	5	9	**6.75**
Number of Projects (demand)	4	5	9	**6.75**
Balanced workload/project intensities	4	1	9	**5.25**
Project manager grade/category	4	7	9	8.25
Project type/category	4	7	9	8.25
Performance on previous projects	4	7	9	8.50
Valid N (listwise)	4			

Note: scores from 4 project heads (PHs)

In terms of the variable 'importance of project manager competencies', the range of scores from the four project heads is 7 to 9, with a mean of 8.25. In particular, the mean (which is above a median of 5.0 in terms of the measurement scale used) indicates the large extent to which the project heads consider this variable in their PM2P matching process. However, this does not imply that the large extent to which they consider the importance of project manager competencies in their PM2P matching process leaves no room for improvement, since the mean is not a perfect score of 9.0 (the maximum on the scale used).

The managers consider the following five variables to a much larger extent in their PM2P matching process, given mean scores of at least 8.25: (1) 'importance of project manager competencies', (2) 'importance of project characteristics/requirements', (3) 'importance of project manager grade/category', (4) 'importance of project type/category', and (5) 'importance of performance on previous projects'. The trend in the importance attached to these five variables does not vary considerably. Although the three variables 'importance of project manager development', 'importance of number of project managers', and 'importance of number of projects', are considered to a lesser extent than the five variables above, the mean score for all three of these variables is 6.75. The extent to which the managers consider the two variables 'importance of number of project managers' and 'importance of number of projects' is the same (i.e., no variation). The absence of variation may indicate that these two variables are related.

Out of nine variables under the PM2P matching process, one variable 'importance of balanced workload/project intensities' has a mean score (5.25) that is relatively lower than the others, although this mean score is above the median score of 5. The quantitative picture relating to the PM2P matching process generally indicates a strength in the existing PM2P practice, given mean scores of above 5 for all nine variables. However, the relatively low mean scores for variables such as 'importance of balanced workload/project intensities', provides an initial opportunity to identify weaknesses in existing PM2P practices.

9.1.4 Summary of quantitative results

In the context of the overarching PM2P practice associated with 34 criteria, analysis of the quantitative data revealed that 11 out of 34 variables (32.4%) measured on a 1 to 9 Likert scale, were not considered adequately by the managers in their PM2P practice. The remaining 23 variables (67.6%) were considered adequately by the managers, on the basis of mean scores below 5. The inclusion of the word 'others' under each of the three processes, to accommodate scope for inclusion of additional criteria, did not result in any new additions. The quantitative results provide an initial picture (first layer of analysis) of the existing PM2P practice, on the basis of the conceptual framework (chapter 8), to uncover strengths and weaknesses in working practices (objective 3). These results were integrated with the qualitative results at both micro-level (criterion by criterion) and macro-level (summaries), to provide a more complete picture of the PM2P practice in organization A.

9.2 Findings from analysis of qualitative data

Analysis of the qualitative data from open ended responses was aimed at uncovering the strengths and weaknesses in organization A's existing PM2P practice, as a second layer of analysis (complementary) to the quantitative strand, through qualitative analysis procedures. This analysis was guided by the four themes (as discussed in section 5.3.4.1) explored in relation to uncovering descriptive characteristics of the existing PM2P practice in terms of strengths and weaknesses. Relevant NVivo tools, such as complex matrix coding queries, were used to further the analysis of qualitative data, in terms of an all-encompassing content analysis of identified words and phrases that are reflective of ineffective PM2P practices, as used by the two groups of informants. A typical result of this analysis is illustrated in Table 9-4.

Table 9-4 Content analysis of ineffective practice indicators

PHs	Negative impact	Delays	Reactive & inconsistent	Over-loaded	Mis-matches	Nature of Business dynamics	Resource capacity issues	No Tools & Techniques	Not optimized	Intuition	Superficial alignment	Bottom-up approach	Not Planned	Not Documented	Not Comprehensive
1	9	104	33	15	50	108	30	17	59	0	160	31	4	6	39
2	8	125	52	23	45	132	42	22	29	4	161	27	3	1	48
3	2	78	24	5	29	81	36	9	17	0	79	18	2	3	16
4	8	94	40	19	39	98	48	15	24	0	112	15	4	4	33
Total	**27**	**401**	**149**	**62**	**163**	**419**	**156**	**63**	**129**	**4**	**512**	**91**	**13**	**14**	**136**
SLEs															
1	0	18	4	1	7	17	6	4	8	0	17	6	3	0	6
2	4	22	14	2	7	30	11	3	4	0	29	10	1	0	4
3	2	19	12	2	3	21	11	3	7	0	16	0	3	1	5
4	0	20	11	1	9	19	11	1	4	0	21	3	0	0	4
5	0	21	13	3	2	17	16	3	3	0	20	4	0	1	7
6	2	16	6	2	4	17	6	2	1	0	18	7	0	0	2
7	6	43	40	1	16	39	27	2	13	0	33	22	0	1	14
8	0	19	8	2	5	24	7	1	5	0	18	6	0	0	8
9	5	31	28	7	22	44	30	19	12	0	43	24	0	2	14
10	1	40	30	12	31	45	25	11	22	0	39	9	1	2	7
11	1	24	4	0	5	24	6	1	7	0	22	8	1	2	7
Total	**21**	**273**	**170**	**33**	**111**	**297**	**156**	**50**	**86**	**0**	**276**	**99**	**9**	**9**	**78**
Totals	**48**	**674**	**319**	**95**	**274**	**716**	**312**	**113**	**215**	**4**	**788**	**190**	**22**	**23**	**214**
Rank	12	3	4	11	6	2	5	10	7	15	1	9	14	13	8
Key: PHs = project heads; SLEs = senior level executives;1, 2, 3, …..= informant number under the two groups.															

‘Superficial alignment’, which indicates an ineffective practice of starting projects and then finding weak links or alignment between those projects (which are already being implemented) and certain strategic goals, was the most dominant indicator of weaknesses in PM2P practices (see Table 9-4). Superficial alignment was linked to the node ‘Bottom up approach’ in terms of starting with projects and forcing strategic alignment rather than the other way round, which was in turn linked to the second most predominant indicator ‘Nature of Business dynamics’. This indicator, reflects weaknesses in the existing PM2P practice, resulting in a ‘Reactive and inconsistent’ approach, in response to unanticipated changes in the business environment. This may explain the indicator ‘Mismatches’ in PM2P allocations, which is influenced by an approach that is ‘Not optimized’ in relation to ‘No Tools & Techniques’ and reliance on ‘Intuition’ alone. For example, the node ‘No Tools & Techniques’ is reflective of a lack of management tools and techniques for use in matching project managers to projects, which also explains evidence of mismatches in PM2P allocations. The content analysis results presented in Table 9-4 regarding the indicator ‘No Tools & Techniques’ was obtained from a closer analysis of this node, in terms of evidence from all project heads’ responses (Figure 9-1), which demonstrates the link between the content analysis results and the original data sources (informant’s verbatim).

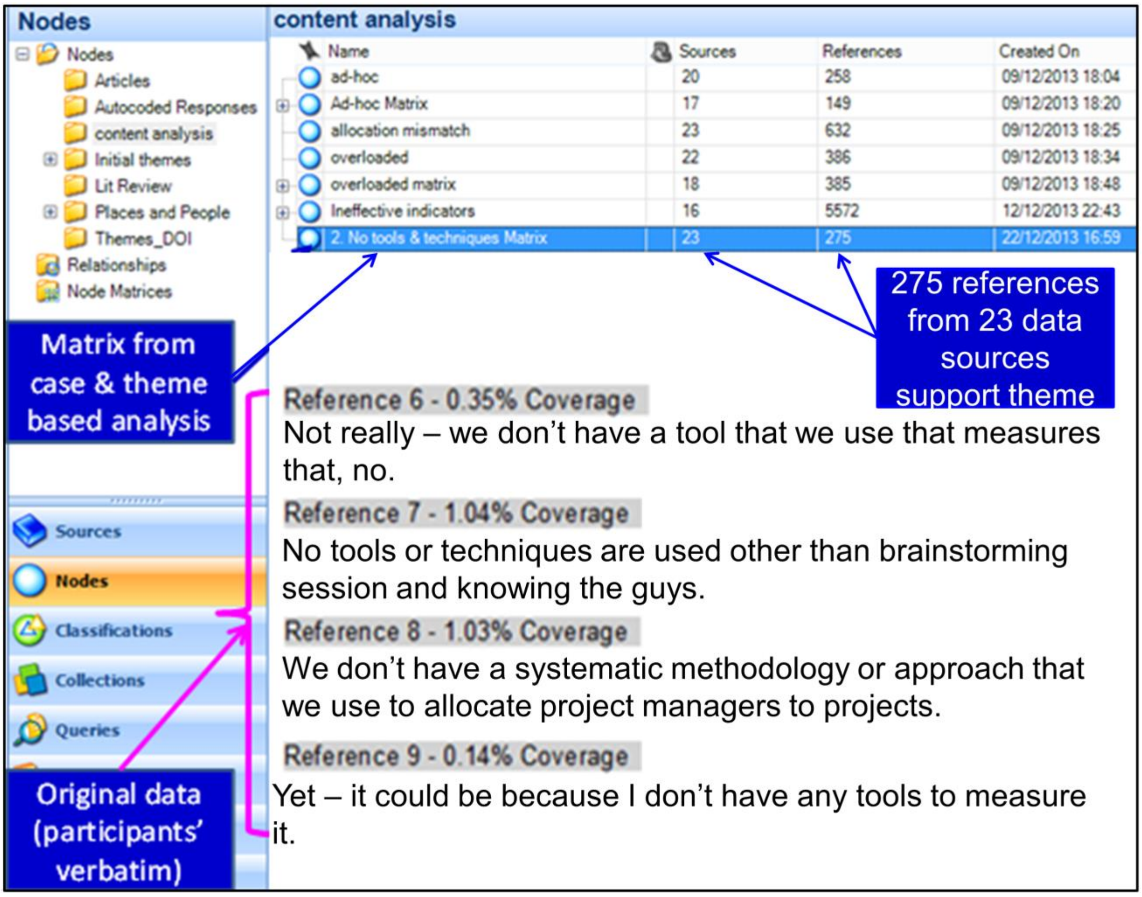


Figure 9-1 Matrix display from content analysis of ineffective practices for node ‘No tools & techniques’

The matrix display in Figure 9-1 is an output from the use of NVivo matrix coding queries, to interrogate the whole data, in relation to informant's use of words and phrases that reflect the absence of management tools and techniques in the existing

PM2P practice. This matrix reveals that 275 text references from 23 primary data sources support the core theme of absence of management tools and techniques in organization A's existing PM2P practice. The variations in context, from project managers to project heads, provide solid evidence that supports this theme. This matrix is therefore, a demonstration of the co-occurrences of the words and phrases (e.g., "we don't really have a tool," "no tools and techniques are used") within the node "No tools & techniques" and most importantly, incorporates the divergent views of 23 data sources that come from informants in different hierarchical positions within organization A. Whilst caution must be exercised in terms of the need to avoid equating numbers to the significance of the theme 'No tools & techniques,' (Krippendorf, 2004) argues that

"the reading of text is qualitative, even when certain characteristics are later converted into numbers" (p. 16).

This means that the matrix display showing the number of times informants used words and phrases that reflect the theme 'No tools & techniques' is in fact qualitative, since it came from analysis of qualitative data in the form of text. The absence of usage of management tools and techniques, along with absence of formalized approaches is contended in (Hossain and Ruwampura, 2008), as one of the reasons for failure to effectively handle a MPE.

9.3 Findings from integrated analysis of both data types

Based on the procedures discussed in section 5.3.6.8 regarding integrated analysis of both the quantitative and qualitative data, the results are presented. These results are presented under the following: (1) validity of the deployed conceptual framework, (2) new insights from complementary analysis of both data types, and (3) identified strengths and weaknesses in organization A's PM2P practice. These three sub-sections address research objective 3.

9.3.1 Validity of the deployed conceptual framework

The validity of the deployed conceptual framework is viewed in the context of its structure and content as a conceptual framework that is up to date, comprehensive in terms of addressing gaps identified in existing conceptual frameworks (section 3.2). This conceptual framework is a key building block in relation to providing a strong basis to justify the identified strengths and weaknesses. For example, the developed conceptual framework used in an in-depth study to describe the existing PM2P practice in organization A is considered capable of standing up to scrutiny from a generic perspective. This argument is based on use of a conceptual framework that is well grounded in both depth and breadth of management literature surrounding the PM2P practice, unlike existing conceptual frameworks on the PM2P practice that are narrowly focussed on limited literature. This means that the identified strengths and weaknesses in the PM2P practice can be seen to come from a solid foundation as part of reliability and validity, following two sources of evidence.

The absence of significant structural modifications to the deployed conceptual framework, including no new additions from emerging data collected in relation to industry practice, represents the second source of evidence as regards validity of the conceptual framework deployed in organization A. For example, the absence of no new additions demonstrates comprehensiveness of the deployed conceptual framework, since practitioners in-depth descriptions of their views on different aspects of the PM2P practice were covered. Given the inclusion of ‘others’ in the research instrument (informed by the contents of the conceptual framework) that accommodated scope for inclusion of additional factors not covered in the research instrument, the absence of new additions or structural modifications may imply that deployment of the conceptual framework represents its validity in practice. For example, practitioners were specifically asked (using the input ‘others’ under each of the three processes within the overarching PM2P practice) certain questions that sought to indicate whether any factors that influence the PM2P practice were omitted. The finding regarding no additions from collected data in the context of the inclusion ‘others,’ is an aspect of the validity of the content of the conceptual framework. Further evidence of validity through deployment of the conceptual framework lies in two resulting publications (Seboni and Tutesigensi, 2014, 2015), in conference proceedings and international journal respectively.

In summary, the absence of significant structural modifications to the developed conceptual framework, following its deployment to real-life industry practice (in organization A), demonstrates its validity on the basis of both literature (first source of evidence) and industry practice (second source of evidence that is empirically based).

9.3.2 New insights from complementary analysis of both data types

The procedures regarding integrated analysis of the quantitative and qualitative data discussed in section 5.3.6.8 revealed new insights presented in this section. Equal integration of each data type, in a complementary manner, led to uncovering new insights about Organization A's PM2P practice, from combined results analysis. For example, in the absence of combined analysis (using the appropriate analytic strategy to integrate the results during analysis), new insights would not have been uncovered from independent analysis of each data type. Table 9-5 is a typical result from project heads' data set, that illustrates the importance of the approach used in data collection and analysis of both data types, in terms of integration at micro level.

Table 9-5 Typical result for integration at micro-level

Qualitative data				Qualitative data
Variables (N=4)	Min	Max	Mean	Description
Importance of project manager's age	1	3	1.5	"For me it's not about age but competence"
Importance of project manager's health condition	1	5	2.5	"That's not an issue since all employees will have gone through a full medical examination"

The quantitative data (left-hand side) depict typical results for two variables (measured on a 1 to 9 Likert scale), in relation to minimum, maximum and mean scores from four project heads. The qualitative data (right-hand side) depict typical results for the same variables, from the project heads' open-ended responses (only one response per variable shown for illustration), in terms of the issues surrounding each variable. The integrated analyses revealed new insights regarding organization A's PM2P practices namely: (1) importance of context, (2) inadequate consideration of all important factors in the PM2P practice, and (3) lack of accountability for outputs. The three insights are discussed below.

9.3.2.1 Importance of context

Practitioners rated three criteria relatively low and did not consider them to be important in their PM2P practice. These criteria were: project manager's age, project manager's health condition and project manager's marital status. Out of these three criteria, project manager's health condition was not considered important on the basis of context. For example, project manager's health condition was rated relatively low, on the basis that organization A requires all employees to undergo a rigorous medical examination, as part of the official procedure prior to appointments. Given this requirement, the implication is that project manager's health condition is assessed during the recruitment process and therefore important in organization A's existing

PM2P practice. Combining the separate analysis of each strand yielded a complete understanding that provides a more accurate representation of the existing PM2P practice, than separate analysis of either stand.

The influences of these contextual elements are represented in the developed conceptual framework (chapter 8) under the input labelled ‘context.’ Independent analysis of either data type would not have revealed this insight and would probably have resulted in a misleading finding regarding these three criteria, leading to an incomplete picture of organization A’s PM2P practice. The above findings justify the approach taken to collect both quantitative and qualitative data, including integration of the combined analysis from both the data types, which led to new insights that provide a complete understanding of the PM2P practice, consistent with research objective 3.

9.3.2.2 Inadequate consideration of all important factors in the PM2P practice

The findings revealed that practitioners did not consider all important factors associated with an effective PM2P practice, as per the conceptual framework verified from both literature and industry expert reviews. In particular, practitioners did not sufficiently consider 12 criteria in their PM2P practices, given the relatively low scores they attached to these criteria, despite their importance in effective PM2P practices. These criteria exclude one of the three criteria discussed in section 9.3.2.1 on the basis of context. The 12 criteria were: project team dispersion, contribution of projects to goals (under project prioritization process); balanced workload/project intensities, number of project managers and number of projects (under PM2P matching process); location of project, location of project manager, decision maker’s personal preferences/self-interests, project manager’s personal interests, project manager’s age, marital status, organizational rules and regulations (under recognition of limitations process). Project team dispersion/distributed or co-located project team is used as an example to demonstrate the evidence from combined results of both the quantitative and qualitative data, as depicted in Figure 9-2.

The integration of the two strands revealed that the variable ‘importance of geographic team dispersion’, is not given adequate attention by the project heads, despite its influence in effective PM2P allocation decisions. In fact, one out of the four project heads does not consider it at all (importance score of 1 representing absence of the variable being measured) in PM2P allocation decisions. This finding represents a weakness in organization A’s existing PM2P practice, given the possible impact of this variable on determining project success. Evidence from existing empirical studies on

PM2P practices (such as Hadad et al., 2013; Patanakul et al., 2007) suggests that the 14 criteria noted above, play an important role in effective PM2P allocation decisions.

QUANT STRAND		**QUANL STRAND**
Variable (N=4)	**Mean**	**Narrative**
Distributed or co-located project team	2.00	4. Am! Where the project team is distributed or located in one area, it's lower than 5, give it a score of 4. Again, you know, as I say, our base is here in Gabs – we are doing our projects from here and basically, during project execution, the support staff for a project will relocate to wherever the site is so that theuy do the work. Am! Any supplementary staff who remain behind will generally not be of the level of importance that they need to be on site. So theyld in most be partial support staff if I can put it like that. It's the same as the other ones. I don't really consider that. **I would give it a 1 because it is expected that the project team will travel to the sites.** **2. That's not really important. The job of the project team or whoever is in the project is to avail themselves to whatever location the project is.** There is some kind for project travel costs, **about 50% or so.** [memo – no full compensation]. **1.We haven't really considered that. People are expected to work on projects regardless. Besides, the company, we meet them halfway with travelling expenses.** [memo– no full compensation].

Figure 9-2 Combined results of quantitative and qualitative data for variable 'importance of distributed or co-located project team'

9.3.2.3 Lack of accountability for outputs

The managers rated five criteria highly (quantitative measures) but could not reflect the importance of those criteria in their actual PM2P practices in reality, based on analysis of the qualitative descriptions of the issues surrounding those criteria. These criteria were: project manager competencies (under PM2P matching process); company goals, company's projects, contribution of projects to goals and contribution of goals to mission (under project prioritization process). Both the project heads and senior level executives recognized the importance of these factors in the PM2P practice, by virtue of the relatively high importance scores they attached to these factors, which in itself indicates a strength. However, practitioners could not account for the given importance scores to these five criteria, which may also indicate a weakness on the basis that it is one thing to attach a high importance score to a certain criterion and quite another to actually reflect or demonstrate that importance score in the actual PM2P practice. The interpretation of this finding may be that whilst practitioners recognize the importance of these five criteria in influencing the PM2P allocation decision, certain organizational policies or dynamics of the business environment, hinder practitioners attempts to follow through in the actual PM2P practice.

The above discussion represents another justification for the approach taken to collect both the quantitative and qualitative data, as well as integrating both data types during analysis rather than when making conclusions (as noted in section 5.3.6.8). For example, the approach of collecting and analysing either data type individually, would not have revealed the three insights discussed. These new insights were used as a basis for identification of weaknesses in organization A's PM2P practice. The next sub-section is a summary of the identified strengths and weaknesses that emerged from integrated analysis of both data types.

9.3.3 Identified strengths and weaknesses in organization A's PM2P practice

The strengths and weaknesses identified in organization A's existing PM2P practices are presented under two sub-sections, in terms of strengths and then weaknesses.

9.3.3.1 Strengths in PM2P practices

The strengths in PM2P practices were demonstrated in two main ways namely: (1) use of management tools and techniques at strategic level, and (2) recognition of some important criteria to be considered in the PM2P practice. These are discussed below.

9.3.3.1.1 Use of management tools and techniques at strategic level

Integrated analysis of data revealed the presence of management tools and techniques (Kraljic matrix and project prioritization matrix) used at strategic level to determine which projects will make the biggest impact to organization A's strategic objectives. Although Kraljic portfolio matrix has its roots in strategic purchasing supply management from the seminal work of Peter Kraljic (Kraljic, 1983), who proposed a technique for organizations to use in minimizing the risks in the supply of their raw materials and services from suppliers and maximising their purchasing power (Padhi et al., 2012), it has since gained popularity for different applications. The results revealed that organization A uses Kraljic portfolio matrix to assess, classify and visualize the project prioritization factors in relation to difficulty and risk of implementation versus impact of project on the bottom line profits. For example, a visual illustration is produced to assess key factors such as technical complexity, in relation to implementation duration (Y-axis) versus managing political complexity in terms of difficulty of implementation (X-axis) of certain mining related projects. This matrix is used for portfolio assessment to rank projects, with a view to determine which ones are critical and score highly on certain criteria in relation to business drivers and risk profiles. Examples of the criteria used to rank projects (referred to as ‘prioritization lenses’) are: financial impact, sustainability, business risk and project readiness (in terms of whether the relevant functions and teams are in a position to actually execute a certain project). This ranking is referred to as a ‘project prioritization matrix’.

9.3.3.1.2 Recognition of some important criteria to be considered in the PM2P practice

A total of 23 out of 34 variables under the overarching PM2P practice had mean scores that are above 5 (as noted in section 9.1.4). This finding demonstrates that managers recognized the crucial role that these criteria play in effective PM2P practices, which supports the identified strength in organization A’s PM2P practice. For example, the importance of allocating project managers with relatively high competency levels to projects which make the biggest impact to organization’s A’s goals and mission was recognized by the mangers, in terms of the relatively high importance scores. This finding concurs with empirical studies conducted in the United States of America (Patanakul, 2004; Patanakul et al., 2004) and Thailand (Ogunlana et al., 2002).

9.3.3.2 Weaknesses in PM2P practices

The output from integrated analysis of data, in relation to identification of weaknesses in organization A’s PM2P practice, was demonstrated in 6 main ways namely: (1) absence of documented and specific competencies required of project managers in various roles, (2) lack of management tools and techniques to match project managers-to-projects, (3) unpredictable nature of business dynamics, (4) lack of consideration of a comprehensive list of criteria, (5) lack of accountability for outputs, and (6) lack of comprehensiveness of stakeholders in decision making.

9.3.3.2.1 Absence of documented and specific competencies required of project managers in various roles

The results revealed absence of documentation that specifically outlines the job roles of the various project managers (e.g., senior project managers, project managers and assistant project managers) within organization A. This means that in terms of documentation, the specific competencies of various project managers within organization A, who lead different categories of projects are not existent. A total of 8 identified competencies, which are generic and not specific to each role, were identified. These competencies were: decisiveness, accountability, change management, people management, strategic business thinking, stakeholder management, values driven and technical proficiency. Whilst there is recognition of the emphasis on behavioural competencies as opposed to technical competencies, in relation to competencies that truly influence results (Draganidis and Gregoris, 2006), the absence of detailed competency descriptions is considered a weakness. For example, the phrase "technical skills" is listed under all 8 identified competencies that are generic to all project management roles, without further details of what constitutes technical skills.

A detailed description of specific project manager competencies is necessary to the understanding of required resource capabilities that are key to successful project delivery (Aritua et al., 2011; OGC, 2003), failing which it will be difficult to discern required organizational resource capabilities, in relation to effective assessment of employees' suitability to roles. This is important to the context of organization A's aspirations of transforming to a high performance organization. The absence of documented and specific competencies required of project managers in various roles may explain the lack of match between project manager competencies and project requirements. This interpretation is consistent with the findings from an evaluation of existing PM2P practices in Botswana, regarding the dominant theme "no match" (section 7.3.5).

9.3.3.2.2 Lack of management tools and techniques to match project managers-to- projects

At project management function level, the results revealed a lack of formalized management tools and techniques to guide PM2P practices, given that all four project heads rely on their experience and gut feel as an approach to match project managers-to-projects. The reliance on the manager's *"gut feelings"* (Shapiro and Spence, 1997, p. 64) is referred to as managerial intuition as discussed in chapters 1 and 2, which points to its ineffectiveness in terms of the structured aspects of decision making (Dane and Pratt, 2007; Schoemaker and Russo, 1993; Shapiro and Spence, 1997; Kahneman et al., 1982). The use of management tools to complement intuition is particularly useful when the decision problem is more complex (Dane and Pratt, 2007).

The absence of formalized tools to effectively match project managers to projects may be a source of mismatches in allocations, which impact negatively on project manager motivation and ultimately project performance. This means that the identified mismatches in allocations is an example of the general problem of a lack of management tools and techniques required to effectively match project managers to projects. This finding is supported by relevant empirical studies conducted in the United States of America (Choothian et al., 2009; Patanakul et al., 2007), as well as the empirical study conducted in Botswana's public and private sector (Seboni et al., 2013), in relation to reliance on managerial intuition for both structured and unstructed aspects of the decision.

9.3.3.2.3 Unpredictable nature of business dynamics

The results indicate the presence of ad hoc projects and the ad hoc manner in which these projects are introduced. This was attributed to unanticipated changes in the global mining industry, leading to sudden changes in business priorities to respond to prevailing conditions. This implies absence of resource planning and forecasting processes in terms of current and future resource requirements (e.g., project managers) that will be required to execute current and future project portfolios, which may be a result of changing business priorities due to unanticipated changes.

The prevalence of ad hoc projects due to the unpredictable nature of the global diamond mining business environment may be linked to a number of performance related issues which came out such as: (1) resource capacity constraints in terms of overloading existing project managers, (2) mismatches in allocations, which impact on performance, (3) strain on capital (short-term cash flows) for approved projects due to issues such as unplanned recruitments and absence of agreements on the limits in terms of how many additional resources can be recruited, and (4) killing projects that have already consumed capital - however, a project can be killed as an effective means to save costs.

9.3.3.2.4 Lack of consideration of a comprehensive list of criteria

Integrated analysis of data revealed six important criteria, under the general theme of inputs to two processes (i.e., PM2P matching and recognition of constraints), that were either missing from organization A’s PM2P practice or not given sufficient attention by practitioners. These criteria were: (1) project manager’s domain knowledge, captured under the conceptual framework input labelled project manager competency, (2) geographic location of project, (3) location of project manager, (4) project phase mix constraint, (5) project manager’s personal interests, and (6) project manager’s personality or cultural fit. However, these criteria are considered as important influencing factors to effective PM2P practices, as per extensive reviews of literature (Hartman and Boyd, 1998; Ogunlana et al., 2002; Patanakul et al., 2004; Owusu et al., 2007; Sebt et al., 2010; Hadad et al., 2013) discussed in chapters 2 and 3.

9.3.3.2.5 Lack of accountability for outputs

A lack of accountability for outputs was discussed in the context of new insights from complementary analysis of both data types (section 9.3) and expanded here under weaknesses. The results revealed discrepancies between the given importance scores for certain criteria (considered important) and their reflection in the actual PM2P practice. The inability on the part of managers to account for differences in given quantitative scores, in terms of qualitative descriptions of the issues surrounding quantitative scores for certain criteria, is demonstrated in Figure 9-3.

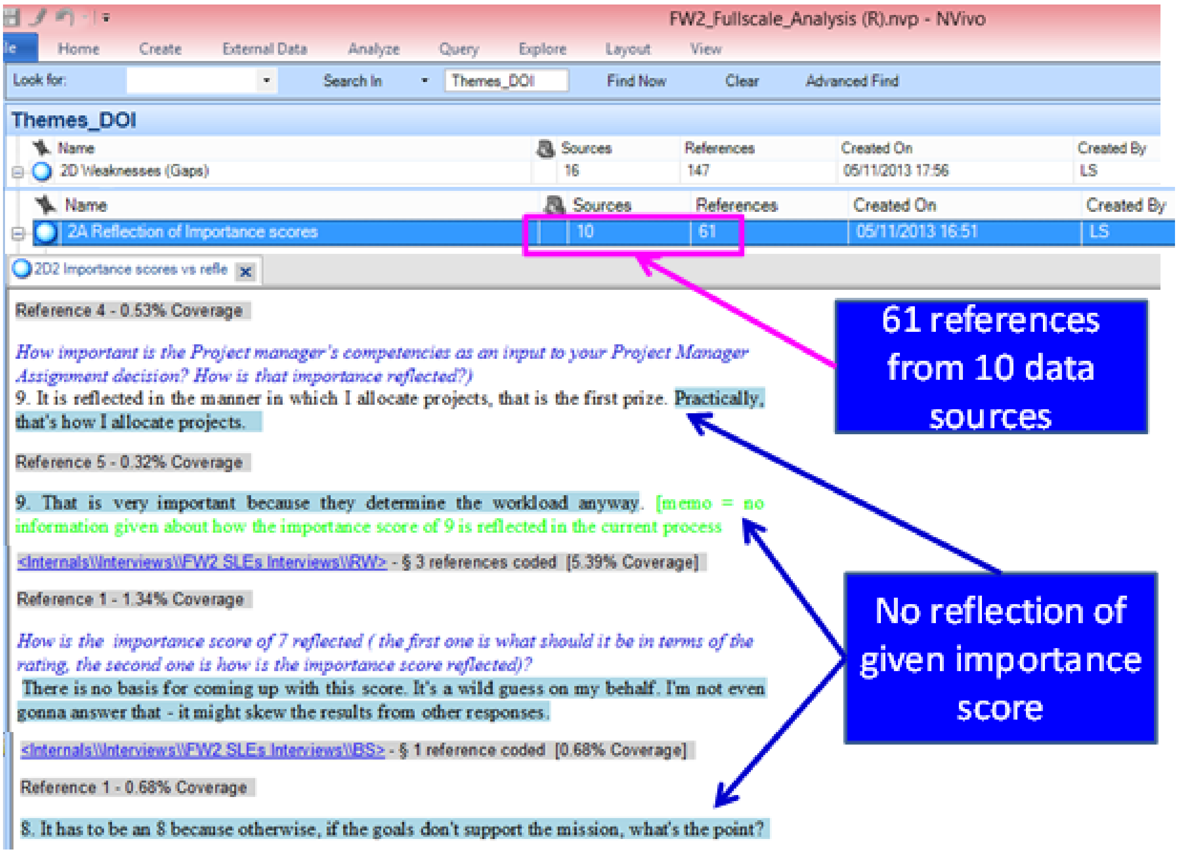


Figure 9-3 Discrepancies between given importance scores and their reflection

There were 61 instances from 10 data sources in which the managers could not account for or demonstrate given importance scores for certain criteria. This means that the managers could not account for differences in given importance scores in their actual PM2P allocation decisions, under the three individual processes of project prioritization, recognition of constraints and PM2P matching. This is despite the managers scoring these criteria highly (on the 1 to 9 rating scale) to indicate that they recognize the significance of such criteria in the PM2P practice. While the recognition by the managers, of the significant importance of these criteria represents a strength in terms of the high rating scores given (quantitative data), the lack of apparent accountability for differences in the given scores (from the qualitative data analysis) represents a weakness. It may be that constraints in existing business processes and the realms of business dynamics do not allow the managers to follow through in terms of actions to reflect their recognition of the importance of certain criteria. The above finding justifies the importance of having collected both quantitative and qualitative data and integrating them in a complementary manner, to uncover a complete explanation of the PM2P practice.

9.4 Implications of findings from PM2P practice in organization A

The implications of findings from PM2P practice in organization A are disccused under the following: (1) implications of selection criteria for the case study organization on quality of data and findings, (2) theoretical implications for the PM2P practices, and (3) practical implications for PM2P practices.

9.4.1 Implications of selection criteria for the case study organization on the quality of data and findings

The implications of the selection criteria for the case study organization, due to challenges of access to data, are estimated not to have a significant impact on the quality of data collected and the results pertaining to a description of the PM2P practice in organization A. This interpretation is made on the basis that the selected case study organization had the largest PMO office as regards the number of project heads and project managers, in comparison to the other cases (eligible MPEs in Botswana). This argument was discussed in section 5.3.2.1, as an important feature of the case, in the context of selection criteria. Furthermore, the discussions in sections 5.3.2 to 5.3.4 provide evidence to support the argument that the the decision to use organization A as a case study, did not have a significant impact on the quality of collected data as it relates to a complete description of the PM2P practice in organization A.

9.4.2 Theoretical implications

The conceptual framework developed in this thesis (chapter 8) has been substantiated by two sources of evidence (i.e., literature and industry practice) as a new way that can be used by project management practitioners to guide effective PM2P practices in MPEs. The incremental contribution to knowledge relates to furthering the understanding of existing knowledge on PM2P practices, given the significant additions made to existing frameworks in terms of revised thinking. The basis for this contribution arose from modifications of existing conceptual frameworks, following contextualization of the literature surrounding the PM2P practice. For example, the identification of resource management as the broader theory surrounding the specific topic of PM2P allocations (currently understudied) and linking it to the concept of PM2P allocations represents a departure from prior studies. The broadening of the literature surrounding the thesis topic was aimed at developing a comprehensive conceptual framework that is well-grounded in management literature, whilst remaining relevant to industry practice. The work involving the development of the conceptual framework was published (Seboni and Tutesigensi, 2014b), providing concrete evidence of contribution to an understanding of the limited literature associated with the PM2P practice in MPEs. The deployed conceptual framework, generic in nature, may be used by other researchers to study the PM2P practices in other context, based on explicit recognition of contextual factors, as part of the significant additions made to existing frameworks. The findings from deploying the conceptual framework in practice, that report on PM2P practices in another context (country, industry, organization and project types) other than existing knowledge from USA high-technology industry, have also been published in conference proceedings (Seboni and Tutesigensi, 2014a) and international journal (Seboni and Tutesigensi, 2015).

9.4.3 Practical implications

The implications for practice lie in a complete illumination of the PM2P practice in organization A. Through the in-depth study of PM2P practices, the author has provided practitioners with new insights regarding areas for improvement in organization A’s PM2P practices. Practitioners now know details of the gaps in their working practices, on the basis of the contents of the conceptual framework for effective PM2P practices. The identified gaps in organization A’s existing PM2P practice provides empirical evidence of the need and potential to improve existing PM2P practices in the context of Botswana, consistent with the main argument in this thesis. A descriptive and complete study contributes to the understanding of the PM2P practices in the context of organization A, which has been, hitherto, unknown in existing body of knowledge. For example, there were no publications that report on details of the PM2P practice in organization A, prior to the in-depth study discussed in this chapter (Seboni and Tutesigensi, 2014a). The identification of strengths and weaknesses in organization A's existing PM2P practices provides significant implications for practice, in relation to the importance of the need to improve working practices. The importance of improving PM2P practices is demonstrated in terms of improved organizational performance, from a USA context (Choothian et al., 2009; Patanakul et al., 2007). Furthermore, the finding from an in-depth study of PM2P practices in organization A, provide a strong basis upon which a DSS can be developed to facilitate a more effective PM2P approach.

9.5 Summary

This chapter elucidated a complete description of the existing PM2P practice of a specific organization (organization A) in Botswana, using the conceptual framework developed in this thesis. The weaknesses identified in organization A's existing PM2P practice provided empirical evidence of the need to improve existing working practices, consistent with the central argument in this thesis. A complete elucidation of organization A's existing PM2P practice, in terms of strengths and weaknesses (hitherto unknown), provides the third successive building block as regards incremental contributions from this thesis. This contribution lies in uncovering and reporting on a complete description of the existing PM2P practice in a new context and geographic locality that has not been done prior to this study, consistent with the definition of originality as defined in (Phillips and Pugh, 2005) and corroborated in (Dunleavy, 2003). The findings from an in-depth empirical study of organization A's existing PM2P practice extend the understanding of existing but limited knowledge on PM2P practices in MPEs.

Furthermore, practitioners in organization A are now aware of the opportunities for improvement, arising from empirical evidence that demonstrated areas for improvement in their existing PM2P practices. Given the weaknesses identified in organization A's PM2P practices, the next chapter proposes a new approach to improve this practice, consistent with the main argument in this thesis.

Chapter 10

A new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana

The previous chapter illuminated a complete description of the existing PM2P practice of a specific organization (organization A) in Botswana, as part of progressing the main argument regarding the need and potential to improve existing PM2P practices. The purpose of this chapter is to advance this main argument, made in chapters 1 to 7 and 9, by proposing a new approach to improve the PM2P practice in organization A, consistent with the aim of this thesis. This chapter presents the results of methods described in section 6.1. The following sections address achievement of the purpose of this chapter: (1) gaps in extant literature on mathematical modelling and application areas of the PM2P allocation problem, (2) need to address identified gaps in existing PM2P allocation models, (3) mathematical formulation of the PM2P allocation problem, (4) graphical user interface (GUI) description and features, (5) verification of proposed new approach, (6) how the new approach works and its usefulness, (7) utility of the proposed new approach as a DSS, and (8) summary.

10.1 Gaps in extant literature on mathematical modelling and application areas of the PM2P allocation problem

Following critical appraisal of relevant literature discussed in sections 3.1 and 3.2, eight gaps were identified. These gaps are: (1) limited studies on the modelling of the PM2P allocation problem in MPEs, (2) absence of applications of mathematical modelling of the PM2P allocation problem to a mining and metals industry, (3) modelling of allocation intensities have not been included in prior PM2P allocation models, (4) lack of articulation of the type of mathematical model proposed in prior studies on PM2P allocation models, (5) lack of comprehensiveness in the modelling of important factors influencing the PM2P practice, (6) absence of a graphical user interface in existing models on PM2P allocation problems, (7) absence of a saving functionality in existing PM2P allocation models, and (8) absence of dynamic capability in existing PM2P allocation models. The 8 gaps influenced this study by informing the development of a new approach to improve the existing PM2P practice in organization A. The proposed new approach addresses all these gaps, in the context of a robust response that addresses the study aim, through a mixed methods approach comprising five objectives linked directly by the need to accomplish the overall aim (as discussed in sections 1.2, 1.3, 4.2, and 4.4). These gaps are described next.

10.1.1 Limited studies on mathematical modelling of the PM2P allocation problem in MPEs (gap 1)

Whilst there is generally a repertoire of articles on resource scheduling, planning and allocations (e.g., Baker, 1974; Duffuaa and Al-Sultan, 1999; Panwalkar and Iskander, 1977; Roberts and Escudero, 1983), mathematical modelling of PM2P allocation problems in MPEs is limited. For example, only a handful of studies have been found with regards to mathematical modelling of the PM2P allocation practice (Choothian et al., 2009; LeBlanc et al., 2000; Patanakul et al., 2007). These studies are unified in demonstrating the value of improving the PM2P practice, although limited to the context of USA, as noted in sections 1.1, 2.3, 3.1.8 and 9.4.2.

10.1.2 Absence of applications of mathematical modelling of the PM2P allocation problem to a mining and metals industry (gap 2)

Mathematical modelling of the PM2P allocation problem has not been applied in a mining and metals industry to optimize the PM2P practice in a new context (Botswana), other than United States of America. This gap is consistent with originality definitions highlighted in section 1.2, in the context of extending mathematical modelling of the PM2P allocation problem to another geographic region, country and industry, which has hitherto been studied.

10.1.3 Absence of modelling of allocation intensities in PM2P allocation models (gap 3)

Existing mathematical optimization models on personnel allocations (Choothian et al., 2009; Hadad et al., 2013; LeBlanc et al., 2000; Patanakul et al., 2007; Sebt et al., 2009) have paved the way in terms of application to resource allocation problems. In particular, mathematical optimization models proposed in (Choothian et al., 2009; Patanakul, 2004; Patanakul et al., 2007) are directly applicable to the PM2P allocation problem in a MPE. A review of these existing mathematical models has revealed the absence of allocation intensities (LeBlanc et al., 2000), as an indication of the management effort required to manage a certain project. The inclusion of these additional attributes in the modelling is a critical step to a representation of reality in the PM2P practice. The modelling of additional attributes demonstrates the advantage of the proposed model in this thesis, compared with existing mathematical models. For example, the modelling of these attributes reveals variations in workloads for each project manager, which has potential to better inform the allocation process in terms of fairness.

10.1.4 Lack of clarity on the type of mathematical model proposed (gap 4)

A limitation in existing PM2P allocation models (Choothian et al., 2009; Patanakul et al., 2007) is the lack of explicit articulation of the type of mathematical model proposed, in relation to nomenclature. For example, readers are left to guise or interpret the model type (e.g., deterministic, stochastic, static, and dynamic), on the basis of assumptions made – if stated. Explicit articulation of the type of mathematical model is an important aspect of furthering the understanding of the literature on mathematical modelling principles.

10.1.5 Lack of comprehensiveness in existing mathematical models (gap 5)

Existing optimization models on the PM2P practice lack comprehensiveness in the modelling of important factors that influence the PM2P allocation decision. For example, the modelling of both soft and hard issues in the allocation is uncommon, probably owing to the complexity involved. Following the discussions in chapter 5 regarding a comprehensive list of identified factors that represent revised thinking in relation to the PM2P practice, the inclusion of additional factors (both hard and soft issues) in the modelling of the PM2P allocation problem brings the mathematical model to a closer representation of reality (Burghes and Wood, 1980).

10.1.6 Absence of a graphical user interface (gap 6)

Existing mathematical models on PM2P allocation problems (e.g., Hadad et al., 2013; LeBlanc et al., 2000; Patanakul et al., 2007; Sebt et al., 2009) have limitations associated with the absence of a graphical user interface (GUI), to separate physical details of the model from users. These physical details are complex to practitioners, who often do not have a background in mathematical modelling concepts. In the absence of a GUI, users are exposed to complex details of the mathematical formulation, which has potential to reduce usefulness to practitioners. For example, practitioners may not be in a position to comprehend the complex discourses involved in mathematical optimization modelling concepts. The disadvantage in existing optimization models is the complexity to industry practitioners, hence the need to develop a GUI, as part of a complete package.

10.1.7 Absence of a saving functionality (gap 7)

A critical appraisal of existing literature on optimization models to solve the PM2P allocation problem in MPEs (see Choothian et al., 2009; LeBlanc et al., 2000; Patanakul et al., 2007) revealed a limitation associated with absence of a saving functionality, to accommodate the reality of the business environment that requires users to be able to save input data. This saving functionality must enable users to save either during or at the end of their data entry process, depending on the circumstances. For example, it could be that the data entry process is interrupted by a telephone call or a fire alarm, requiring users to save input data and come back at a later time.

10.1.8 Absence of dynamic capability (gap 8)

Optimization models to improve the PM2P allocation decision in existing studies (see Choothian et al., 2009; Patanakul et al., 2007) lack dynamic capability. The lack of dynamic capability means that users are not enabled to change problem size parameters and obtain an optimized output for different problem sizes (or the same problem size with different parameters). This means that users are not able to do the following activities as demanded by the reality of the business environment relating to solving the PM2P allocation problem: (1) define a specific problem size in terms of appropriate parameters, (2) input data for that specific problem size, (3) run the model to obtain an optimum PM2P allocation decision associated with that problem size, as an authenticated and documented record that can be archived, (4) change parameters by defining another problem size or analysis within the same DSS or application, and (5) run the model and obtain an optimum PM2P allocation decision associated with that problem size, in a seamless manner.

10.2 Need to address identified gaps in existing PM2P allocation models

Given the identified gaps in existing PM2P allocation models applicable to MPEs, there is a need to address these gaps as part of contributing to the understanding of existing knowledge on mathematical modelling and its applications. This need is significant in the context of direct application to real-life industry problems. There is a need to extend mathematical modelling applications and usefulness in the eyes of industry practitioners, not only to other regions of the world such as Africa (specifically Botswana) but also other industries such as mining and metals (in which organization A operates) and for other project types such as underground mineral exploration projects. Addressing the identified gaps discussed in section 10.1 is a contribution to existing knowledge on improving PM2P allocation models in MPEs.

10.3 Mathematical formulation of the PM2P allocation problem

Mathematical formulation of the PM2P allocation problem, as an outcome from methods associated with steps 1 to 6 (Figure 6-1) is presented as part of addressing objective 4. This formulation represents operationalization of the conceptual framework developed in this thesis (chapter 8), using organization A, to demonstrate an improved way of allocating project managers-to-projects. In particular, two proposal options were presented to key stakeholders in organization A. Option 1 involved developing a full-scale proposal, using commercial optimization software. Option 2 involved developing a demonstration project, using non-commercial optimization software (limited in terms of number of variables it can handle) to demonstrate the proposed new approach, as a solution to improve the PM2P practice in organization A. Following discussions with key stakeholders in organization A, option 2 was chosen and considered satisfactory in the eyes of practitioners, along with the requirements for this thesis as defined in section 1.5.

Understanding the problem (step 1) is discussed in chapter 9, in relation to an in-depth study of organization A's PM2P practice. The in-depth study was informed by the developed conceptual framework (section 8.1) for this thesis, using a case study approach. The findings from the in-depth study were used to formulate a mathematical model to solve the PM2P allocation problem in organization A. The aim was to improve the existing PM2P practice in organization A by incorporating all the important decision criteria that theory suggests should be considered (chapter 8) in line with best practices, including those not considered adequately by practitioners in organization A. The formulation is an approach that addresses the gaps associated with informal approaches (section 3.3.1) and enables benefits highlighted in section 3.4.3.1. This formulation uses algebraic equations that express the relationships between the variables considered in the PM2P allocation process. It comprises three key components namely: decision variables, objective function and constraints. These three components are consistent with requirements for mathematical formulation of an optimization modelling problem in the field of operations research (Ragsdale, 2003; Conway and Ragsdale, 1997; LeBlanc et al., 2000). The next section presents the notation used in the formulation of the PM2P allocation problem.

10.3.1 Notation (step 1)

The notation used in the formulation is presented first, followed by the formulation.

i subscript for the i[th] project manager; j subscript for the j[th] project; k subscript for the k[th] goal; t subscript for the t[th] month in which project j is active;

[A_{ij}] Index set to indicate the allocation of project manager i to project j;

[w_{ij}] Index set for the intensity of allocating project manager i to project j;

[s_{ij}] Index set for the suitability of project manager i to project j;

[g_k] Index set for the relative contribution of goal k to achieve the organization's mission;

[p_{jk}] Index set for the relative contribution of project j to goal k;

[e_{ijk}] Index set for the extent of effectiveness of project manager i to manage the discontinuity of project j's contribution to goal k;

[M_{ij}^{t}] Index set for the maximum allowable intensity of allocating project manager i to project j in time period t;

[m_{ij}^{t}] Index set for the minimum allowable intensity of allocating project manager i to project j in time period t;

[d_{ij}] Index set for the individual time demand of project j on project manager i;

[l_i] Index set for the loss in productivity of project manager i in managing multiple projects;

[T_i] Index set for the time availability of project manager i;

P_j^c Denotes project j which requires a project manager with special competencies;

F_i^c Current projects in feasibility and post-completion audit phase managed by project manager i;

F_i^m Maximum number of projects in feasibility and post-completion audit phases that project manager i can effectively manage concurrently;

G_i^c Current geotechnical drilling types of projects managed by project manager i;

G_i^m Maximum number of geotechnical drilling projects that project manager i can effectively manage concurrently;

[n_i] Index set for the number of existing projects managed by project manager i;

[N_i] Index set for the maximum allowable number of concurrent projects managed by project manager i;

a_j^t Binary variable to determine if project j is active in month t;

F_j Binary variable to determine if project j is in feasibility and post completion audit phase;

G_j Binary variable to determine if project j is a geotechnical drilling type of project;

P_j^c Binary variable to determine if project manager i possesses special competencies required by project j.

The binary variables are represented as:

$$a_j^t = \begin{cases} 1, \text{if project j is active in month t,} \\ 0, \text{if project j is not active in month t} \end{cases}$$

$$F_j = \begin{cases} 1, \text{if project j is in feasibility or post completion audit phase,} \\ 0, \text{if project j is not in feasibility or post completion audit phase} \end{cases}$$

$$G_j = \begin{cases} 1, \text{if project j is a geotechnical drilling project,} \\ 0, \text{if project j is not a geotechnical drilling project} \end{cases}$$

$$P_j^c = \begin{cases} 1, \text{if project manager i possesses special competencies required by project j,} \\ 0, \text{if project manager i does not posess special competencies needed by project j} \end{cases}$$

Using the notation outlined above, the mathematical formulation of the PM2P allocation problem is presented in terms of defining: decision variables, objective function and constraints.

10.3.2 Define decision variables (step 2)

Decision variables are the main components of the PM2P allocation problem to be solved. In the decision to determining the optimal PM2P allocation regarding which project manager (represented by i) to allocate to which project (represented by j), a mathematical expression for the decision variables is represented as:

$$A_{ij} = \begin{cases} 1, \text{if project manager i is allocated to project j,} \\ 0, \text{if project manger i is not allocated to project j.} \end{cases}$$

Decision variables are also known as changing cells in spreadsheet modelling (Conway and Ragsdale, 1997; Ragsdale, 2015). They can be expressed in the context of binary variables (i.e., zeros and ones). In the context of the PM2P allocation problem, a zero indicates no allocation and a one indicates an allocation. The idea of zeros and ones is similar to an off-on switch.

10.3.3 Define objective function (step 3)

An objective function is an equation that represents the problem to be minimized or maximized. The general form of this equation expresses the relationship between the decision variables (Ragsdale, 2003). In the context of the PM2P allocation problem, the objective function is a maximization problem, expressed as linear combinations of the decision variables. This objective function maximizes the PM2P allocation decision, which is a process made up of numerous factors influencing the decision (section 8.1.1). Using the notation (section 10.3.1), the objective function is defined as:

Maximize: $\sum_{i=1}^{l} \sum_{j=1}^{p} \sum_{k=1}^{r} (w_{ij} \; e_{ijk} \; g_{k} \; p_{jk} \; s_{ij} \; A_{ij})$……………………………………………….(6)

where i ε project managers, j ε projects and k ε goals (using set theory). i, j and k, each take values from 1 to infinity. For the sake of presentation, i takes values from 1 to l, j takes values from 1 to p, and k takes values from 1 to r. l is the maximum number of candidate project managers to be allocated to projects, p is the maximum number of candidate projects for which PM2P allocation decisions must be made, and r is the maximum number of organizational goals to be achieved through projects.

w_{ij} , e_{ijk} , g_{k} , p_{jk} and s_{ij} are the parameters (values) as defined in the notation. These parameters are briefly discussed.

10.3.3.1 Parameter representing PM2P allocation intensities (w_{ij})

w_{ij} is the intensity of allocating project manager i to project j. It is a dimensionless parameter that indicates the management effort required to manage a particular project and derived from the original work in (Towle, 1990). It is defined by equation 7.

Project intensity = 6 * log (project cost in £m) + 1……………………………….........(7)

LeBlanc et al. (2000) modified this intensity function by incorporating the concept of travelling time from project manager's location to project site, into their spreadsheet optimization-based model to allocate project managers to construction projects. However, the criticism in this spreadsheet model is the lack of flexibility in terms data input in different parts of the spreadsheet (section 3.3.2), including the absence of a user-interface. The PM2P practice at organization A is such that project managers are based in different towns, relative to project sites and travel different distances to respective project sites. The approach of calculating intensity values for each different PM2P allocation combination was preferred, since it takes into account the different project manager locations and respective travel distances to allocated project sites. Unlike existing approaches (LeBlanc et al., 2000), this approach takes into account the total intensities (i.e., maximum and minimum allowable) for each project manager, as opposed to simply considering a single intensity value for each project, resulting in a better indication of overall workload for each project manager. This approach was adopted because it is an important consideration that reflects the situation at organization A and reveals reality regarding variations in workloads, on the basis of driving times (hours) and project costs (£m). The modified intensity function (ibid) is defined by equation 8.

Project intensity = [1+driving time]*[6*log (project cost) + 1………………….…..…..…(8)

The intensity value for each individual PM2P allocation is to be incurred only if the following conditions are satisfied: project manager i is allocated to project j, and project j is active in month t. Otherwise the PM2P allocation intensity will not be incurred since its overall value will be zero, as a result of multiplication by zero.

10.3.3.2 Parameter representing re-allocation effectiveness (e_{ijk})

e_{ijk} is the extent of effectiveness of project manager i to manage the discontinuity of project j's contribution to achievement of goal k. It indicates the re-allocation effectiveness of each project manager. There are two conditions in which the value of e_{ijk} is equal to 1 (i.e. 100%), representing no discontinuity in the management of a project. These conditions are: (1) when a project manager is allocated to a new incoming project, and (2) when an existing project manager is allocated to his/her existing project, following re-allocation decisions. The mathematical expressions for these two conditions are presented in equations 9 and 10.

e_{ijk} = 1 $\forall$ i,j ε [new incoming project j], k……………………………………….……………(9)

e_{ijk} = 1 $\forall$ k [in the case of existing project manager i of an existing project j]……………………………………………………………………….………………....(10)

Beyond the above two conditions, the value of e_{ijk} varies between 0 and 1, depending on the decision maker's judgement about the capabilities of each project manager to take over a project that was managed by another project manager and manage its discontinuity in delivery. In this case, the values 0 and 1 indicate no effectiveness (0%) and maximum effectiveness (100%) respectively.

Re-allocation effectiveness is modelled to ensure that there is continuity in the delivery of on-going projects from both existing and new allocations (LeBlanc et al., 2000; Patanakul, 2004; Patanakul et al., 2007). It accommodates the reality of the business environment, in terms of new in-coming projects to existing project portfolio, including projects in the pipeline that are awaiting implementation. The modelling of re-allocation decisions is important for two reasons namely: (1) a project that is currently being delivered well by a particular project manager must continue its momentum, following re-allocations to accommodate new in-coming projects and pipeline projects, and (2) a project that is currently not being delivered well by a particular project manager must find another project manager who can improve its delivery.

The findings from the PM2P practice in organization A is that a strategically important project or an emergency project can suddenly arrive into the existing portfolio, such that it must be implemented right away. This means that the existing PM2P allocations become out-dated to some extent and must therefore, be revised (Duffuaa and Al-Sultan, 1999) to accommodate this kind of change in the business environment. On the other hand, the reality of business practice is that all project managers will be busy executing their allocated projects, which represent their existing workloads. This means that the right project manager for the newly strategically important or emergency project must be off-loaded from some of his/her projects, to create sufficient time availability to accommodate the in-coming project. The objective is that all projects in the portfolio (existing and in-coming) must be allocated accordingly, such that there is minimal disruption in the delivery of projects, following re-allocations.

Re-allocation decisions, whilst necessary to accommodate changes in the business environment, cause potential disruptions (Duffuaa and Al-Sultan, 1999) to the PM2P allocation process. The modelling of each project managers' re-allocation effectiveness, is necessarily to address the difficulty of achieving effectiveness in the re-allocations. The word effectiveness is used in this context to refer to minimizing disruptions in the allocation process, while maximizing re-allocation decisions.

10.3.3.3 Parameters representing project prioritization process (g_k , p_{jk})

g_k is the relative contribution of goal k to achievement of the organization's mission. It takes values from 0 to 1 (or 0% to 100%) and depends on the strategic importance of each organizational goal (relative to other goals) to the accomplishment of the mission, as per decision maker's judgements during prioritization process.

p_{jk} is the relative contribution of project j to achievement of goal k. This parameter takes values from 0 to 1 (or 0% to 100%) and depends on the strategic importance of each project (relative to other projects) to the accomplishment of each organizational goal, as per the decision maker's judgements during prioritization process. A project may contribute to accomplishment of more than one goal.

The above parameters are discussed using a systematic process to visualize them in a decision hierarchy (Kocaoglu, 1984). The decision hierarchy was used only to break down the PM2P allocation problem into three levels (Figure 10-1), for reasons given in section 3.4.3.4.

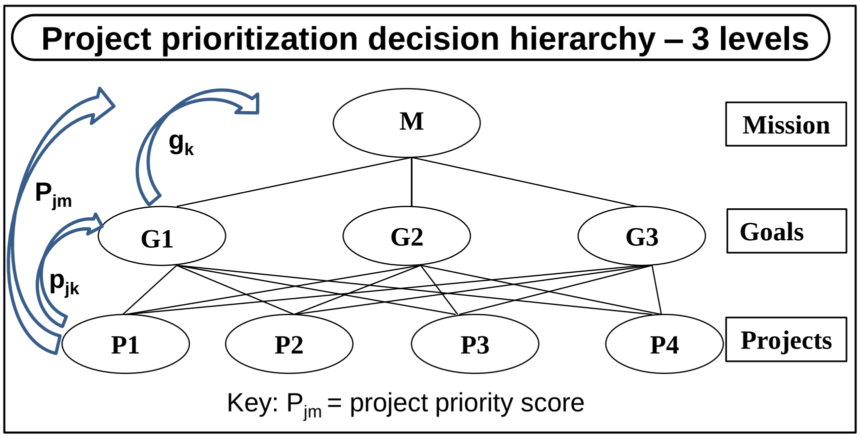


Figure 10-1 Project prioritization decision hierarchy

g_k is the relative contribution of each organizational goal to the accomplishment of the mission, and p_{jk} is the relative contribution of each project to the accomplishment of each strategic goal (Choothian et al., 2009; Patanakul et al., 2007).

10.3.3.4 Parameter representing PM2P matching process (s_{ij})

s_{ij} is the suitability of project manager i to project j. This parameter takes values from 0 to 1 (or 0% to 100%) and depends on the decision maker's judgment about the competencies of available project managers versus required competencies.

10.3.4 Define constraints (steps 4 and 5)

Based on definitions in section 3.4.5, a set of constraints for the PM2P allocation problem are defined by equations, using algebraic expressions. These equations include identification of lower and upper bounds (Ragsdale, 2015), where appropriate. These constraints are presented in equations 11 to 27.

Time availability: $\sum_{j=1}^{p} d_{ij} A_{ij} + l_i \leq T_i \quad \forall$ i ……………………..………..…………………..(11)

This set of constraints enforces a condition such that project manager i is allocated to project j only if project manager i has sufficient time available to manage project j, without an impact on his/her productivity. If this condition is not met, project manager i will not be allocated to project j (Choothian et al., 2009; Patanakul et al., 2007). This condition avoids overloading project managers as the resources to be utilized by modelling two time demands. These time demands are: consideration of individual time demand of project j on project manager i (represented by d_{ij} in equation 6), and consideration of loss in productivity due to project manager i switching tasks from managing multiple concurrent projects (represented by l_i in equation 6). The loss in productivity is referred to as *"task switching"* (Rubinstein et al., 2001 , p. 765). T_i is derived from the effective capacity of a project manager, existing workload in terms of number of projects and the loss in productivity, as a result of managing multiple concurrent projects. The loss in productivity is based on the number of concurrent projects that a project manager is managing. Generally, an increase in the number of concurrent projects per project manager will result in an increase in productivity loss, as a result of the project manager having to switch context from managing issues of one project to the next, several times a day. This increase is assumed to follow a linear relationship as suggested in (KapurInternational, 1993). In essence, equation 6 is true where:

T_i = c_i (effective capacity) - w_i (existing workload)…………………………….......(11.1)

l_i (loss in productivity) = 1.5Y_i + 4.5Z_i ……………………………………………(11.2)

Y_i is the number of concurrent projects that exceed one and managed by project manager i. Z_i is a binary variable to indicate whether project manager i is managing concurrent projects (Choothian et al., 2009; Patanakul et al., 2007). Equation 11 (including 11.1 and 11.2) indicate each project manager's availability as a resource, in the context of effectively managing projects. The symbol $\forall$ i in equation 11 denotes repeating the same procedure for all values of i.

Total number of concurrent projects: $N_i = \sum_{j=1}^{p} A_{ij} + n_i \quad \forall i$………………………....(12)

Equation 12 indicates the total number of concurrent projects under the responsibility of project manager i. It imposes an upper limit on the maximum allowable number of concurrent projects for each project manager, to maintain productivity, based on organization A's requirements. An application of the above equation is demonstrated in equation 13.

Maximum allowable number of projects: $\sum_{j=1}^{p} A_{ij} + n_i \leq M_i \; \forall i$……………………….....(13)

This constraint set imposes an upper limit on the number of projects that project manager i can be allocated to, without an impact on his/her productivity. This upper limit is necessary to avoid overloading project managers.

PM2P allocation intensity: $m_{ij}^{t} \geq [(w_{ij} * a_j^t)\, A_{ij}] \leq M_{ij}^{t} \; \forall i$ …………………..…………..…(14)

Two sets of constraints were introduced to impose lower and upper limits on the total PM2P intensity of each project manager, in a specified planning horizon. The first set of constraints, minimum total PM2P intensity constraints set, imposes a lower limit on the total intensity of each project manager in each month, such that it is controlled to be at least a specific value in each month. The second set of constraints, maximum total PM2P intensity constraints set, imposes an upper limit on the total intensity of each project manager in each month, such that it is controlled not to exceed a specific value in each month. The intent is to balance workload and improve the perception of fairness in the allocation process for each individual project manager.

These constraints represent some of the additions made to existing PM2P allocation models applicable to a MPE. This approach is preferred to that of estimating the man hours required for each specific task of each project, which is unmanageable (LeBlanc et al., 2000), particularly for large projects with numerous tasks.

Project phase mix: $\sum_{j=1}^{p} F_j \, A_{ij} + F_i^c \leq F_i^m \; \forall i$……………………………..………...….(15)

This constraint set accommodates the reality of managing projects, since projects in different phases require different levels of management effort from a project manager. For example, a project in its initiation phase requires relatively less management effort and time from a project manager, in comparison to a project in its execution phase (Choothian et al., 2009; Patanakul et al., 2007). In the context of managing concurrent projects, the issue of mix of projects in different phases becomes significant, in relation to different levels of management effort required from the same project manager. This constraints set ensures that the same project manager will not be allocated to concurrent projects in phases that require relatively more management effort from the same project manager, than projects in other phases. In the context of organization A, a project in feasibility and post-completion audit phase (represented by F_j in equation

11) requires relatively more effort from a project manager than in any other phase. For this reason, it is necessary to ensure that the total number of projects in terms of existing allocations (F_i^c) and new allocations ($\sum_{j=1}^{p} F_j A_{ij}$) under the responsibility of the same project manager (project manager i), must be less or equal to the maximum number of projects in feasibility and post-completion audit phases (F_i^m).

Binary variables are used to simplify the algorithm in terms of determining whether the project in question is in feasibility and post-completion audit phases (equation 16).

$$F_j = \begin{cases} 1, \text{if project j is in feasibility or post completion audit phase,} \\ 0, \text{if project j is not in feasibility or post completion audit phase} \end{cases} \text{..................(16)}$$

Project type mix: $\sum_{j=1}^{p} G_j A_{ij} + G_i^c \leq G_i^m \ \forall$ i...(17)

This constraint set accommodates the reality of managing projects in that projects of different types, which indicate different levels of complexities (Crawford et al., 2006; Crawford, 2000; Müller and Turner, 2007) require different levels of management effort from a project manager (Choothian et al., 2009; Patanakul et al., 2007). The PM2P practice in organization A is such that the project heads will not allocate the same project manager to certain types of projects to be managed concurrently, since these projects require more management effort. Equation 17 represents the modelling of this situation, to impose an upper limit on the maximum number of geotechnical drilling projects that project manager i can manage concurrently (G_i^m), without an impact on his/her productivity. This upper limit includes both new allocations ($\sum_{j=1}^{p} G_j A_{ij}$) and existing allocations (G_i^c). Binary variables were used to simply the algorithm, in terms of determining whether the project type in question is a geotechnical drilling project as presented in equation 18.

$$G_j = \begin{cases} 1, \text{if project j is a geotechnical drilling project,} \\ 0, \text{if project j is not a geotechnical drilling project} \end{cases} \text{..................................(18)}$$

Fixed PM2P allocations: $A_{ij} = 1 \ \forall$ i, where j ε [fixed PM2P allocations]...................(19)

The set of constraints in equation 19 accommodate soft issues in the allocations, such as consideration of project manager’s personal preferences or making the PM2P allocation solely for the purpose of developing a project manager (Choothian et al., 2009; Patanakul et al., 2004, 2007) for future complex projects.

Prohibited allocations: $A_{ij} = 0 \ \forall$ i, where j ε [prohibited allocations]……………….….(20)

The set of constraints in equation 20 accommodate the reality of the project management environment regarding issues of requirements from clients and stakeholders. These requirements may be a result of factors such as: degree of trust on project manager, relationships between clients and stakeholders for whom the project is being delivered (ibid). For example, certain project manager personalities may clash with personalities of clients and stakeholders. It could be that clients prohibit certain project managers from being allocated to projects that are delivered for them, which requires the decision maker to consider such intangible issues.

Special requirements: $\sum_{i=1}^{I} (p_j^c A_{ij}) = 1 \ \forall$ j, where j ε [projects requiring special competencies] ………………………………………………………………….…...……(21)

The above set of constraints accommodates situations where only certain project managers possess specific competencies to handle certain projects (ibid). For example, certain high profile projects may require such project managers. In the context of the PM2P practice in organization A, certain competencies are required to manage certain high profile and sensitive projects that involve a diversity of high-profile stakeholders from government, investors and unions. In such situations, the project manager must possess special competencies to handle the diversity and sophistication of all stakeholders (local and international), to avoid project delays. It may be that through past experiences, stakeholders will have input in terms of their preference on certain project managers, on the basis of a project managers' ability to handle these situations. Binary variables were used to simply the algorithm in terms of determination of a candidate project manager's presence or absence of special competencies to handle the project's demands, in relation to the situations described (equation 21).

$$P_j^c = \begin{cases} 1, \text{if project manager i possesses special competencies required by project j,} \\ 0, \text{if project manager i does not posess special competencies needed by project j} \end{cases} \text{......(22)}$$

Project interdependencies: $A_{ij} = A_{ib} \ \forall$ i, where (j and b) ε [a set of projects such that project manager i must be allocated to those set of projects]…………………….…………(23)

These set of constraints take account of interdependencies and interactions between two projects j and b. In such situations, allocating the same project manager i to those projects may improve the management of those projects (ibid), leading ultimately to success. The PM2P practice in organization A is such that management considers (in some cases) situations where one project might actually influence another in terms of their interactions. In such situations, the project head in each location allocates the same project manager to those projects, since the two projects are related in some way and hence desirable to ensure that one project fully considers the activities and outcomes of another.

Only one project manager per project: $\sum_{i=1}^{l} A_{ij} = 1 \; \forall$ j,

........……………………………(24)

The set of constraints (equation 24) ensure that each project is managed by only one project manager (ibid). For example, imposing this set of constraints on the decision variables ensures that no two project managers are allocated to the same project, in line with effective utilization of resources. In the context of the PM2P practice in organization A, no more than one project manager will manage one project. To simplify the algorithm in terms of finding a feasible and optimum solution, the above constraints set was relaxed to an inequality as presented in equation 25.

$\sum_{i=1}^{l} A_{ij} \leq 1 \; \forall$ j,

........……………………………………………………………………...(25)

No idling project manager: $\sum_{j=1}^{p} A_{ij} \geq 1 \; \forall$ i, ...……………………….……………….....(26)

As part of addressing identified gaps in extant PM2P models (Choothian et al., 2009; LeBlanc et al., 2000; Patanakul et al., 2007), additional mechanical constraints were included to ensure that each project is managed by only one project manager.

Binary variables: A_{ij}, F_j, a_j^t, p_j^c, G_j, Z_i = 0,1…………..……………..……………….…(27)

The constraints set in equation 27 ensure that all the six variables are binary, which implies that they will only take the form of two values, either a zero or a one.

10.3.5 Summarize mathematical model formulation and state assumptions (step 6)

A summary of the mathematical model formulation for the PM2P allocation problem, along with assumptions made, are presented.

10.3.5.1 Summary of the mathematical model formulation

Maximize: $\sum_{i=1}^{l} \sum_{j=1}^{p} \sum_{k=1}^{r} (w_{ij}\ e_{ijk}\ g_k\ p_{jk}\ s_{ij}\ A_{ij})$…………………………………….............(6)

Subject to:

Time availability: $\sum_{j=1}^{p} d_{ij}\ A_{ij} + l_i \leq T_i \quad \forall$ i…………………………………..……………(11)

Total number of concurrent projects: $N_i = \sum_{j=1}^{p} A_{ij} + n_i \quad \forall$ i……………………..……...(12)

Maximum allowable number of projects: $\sum_{j=1}^{p} A_{ij} + n_i \leq M_i \quad \forall$ i………….....…......(13)

PM2P allocation intensity: $m_{ij}^{t} \geq [(w_{ij} * a_j^t)\ A_{ij}] \leq M_{ij}^{t} \ \forall$ i ………………………..........(14)

Project phase mix: $\sum_{j=1}^{p} F_j\ A_{ij} + F_i^c \leq F_i^m \quad \forall$ i………………………….......……..….(15)

Project type mix: $\sum_{j=1}^{p} G_j\ A_{ij} + G_i^c \leq G_i^m \quad \forall$ i……………….…………….............…...(17)

Fixed PM2P allocations: $A_{ij} = 1 \quad \forall$ i, where j ε [fixed PM2P allocations]….........…(19)

Prohibited allocations: $A_{ij} = 0 \quad \forall$ i, where j ε [prohibited allocations]……………..…(20)

Special requirements: $\sum_{i=1}^{l} (p_j^c\ A_{ij}) = 1 \quad \forall$ j, where j ε [projects requiring special competencies]……………………..………………..………….…………………...…(21)

Project interdependencies: $A_{ij} = A_{ib} \quad \forall$ i, where (j and b) ε [a set of projects such that project manager i must be allocated to those set of projects]…….........(23)

Only one project manager per project: $\sum_{i=1}^{l} A_{ij} \leq 1 \; \forall j$,...(25)

No idling project manager: $\sum_{j=1}^{p} A_{ij} \geq 1 \; \forall i$,...(26)

Binary variables: A_{ij}, F_j, a_j^t, p_j^c, G_j = 0, 1..(27)

10.3.5.2 Assumptions of the PM2P allocation problem

i. All project managers and projects are assessed at a specific snapshot in time (Patanakul et al., 2007), in line with a static model (section 3.4.6).

ii. The relationship between number of concurrent projects per project manager and the loss in productivity is linear (KapurInternational, 1993).

iii. The project heads can express their judgement regarding the performance of each individual project manager, relative to other project managers (Triantaphyllou, 2000), on the basis of identified criteria to be assessed (Seboni and Tutesigensi, 2014b).

iv. The planning horizon is known and used to estimate time availabilities of project managers as well as time demands of each project in terms of management effort required from each project manager (Choothian et al., 2009; Patanakul et al., 2007). For example, there are known competencies that are available (including known workloads) at the beginning of the planning horizon. This situation describes a deterministic model, on the basis that things can be planned in terms of making the PM2P allocations.

v. All project managers are full-time, since overhead time is not applicable for part-time project managers (Patanakul et al., 2007).

10.3.6 Advantages of the proposed mathematical model to existing PM2P allocation models

In the context of addressing the gaps identified in existing PM2P allocation models (section 3.2), some additions were introduced to the modelling of the PM2P practice, as part of contributing to existing body of knowledge on mathematical optimization modelling of the PM2P allocation problem. These additions, discussed in sections 8.1.1, 8.1.2, 8.1.3.3, 8.1.3.6 and included in the formulation (section 10.3), are summarized as:

i. the mathematical formulation incorporates variables associated with the location of projects and project managers and provides the opportunity to impose lower and upper limits on management effort for each project manager, in an attempt to balance workload for individual project managers;

ii. the inclusion of soft issues in the modelling (e.g., decision maker's self-interest and project manager development) brings it closer to a representation of reality, in relation to industry practice, as opposed to a mechanical system that lacks consideration of soft issues; and

iii. the addition of a set of constraints associated with imposing limits on the status of each project manager, ensures that each project manager is allocated at least one project, representing an addition to existing PM2P allocation models.

10.3.7 Quantification of mathematical model parameters

The quantification of parameters in the mathematical model is discussed under the three processes within the overall PM2P allocation process.

10.3.7.1 Project prioritization process

A decision hierarchy was used to facilitate quantification of parameters in the project prioritization process. The nature of the PM2P allocation decision, in relation to the large number of factors influencing this decision (chapter 8), makes it a complex multi-criteria decision making problem. This complex problem suits the use of a decision hierarchy to break down the decision problem, as discussed in section 10.3.3.3. The prioritization process was broken down into three hierarchical levels.

Algebraic equations were set up in a spreadsheet, using functions (such as sum product), to quantify parameters in the three hierarchical levels. This resulted in two matrices (Goals-To-Mission matrix and Projects-To-Goals matrix), multiplied together to yield a resultant matrix that identifies the global contribution of each project (relative to other projects) to the achievement of the organization's mission (i.e., project priorities). This approach was chosen over competing alternatives such as use of constant sum method and pairwise comparisons (Comrey, 1950; Dudek and Baker, 1956; Kocaoglu, 1983; Metfessel, 1947) in existing studies (Choothian et al., 2009; Patanakul et al., 2007). The algebraic equations in a spreadsheet that is linked directly to OpenSolver, avoids lots of comparisons that require significant time from busy professionals, while producing the same outcome. Instead of asking busy professionals to do pairwise comparisons manually, the computations are executed through functions in a spreadsheet, based on input data. This approach achieves the same outcome as pairwise comparisons, which would have been cumbersome for practitioners, in terms of a large number of criteria and sub-criteria in judgement quantifications.

10.3.7.2 PM2P matching process

The quantification of parameters in the PM2P matching process comprises three parameters in the objective function (equation 6) namely: PM2P allocation intensities (w_{ij}), re-allocation effectiveness of each project manager (e_{ijk}), and suitability of each project manager to a given project (s_{ij}). The quantification of these three parameters is briefly discussed.

10.3.7.2.1 PM2P allocation intensities

Input data regarding three derived variables were used to quantify the PM2P allocation intensities. These derived variables were: driving times (hours) between location of project managers and project sites, average trip frequencies over the project duration, and project costs (LeBlanc et al., 2000). Input data were hosted in a spreadsheet containing the formulation. The overall PM2P allocation intensities for each project manager were then computed (using equation 5) behind the scenes and linked to the decision variables in the formulation, such that the optimization software concurrently considers this parameter (along with all other parameters, all at the same time) in searching for an optimal PM2P allocation decision to be displayed as an output.

10.3.7.2.2 Re-allocation effectiveness of each project manager

This parameter was quantified using input data from organization A, in terms of the ability of each project manager to take over an existing project from its current project manager, in the event of a "re-allocation", as part of accommodating the reality of managing projects in a MPE (Choothian et al., 2009; Patanakul et al., 2007). A scale of 0 (ineffectiveness) to 100% (effectiveness) was used to quantify this parameter. Two conditions exist in which a score of 100% can be given. These conditions were discussed in section 10.3.3.2. Re-allocation is used in the context of shuffling existing PM2P allocations to accommodate new incoming projects, which means that a project manager can be informed to continue managing one of his/her existing projects as an outcome of a re-allocation decision.

10.3.7.2.3 Suitability of each project manager to a given project

This parameter was quantified using two derived variables namely available and required project manager competencies, as per project characteristics (Choothian et al., 2009; Patanakul et al., 2007). The required competencies represent the organization's needs in the delivery of projects. Data were collected from organization A regarding rating scores, measured on a Likert scale (1 = very low, 5 = very high) for available competencies (matrix 1) and required competencies (matrix 2). Matrix 1 involved measuring a total of 21 competencies against six candidate project managers within the pool of project managers in the organization (available competencies). Matrix 2 involved measuring the same 21 competencies against six candidate projects, in relation to project characteristics (required competencies). The 2 matrices were then multiplied together; yielding a matching score between candidate project managers and candidate projects. The resultant matrix was an individual matching score for each project manager, relative to other project managers. The difference between this output (available competency minus required competency) was then inspected.

A coding scheme was applied to interpret the individual matching scores. For example, a difference of zero was coded as a "1", to indicate a perfect match. A difference of a positive number was coded as a "1.5", to indicate that the project manager's competencies are higher than what the project requires. However, a difference of a negative number was coded as a "0", to indicate that there is no match between a project manager's competencies and the project's requirements, since the project manager's competencies are lower than what the project requires. To accommodate the PM2P practice at organization A, a difference of negative one was coded as a "0.5", to indicate that the project manager's competencies are one unit below what the project requires. For this situation, an allocation may be made to accommodate project manager development, an example of a soft issue incorporated in the modelling of the PM2P practice. The coding scheme applied has an offsetting effect in cases where a project manager possesses higher or lower competencies than what the project requires, given that the overall PM2P matching score was computed from the sum product of two matrices (Patanakul et al., 2007).

It follows that the resulting PM2P matching score indicates the extent of match between each project manager's competencies and each project's requirements (Choothian et al., 2009; Patanakul et al., 2007) and expresses the suitability of each project manager to a given project. The quantification of this parameter becomes input data, such that the optimization model considers all input data to run the algorithm behind the scenes, resulting in an optimal PM2P allocation decision.

Given the intangible nature of the decision criteria to be assessed in the PM2P allocation decision, the quantification of parameters is subjective. Mathematical modelling of the PM2P allocation process (involving intangible attributes that are otherwise commonly assessed informally using managerial intuition) provides a formal and less subjective process that concurrently takes account of all important factors, in a consistent manner. For example, this formal process uses a carefully designed measurement instrument that quanties all the factors influencing the PM2P allocation process in a less subjective manner that is standardized and used consistently by practitioners. This approach is complementary to managerial intuition, in terms of an effective PM2P approach.

10.3.7.3 Recognition of constraints process

The parameters in the list of constraints (equations 11 to 27) are set up such that they are in the form of values used as input data into the mathematical model. These parameters must be known by the decision maker, on the basis of his/her experience in the role of making PM2P allocation decisions, which involves assessing project manager competencies and project characteristics. Given the dynamic nature of some of this data, the decision maker may need to consult the project managers prior to making PM2P allocation decisions, including reference to existing and up to date records on the information required as input data.

Following quantification of parameters in the mathematical formulation, data input into the model follows. The mathematical model was implemented in an optimization software called OpenSolver (Mason, 2011, 2013; Ragsdale, 2015), as part of a demonstration project. The demonstration project was concerned with a problem to allocate 6 project managers to 6 projects, in terms of processing input data.

10.4 Graphical user interface (GUI) description and features

The outcomes from implementing steps 9 and 10 methods is a GUI. The GUI separates physical and complex details of the model formulation, such that users are not exposed to these details but able to interact with the integrated DSS via command buttons. The GUI addresses gap 6 (section 10.1.6) and extends the usefulness of mathematical optimization modelling for acceptance by practitioners. It is made up of 10 pages in the form of tabs that contain fields for data input (see Figure 10-2). Each tab has a title that briefly indicates the information required in the relevant fields as far as data input is concerned. The fields under each of the 10 tabs require input data in relation to important factors that play a role in effective PM2P practices.

These important factors are consistent with the contents of the conceptual framework discussed in chapter 8 and the mathematical formulation of the PM2P allocation problem (section 10.3). Among the 10 tabs, some have IDs while others do not. The IDs act like sub-tabs that share common fields in terms of data input.

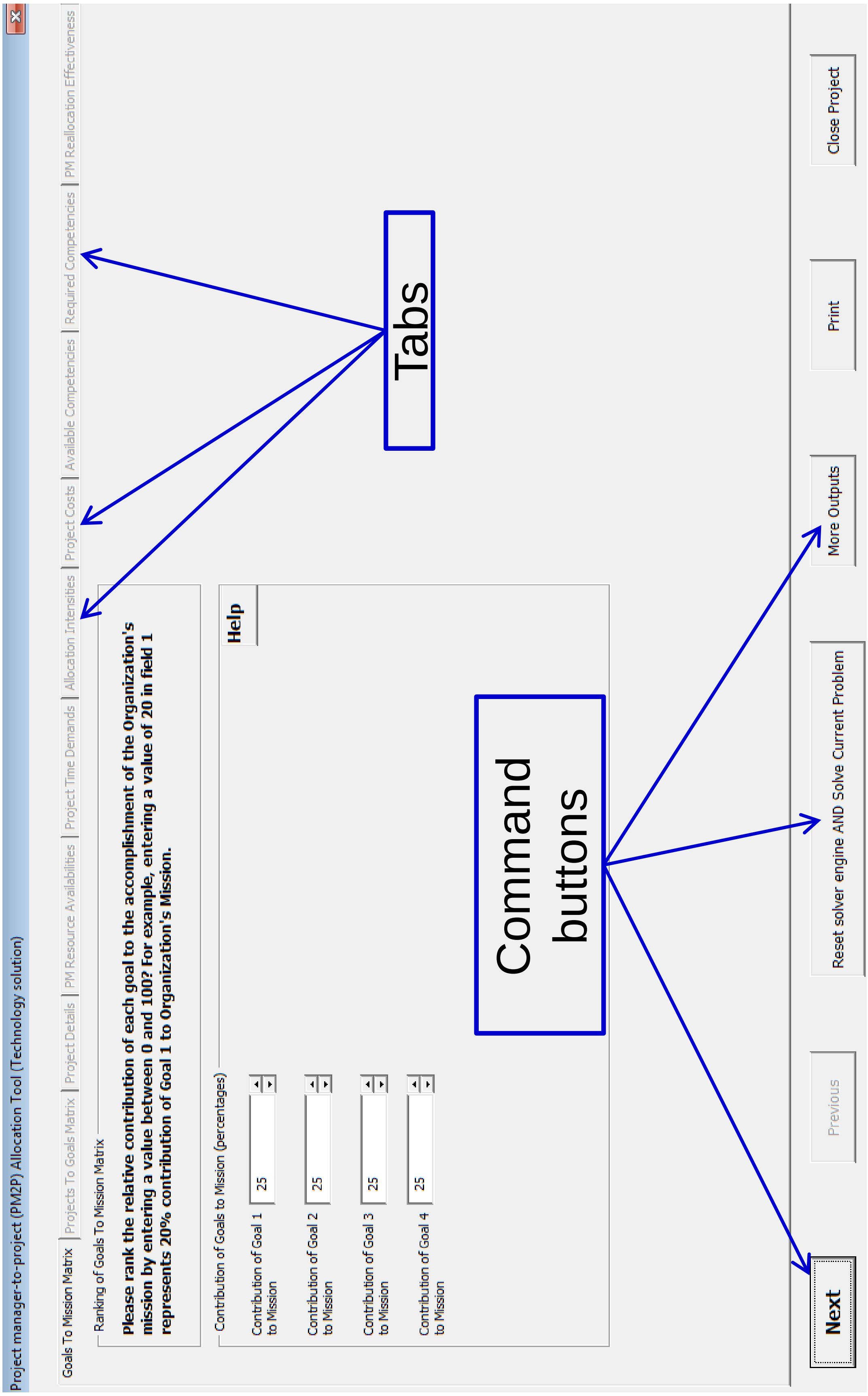


Figure 10-2 Graphical user interface

10.5 Verification of proposed new approach

Whilst the term verification has different conceptions, it is defined in this thesis as an internal design process that seeks to test or assure that the DSS is built right (Boehm, 1981; PMBOK, 2013), in light of its components. The proposed new approach was operationalized in the form of a DSS, customized to the PM2P problem in organization A. The DSS was verified as part of the proposal development process for the new approach, in the context of functionality of the various components depicted in Figure 6-2. The verification process is discussed under the next three sub-sections.

10.5.1 Determining appropriate OpenSolver tolerance value

Based on the procedure to determine an appropriate tolerance value (section 6.1.1.3.5), the outcomes are presented. The output from two cases (described in section 6.1.1.3.5) used to determine an appropriate tolerance value for the PM2P problem in question, yielded an objective function value of 7,407.7 for case 1 and 7,400 for case 2. The recommended PM2P allocation decisions for these two objective functions were slightly different. However, after exploring with several tolerance values for both cases, by changing the tolerance from 10% (iteration 1) to 9% (iteration 2), 8% (iteration 3) and all the way to 1% (last iteration), the solution outputs from the two cases became exactly the same. Input data was kept constant for both cases, and the objective function value was 7,404.7 for both cases (Figure 10-3). The output in Figure 10-3 provides evidence to conclude that the appropriate tolerance value for the PM2P allocation problem in question is 1%, instead of the default value of 10%. Therefore, the default values did not have any impact on the outcome.

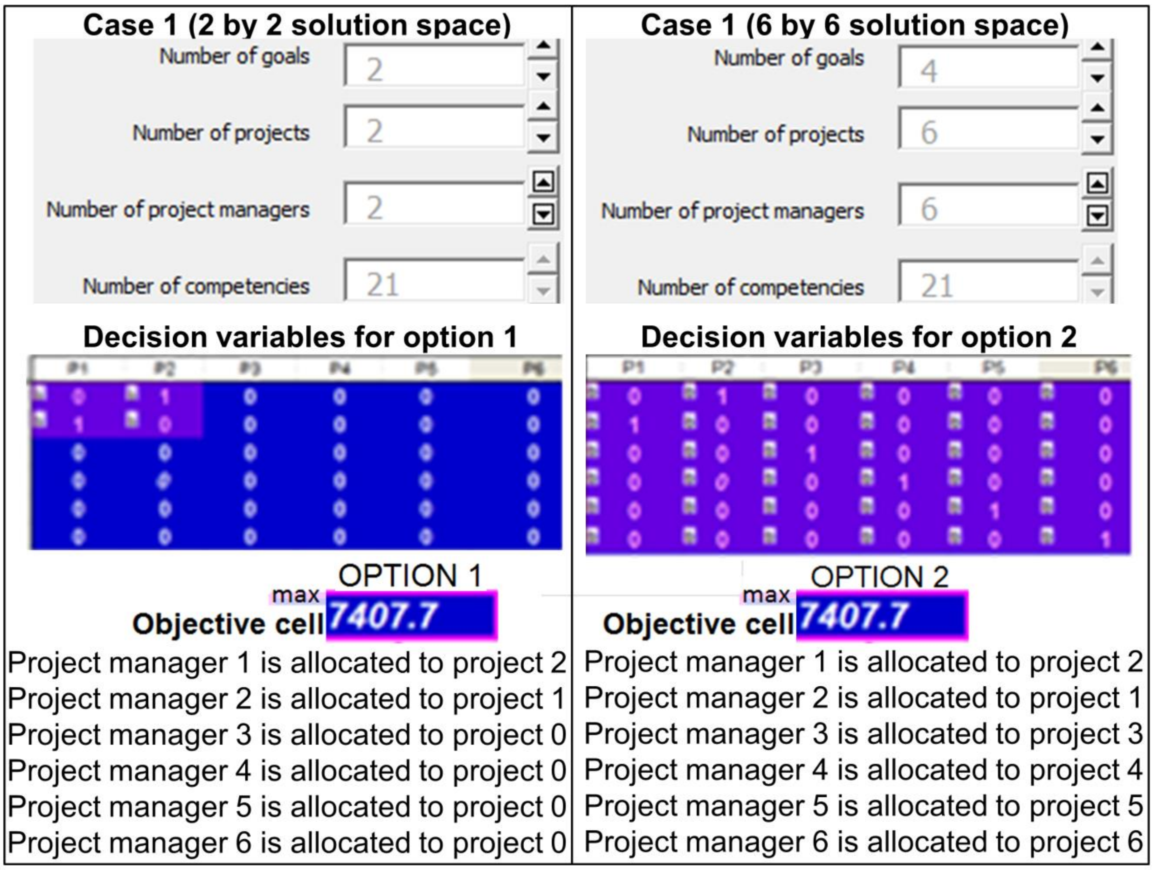


Figure 10-3 Outputs from two cases

10.5.2 Verification of OpenSolver optimization model results

Based on the methods described in section 6.1.1 associated with implementing the model formulation in an optimization software, the results are presented. These results are associated with a demonstration project to solve an allocation problem involving determination of an optimum PM2P allocation decision, based on allocating six project managers to six projects, using the context of organization A.

Following implementation of physical details of the mathematical formulation of the PM2P allocation problem in OpenSolver, the results are displayed in Figure 10-4. These results pertain to the allocation of six project managers to six projects as a demonstration project. The results reflect the output from the optimization software, after running the algorithm to find the optimum PM2P allocation decision, on the basis of input data relating to all factors that influence the decision (considered concurrently in the computation). If OpenSolver does not find an optimum solution to the PM2P allocation problem in question, an output is displayed in the form of an error message.

Key: PM = project manager, P = project

Solve button → Output

A_{ij}	P1	P2	P3	P4	P5	P6
PM1	0	0	0	0	0	1
PM2	0	1	0	0	0	0
PM3	$\boxed{1}$	0	0	0	0	0
PM4	0	0	0	1	0	0
PM5	0	0	0	0	1	0
PM6	0	0	$\boxed{1}$	0	0	0

Objective function value = 0.95

P_{jk} and s_{ij} scores to check results from optimization model

P_{jk}	P1	P2	P3	P4	P5	P6
	22.86	15.00	12.01	19.23	13.43	17.47

s_{ij}	P1	P2	P3	P4	P5	P6
PM1	59.7	68.3	68.5	58.1	77.6	100.0
PM2	97.8	98.4	98.4	95.9	98.4	98.5
PM3	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
PM4	99.3	99.0	99.0	99.0	99.0	100.0
PM5	80.3	88.8	83.7	75.8	94.3	88.8
PM6	**47.2**	**59.1**	**53.9**	**37.9**	**73.4**	**60.4**

Figure 10-4 Optimization model results

However, if OpenSolver finds an optimum solution, an output (shown in Figure 10-4) is displayed. The results indicate that project managers 1, 2, 3, 4, 5, and 6 should be allocated to projects 6, 2, 1, 4, 5 and 3 respectively. This optimum solution occurs at an objective function value of 0.95, the maximum value for this problem. The results indicate that the optimization model is capable of making optimum PM2P allocations in less than one second, with a solution precision of 99%. This means that there is a 1% chance that the OpenSolver software will not find an optimum PM2P decision, owing to the practical limitations discussed in section 6.1.1.3.4.1.

The verification of the OpenSolver optimization model results (step 8) involved an iterative process, to verify that the model results are satisfactory. For example, if the results of implementing the model base were not satisfactory, the procedure involved going back to step 1 (Figure 6-1) and beginning another cycle to troubleshoot and provide corrective actions for any errors in the modelling, until the results were satisfactory. On this note, the model results were verified using intuitive checks on certain expectations regarding comparisons between project priorities and matching scores with recommended allocation decisions (see bottom of Figure 10-4). For example, project manager 3 (the most competent project manager given that his/her matching scores for all projects was a maximum value of 100) was allocated to project

1 (the highest priority project, given that it contributes 22.86% to the achievement of organization A's mission, relative to other projects). Similarly, project manager 6 (the least competent project manager, who's matching scores were the lowest across the board) was allocated to project 3 (the lowest priority project). The results were therefore, considered satisfactory, leading to step 9 in Figure 6-1.

10.5.3 Verifying functionality of GUI (step 10)

The functionality of the GUI was verified throughout its development and hence cannot be discussed in isolation. For example, verification took place to test the functionality of the following features: command buttons (e.g., open, print, close, save, solve, next, previous), dynamic capability, and testing accuracy of input values. Testing accuracy of input values is discussed briefly, to provide an example of the verification process. The results of mechanisms to test accuracy of input values are presented.

Figure 10-5 is an example of the mechanisms developed as part of the verification process, to monitor the accuracy of input values from a user. This verification process prohibits unacceptable entries. Unacceptable entries, arising out of either human error or intentional, have potential to cause computational problems in the developed DSS.

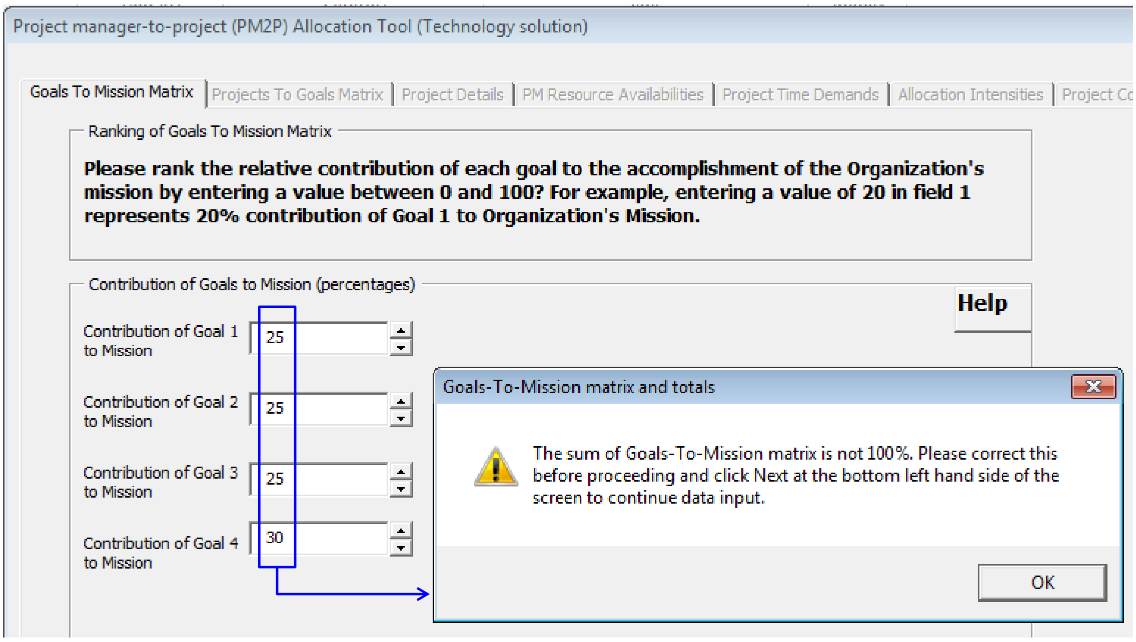


Figure 10-5 Mechanisms to test accuracy of input values

The mechanisms were designed to become active in terms of warning messages, only when the user enters unacceptable entries, an element of user-friendliness in the design of the DSS. These mechanisms were intended to enable seamless data input and usage of the DSS, avoiding disruptions in the data entry process, in situations where the user does not input acceptable entries. Figure 10-5 is an example of these mechanisms, in the context of testing that the sum of input values for the Goals-To-Mission matrix is 100%, consistent with multi-attribute utility theory (Dyer, 2005), failing which the user will not be allowed to proceed.

Programming code written to execute user commands, in light of the various components of the GUI, was verified with four domain experts, in the context of developing applications using VBA programming. Two experts were from industry, with expertise in developing, packaging and commercializing applications for organizations such as Microsoft. The other two experts were from academia, with a combined 10 years' experience in writing programming code using languages such as VBA, c++ and VB.net. Feedback concerning the design of the GUI, including its components and conventional principles associated with writing and troubleshooting errors in executing code, was obtained from all four experts and used to build a fully functional GUI.

10.6 How the new approach works and its usefulness

The new approach, developed in the form of a DSS, is discussed in the context of how it works. The user inputs data in each of the ten tabs and clicks command buttons that sends input data to the spreadsheet and later loads it back into the GUI controls, to enable saving capability. Similarly, the user clicks command buttons (such as 'reset solver engine and solve current problem') to instruct the optimization software to search for and find the best possible PM2P allocation decision, on the basis of input data. The two command buttons (reset and solve) were integrated into one command labelled "Solve current Problem" on the GUI. The 1st command button resets all values in the spreadsheet to default values and updates the solver engine to prepare it to find the optimal allocation decision by starting from a zero position. The 2nd command button instructs the solver engine to search for and find the optimal solution, based on input data. This integration eliminates the possibility of users forgetting to click the reset button prior to clicking the solve button. This possibility is likely to occur if the two command buttons were separate and not integrated into one button. The user is thus empowered to enable him/her to send two commands to the solver engine simultaneously, to be executed sequentially (behind the scene), as part of design considerations to allow user friendliness.

Several useful features were incorporated into the design of the GUI, in terms of enabling the utility of the resulting product, in the eyes of practitioners. The developed

GUI provides a platform to enable the utility of the proposed DSS, which is a new approach to improve the PM2P practice in organization A. The development of the GUI addresses the gaps identified and discussed in section 10.1, specifically gap 6 (section 10.1.6). The GUI fills this gap and represents not only a significant addition to existing PM2P allocation models in MPEs (Hadad et al., 2013; Patanakul, 2004; Patanakul et al., 2007) but also an important extension of the usefulness of optimization modelling to enable industry application. Through the GUI, all potential users can interact with the entire system, without prior knowledge of complex mathematical modelling and optimization concepts. The aim of building a GUI was to enable practitioners (in organization A) to interact with the DSS, without exposing them to details of the first two components requiring prior knowledge of mathematical modelling and optimization. A practical example, customized for organization A, was used to illustrate the utility of the developed application as a DSS that represents the proposed 'new' approach. Through the GUI, project heads are able to send input data to the first two components and get an output that has been converted to simple language and useful to them, as part of an industry application. Brief descriptions of the GUI features, in the context of the utility of the developed new approach, are presented.

10.6.1 Working on an existing or new PM2P allocation

A dialog box was created (see Figure 10-6) within the GUI's functionality, comprising two options to allow the user to indicate whether they are working on an existing or a new PM2P allocation decision, in terms of the PM2P allocation problem to be solved.

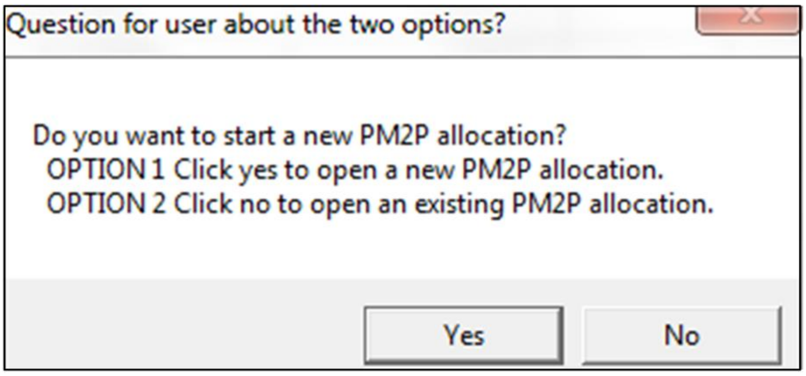


Figure 10-6 Dialog box for opening an existing or new PM2P allocation

Option 1 allows the user access to: (a) values entered previously and saved at any point during data entry, and (b) values entered previously and the output obtained after clicking the command button "solve current problem. Option 2 allows the user to start from a clean slate with all values reset to their initial default values. After the user selects the appropriate option, based on his/her requirements, the GUI launches the appropriate screen as per the user's commands.

The two options are consistent with basic requirements of application development, in relation to important and conventional attributes from the perspective of application utility, as expected by users (Walkenbach, 2010; Albright, 2012; Bovey et al., 2009). For example, using the analogy of a Microsoft (MS) office application such as MS Excel, where a user can execute or perform the following two tasks: (1) open a new file or blank MS Excel file loaded with default values (e.g., sheet 1, sheet 2, etc.), to enable starting from a clean slate, or (2) open an existing MS Excel file that was saved previously and hence loaded with values from having previously worked on the file and saving changes made. This functionality is similar to the developed DSS in terms of allowing the user to work with the two options described above. Programming code, using Visual Basic for Applications (VBA), has been written to invoke the appropriate commands (behind the scenes), on the basis of the user's commands. The programming code is stored in different programming paths (Chapra, 2003; Harris, 1997). It can therefore be concluded that the design of the developed DSS is consistent with conventions of common windows applications (Bovey et al., 2009) in terms of commands and similarities in functionality, in line with improving potential for acceptance by users, who are familiar with these types of commands.

10.6.2 Saving functionality

A saving functionality was built into the developed DSS, to address gap 7 highlighted in section 10.1.7. This was achieved in two ways: (1) saving input data entered in the GUI controls by sending the data to the spreadsheet, and (2) loading input data saved in the spreadsheet back into the GUI controls. This includes data in all pages or tabs (and fields) with and without IDs.

Users are also able to save individual macro-enabled workbooks in different locations in terms of file path. These individual workbooks contain respective records or datasets for either the same problem size or different problem sizes, and saved in the specified file path or location. The input values or entries in each dataset of a specific file name are exactly similar to the values in the GUI controls. An appropriate VBA programming code has been written to load the values on the spreadsheet back into the GUI controls (Walkenbach, 2010; Harris, 1997). This is part of the saving functionality that allows accountability in terms of saving the same records in two places (the spreadsheet and the GUI controls).

10.6.3 Dynamic capability for handling different problem sizes

Despite the limitations of OpenSolver in terms of inability to use one optimization model for different problem size parameters by simply changing the problem size parameters and solving for each respective problem size or scenario, innovative strategies were implemented in the design of the GUI, through programming code in VBA, to enable handling of different problem size parameters. For example, through VBA programming code that enables communication between user input values in the GUI and the two components of the DSS architecture, the existing limitations of OpenSolver were overcome. These innovative strategies were performed to accomplish dynamic capability in terms of allowing users to seamlessly change problem size parameters and obtain an optimized solution for the problem size in question, based on user pre-defined parameter values. Figure 10-7 illustrates this dynamic capability in terms of user pre-defined values (i.e., problem size with 4 strategic goals, 4 projects and 4 project managers) and the respective associated output.

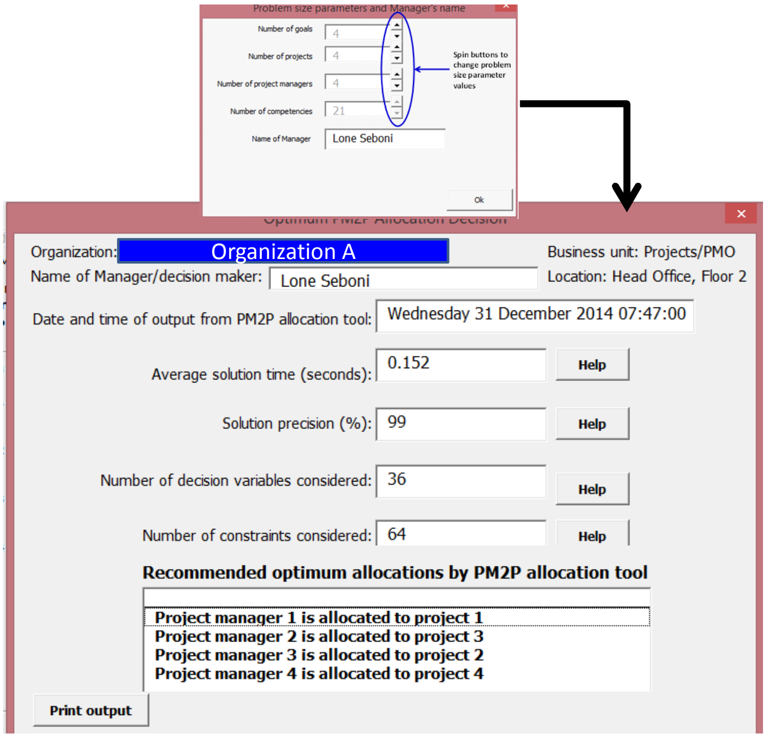


Figure 10-7 Dynamic capability

Enabling this dynamic capability addresses gap 8 highlighted in section 10.1.8. This achieved functionality represents one of the criteria for the award of PhD, on the basis of innovativeness. Dynamic capability demonstrates novel techniques for application (Chileshe, 2005; Tinkler and Jackson, 2004), given limitations of both OpenSolver and existing studies on PM2P allocation models. The achieved functionality arose from acquisition of appropriate programming skills during the PhD process and demonstrates development and application of expertise (Hughes, 1994) to address limitations in existing PM2P approaches.

10.6.4 Command buttons

Several command buttons were created and VBA programming code written to execute the relevant command, in the event of the user invoking the appropriate VBA code by clicking on a respective command button. These command buttons are briefly described in terms of their functionality.

10.6.4.1 Command button “Next”

This command button accomplishes two things namely: (1) moves the user from one tab to the next during data input, in terms of the relevant fields in the active tab, and (2) enables saving of input values entered in respective fields of the GUI, by sending them to the spreadsheet, waiting to be loaded back into the GUI controls. It is dynamically enabled and disabled on the basis of input data regarding the problem size in question.

10.6.4.2 Command buttons “Next,”“Previous,” “Print” and “Save”

The command button “Previous” takes the user to a previous tab when clicked, to allow access to all respective fields. The user can then review or edit the data entered in all the fields of each tab, as part of data retrieval process. Through this command button, along with command button “Print”, and “Save”, users are able to go back to previous tabs to edit or review the data entered in those fields. The two command buttons (“Next” and “Previous”), together, allow users to toggle back and forth within the GUI tabs, for all data fields including those containing IDs. All command buttons address the following what-if questions:

i. what if users want to view values they entered previously, during the data entry process, before completing all fields in all tabs or pages?
ii. what if users want to view values they entered previously, after completing the data entry process and clicking ‘solve current problem’, for the purpose of making comparisons between the data entered in relation to a specific problem size and the data they wish to enter on another problem size?
iii. what if users want to print the data entered previously, for making comparisons, discussing in meetings with other stakeholders, archiving hard copy records to demonstrate how allocation decisions were made as part of accountability?

iv. what if users want to save electronically, a record of the data entries and the associated outputs recommended by the DSS, as well as making comparisons between previous data entries and outputs?

Given the above what if questions addressed in the design of the DSS, every tab is accessible to the user and allows saving of input values previously entered in respective fields of that tap, for review as part of data retrieval. The data retrieval process is an important component of the DSS that allows users to perform the following useful activities: (1) come back at a later stage to access all the tabs (fields in pages and sub-pages) in terms of what values were entered and the output obtained, (2) print all the data in those tabs for a management meeting on the basis of access to the original print outs as well as electronic copies of input data, and (3) perform comparisons between existing records and new blank data entry process.

10.6.4.3 Command button “Reset Solver engine and Solve current problem”

This integrated command button accomplishes the following : (1) resetting all values in the spreadsheet to default values, (2) updating the solver engine to prepare it to start from a zero position, and (3) instructing the solver engine to find the optimal PM2P allocation decision, based on user input data. This integrated command is an example of innovative design in terms of the functionality of the built GUI (Chileshe, 2005; Tinkler and Jackson, 2004), as an industry application to solve a real PM2P allocation problem. Practitioners are able to interact with all components of the DSS architecture (Figure 6-2). The integrated command button allows the user to view and print the recommended PM2P allocation, as a system generated output that is optimum.

This output is most important as far as the managers are concerned, although the process of arriving at this output is also important and embedded within the DSS, as part of an improved way of allocating project managers-to-projects. Figure 10-8 is an illustration of the output, which has been authenticated with a date and time stamp, to avoid unauthorized changes. This output can be printed for archiving.

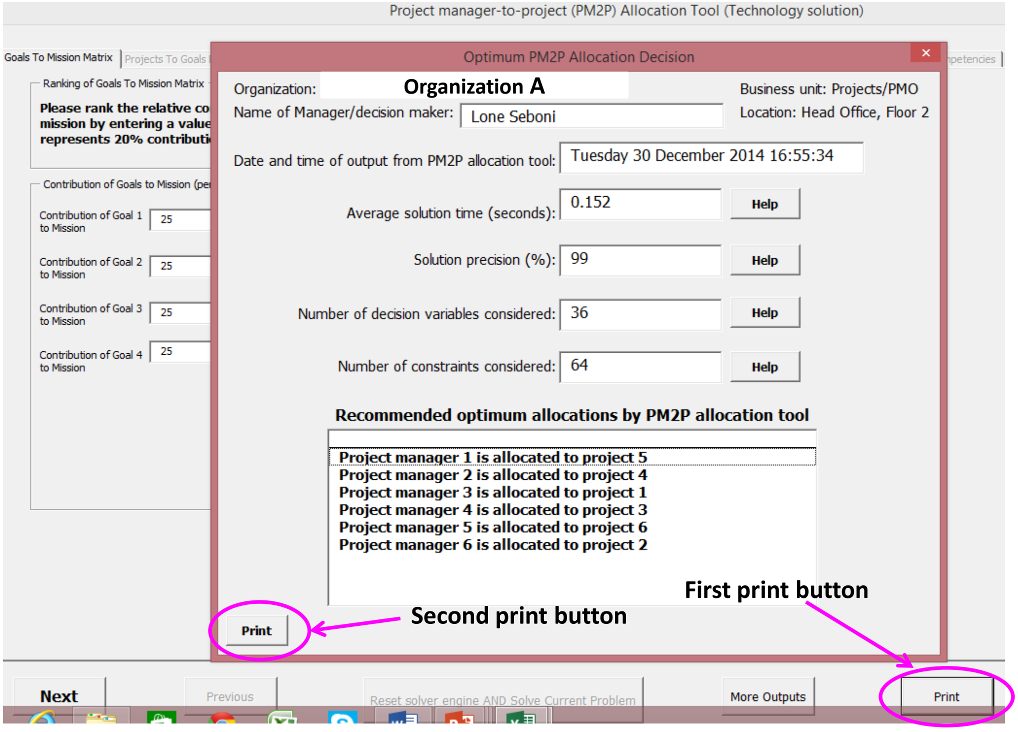


Figure 10-8 Printout of the recommended PM2P allocation decision

10.6.4.4 Other command buttons

The command button “More Outputs” pulls summary data from various places within the appropriate worksheets and displays it back to the user, within the GUI controls. The user can interrogate this summary data, as part of justification for recommended PM2P allocation decisions. The command button “Close Project” closes the project and prompts the user to save input data. The user is presented with the option of either saving or not saving changes made, prior to closing the project.

10.7 Utility of the proposed new approach as a DSS

The proposed new approach addresses the identified limitations in existing spreadsheet models, as discussed in sections 3.3.3 and 10.3.3.1. The new PM2P approach does not only indicate why a certain project manager should be allocated to a particular project but also, why other project managers were not allocated to a specific project. The project heads in organization A indicate that their current PM2P approach does not indicate why alternative project managers were not allocated to a specific project, which is an indication of the absence of a formal and objective approach in the allocation process. The ability of the new approach to indicate the optimal PM2P allocations and why other project managers were not allocated to specific projects (whilst accommodating project manager development) may be of value to the organization, in terms of a transparent process that justifies allocation decisions, particularly since project managers are at liberty to question allocation decisions that affect them, either positively or negatively.

The utility of the resulting product is consistent with conventional approaches that users normally expect from a major Windows system in terms of common functionality (Albright, 2012; Bovey et al., 2009; Harris, 1997; Walkenbach, 2010). These conventional approaches are well known and hence provide a useful platform for user-friendliness. For example, the DSS incorporates in its design, conventional dialogs such as Save As, Print (with options for defining print settings), Open and Close. These conventional dialogs are expected of any system, including Microsoft office systems (ibis). Users are able to execute familiar tasks, all of which enables the DSS to conform to conventions that users are familiar with. For example, the saving and retrieval of data is possible and more importantly, works in a conventional manner to other well-known windows systems.

Specifically, users are able to save their data entry process during the actual live process, which addresses gap 7 highlighted in 9.1.7. This means that users have the option to stop data entry anywhere within the GUI pages and sub-pages, or the last page prior to clicking “solve current problem” and come back later to access and review the values entered in each field. This is an important functionality and considered a contribution to existing PM2P allocation models, given that existing studies on PM2P allocation models (Choothian et al., 2009; Hadad et al., 2013; LeBlanc et al., 2000; Patanakul et al., 2007; Sebt et al., 2009, 2010) do not have this functionality. Another advantage of the new approach over existing studies is the presence of a GUI that enables direct industry application.

On this basis, the developed new approach is an original contribution to existing knowledge in relation to improving the PM2P practice (Chileshe, 2005; Phillips and Pugh, 2005; Tinkler and Jackson, 2004; Booth et al., 2008). The new approach enables accountability in decision making, given that users can print system generated reports and make comparisons between previous and new entries (along with associated outputs). This accountability arises from documented and authenticated records that can be archived and discussed in meetings, instead of the existing PM2P practice in organization A, including limitations in existing PM2P approaches (section 10.1). Furthermore, the system generated reports that indicate why other project managers were not allocated to certain projects can be used to identify project manager development areas, in terms of training needs analysis. The training needs analysis may begin by using the system's outputs to identify gaps in terms of fit for the individual project managers (employees) to the projects (jobs), such that these gaps become the departmental training needs in terms of development plans. The development plans of the individual project managers in the project management department can then be aligned with the project demands to build a fit between project manager competencies and project demands (i.e., organization's needs), to address the gaps discussed in section 8.1.3.5.6.

The dynamic capability of the proposed DSS is of value to industry practitioners in that it eliminates the need and unwieldy process of modifying data entries directly in the spreadsheet, often in different places of the spreadsheet, noted as a limitation in section 3.3.3. This dynamic capability addresses gaps in existing PM2P allocation models, specifically gap 8 (section 10.1.8). Dynamic capability also eliminates the need to change or modify parameters directly within either the spreadsheet or the OpenSolver interface. The fact that the DSS allows users the ability to change problem size parameters in relation to dataset arrays or data setup for different numbers of projects, project managers and organizational goals, is of value to users as regards modifiability for different data sets or scenarios. This ability represents another contribution to existing PM2P allocation models (see Choothian et al., 2009; Patanakul et al., 2007), by extending applications of mathematical modelling of the PM2P allocation problem, for direct use and probably acceptance by industry practitioners.

10.8 Summary

This chapter has proposed a new approach to improve the PM2P practice of a specific organization (organization A) in Botswana, including its verification. The modelling of the PM2P problem, as part of the new approach, is superior to existing PM2P approaches as discussed in section 10.3.6 and addresses the gaps discussed in section 10.1. The superiority of this new approach comes from significant additions made in the modelling of both hard and soft issues in the PM2P allocation problem that is comprehensive and balanced. Contrary to existing models (see Choothian et al., 2009; Patanakul et al., 2007) on the specific topic of PM2P allocations applicable to MPEs, the concept of PM2P allocation intensities was introduced in the proposed model formulation, to reveal variations in each project manager's workload. This enrichment moves the proposed model closer to a representation of reality (Burghes and Wood, 1980; Ragsdale, 2003), in the PM2P allocation problem. Furthermore, this chapter has proposed a mathematical model to improve the PM2P practice, in the form of an integrated DSS with a built-in GUI, to extend the usefulness of the resulting new approach as an application to industry practitioners. This attempt is considered a contribution, given that the proposed DSS enables practitioners to use it, without the need for prior background knowledge in mathematical optimization modelling (unlike existing systems). This contribution provides a fourth building block, in terms of incremental contributions arising from an overall mixed methods approach chosen to fully address the study aim. The next logical step is to validate the proposed new approach, the subject of the next chapter.

Chapter 11

Validation of the proposed new approach and application in organization A

The previous chapter proposed a new approach to improve the PM2P practice in organization A. The purpose of this chapter is to validate this new approach, in the context of potential to improve organization A's existing PM2P practice, consistent with the study aim. This purpose is achieved through the following: (1) typical results from two test cases for illustration, (2) practical application of the DSS in organization A, (3) benefits of the proposed new approach – practitioner's perspective, and (4) summary.

11.1 Typical results from two test cases for illustration

Secondary input data from two test cases (test case 1 and 2 above), is used for illustration purposes, in the context of internal validation of the DSS. A typical result from internal validation of the developed DSS, using secondary input data from two test cases (test case 1 and 2) is shown in Figure 11-1.

A_{ij}	P1	P2	P3	P4	P5	P6
PM1	b 0	b 0	b 0	b 0	b 0	b 1
PM2	b 0	b 1	b 0	b 0	b 0	b 0
PM3	b 1	b 0	b 0	b 0	b 0	b 0
PM4	b 0	b 0	b 0	b 1	b 0	b 0
PM5	b 0	b 0	b 0	b 0	b 1	b 0
PM6	b 0	b 0	b 1	b 0	b 0	b 0

Objective value max 0.95

Key: PM = project manager, P = project

Figure 11-1 Typical result of internal validation of DSS

The results indicate the following: project managers 1 to 6 should be allocated to projects 6, 2, 3, 4, 5 and 3 respectively, with an objective function value of 0.95. From these results, the most competent project manager (PM3) was allocated to the highest priority project (P1). Similarly, the results of the DSS show that the least competent project manager (PM6) was allocated to the lowest priority project (P3). On this basis, the DSS is producing realistic and reasonable recommended allocation decisions that are optimal. These results also compare well with secondary data results for test case 2 (Patanakul et al., 2007) in terms of recommended allocation decisions as follows: PM1 to P3, PM2 to P2 (same result), PM3 to P1 (same result), PM4 to P4 (same result), PM5 to P6 and PM6 to P5. The differences in results for allocations of PM5 to

P6 and PM6 to P5 are expected due to the addition of some derived variables and constraints to existing PM2P allocation models. This means that the differences are explained by the additional variables added to the proposed DSS, in comparison to existing systems. The DSS results did not differ significantly in comparison to the results from the test cases. Furthermore, no significant surprises or unrealistic outputs were observed.

11.2 Practical application of the DSS in organization A

Application of the proposed new approach is discussed in the context of practical application in organization A, using fieldwork 3 activities as part of outcomes from step 11 methods depicted in Figure 6-1. Based on a description of the methods (step 11) to accomplish objective 5, in chapter 6, the results are presented. The quantitative and qualitative data were analysed separately and integrated to obtain a complete understanding regarding the validation of the proposed new approach, using the analytic strategies discussed in chapter 6.

11.2.1 Results from analysis of quantitative data

The results from analysis of the quantitative data related to validation of the proposed DSS, using univariate descriptive analysis of 8 key variables, in terms of measures of central tendency, are presented in Table 11-1. These results provide a picture of the benefits of the proposal over the status quo, regarding organization A's PM2P practice. Table 11-1 reveals that the variable "impact on project success" has a range of scores from 2 to 5, with the highest mean score of 3.50. All twenty-one informants from five business units believe that the proposed DSS is superior to the existing PM2P practice and will have a positive impact on project success.

Table 11-1 Descriptive statistics for key variables

Variables	N	Minimum	Maximum	**Mean**
Extent of formality	21	2	5	**3.14**
Extent of objectivity	21	1	5	2.73
Extent of match between project managers and projects	21	1	5	**3.14**
Extent of comprehensiveness	21	-3	5	**2.93**
Impact on project manager motivation	21	-2	5	2.00
Impact on project success	21	2	5	**3.50**
Impact on project manager rewards	21	0	4	2.59
Impact on project manager performance	21	0	4	2.64
Valid N (listwise)	21			

Note: scores from 21 informants in 5 business units of Organization A

The mean is used to interpret these results because it is the most common measure of central tendency (Blaikie, 2003) that is useful in this situation, in terms of the type of measurement scale used (i.e., continuous). Overall, given that the lowest mean score is 2.00, which reflects that the proposed DSS will result in a positive improvement to the current PM2P practice in organization A, all 21 informants are unified in seeing the value of the proposal, in comparison to their existing PM2P practices.

11.2.2 Results from analysis of qualitative data

The results are presented under 2 sub-headings namely technical solution to the PM2P problem and practical solution to the PM2P problem, as per the themes in the interview schedule. The technical solution relates to testing the proposed new approach side by side with the existing PM2P practice, on the basis of the 8 key variables, without actual implementation (as per the scope defined in section 1.5).

11.2.2.1 Technical solution to the PM2P problem

The results of a matrix coding query from all twenty-one informants (P1 to P21) in relation to the parent node 'Testing technical solution to problem' is depicted in Table 11-2. The cells of the matrix show the coding references for the specific child nodes (columns) pertaining to each specific informant (rows). The results indicate that the dominant theme is extent of formality, followed by extent of objectivity, extent of match and extent of comprehensiveness, respectively.

Table 11-2 Matrix coding query for technical solution to PM2P problem

	Extent_of_Comprehensiveness	Extent_of_Formality	Extent_of_Match	Extent_of_Objectivity	Impact_on_PM_motivation	Impact_on_PM_performance	Impact_on_PM_rewards	Impact_on_Project_success
P1	2	4	3	8	1	1	1	1
P2	0	11	0	6	1	0	0	0
P3	2	5	2	4	0	1	1	1
P4	2	4	3	4	6	1	0	1
P5	3	2	4	3	4	2	1	4
P6	3	12	4	4	2	1	2	1
P7	6	8	3	3	3	4	2	5
P8	0	3	0	2	0	0	0	0
P9	0	2	8	7	5	3	1	5
P10	1	5	3	1	2	1	0	0
P11	2	2	2	4	0	0	0	3
P12	6	4	4	2	1	0	2	3
P13	2	10	4	3	4	1	0	2
P14	1	5	3	1	1	0	1	1
P15	0	3	3	1	1	1	1	1
P16	1	1	3	2	1	2	0	1
P17	1	2	3	2	1	0	1	2
P18	1	3	2	2	2	2	0	2
P19	0	3	1	2	0	0	0	0
P20	6	3	4	2	0	0	2	3
P21	5	2	4	1	4	2	0	3
Total	**44**	**94**	**63**	**64**	**39**	**22**	**15**	**39**

The themes impact on project manager motivation and impact on project success were equally supported in terms of the fifth dominant theme.

The node 'extent of comprehensiveness' for informant 'P1', reveals 2 coding references, illustrated in more depth in Figure 11-2.

	Extent_of_Comprehensiveness
P1	2
P2	0
P3	2
P4	2
P5	3
P6	3
P7	6
P8	0
P9	0
P10	1
P11	2
P12	6
P13	2
P14	1
P15	0
P16	1
P17	1
P18	1
P19	0
P20	6
P21	5
Total	**44**

<Internals\\FW3 Interviews\\SLE Interview transcripts\\UE FW3 interview> - § 2 references coded [2.34% Coverage]

Reference 1 - 1.33% Coverage

The reason why it will score positive throughout for me, is because we are starting from a zero base, we don't have anything.

Reference 2 - 1.01% Coverage

So if you don't have anything basically whatever little improvement you bring, it's a positive.

Figure 11-2 Coding references for node 'extent of comprehensiveness'

The evidence in Figure 11-2 demonstrates the superiority of the proposed DSS, when compared with organization A's existing PM2P practice, in relation to consideration of all important factors that influence the PM2P allocation decision. This evidence implies that practitioners see the value of the proposed DSS, in terms of incorporating and concurrently processing all the important factors, yielding an optimized output.

11.2.2.2 Practical solution to the PM2P problem

The results of a matrix coding query from all twenty-one informants in relation to the parent node 'Testing practical solution to problem' is depicted in Table 11-3. The cells of the matrix represent the coding references for the specific child nodes or sub-themes (columns) pertaining to each specific informant (rows). The node 'costs_to_implement_vs_benefits' for informant 'P4' reveals 2 coding references, which are illustrated in more depth in Figure 11-3. The results in Figure 11-3 indicate evidence of the potential benefits of the proposed new approach, in direct comparison with the existing PM2P practice, in the context of practical solution to the PM2P problem.

Table 11-3 Matrix coding query for practical solution to PM2P problem

	Costs_to_implement_vs_benefits	Is_it_a_suitable_alternative	Problems_envisaged_in_implementation	Timelines_to_adopt_system	When_will_they_implement
P1	3	11	6	3	3
P2	2	5	3	1	1
P3	0	0	0	0	0
P4	2	5	2	3	3
P5	2	3	5	3	2
P6	1	5	4	1	1
P7	1	1	2	1	1
P8	2	0	1	0	0
P9	1	3	3	0	1
P10	3	5	4	1	0
P11	1	4	6	2	1
P12	4	2	2	1	2
P13	3	3	4	1	1
P14	0	0	0	0	0
P15	5	6	9	2	2
P16	1	4	3	3	3
P17	2	3	4	1	1
P18	3	3	14	3	0
P19	1	2	2	1	4
P20	0	0	7	0	0
P21	1	2	7	3	1
Total	**38**	**67**	**88**	**30**	**27**

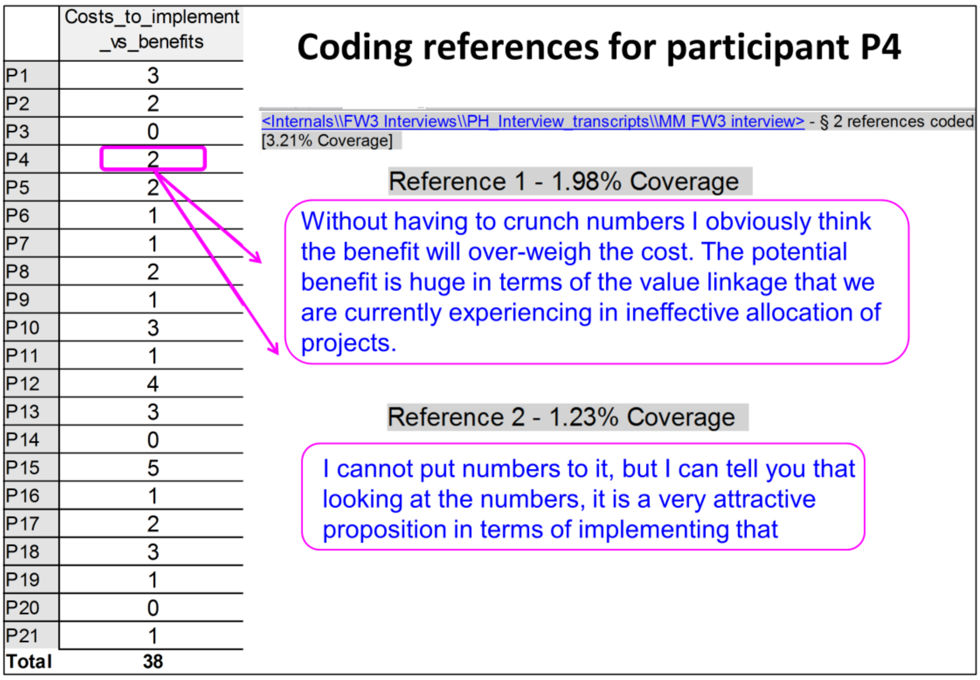


Figure 11-3 Details of the 2 coding references for node ‘costs to implement versus benefits’

11.2.2.3 Content analysis of the 2 parent nodes

The results of a qualitative content analysis (Krippendorf, 2004) of primary data from project heads and senior level executives are presented in Figure 11-4. These results are an output from the use of NVivo's complex coding queries, specifically matrix coding queries, in relation to a case and theme based analysis to interrogate the whole data in the pursuit of informants' use of words and phrases that reflect the two main themes (‘Testing practical solution to problem’ and ‘Testing technical solution to problem’). The matrix in Figure 11-4 reveals that 380 text references from 21 primary data sources support the core theme ‘testing technical solution to the problem’. This core theme is made up of 8 sub-themes (or child nodes), consistent with the 8 key variables discussed in section 3.5.1. Furthermore, the number of references coded at each sub-theme (under the two main themes) is consistent with the total shown in Figure 11-2, Figure 11-3, Table 11-2 and Table 11-3. Similarly, the matrix in Figure 11-4 reveals that 250 text references from 19 primary data sources support the core theme ‘testing practical solution to the problem’.

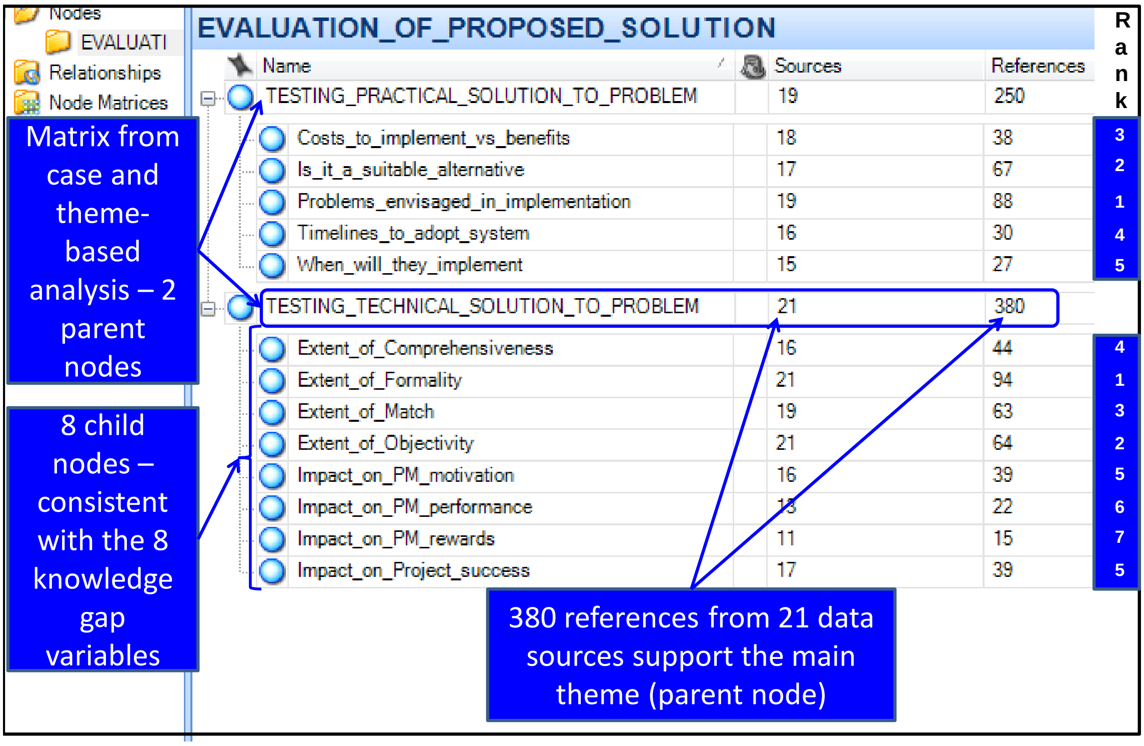


Figure 11-4 Matrix display for the 2 main themes in the validation

In the context of testing practical solution to the problem, the node ‘Problems_envisaged_in_implementation’ is the most dominant. These envisaged implementation problems are associated with the following: availability of the author as developer of the application, allowing sufficient time for training and full user acceptance testing in relation to possible integration with existing systems in organization A.

The second most dominant theme is associated with the proposed new approach being a suitable alternative to the status quo, particularly in view of its superiority as a positive improvement to organization A's existing PM2P practice. The third and fourth dominant themes were as follows: 'Costs_to_implement_vs_benefits' and ''Timelines_to_adopt_system,' respectively. The least dominant theme was related to testing when the practitioners in organization A will actually implement the proposed new approach.

As regards testing technical solution to the problem, the node 'Extent_of_Formality,' was the most dominant across all informants. The interpretation is that practitioners see the proposed DSS as a positive improvement to their existing PM2P practice, in terms of formalizing the PM2P allocation process by introducing a structured and standardized process. The nodes 'Extent_of_Objectivity' and 'Extent_of_Match', came second and third respectively. The practitioners see the value of the proposed DSS in terms of its attempt to reduce the level of subjectivity in the PM2P allocation process but not eliminate subjectivity. The node 'Extent_of_Comprehensiveness' is the fourth dominant. Evidence to support this node is illustrated in Figure 11-2.

The variations in context, from project heads and senior level executives, provide solid evidence that supports the two main themes used in the validation of the proposed solution, in comparison to the existing PM2P approach. The matrix in Figure 11-4 is a demonstration of the co-occurrences of words and phrases that support the two parent nodes. These words and phrases, incorporate divergent views of 21 primary data sources that come from informants in different hierarchical positions within organization A. Whilst caution must be exercised in terms of the need to avoid equating numbers to the significance of themes 'Testing practical solution to problem' and 'Testing technical solution to problem', Krippendorf (2004, p. 16) argues that *"the reading of text is qualitative, even when certain characteristics are later converted into numbers".* The interpretation of this quote is that the matrix display in Figure 11-4, showing the number of times informants used words and phrases that reflect or support the two main themes (including the sub-themes) is in fact qualitative, since it came from analysis of qualitative data in the form of text.

11.3 Benefits of the proposed new approach – practitioners' perspective

The value of the research conducted in this thesis, in terms of the proposed DSS as a new approach to improve the PM2P practice in organization A, is presented in terms of the following: (1) robustness, (2) comprehensiveness, (3) user-friendliness, (4) useful decision making insights, (5) simplicity and (6) solution time. These benefits are discussed below.

11.3.1 Robustness

Unlike the status quo (PM2P practice in organization A), the proposed DSS does not get affected by decision makers changing roles within the organization or leaving the organization. Furthermore, the proposed DSS does not get affected by addition or departure of project managers. The above arguments, which represent reality of the business environment, are addressed by the proposed DSS, on the basis of a standard measurement instrument that encourages consistency in decision making.

11.3.2 Comprehensiveness and formality

The proposed mathematical model, along with its operationalization as part of the new approach, helps to avoid making allocation decisions simply based on a few decision criteria but rather, considers all the important criteria concurrently. The formality of the new approach from processing of both unstructured and structured aspects of the allocation decision brings about effectiveness in the PM2P practice, to address the gaps highlighted in section 7.3.5.1.1. This finding is consistent with the arguments made in sections 1.2, 7.3.8, 7.3.5.1.1 and 10.7, regarding the need for a formal approach to improve the PM2P practice.

This new approach produces an optimum PM2P allocation decision that is characterized by the following: effectiveness, less subjectivity, accountability (managers can account fully for the decisions made from the audit trail produced by the DSS), formality and comprehensiveness (from consideration of all the important factors that influence the decision). The word optimum is used in the context of minimizing mismatches between project managers and projects, which may lead to improved performance. Given the dicussions in section 2.1, the proposed new approach may improve productivity and organizational profits.

11.3.3 User-friendliness

A built-in GUI eliminates the need for practitioners to have prior knowledge or training associated with the following: (1) mathematical optimization modelling skills, (2) optimization software skills needed to convert a complex mathematical model formulation of the PM2P allocation problem into a language understood by the optimization engine (labelled component 2 in Figure 6-2). The user does not need to have prior knowledge of both mathematical modelling and optimization software nor see details of the complex optimization model that runs behind the scenes within the OpenSolver engine in its search for an optimum solution to the problem, and (3) programming skills associated with writing programming code (using VBA) that links the components of the DSS through user commands. Users can simply click on command buttons to communicate with the entire DSS and obtain an output that is easy to understand. The optimization software produces an output that is not easy to interpret without significant training and hence would have been useless to practising managers in its format. This output has been converted to simply language and displayed back to users, through programming code as illustrated in Figure 10-8.

11.3.4 Usefulness – greater decision making insights

The proposed DSS gives insights regarding certain outputs such as levels of match between project managers and projects and variations in project manager workloads, providing practitioners with a mechanism to identify specific workload imbalances across project managers, in relation to the overall project portfolio. These insights are a result of additional variables added to existing PM2P allocation models such as PM2P allocation intensities (LeBlanc et al., 2000; Towle, 1990; Seboni and Tutesigensi, 2014a, 2014b, 2015a, 2015b), with potential to promote transparency and fairness (LeBlanc et al., 2000) in the allocation process. Time-consuming and most complex projects can be identified from the system generated outputs. The fact that there is a consistent measurement tool in place to guide the PM2P allocation decisions by considering all important factors in a consistent manner is likely to improve the perception of fairness in the allocation process. Fairness is important given that project managers (who are impacted by allocation decisions) feel strongly about workload imbalances that act as a stumbling block to their ability to manage projects effectively.

11.3.5 Simplicity

The proposed DSS offers practitioners insights into the PM2P decision making process by breaking down the complex multi-criteria decision making problem (Triantaphyllou, 2000) into manageable components. This break down is also done in a systematic manner, in terms of different hierarchical levels (Saaty, 1980; Saaty, 2008). However, all input data associated with the different levels is processed concurrently, resulting in an optimal PM2P allocation decision (Seboni and Tutesigensi, 2015a).

11.3.6 Solution time

The excellent computation time (LeBlanc et al., 2000; Seboni and Tutesigensi, 2015a), following data input, is of great benefit to practitioners, given the importance of timely but optimum decisions in a MPE. Recommended optimum allocation decisions are produced by the DSS in less than one second, owing to the capability of OpenSolver, which is linked to the developed GUI (Seboni and Tutesigensi, 2015a).

11.4 Summary

This chapter has discussed the validation of the proposed new approach in terms of potential to improve the PM2P practice, using organization A as a case study. The importance of mathematical modelling and optimization, as appropriate tools to improve PM2P practices in MPEs were highlighted.

The discussions regarding benefits of the DSS (sections 10.3, 10.6 and 10.7) represent a contribution to existing knowledge, on the basis of addressing the gaps in existing literature on PM2P allocation models (section 10.1). This contribution advances the understanding of PM2P practices in MPEs. The view regarding contribution is consistent with originality definitions (Dunleavy, 2003; Phillips and Pugh, 2005) as highlighted in section 1.2. The development of a novel new approach that has been validated in terms of direct application and value to industry practice, in comparison to existing PM2P practices in organization A, represents a contribution, on the basis of extending the usefulness of mathematical optimization modelling concepts to industry practice. This contribution provides the fifth and last building block, in terms of incremental contributions from an overall mixed methods approach geared to sufficiently address the study aim. All five contributions are taken together, in an incremental and sequencial manner that optimally accomplishes the overall study aim.

This chapter has provided compelling evidence of the value of the proposed and validated new approach, in terms of its potential to improve organization A’s PM2P practice. The findings from this chapter are original because they address existing weaknesses in organization A’s PM2P practice, including several gaps in existing studies on PM2P allocation models (section 10.1). The discussions in this chapter lead into the culmination of the entire PhD work involving the complete set of responses to the research problem, the subject of the next and final chapter.

Chapter 12
Conclusions and recommendations

This thesis is concerned with improving the existing PM2P practice in the context of Botswana. A review of extant management literature on empirical studies that report on PM2P practices, some of which received awards for best paper in leading journals, shows that no attempt has been made to report on practices in other countries such as Botswana. This observation is despite evidence of both the cost implications of making sub-optimal PM2P allocation decisions and the need to improve existing practices in the context of Botswana. The purpose of this thesis was to fill this gap, by developing a new approach to improve the existing PM2P practice of a specific organization (organization A) in Botswana. The overall contextual approach taken was geared to make a practical contribution to the allocation of project managers-to-projects in a new context that has hitherto not been conducted. This new approach enables practitioners to use it directly in improving the existing PM2P practice, for the first time, without the need for prior knowledge of complex mathematical optimization modelling concepts.

This chapter is structured into three sections. Section 12.1 discusses achievement of objectives. Section 12.2 discusses realization of the study aim and potential implementation challenges, to demonstrate critical reflection of the limitations of introducing the proposed new approach to an organization (out of scope for this thesis). Section 12.3 highlights recommendations for future research.

12.1 Achievement of objectives

Five objectives were set (section 1.3). These objectives are tightly linked together to collectively accomplish the study aim, through a mixed methods approach. The achievement of these objectives is presented next, in relation to addressing four key questions namely: (1) what was set out to be done (objective)? (2) what was found? (3) what is the significance or contribution of that finding? and (4) limitations.

12.1.1 To evaluate existing PM2P practices in MPEs of Botswana (objective 1)

The author set out to evaluate existing PM2P practices in Botswana and the impact of those practices on performance. A survey of Botswana’s public and private sector organizations, involving a total of 73 questionnaires and interviews with project managers and project heads, was conducted.

The findings provided compelling empirical evidence of the ineffectiveness of existing PM2P practices and that those practices impact negatively on organizational performance, in Botswana’s public and private sector.

The findings provide, for the first time, strong empirical evidence of the state of existing PM2P practices in Botswana that has been lacking. This is a contribution to existing project management knowledge, in the context of findings from a new setting that has hitherto, not been studied. The extent of this contribution is large for two reasons namely: absence of empirical studies on PM2P practices from a Botswana context, and currently limited empirical studies on PM2P practices, focussed predominantly on one country (USA). The findings from Botswana extend our understanding of existing knowledge on PM2P practices in another country, industries and project types, other than US high-technology industry and new product development projects. This state of practice, now known, can be used to facilitate improvements in existing PM2P practices, to provide real value to project-based organizations in Botswana. The findings from Botswana resulted in a publication, which provides further evidence of the significance of extending existing knowledge on PM2P practices to a new context.

However, the findings regarding existing PM2P practices in Botswana may not be representative of all MPEs in Botswana, given that not all eligible MPEs in Botswana participated in the survey (due to challenges of access to data). The impact of this limitation on the significance of the findings is estimated to be minimal, given that 12 out of 15 (80%) eligible MPEs in Botswana, participated in the evaluation of existing PM2P practices, consistent with the discussions in sections 4.1.3, 4.3.1, 4.5.2, 7.3.5 and 7.3.5.1.2. Therefore, this limitation is not severe and can be mitigated by inclusion of the remaining 3 MPEs in future studies.

12.1.2 To develop a conceptual framework for understanding effective PM2P practices in MPEs (objective 2)

The intent was to develop a conceptual framework for understanding effective PM2P practices in MPEs, from a best practice perspective. A critical appraisal of the depth and breadth of management literature was conducted and complemented with industry expert reviews, to ensure theoretical grounding of the resulting conceptual framework.

The results from a critical review of extant literature (narrowly focussed) revealed gaps in existing conceptual frameworks on PM2P practices. These gaps included: lack of comprehensiveness in consideration of 34 important factors identified to influence effective PM2P practices, absence of feedback loops between conceptual framework elements, and lack of explicit recognition of contextual factors.

These results represent a contribution to the theoretical understanding of the PM2P practice in MPEs, in the context of addressing identified gaps in existing conceptual frameworks. The extent of this contribution is large, given 12 significant additions made to existing conceptual frameworks, as discussed in sections 3.2.3, 8.1.3.3, 9.4.2 and 10.8. This thesis is the first major attempt to broaden the theoretical base, underpinned by a comprehensive list of important factors influencing an effective PM2P practice. These factors range from not only organizational strategic factors, project characteristics, project manager competencies, constraints associated with both the organization and the individual project manager but also explicit consideration of context that influences these factors, as well as feedback loops to enable continuous improvements. The identified factors, including the significant additions made to existing studies, represent components of a robust conceptual framework that builds on and extends existing literature on PM2P practices in MPEs. This thesis contributes to practice by providing, for the first time, new insights regarding a comprehensive list of influencing factors to act as a vital guideline to practitioners, in relation to what constitutes an effective PM2P decision-making approach. A publication associated with the development and verification of the conceptual framework provides concrete evidence of the importance of having addressed gaps in existing conceptual frameworks, in terms of revised thinking that can be applied by other researchers to study PM2P practices.

Although the conceptual framework developed in this thesis provides a comprehensive guideline that has stood up to scrutiny in terms of components of an effective PM2P practice, it will need to be modified on the basis of context, prior to applying it to study PM2P practices in another context. This limitation is not serious and in fact positive because there will be no need to invent a completely new conceptual framework to study PM2P practices in another context. In the absence of a robust conceptual framework that draws on broader management theories to understand effective PM2P practices, the author had to develop it first. The impact of this limitation on the significance of the findings is minimal, given that the PM2P practice is underpinned by generic theories but shaped by contextual application of those theories (section 4.2). This argument implies that some of the conceptual framework elements may change based on context, when used to study PM2P practices in another context. This limitation merely provides scope for future studies, in terms of building on and using the conceptual framework to study the PM2P practice in another context.

12.1.3 To describe the existing PM2P practice of a specific organization (organization A) in Botswana (objective 3)

This objective was about using the conceptual framework for an in-depth study of organization A's existing PM2P practice. A case study approach (single case study) was used to elucidate a complete description of the existing PM2P practice, for reasons given in section 5.2.

The findings revealed three things namely: (1) it is important to understand the organizational context in which the PM2P allocation decision is made; (2) two main gaps identified in organization A's existing PM2P practice were: inadequate consideration of all important factors influencing the PM2P practice, and practitioners' inability to account for high rating scores to some influencing factors, in their existing PM2P practice; and (3) practitioner's use some management tools at strategic level and recognize the importance of some influencing factors to effective PM2P practices.

These findings are significant because they represent the first major piece of empirical research that provides a complete description of the existing PM2P practice in organization A, hitherto unknown. The findings from this new empirical research are a contribution to existing knowledge on PM2P practices and challenge existing working practice, in the context of gaps undercovered. Organization A is now in a better position to address these gaps as part of improving the existing PM2P practice, consistent with the strategic intent of transforming to high performance through an improvement in processes. The findings from this thesis shape the research landscape by extending limited empirical studies on PM2P practices to a new context, other than USA high-technology industry. The findings from a new context provide a strong basis upon which a new approach can be developed to facilitate an improved PM2P approach, given the identified gaps. A publication associated with these findings provides further evidence of the impact of extending the limited empirical studies on PM2P practices to a new context, for the first time. Other organizations in Botswana that undertake business in a multi-project context, may benefit from these findings.

However, the findings from a description of the existing PM2P practice in organization A may not be applicable to other contexts, given a case study approach. Similar to research involving a case study approach, this limitation is not serious because it arises from the specific conditions pertaining to the PM2P allocation problem in organization A, consistent with the intent to describe the existing PM2P practice in organization A (depth of application) rather than generalizing to other contexts (breadth of application). Therefore, this limitation does not affect the significance of the findings pertaining specifically to organization A's existing PM2P practice.

12.1.4 To propose a new approach to improve organization A's PM2P practice (objective 4)

This objective was about proposing a new approach to improve the PM2P practice of a specific organization (organization A) in Botswana. Literature spanning four disciplines (operations research, project management, mathematics and computer science) was critically appraised and brought to bear on the proposed new approach.

8 gaps were identified in extant literature on mathematical modelling of the PM2P allocation problem (section 9.1), some of which include: lack of comprehensiveness in the modelling of both soft and hard issues influencing effective PM2P practice, and absence of a user interface in existing PM2P approaches. The identified gaps informed the development of a new PM2P approach.

This thesis is the first major attempt to propose a novel and integrated PM2P approach that is superior to existing approaches, given incorporation of identified gaps in extant literature (section 10.1). This attempt is a contribution to existing knowledge because it advances mathematical modelling of the PM2P allocation problem, in terms of a comprehensive and balanced approach that incorporates modelling of both hard and soft issues, whilst being user-friendly to practitioners. The extent of this contribution is large, given absence of an existing PM2P DSSs that can be used directly by practitioners, prior to this thesis. The proposed new approach in this thesis has unlocked the modelling of the PM2P problem to industry practitioners (intended users) for the first time, in terms of improving uptake and acceptance. Users can interact with the unique new approach (as an integrated DSS) via a built-in interface, in a user-friendly manner that avoids being intimidated by details of complex optimization algorithms, unlike existing PM2P approaches. The OpenSolver model results revealed capability of the proposed approach to complement managerial intuition, producing optimum PM2P allocation decisions. This capability has significant implications in terms of real value to an organization, given the opportunity to assess system output reports (such as levels of match between project managers and projects) before a decision is made. The findings from proposing a new approach also have wider implications for research, in the context of advancing the understanding of existing literature on innovative ways to improve PM2P practices in MPEs. A publication associated with these findings provides further evidence of this argument.

However, the proposed new approach cannot eliminate subjectivity in the PM2P allocation decision, nor is it integrated with existing organizational systems. The absence of integration may be a limitation in terms of possibility to pull some of the required data from existing company systems (i.e. records), thereby reducing both the time for data input from the user and subjectivity in the PM2P allocation decision. The objectivity of the PM2P decision is improved, however, by having a common and consistent measurement scale.

12.1.5 To validate the new approach (objective 5)

This objective was about validating the proposed new approach, in terms of potential to improve the existing PM2P practice in organization A. A case study approach was used to validate the new approach, for reasons given in section 6.2.3.

All twenty-one informants from organization A’s five business units were unified in seeing the value and superiority of the new approach, over the existing PM2P practice, in terms of significant potential to improve the existing PM2P practice. The results also showed that the potential value of the proposed approach outweighs the costs to implement it, in the context of organization A’s project portfolio of about £422 million.

For the first time, key principles from four disciplines were brought together in a creative manner, operationalized to demonstrate the utility of the validated new approach in improving organization A’s existing PM2P practice. The new approach is a major contribution to the PM2P practice, which has now been developed, verified and validated in practice for the first time. This thesis is a pioneering piece of research and a first major attempt to provide an integrated and user-friendly approach that has been validated to aid practitioners in solving a real-life and complex industry PM2P allocation problem. Moreover, the proposed approach is a contribution to existing practice because it enables practitioners to make optimized and accountable decisions for the first time, given a systematic, comprehensive, transparent, more explicit and less subjective process than existing PM2P approaches. This new approach has flexibility to be applied to allocate project managers to incoming new projects as well as re-allocating project managers to existing projects, to cope with unpredictable nature of business dynamics. Organizations are increasingly seeking to shift to high performance through an improvement in processes for delivery of multi-projects. Notwithstanding, existing PM2P approaches have hitherto been based on managerial intuition (for both structured and unstructured aspects of the decision) and/or approaches that require an understanding of complex mathematical programming concepts, which may intimidate practitioners and of no direct benefit to them. The innovative and multi-disciplinary approach proposed in this thesis addresses these problems, by providing a practicable and accessible solution that can be used directly by practitioners (non-specialists). The proposed new approach has real-value to an organization in terms of enhancing practitioners' PM2P decision making, leading to reductions in: mismatches between project managers and projects, manager's time spent on rectifying PM2P allocation decisions, and associated costs (direct and indirect). This value translates to improvements in project manager motivation, productivity and project delivery.

Practical application of the outcomes from this thesis was demonstrated through organization A's significant interest and commitment to roll-out the new approach. Given that Organization A has no existing formal management tool to match project managers-to-projects, the new approach has significant potential to improve the existing PM2P practice. Discussions to implement the proposed new approach for use by portfolio managers across Organization A's geographic locations are at an advanced stage. Organization A has already purchased commercial optimization software to run the algorithms for bigger PM2P problem sizes. This thesis has therefore, made a series of five major contributions to knowledge and practice, as discussed in section 12.1.1 to 12.1.5. These series of contributions, when taken together, become significant, in terms of a coherent piece of research at PhD level.

As regards publications arising directly from this thesis, the author has published five research papers in peer reviewed conference proceedings and international journals (see appendix A). These publications demonstrate concrete evidence of original contributions to knowledge from this thesis, as they relate to the significance of the PhD work in influencing the broader management field. This thesis will lead to more publications, in an attempt to disseminate the importance and usefulness of improved principles associated with the new PM2P approach. The adoption of these principles by other researchers, for practical application in other contexts, is likely to fundamentally change the process of allocating project managers-to-project in future.

However, whilst the principles behind developing and validating the new approach may be applied to other contexts, the proposed new approach will need to be modified to suit the specific conditions for validation in those contexts. An alternative interpretation is that this limitation undermines the value of the work conducted in this thesis.

However, this work should be taken in the context of the approach taken in this thesis, which was contextual to a specific set of conditions pertaining to the PM2P allocation problem of a specific organization (organization A) in Botswana, consistent with the discussions in sections 2.7.2, 4.2, 4.3, 6.1.1, 3.1.1 and 8.1.3.1. In hindsight, informants from IT could have been included in the validation, to give greater insights and specific details on implementation issues surrounding the introduction of new systems and the likely impact (if any), from integration with existing systems. Furthermore, sensitivity analysis could have been included to produce additional system reports, as part of enhancing acceptability of the new approach by intended users. Some will argue that the absence of sensitivity analysis may undermine the quality of the validation findings, in terms of utility of the new approach. However, this argument could also be taken in the context of necessary and incremental stages for proposing and validating a new approach or system, and then refining it in terms of different versions, similar to the procedure for introducing new products and consistent with the discussions in section 6.2.3.

12.2 Achievement of aim and potential implementation challenges

The aim of this thesis was to develop a new approach to improve the existing PM2P practice of a specific organization in Botswana, to potentially optimize organizational performance. This aim was quite an ambitious undertaking, given the following reasons: (1) currently limited empirical research into the PM2P practice in MPEs, (2) absence of relevant empirical studies from a Botswana context, necessitating collection of empirical data (from a different continent to where the researcher was based) to first build a solid foundation for the research, instead of merely relying on limited empirical studies, and (3) stringent timelines for the PhD work. The five objectives, whose conclusions were discussed in section 12.1, are taken together to adequately address the ambitious study aim. This aim has been adequately achieved through an overall mixed methods study involving five objectives conducted sequentially, objectives of which are tightly linked together by the need to address the study aim. This argument is consistent with the discussions in sections 1.2, 1.3, 4.2, 4.3, 4.4, 4.7 and 10.1. A critical reflection of the limitations of the proposed new approach, from a potential implementation perspective (out of scope for this thesis), is discussed next.

Firstly, managerial buy-in is the first and main issue to be obtained, in terms of the decision to accept and use the proposed new approach. This decision is a process that requires engaging all relevant stakeholders in terms of educating them about the benefits of the new approach, to address willingness to change from the managers' existing PM2P approach that they are accustomed to, into a new way of doing things. Resistance to change, on the part of all relevant stakeholders, is common in any change management initiative. The validation results suggest however that managerial buy-in has been achieved to some extent, although it is acknowledged to be a process, in the context of potential implementation (out of scope for this thesis).

Secondly, a related implementation issue from a technical back office type of process may be the issue of ownership of the new system. Certain individuals (primary users) would need to be identified to own it and ensure its sustainability (from a front office process), with some sort of read-only access by possibly some other individuals (secondary users). The organization may need to decide whether to give certain users full access rights and others limited access, depending on the organizational set-up.

Thirdly, data management issues associated with implementation of the new system (a scope exclusion item for this thesis) may occur. This means that the new system, if it were to be implemented, will bring about potential consequences of sensitive information being compromised by falling into the wrong hands. These implications call for the need to plan and include data management and storage procedures to be followed by users (in training on how to use the system), to safeguard this sensitive information. The use of strong passwords, coupled with the built-in system functionality associated with avoiding unauthorized changes to the system, will need to be in place.

Lastly, there are probable technical problems associated with the need to get the system working on a continuous basis, which calls for plans to sustain the new system during and post implementation (out of scope for this thesis). These problems can be addressed by properly engaging organization A's IT department at an early stage, such that they are in a position to provide internal support in all aspects of the new system. The IT department must also be involved with the necessary annual technology support provided by the optimization software developers, as regards supporting the new system.

12.3 Recommendations

Recommendations for future research are presented below.

i. The limitations give scope for inclusion of additional informants from information technology in future studies, to strengthen the validity of claims made regarding benefits of the new approach. These informants may provide deeper insights on implementation issues (i.e., user acceptance testing).

ii. The subjectivity in the quantification of parameters (section 10.3.7) in the mathematical modelling of the PM2P allocation problem may be improved through a Delphi technique for consensus building.

iii. Research is needed to extend the scope to include flexibility of the proposed approach for different contexts and applications. The GUI can be designed with capability to pull out some of the variables and make them configurable, such that users from different organizations are able to select their preferred parameters from the list.

iv. Full implementation of the proposed DSS may be carried out, to test the system's impact on performance variables over time.

v. Integration of the proposed DSS with existing systems, to align it with existing management systems within a particular organization can be pursued, to get maximum value from the proposed DSS.

vi. Future work is needed to focus on potential to commercialize the DSS. Commercialization can be rolled out in stages, such that it includes enhancements to the system, with input from users. For example, sensitivity analysis reports can be incorporated within the system generated reports.

References

Abara, J. (1989). Applying Integer Linear Programming to the Fleet Assignment Problem. *Interfaces.* **19**(4), pp.20-28.

Adair, J. (2007). *Decision Making & Problem Solving Strategies.* London: Kogan Page Limited.

Adams, J. R., Barndt, S. E. and Martin, M. D. (1979). *Managing by Project Management.* Dayton, Ohio: Universal Technology Corporation.

Adler, P. S., Mandelbaum, A., Nguyen, V. and Elizabeth, S. (1996). Getting the most out of your product development process. *Harvard Business Review.* **74**(2), pp.134-152.

Adobor, H. (2004). Selecting management talent for joint ventures: A suggested framework. *Human Resource Management Review.* **14**(2), pp.161-178.

Aguilar-Savén, R. S. (2004). Business process modelling: Review and framework. *International Journal of Production Economics.* **90**(2), pp.129-149.

Ahadzie, D. K., Proverbs, D. G. and Olomolaiye, P. (2008). Towards developing competency-based measures for construction project managers: Should contextual behaviours be distinguished from task behaviours? *International Journal of Project Management.* **26**(6), pp.631-645.

Ahoy, C. (2013). *What is Process Mapping.* Retrieved from http://www.fpm.iastate.edu/worldclass/process_mapping.asp.

Aitken, A. and Crawford, L.H. (2007a). Coping with stress: Dispositional coping strategies of project managers. *International Journal of Project Management.* **25**(7), pp.666-673.

Aitken, A. and Crawford, L. H. (2007b). A study of project categorisation based on project management complexity. In: *International Reserach Network for Organizing by Projects (IRNOP VIII)*, *Brighton, UK*.

Albar, F. M. (2013). *An Investigation of Fast and Frugal Heuristics for New Product Project Selection*. PhD thesis, Portland State University.

Albar, F. M. and Jettera, A. J. (2013). Uncovering Project Screening Heuristics with Cognitive Task Analysis: How Do Gatekeepers Decide Which Technologies to Promote? In: *Portland International Centre for Management of Engineering and Technology(PICMET), San Jose, California, USA*. IEEE, pp.459-467.

Albright, S. C. (2012). *VBA for Modelers: Developing Decision Support Systems with Microsoft Office Excel.* 4th ed. Mason, OH Cengage Learning.

Alison, G. T. (1971). *Essence of decisions.* Boston: Little: Brown and Company.

Amit, R. and Shoemaker, P. (1993). Strategic assets and organisational rents. *Strategic Management Journal.* **14**(1), pp.36-46.

Archibald, R. D. (1975). *Managing High-Technology Programs and Projects.* New York: Wiley.

Aritua, B. (2009). *Managing Risk and uncertainty in construction multi-projects*. thesis, University of Leeds.

Aritua, B., Male, S. and Bower, D. (2009a). Defining the intelligent public sector construction client. *Management, Procurement and Law.* **162**(MP2), pp.75-82.

Aritua, B., Male, S., Bower, D. and Madter, N. (2011). Competencies for the intelligent public sector construction client In: *Proceedings of the ICE - Management, Procurement and Law*, pp.193-201.

Aritua, B., Smith, N. J. and Bower, D. (2009c). Construction client multi-projects - A complex adaptive systems perspective. *International Journal of Project Management.* **27**(1), pp.72-79.

Artto, K. A. and Dietrich, P. H. (2004). Strategic business management through multiple projects. In:Morris P.W.G. and Pinto J.K. eds. *The Wiley guide to managing projects.* London: John Wiley & Sons, pp.144-76.

Ashley, D. B. (1986). "New Trends in Risk Management". In: *Internets 10th International Expert Seminar on "New Approaches in Project Management", Zurich*.

Asosheh, A., Nalchigar, S. and Jamporazmey, M. (2010). Information technology project evaluation: An integrated data envelopment analysis and balanced scorecard approach. *Expert Systems with Applications.* **37**(8), pp.5931-5938.

Augustine, N. R. (1959). Managing Projects and Programs. *Harvard Business School Press.* pp.145-162.

Avots, I. (1969). Why does project management fail? *California Management Review.* **12**(1), pp.77-82.

Ayag, Z. and Ozdemir, R. G. (2009). "A hybrid approach to concept selection through fuzzy analytic network process". *Computers & Industrial Engineering.* **56**(1), pp.368-379.

Azani, H. and Khorramshahgol, R. (1990). *Analytic Delphi Method (ADM): A Strategic Desicion Making Model Applied to Location and Planning. Engineering Costs and Production Economics.* **20**(1), pp.23-28.

Azarmi, N. and Smith, R. (2007). Intelligent scheduling and planning systems for telecommunications resource management. *BT Technology Journal.* **25**(3 & 4), pp.241-248.

Baccarini, D. (1996). Concept of project complexity: a review. *International Journal of Project Management.* **14**(4), pp.201-204.

Badiru, A. B. (1996). *Project Management in Manufacturing and High-Technology Operations.* New York: John Wiley & Sons.

Baker, K. R. (1974). *Introduction to sequencing and scheduling.* New York: John Wiley & Sons.

Balachandra, R. and Friar, J. H. (1997). Factors for success in R&D projects and new product innovation:A contextual framework *IEEE Transactions on Engineering Management.* **44**(3), pp.276-287.

Ballesteros-Pérez, P., González-Cruz, M. C. and Fernández-Diego, M. (2012). Human resource allocation management in multiple projects using sociometric techniques. *International Journal of Project Management.* **30**(8), pp.901-913.

Baruch, Y. and Holtom, B. C. (2008). Survey response rate levels and trends in organizational research. *Human Relations.* **61**(8), pp.1139-1160.

Bazeley, P. (2002). The evolution of a project involving an integrated analysis of structured qualitative and quantitative data: from N3 to NVivo. *International Journal of Social Research Methodology.* **5**(3), pp.229-243.

Bazeley, P. (2003). Teaching Mixed Methods. *Qualitative Research Journal.* **3**(1), pp.117-126.

Bazeley, P. (2006). The Contribution of Computer Software to Integrating Qualitative and Quantitative Data and Analyses. *Research in the Schools.* **34**(1), pp.64-74.

Bazeley, P. (2007). *Qualitative Data Analysis with NVivo.* London: SAGE.

Bazeley, P. (2009a). Analysing Qualitative Data: More Than 'Identifying Themes' *Malaysian Journal of Qualitative Research.* **2**(1), pp.6-22.

Bazeley, P. (2009b). Editorial: Integrating Data Analyses in Mixed Methods Research. *Journal of Mixed Methods Research.* **3**(3), pp.203-207.

Bazeley, P. (2012). Integrative Analysis Strategies for Mixed Data Sources. *American Behavioral Scientist.* **56**(6), pp.814-828.

Bazeley, P. (2013). *Qualitative Data Analysis: Practical Strategies.* London: SAGE.

Bazeley, P. and Jackson, K. (2013). *Qualitative Data Analysis with NVivo.* 2nd ed. London: SAGE.
Bazeley, P. and Richards, L. (2000). *The NVivo Qualitative Project Book* London: SAGE.
Beck, D. R. (1983). *"Implenting Top Management Plans Through Project Management".* New York: Van Nostrand ReonHold Co.
Bell, D. E., Raiffa, H. and Tversky, A. (1988). Descriptive, Normative and Prescriptive Interations in Decision Making. In: Bell, D.E., et al. eds. *Decision Making: Descriptive, Normative, and Prescriptive Interactions* Cambridge: Cambrodge University Press.
Belton, V. (1986). A comparison of the analytic hierarchy process and a simple multi-attribute value function. *European Journal of Operational Research.* **26**(1), pp.7-21.
Berg, B. L. (2007). *Qualitative Research Methods for the Social Sciences.* 6th ed. London: Pearson.
Berg, P. (1999). The effects of high performance work practices on job satisfaction in the United States steel industry. *Industrial Relations.* **54**(1), pp.111-135.
Berry, J. and Houston, K. (1995). *Mathematical modelling.* London: Edward Arnold.
Birkhead, M., Sutherland, M. and Maxwell, T. (2000). Core competencies required of project managers. *South African Journal of Business Management.* **31**(3), pp.99-105.
Birnberg, H. (1997). How many project managers do you need? *Civil Engineering News*.
Blaikie, N. (2000). *Designing Social Research: The logic of anticipation.* Cambridge: Polity Press.
Blaikie, N. (2003). *Analyzing Quantitative Data.* London: SAGE.
Blismas, N., Sher, W., Thorpe, A. and Baldwin, A. (2004). A typology for clients' multi-project environments. *Construction Management & Economics.* **22**(4), pp.357-371.
Blissmass, N., Sher, W. D., Thorpe, A. and Balwin, A. N. (2004). Factors influecing delivery within construction clients' multi-project environments. *Engineering Construction Architect Management.* **11**(2), pp.113-125.
Bockerman, P., Johansson, Y. E. and Kauhanen, A. (2011). Innovative work practices and sickness absence: what does a nationally representative employee survey tell? *Industrial and Corporate Change.* **21**(3), pp.587-613.
Boehm, B. W. (1981). *Software Engineering Economics.* New Jersey: Prentice Hall.
Boeije, H. (2002). A Purposeful Approach to the Constant Comparative Method in the Analysis of Qualitative Interviews. *Quality and Quantity.* **36**(4), pp.391-409.
Booth, W. C., Colomb, G. G. and Williams, J. M. (2008). *The Craft of Research: Chicago Guides to Writing, Editing and Publishing.* Third Edition ed. Chicago: University of Chicago Press.
Borrego, M., Douglas, E. P., and Amelink, C. T. (2009). Quantitative, Qualitative, and Mixed Research Methods in Engineering Education. *Journal of Engineering Education*. **98** (1), pp. 53-66.
Botswana Government, Ministry of Trade and Industry. (2012). *Botswana Listed Companies.* Retrieved from http://www.bloomberg.com/markets/companies/country/Botswana.
Botswana Federation of Trade Unions – Policy on Education in Botswana. Retrieved from http://library.fes.de/pdf-files/bueros/botswana/04922.pdf.
Botswana Insurance Holding Limited Group. (2013). Sustainability. Retrieved from http://www.bihl.co.bw/sustainability.

Botswana National Development Plan 10. (2009). NDP 10, 2010-16. Retrieved from http://www.finance.gov.bw/index.php?option=com_content1&parent_id=334&id=338.

Bovey, R., Wallentin, D., Bullen, S. and Green, J. (2009). *Professional Excel Development: The Definitive Guide to Developing Applications Using Microsoft Excel, VBA, and .Net.* 2nd ed. Boston, MA: Pearson Education, Inc.

Bowen, H. K., Clark, K. B., Hollowway, C. A. and Wheelwright, S. C. (1994). Development Projects: The Engine of Renewal. *Harvard Business Review.* **72**(5), pp.110-120.

Bower, D. (2013). The new infrastructure procurement routemap: a global guide to improving delivery capability. In: *Proceedings of the Institution of Civil Engineers -Civil Engineering* pp.99-99.

Boyatzis, R. E. (2007). Competencies in the 21st century. *Journal of Management Development.* **27**(1), pp.5-12.

Braun, V. and Clarke, V. (2006). Using Thematic Analysis In Psychology. *Qualitative Research in Psychology.* **3**(2), pp.77-101.

Brewer, J. and Hunter, A. (2006). *Foundations of multimethod research: Synthesizing styles.* 2nd ed. Thousand Oaks, CA: SAGE.

Briner, W., Hastings, C. and Geddes, M. (1996). *Project Leadership.* Second ed. England: Gower Publishing Limited.

Bringer, J. D. (2002). *Sexual exploitation: Swimming coaches' perceptions and the development of role conflict and role ambiguity*. PhD thesis, University of Gloucestershire.

Broomes, V. (2013). Governance, Risk and Stakeholder Engagement: What Lessons can be Learnt from Mining? In: Crowther, D. and Aras, G. eds. *Emerald Group Publishing Limited.* UK, **5**(1), pp.157-180.

Brown, A. W., Adams, J. D. and Amjad, A. A. (2007). The relationship between human capital and time performance in project management: A path analysis. *International Journal of Project Management.* **25**(1), pp.77-89.

Brown, S. L. and Eisenhardt, K. M. (1995). Product Development: Past research, present findings, and future directions. *Academy of Management Journal.* **20**(2), pp.343-378.

Bryman, A. (1989). *Research Methods and Organization Studies* London: Routledge.

Bryman, A. (1995). *Research methods and organization studies.* London: Routledge.

Bryman, A. (2008). *Social research methods.* New York: Oxford University Press Inc.

Bryman, A. and Bell, E. (2007). *Business research methods.* Oxford: Oxford University Press.

Burghes, D. N. and Wood, A. D. (1980). *Mathematical models in the social, management and life sciences.* New York: Chichester: Wiley.

Busha, C. H. and Harter, S. P. (1980). *Research Methods in Librarianship: Techniques and Interpretation.* New York: Academic Press.

Campbell, D. T. and Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin.* **56**(2), pp.81 -105.

Campos, J., Worseley, D. and Buxton, B. (2010). *Leveraging New Products Metrics to Gain Velocity.* LLC.

Caniels, M. C. J. and Bakens, R. J. J. M. (2012). The effects of Project Management Information Systems on decision making in a multi project envirionment. *International Journal of Project Management.* **30**(2), pp.162-175.

Chaw, A., Yung, E., Lam, P., Tam, C. and Cheung, S. (2001). Application of Delphi method in selection of procurement systems for construction projects. *Construction Management and Economics.* **19**(7), pp.699-718.

Chapra, S. C. (2003). *Power Programming with VBA/Excel.* New Jersey: Prentice Hall.

Charouz, J. and Ramik, J. (2010). A multicriteria desicion making at portfolio management. In: *E+M Ekonomie a Management*. **13**(2), p.44-52.
Cheng, M. I. and Dainty, A. R. J. (2005). What makes a good project Manager. *Human Resource Management Journal.* **15**(1), pp.25-37.
Chileshe, N. (2005). PhD in construction management research: what is original contribution to knowledge? the case of TQM. In: *21st Annual ARCOM Conference 6-7 September 2005, University of London*. Salford, Association of Researchers in Construction Management, pp.1267-1278.
Choothian, W., Khan, N., Mupemba, K. Y., Robinson, K. and Tunnitisupawong, V. (2009). A Decision Support Model for Project Manager Assignments 2.0. In: PICMET, ed. *PICMET 2009 Proceedings, August 2-6*, *Portland, Oregon, USA* IEEE, pp.1415-1424.
Cicmil, S. J. K., Cooke-Davies, T. J., Crawford, L. H. and Richardson, K. A. (2009). *Exploring the Complexity of Projects: Implications of Complexity Theory for Project Management Practice.* Newtown Square, PA: Project Management Institute.
Citoni, G., Mahy, B. and Rycx, F. (2012). Work organization, performance and health: introduction. *International Journal of Manpower.* **33**(3), pp.224-232.
Clegg, C. W. (2000). Sociotechnical priniciples for system design. *Applied Ergonomics.* **31**(5), pp.463-477.
Cochran, W. G. and Chambers, S. P. (1965). The Planning of Observational Studies of Human Populations. *Journal of the Royal Statistical Society.* **128**(2), pp.234-266.
Coffey, A., Holbrook, B. and Atkinson, P. (1996). Qualitative data analysis:technologies and representations. *Sociological Research Online,* **1**(1). Retrieved from http://www.socresonline.org.uk/1/1/4.html
Cohen, B. H. (2008). *Explaining Psychological Statistics.* 3rd ed. Hoboken, New Jersey: John Wiley & Sons, Inc.
Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* 2nd ed. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc.
Cohen, L., Manion, L. and Morrison, K. (2011). *Research Methods in Education. 7th* ed. New York, Routledge.
COIN-OR. (2007). *COIN-OR Annual Report 2007.* Retrieved from http://www.coin-or.org/coin-or-foundation/annual_report2007.pdf.
Comrey, A.L. (1950). A proposed method for absolute ratio scaling. *Psychometrika.* **15**(3), pp.317-325.
Conway, D. G. and Ragsdale, C. T. (1997). Modeling optimization problems in the unstructured world of spreadsheets. *Omega International Journal of Management Science.* **25**(3), pp.313-322.
Cook, S. and Slack, N. (1991). *Making Management Decisions.* Hertfordshire: Prince Hall International (UK) Ltd.
Cook, T. D. and Campbell, D. T. (1979). *Quasi-Experimentation: Design and Analysis Issues in Field Settings.* Boston: Houghton Mifflin.
Cooke-Davies, T. J. and Patton, S. E. (2008). Developing the Organizational Capacity to Deliver Complex Projects. In: *PMI Global Congress Proceedings, Denver, Colorado, USA*. PMI.
Cooke, S. and Slack, N. (1991). *Making Management Decisions.* 2nd ed. London: Prentice Hall.
Cooper, R. G., Edgett, S. J. and Kleinschmidt, E. J. (1998). *Portfolio Management for New Products.* Reading, M.A.: Perseus Books.

Crawford, L.H. (1998). Standards for a global profession - project managment. In: *29th Annual Project Management Institute Symposium October 9-15, Long Beach, California*.
Crawford, L.H. (2005). Senior management perceptions of project management competence. *International Journal of Project Management.* **23**(1), pp.7-16.
Crawford, L.H. (2007a). Developing Individual Competence. In: Turner, J.R. eds. *Gower Handbook of Project Management.* 4th ed. Hampshire, England: Gower Publishing Limited.
Crawford, L.H. (2007b). Developing project management competence of individuals In: Turner, J.R. and Simister, S.J. eds. *Gower Handbook of Project Management.* 4th ed. Aldershot: Gower Publishing Limited.
Crawford, L.H, French, E. and Lloyd-Walker, B. (2013). From outpost to outback: project career paths in Australia. *International Journal of Project Management.* **31**(8), pp.1175-1187.
Crawford, L.H. and Nahmias, A. H. (2010). Competencies for managing change. *International Journal of Project Management.* **28**(4), pp.405-412.
Crawford, L.H. and Pollack, J. (2004). Hard and soft projects: a framework for analysis. *International Journal of Project Management.* **22**(8), pp.645-653.
Crawford, L.H, Pollack, J. and England, D. (2006). Uncovering the trends in project management: Journal emphases over the last 10 years. *International Journal of Project Management.* **24**(2), pp.175-184.
Crawford, L.H. (1997). Project Management Competence for the Next Century. In: *28th Annual Seminars and Symposium Chicago, Illinois*. Project Management Institute.
Crawford, L.H. (2000). Profiling the Competent Project Manager. In: *Project Management Research at the Turn of the Millenium:Proceedings of the PMI Research Conference June, 2000, Paris, France*. Project Management Institute, pp.3-15.
Crawford, L.H. (2003). *Assesing and developing the project management competence of individuals.* England: Gower.
Crawford, L.H. (2006). Competencies of Project Managers. In: Cleland David, I. and Gareis, R. eds. *Global Project Management Handbook.* New York: McGraw-Hill, Inc.
Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches.* London: SAGE.
Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* California: SAGE.
Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* 4th ed. London: SAGE.
Creswell, J. W. and Clark, V .L. P. (2011). *Designing and Conducting Mixed Methods Research.* 2nd ed. London: SAGE.
Creswell, J. W., Clark, V. L. P., Gutmann, M. L., and Hanson, W. E. (2003). *Advanced mixed methods research designs.* In Handbook of mixed methods in social and behavioral research, eds. Tashakkori, A., and Teddlie, C., pp.209-240. Thousand Oaks, CA: SAGE.
Crotty, M. (1998). *The foundations of social research: meaning and perspective in the research process.* London: SAGE.
Crotty, M. (2003). *The Foundations of Social Research: Meaning and perspective in the research process.* London: SAGE.
Crowley, C., Harré, R. and Tagg, C. (2002). Qualitative research and computing: methodological issues and practices in using QSR NVivo and NUD*IST. *International Journal of Social Research Methodology*. pp.193-197.

Cushing, B. E. (1970). The Application Potential of Integer Programming. *The Journal of Business.* **43**(4), pp.457-467.
Dainty, A. R. J., Cheng, M. I. and Moore, D. R. (2003). Redefining performance measures for construction project managers: an empirical evaluation. *International Journal of Project Management.* **21**(2), pp.209-218.
Dalkey, N. C. and Helmer, O. (1963). An Experimental application of the Delphi method to the use of experts. *Management Science.* **9**(3), pp.458-467.
Dane, E. and Pratt, M. G. (2007). Exploring Intuition and Its Role in Managerial Decision Making. *The Academy of Management Review.* **32**(1), pp.33-54.
Darren, W., Carol, B., Sharon, L., Charlie, B. and Tony, R. (2003). *Resource Management Plan Guidebook:Planning for the future.*
Denscombe, M. (2007). *The Good Research Guide: for small-scale social research projects.* 3rd ed. London: McGraw Hill.
Denzin, N. K. (1970). *The Research Act in Sociology.* Chicago: Aldine.
Denzin, N. K. and Lincoln, Y. S. (2000). *Handbook of qualitative research.* 2nd ed. Thousand Oaks, CA: SAGE.
Di Gregorio, S. and Davidson, J. (2008). *Qualitative Research for Software Users.* UK: McGraw Hill, Open University Press.
Dickinson, M. W.,Thornton, A. C. and Graves, S. (2001). Technology portfolio management: optimizing interdependent projects over multiple time periods. *IEEE Transactions on Engineering Management.* **48**(4), pp.518-527.
Dietrich, P. H., Jarvenpaa, E., Karjalainen, A. and Artto, K. A. (2002). Successful management in multi-project environment. In: *Helsinki University of Technology, TAI Research Centre*.
Divan, A. (2009). *Communication skills for the Biosciences: A graduate guide.* Oxford: Oxford University Press.
Draganidis, F. and Gregoris, M. (2006). Competency based management: a review of systems and approaches. *Information Management & Computer Security.* **14**(1), pp.51-64.
Drummond, H. (1991). *Effective Decision Making: A practical guide for management* London: Kogan Page Limited.
Dudek, F.J. and Baker, K.E. (1956). The Constant-Sum Method Applied to Scaling Subjective Dimensions. *American Journal of Psychology.* **69**(4), pp.616-624.
Duffuaa, S. O. and Al-Sultan, K. S. (1999). A stochastic programming model for scheduling maintenance personnel. *Applied Mathematical Modelling.* **23**(5), pp.385-397.
Dulewicz, V. and Higgs, M. (2005). Assessing leadership styles and organisational context. *Journal of Managerial Psychology.* **20**(1/2), pp.105-123.
Duncan, W. R. (1999). The Project Manager. *PM Network.* **13**(1), p19.
Dunleavy, P. (2003). *Authoring a PhD: How to plan, draft, write and finish a doctoral thesis or dissertation.* London: Macmillan.
du Prel, J.B., Hommel, G., Röhrig, B. and Blettner, M. (2009). Confidence Interval or P-Value?: Part 4 of a Series on Evaluation of Scientific Publications. *Dtsch Arztebl Int.* **106**(19), pp.335–339.
Dyer, J. S. (2005). MAUT – Multiattribute Utility Theory. In: Ehrgott, M. eds. *Multiple Criteria Decision Analysis: State of the Art Surveys.* New York: Springer.
Edhlund, B. (2011). *NVivo essentials.* Sweden: Form & Kunskap AB.
Edwards, D. and Hamson, M. (2001). *Guide to mathematical modelling.* 2nd ed. Basingstoke: Palgrave.
Edwards, W., Miles Jr, R. F. and Winterfeldt, D. V. (2007). Introduction. In: Edwards, W., et al. eds. *Advances in Decision Analysis: From Foundations to Applications.* New York: Cambridge University Press.

Einsiedel, A. A. Jr. (1987). Profile of effective project managers. *Project Management Journal.* **18**(5), pp.51-53.
Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review.* **14**(4), pp.532-550.
Eisenhardt, K. M. and Brown, S. L. (1998). Time pacing: Competing in markets that won't stand still. *Harvard Business Review* **76**(2), pp.59-69.
El-Sabaa, S. (2001). The skills and career path of an effective project manager. *International Journal of Project Management.* **19**(1), pp.1-7.
Elonen, S. and Artto, K. A. (2003). Problems in managing internal development projects in multi-project environments. *International Journal of Project Management.* **21**(6), pp.395-402.
England, G. W. (1967). Personal value systems of American managers. *Academy of Management Journal.* **10**(1), pp.53-68.
Engwall, M. and Jerbrant, A. (2003). The resource allocation syndrome: the prime challenge of multi-project management? *International Journal of Project Management.* **21**(6), pp.403-409.
Farole, T. (2014) Infrastructure in Botswana: why, what, how? World Bank Group, National Business Conference, 23 to 26 November, Maun, Botswana.
Farris, G. F. (2008). From the Editor. *IEEE Transactions on Engineering Management.* **55**(3), pp.389-391.
Fellows, R. and Liu, A. (2003a). *Research methods for construction.* Oxford: Blackwell Science.
Fellows, R. and Liu, A. (2003c). *Research methods for contruction.* 2nd ed. Cambridge: Blackwell Science Publishers.
Fellows, R. and Liu, A. (2008). *Research Methods for Construction.* Chichester: John Wiley & Sons.
Ferns, D. C. (1991). Developments in programme management. *International Journal of Project Management.* **9**(3), pp.148-156.
Ferreiros, J. (2000). *Labyrinth of Thought - A History of Set Theory and its Role in Modern Mathematics.* 2nd ed. Berlin: Birkhauser Verlag AG.
Fico. (2012). *Xpress Optimization Suite.* Fico.
Fiedler, F. E. and Chermers, M. M. (1974). *Leadership and Effective Management.* USA: Foresman and Company.
Field, A. (2005). *Discovering statistics using SPSS.* 2 ed. London: SAGE.
Fielding, N. G. and Lee, R. M. (1998). *Computer Analysis and Qualitative Research.* London: SAGE.
Fielding, N. G. and Lee, R. M. (2002). New Patterns in the Adoption and Use of Qualitative Software. *Field Methods.* **14**(2), pp.197-216.
Fitsimmons, G. (2009) . Resource Management: materials, equipment and facilities. *The Bottom Line.* **22**(3), pp.86-88.
Forman, E. H. and Gass, S. I. (2001). The Analytic Heirachy Process-An Explosion. *Operations Research.* **49**(4), pp.469-486.
Forseberg, K., Mooz, H. and Cotterman, H. (2000). *Visualizing Project Management.* 2nd ed. John Wiley & Sons.
Fortune, J. and White, D. (2006). Framing of project critical success factors by a systems model. *International Journal of Project Management.* **24**(1), pp.53-65.
Frame, J. D. (1999). *Building Project Management Competence.* San Francisco,CA: Jossy-Bass.
Frey, J. H. and Oishi, S. M. (1995). *How to Conduct Interviews by Telephone and in Person.* Thousand Oaks, California: SAGE.

Fricke, S. E. and Shenhar, A. J. (2000). Managing multiple engineering projects in a manufacturing support environment. *IEEE Transactions on Engineering Management.* **47**(2), pp.258-268.
Frontline Solvers, S. D. (2014). *Academic Order: Effective June 23, 2014.* Incline Village, Nevada, USA.
FrontlineSystems. (2015). *Frontline Systems Releases Solver SDK Platform V2015, REST API with New RASON Modeling Language.* Retrieved from http://www.12newsnow.com/story/28794506/frontline-systems-releases-solver-sdk-platform-v2015-rest-api-with-new-rason-modeling-language.
Frost, P. J. and Stablein, R. E. (1992). *Doing exemplary research.* Newbury Park, CA: SAGE.
Furusaka, S. and Gray, C. (1984). A model for the selection of the optimum crane for construction sites. *Construction Management & Economics.* **2**(2), pp.157-176.
Fylstra, D. and Lasdon, L. (1998). Design and Use of the Microsoft Excel Solver. *Interfaces.* **28**(5), pp.29-55.
Gaddis, P. O. (1959). THE PROJECT MANAGER. *Harvard Business Review.* **37**(3), pp.89-97.
Gale, N., Heath, G., Cameron, E., Rashid, S. and Redwood, S. (2013). Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Medical Research Methodology.* **13**(1), p117.
Galili, T. (2011). "The popularity of data analysis software - *r4stats. Com.*" Retrieved from *http://r4stats. com/articles/popularity/.*
Gareis, R. (1991). Management by Projects: the management strategy of the new project-oriented company. *International Journal of Project Management.* **9**(2), pp.71-76.
Gareis, R. (2006). Program management and project portfolio management. In: Cleland, D.I. and Gareis, R. eds. *Global Project Management Handbook.* 2nd ed. New York: McGraw-Hill.
Geoghegan, L. and Dulewicz, V. (2008). Do project manager's leadership competencies contribute to project success? . *Project Management Journal.* **39**(4), pp.58-67.
Geraldi, J. G. (2008). The balance between order and chaos in multi-project firms: A conceptual model. *International Journal of Project Management.* **26**(4), pp.348-356.
Geraldi, J. G. (2009). What complexity assessment can tell us about projects: dialogue between conception and perception. *Technology Analysis and Strategic Management.* **21**(5), pp.665-678.
Geraldi, J. G. and Adlbrecht, G. (2007). On Faith, Fact and Interaction in Projects. *Project Management Journal.* **38**(1), pp.32-43.
Gibbs, G. R. (2002). *Qualitative data analysis: Explorations with NVivo.* Philadelphia: Open University Press.
GICS. (2008). *Global Industry Classification Standard: Methodology.*
Gilbert, L. S. (2002). Going the distance: 'closeness' in qualitative data analysis software. *International Journal of Social Research Methodology.* **5**(3), pp.215-228.
Gill, J. and Johnson, P. (2002). *Research methods for managers.* 3rd ed. London: SAGE.
Gill, J. and Johnson, P. (2010). *Research Methods for Managers.* 4th ed. London: SAGE.
Glaser, A. and Strauss, A. L. (1967). *The discovery of grounded theory.* Chicago: Aldine.

Glover, F. (1969). Management Decision and Integer Programming. *Accounting Review.* **44**(2), p300.
Godbout, A. J. (2000). Managing core competencies: the impact of knowledge management on human resources practices in leading-edge organizations. *Knowledge and Process Management.* **7**(2), pp.76-86.
Government of Botswana. (2012). *Botswana Government Ministries.* Retrieved from http://www.commonwealth-of-nations.org/Botswana/GovernmentMinistries.
Gowens, C. (2012). Strategic plans: CEO's presentation. High Performance Organization through improvement in processes. Company document, Gaborone, Botswana.
Grandine, T. A. (1998). Assigning Season Tickets Fairly. *Interfaces.* **28**(4), pp.15-20.
Gray, C. D. and Kinnear, P. R. (2012). *IBM SPSS Statistics 19 made simple.* East Sussex, England: Psychology.
Gray, D. E. (2004). *Doing Research in the Real World.* 1st ed. London: SAGE.
Gray, R. J. (1997). Alternative approaches to programme management. *International Journal of Project Management.* **15**(1), pp.5-9.
Greene, J. C. (2007). *Mixed methods in social inquiry.* San Francisco: Jossey-Bass.
Greene, J. C. and Caracelli, V. J. (1997). *Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms.* San Francisco: Jossey-Bass.
Guba, E. G. and Lincoln, Y. S. (1994). *Competing paradigms in qualitative research In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research.* London: SAGE.
Gudienė, N., Banaitis, A., Banaitienė, N. and Lopes, J. (2013). Development of a Conceptual Critical Success Factors Model for Construction Projects: A Case of Lithuania. *Procedia Engineering.* **57**, pp.392-397.
Gueret, C., Prins, C. and Sevaux, M. (2002). *Applicatins of Optimization with Xpress-MP.* Northants: United Kingdom: Dash Optimization Limited.
Gurobi. (2015). *Gurobi Optimizer: State of the Art Mathematical Programming Solver.* Retrieved from http://www.gurobi.com/products/gurobi-optimizer.
Habitat, C. (2012). *Habitat Consevation.* Retrieved from http://www.dfg.ca.gov/habcon/.
Hadad, Y., Keren, B. and Laslo, Z. (2012). A decision-making support system model for project manager selection according to past performance. *International Journal of Project Management.*
Hadad, Y., Keren, B. and Laslo, Z. (2013). A decision-making support system module for project manager selection according to past performance. *International Journal of Project Management.* **31**(4), pp.532-541.
Hagan, G. N., Bower, D. and Smith, N. J. (2011). Managing complex projects in multi-project environments. In: *Proceedings 27th Annual ARCOM Conference, Bristol, UK*. Association of Researchers in Contrcution Management, pp.787-796.
Hans, E. W., Herroelen, W., Leus, R. and Wullink, G. (2007). A hierarchical approach to multi-project planning under uncertainty. *Omega.* **35**(5), pp.563-577.
Harris, J. R. and McKay, J. C. (1996). Optimizing product development through pipeline management In: Rosenau, M.D. ed. *The PDMA Handbook of New Product Development.* New York: John Wiley and Sons, pp.63-76.
Harris, M. (1997). *Teach Yourself Visual Basic for Applications 5 in 21 Days.* 3rd ed. Indianapolis, Indiana: Sams Publishing.
Harrison, E. F. (1981). *The Managerial Decision-Making Process.* 2nd ed. Boston: Houghton Mifflin Company.
Hartman, W. T. and Boyd, W .L. (1998). *Resource Allocation and Productivity in Education: Theory and Practice.* London: Greenwood Press.

Hashim, N. I., Chileshe, N. and Baroudi, B. (2012). Management challenges within multiple project environments: Lessons for developing countries. *Australasian Journal of Construction Economics and Building, Conference Series.* **1**(2), pp.21-31.
Hatcher, C., Linger, H.Owen, J. and Algeo, C. (2013). The challenges of managing complexity in projects: An Australian perspective. *International Journal of Project Management.* **31**(8), pp.1069-1071.
Hauschildt, J., keim, G. and Medof, J. W. (2000). Realistic Criteria for Project Manager Selection and Development. *Project Management Journal.* **31**(3), pp.23-32.
Ho, W. (2008). Integrated Analytic Heirachy Process and its Applications- A Literature Review. *European Journal of Operational Research.* **186**(1), pp.211-228.
Ho, W., Xiaowei, X. and Prasanta, D. K. (2010). Multi-criteria Decision making approaches for supplier evaluation and selection: A Literature Review. *European Journal of Operational Research.* **202**(1), pp.16-24.
Hoobler, J. M. and Johnson, N. B. (2004). An analysis of current resource management publications. *Personal Review.* **33**(6), pp.665-676.
Hossain, L. and Ruwampura, J. (2008) Optimization of Multi-Project Environment (OPMPE). In: *Proceedings of the 2008 Winter Simulation Conference*: IEEE, pp.2421-2430.
House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W. and Gupta, V. (2004). Culture, Leadership and Organisations. In: *The Globe Study of 62 societies*, London: SAGE.
Hruschka, D. J., Schwartz, D., St.John, D. C., Picone-Decaro, E., Jenkins, R. A. and Carey, J. W. (2004). Reliability in Coding Open-Ended Data: Lessons Learned from HIV Behavioral Research. *Field Methods.* **16**(3), pp.307-331.
Hughes, D (2014) Stocktake survey and maturity assessment baseline report, version 3, Expert Group Botswana, Gaborone, Botswana.
Hughes, W. (1994). The PhD in construction management. In: *10th Annual ARCOM conference, Loughborough University, 14-16 September 1994*. Salford, Association of Researchers in Construction Management pp.76-87.
Ihuah, P. W., Kakulu, I. I. and Eaton, D. (2014). A review of Critical Project Management Success Factors (CPMSF) for sustainable social housing in Nigeria. *International Journal of Sustainable Built Environment.* **3**(1), pp.62-71.
Ilincuta, A. and Jergeas, G. F. (2003). A Practical Approach to Managing Multiple Small Projects. *AACE International Transactions.* pp.PM13.1 -13.6.
IPMA. (2012). *ICB-IPMA Competence Baseline Version 3.0.* Retrieved from http://www.**ipma**.world/assets/**ICB**3.pdf.
Ireland, L. R. (1997). Managing multiple projects in the twenty-first century. In:
Pennypacker, J.S. and Dye, L. eds. Chicago, IL: Marcel Dekker Inc., pp.471-477.
Ishak, N. M. and Abu Bakar, A. Y. (2012). Qualitative data management and analysis using NVivo:An approach used to examine leadership qualities among student leaders. *Education Research Journal.* **2**(3), pp.94-103.
Ivancevich, J. M. (1979). High and Low Task Stimulation Jobs: A Causal Analysis of Performance-Satisfaction Relationships. *Academy of Management Journal.* **22**(2), pp.206-222.
Ives, B., Jarvenpaa, S. L. and Mason, R. O. (1993). Global business drivers: Aligning information technology to global business strategy. *IBM Systems Journal.* **32**(1), pp.143-161.
Jansson, A. (1999). Goal Achievement and Mental Models in Everyday Decision Making. In: Juslin, P. and Montgomery, H. eds. *Judgement and Decision Making: Neo-Brunswikian and Process-Tracing Approaches.* New Jersey: Lawrence Erlbaum Associates, Inc.

Jennings, D. and Wattam, S. (1998). *Decision Making: An Integrated Approach.* 2nd ed. Harlow: Prentice Hall.
Jensen, P. A. and Bard, J. F. (2003). *Operations Research Models and Methods.* Wiley.
Jiang, J., Klein, G. and Margulis, S. (1998). Important behavioural skills for IS project managers: the judgements of experienced IS professionals *Project Management Journal.* **29**(1), pp.39-43.
Johnson, P. and Clark, M. (2006). *Business and Management Research Methodologies.* London: SAGE.
Jonas, D. (2010). Empowering project portfolio managers: How management involvement impacts project portfolio management performance. *International Journal of Project Management.* **28**(8), pp.818-831.
Jones, J. and Hunters, D. (2000). *Using the Delphi and nominal Group Technique in Heatlh Services Research in Qualitative Research in Health Care.* 2nd Edition ed. London: BMJ Books.
Jupp, V. (2006). *The Sage Dictionary of Social Research Methods*. Thousand Oaks:California, SAGE.
Kabli, M. R. (2009). *A Multi-attribute decision making methodology for selecting new R & D projects portfolio with a case study of Saudi oil refining industry*. Unpublished PhD Thesis thesis, The University of Nottingham.
Kahneman, D., Slovic, P. and Tversky, A. (1982). *Judgement under uncertainty: Heuristics and biases.* Cambridge, UK: Cambridge University Press.
Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika.* **39**(1), pp.31 - 36.
KapurInternational. (1993). *Project Management Seminar Handbook.* San Ramon, CA: Centre for Project Management.
Karz, R. L. (1955). Skills of an effective administrator. *Harvard Business Review.* **33**(1), pp.33-42.
Katwal, N., Ganesh, L. S. and Kamalanabhan, T. J. (2006). Development of a Tool to Measure Competencies of Software Project Managers: A Confirmatory Factor Analytic Study. *International Journal of Management Practices and Contemporary Thought.* **1**(1), pp.1-9.
Keeney, R., L. and Raiffa, H. (1993). *Decisions with Multiple Objectives: Preferences and Value Tradeoffs.* Cambridge: Cambridge University Press.
Keren, G. (1992). Improving Decisions and Judgements: The Desirable versus the Feasible In: Wright, G. and Bolger, F. eds. *Expertise and Decision Support.* London: Plenum Press.
Keren, G. and Lewis, C. (1993). *A Handbook for Data Analysis in the Behavioral Sciences.* Hillsdale, New Jersey: Lawrence Erlbaum Associates.
Kervin, J. B. (1992). *Methods for Business Research.* New York: HerperCollins Publishers Inc.
Kester, L., Griffin, A., Hutlink, E. J. and Lauch, K. (2001). Exploring Portfolio Decision-Making Processes. *Journal of Product Innovation Management.* **28**(5), pp.641-661.
Kew, J. and Stredwick, J. (2010). *Human Resource Management in Business Context.* 1st ed. CIPD publishers.
Kitco. (2012). *Ranking of the world's diamond mines.* Retrived from http://www.kitco.com/ind/Zimnisky/2013-08-20-Ranking-Of-The-World-s-Diamond-Mines-By-Estimated-2013-Production.html.
Kitco (2013). Botswana Diamonds – Facts and Figures. Retrieved from http://diamondfacts.org/facts/fact_09.html.
Kleindorfer, P. R., Kunreuther, H. C. and Schoemaker, P. J. H. (1993). *Decision Sciences: An Integrated Perspective.* Cambridge: Cambridge University Press.

Kocaoglu, D. F. (1983). A Participative Approach to Program Evaluation. *IEEE Transaction on Engineering Management*. **EM-30**(3), pp.112 -118.

Kocaoglu, D. F. (1984). Hierarchical Decision Modelling: A Participative Approach to Technology Planning. In: *Proceedings of the International Congress on Technology and Technology Exchange: Technology and the World Around Us*, *Pittsburgh, USA*. International Technology Institute.

Kraljic, P. (1983). Purchasing must become supply management. *Harvard Business Review.* **61**(5), pp.109-117.

Krippendorff, K. (2004). *Content Analysis: An Introiduction to Its Methodology.* 2nd ed. London: SAGE.

Kuhn, T. S. (1970). *The structure of scientific revolutions.* 2nd ed. Chicago: University of Chicago Press.

Kuprenas, A. J., Jung, C. L., Fakhouri, S. A. and Jreij, G. W. (2000). Project manager workload-assessment of values and influences. *Project Management Journal.* **31**(4), pp.44-51.

Lagesse, B. (2006). A Game-Theoretical model for task assignment in project management. In: IEEE, ed. *International Conference on Management of Innovation and Technology*. pp.678-680.

Laslo, Z. (2010). Project portfolio management: An integrated method for resource planning and scheduling to minimize planning/scheduling-dependent expenses. *International Journal of Project Management.* **28**(6), pp.609-618.

Laslo, Z. and Goldberg, A. I. (2008). Resource allocation under uncertainty in a multi-project matrix environment: Is organizational conflict inevitable? *International Journal of Project Management.* **26**(8), pp.773-788.

LeBlanc, L. J., Randels, D. J. and Swann, T. (2000). Heery International's Spreadsheet Optimization Model for Assigning Managers to Construction Projects. *INTERFACES.* **30**(6), pp.95-106.

Lewins, A. and Silver, C. (2007). *Using Software in Qualitative Research: A Step-by-Step Guide.* London: SAGE.

Lewis, A. and Silver, C. (2007). *Using Software in Qualitative Research:A Step-by-Step Guide* London: SAGE.

Lincoln, Y. S. and Guba, E. G. (2000). Paradigmatic controversies, contradictions, and emerging confluences In: Lincoln, Y.S. and Guba, E.G. eds. *Handbook of qualitative research* 2nd ed. London: SAGE.

Ling, Y. Y. (2003). A conceptual model for selection of architects by project managers in Singapore. *International Journal of Project Management.* **21**(2), pp.135-144.

Linstone, H. A. and Turoff, M. (1975). *The Delphi Method: Techniques and Applications.* London: Addison-Wesley.

Luck, L., Jackson, D. and Usher, K. (2006). Case study: a bridge across the paradigms. *Nursing Inquiry.* **13**(2), pp.103-109.

Ludwig, B. (1997). Predicting the future: Have you considered using the Delphi Methodology? *Journal of Extension.* **35**(5), pp.1-5.

MacQueen, K. M., McLellan, E., Kay, K. and Milstein, B. (1998). Codebook Development for Team-Based Qualitative Analysis. *Field Methods.* **10**(2), pp.31-36.

Madter, N., Bower, D. A. and Aritua, B. (2012). Project and personalities: A framework for individualising project management career development in the construction industry. *International Journal of Project Management.* **30**(3), pp.273-281.

Marshall, C. and Rossman, G. (1995). *Designing Qualitative Research.* 1st ed. London: SAGE.

Martinsuo, M., Gemunden, H. G. and Hueman, M. (2012). Toward Strategic Value from Projects. *Project Management Journal.* **30**(6), pp.637-638.

Mason, A. J. (2011). OpenSolver – An Open Source Add-in to Solve Linear and Integer Progammes in Excel. In: *Operations Research Proceedings 2011, Berlin Heidelberg*. Springer, pp.401-406.

Mason, A. J. (2013). SolverStudio: A New Tool for Better Optimisation and Simulation Modelling in Excel. *INFORMS Transactions on Education.* **14**(1), pp.45-52.

Maxwell, J. A. (2004). Using Qualitative Methods for Causal Explanation. *Field Methods.* **16**(3), pp.243-264.

McLellan, E., MacQueen, K. M. and Neidig, J. L. (2003). Beyond the Qualitative Interview: Data Preparation and Transcription. *Field Methods.* **15**(1), pp.63-84.

Meerschaert, M. M. (2007). *Mathematical modeling.* 3rd ed. London: Elsevier/Academic Press.

Meindl, B. and Templ, M. (2013). Analysis of Commercial and Free and Open Source Solvers for the Cell Suppression Problem. *Transactions on Data Privacy.* **6**(2), pp.147-159.

Meredith, J. R. and Mantel, S. J. (2005). *Project management: a managerial approach.* 6th ed. Indiana: USA: John Wiley.

Mertens, D. M. (2015). *Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods.* 4th ed. London: SAGE.

Metfessel, M. (1947). A proposal for quantitative reporting of comparative judgements. *Journal of Psychology.* **24**(2), pp.229-235.

Meskendahl, S. (2010). The influence of business strategy on project portfolio management and its success- A conceptual framework. *International Journal of Project Management.* **28**(8), pp.807- 817.

Mian, S. A. and Dai, C. X. (1999). Decision-Making Over the Project Life Cycle: An Analytical Hierarchy Approach. *Project Management Journal.* **30**(1), pp.40-52.

Microsoft. (2015). *SolverStudio for Excel: An integrated environment for optimisation using modelling languages within Excel.* Retrieved from http://solverstudio.org/.

Miles, M. B. and Huberman, A. M. (1994). *Qualitative Data Analysis: A Sourcebook of New Methods.* London: SAGE.

Miles, M. B.Huberman, A. M. and Saldana, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook.* 3rd ed. London: SAGE.

Milosevic, D. and Patanakul, P. (2004). A model for assigning projects to project managers in multiple project management environments. In: Slevin, D.P., et al. eds. *Innovations - Project Management Research.* Newton Square, PA: Project Management Institute.

Moodley, K. (2008). Project Design and Structure: multiple projects. In: Smith, N.J. ed. *Engineering Project Management.* 3rd ed. Oxford, UK: Blackwell Publishing.

Mook, D. G. (1983). In defense of external invalidity. *American Psychologist.* **38**(4), pp.379-387.

Muenchen, R. A. (2012). "The popularity of data analysis software *-r4stats. com*." Retrieved from *http://r4stats. com/articles/popularity/.*

Müller, R., Geraldi, J. and Turner, J. R. (2012). Relationships Between Leadership and Success in Different Types of Project Complexities. *IEEE Transactions on Engineering Management.* **59**(1), pp.77-90.

Muller, R. and Turner, J. R. (2010). Leadership competency profiles of successful project managers. *International Journal of Project Management.* **28**(5), pp.437-448.

Müller, R. and Turner, J. R. (2007). Matching the project manager's leadership style to project type. *International Journal of Project Management.* **25**(1), pp.21-32.

Müller, R. and Turner, R. (2010). Leadership competency profiles of successful project managers. *International Journal of Project Management.* **28**(5), pp.437-448.

Murray and Roberts Botswana. (2014). Sustainability – Overview. Retrieved from http://www.botswana.murrob.com/sus_overview.asp.
Murthy, D. N. P., Page, N. W. and Rodin, E. Y. (1990). *Mathematical modelling: a tool for problem solving in engineering, physical, biological and social sciences.* Oxford: Pergamon.
Mustapha, F. H. and Naoum, S. (1998). Factors influencing the effectiveness of construction site managers. *International Journal of Project Management.* **16**(1), pp.1-8.
Mwamba, A., Honde, G., Walker, R., Darbo, S., Mubila, M., Yahaya, A., (2009) *Botswana Country Strategic Paper*, African Development Bank, Regional Department, South Region A.
NatCen, T. (2010a). *Framework analysis.* Retrieved from http://onlineqda.hud.ac.uk/methodologies.php#Framework_analysis.
NatCen, T. (2010b). *Framework analysis.* Retrieved from http://onlineqda.hud.ac.uk/methodologies.php#Framework_analysis.
Newby, P. (2014). *Research Methods for Education.* 2nd ed. London: Routledge: Taylor & Francis.
Newman, I. and Benz, C. R. (1998). *Qualitative-Quantitative Research Methodology: Exploring the Interactive Continuum.* New York: Southern Illinois University.
Ngowi, A. (2002). Challenges facing construction industries in developing countries. *Building Research and Information.* **30**(3), pp.149-151.
NIMS. (2009). National Incident Management System, Student Manual. *Resource Management. Retrieved from* http://www.wsdot.wa.gov/nr/rdonlyres/0b44da18-19e6-45fe-9a07-00211a30c739/0/is700astudentmanualunit1.pdf.
O'Neill, M. (2013). *High performance school-age athletes at Australian schools: A study of conflicting demands*. PhD thesis, University of the Sunshine coast.
Ofori, G. (2000). Challenges of construction industries in developing countries: Lessons from various countries. In: *Proceedings of the 2nd international conference in developing countries: challenges facing the construction industry in developing countries, 15 - 17 November 2000, Gaborone, Botswana*.
OGC. (2003).*Managing Successful Programmes.* Norwich, United Kingdom: The Stationery Office.
Ogunlana, S., Siddiqui, Z., Yisa, S. and Olomolaiye, P. (2002). Factors and procedures used in matching project managers to construction projects in Bangkok. *International Journal of Project Management.* **20**(5), pp.385-400.
Oishi, S. M. (2003). *How to conduct in-person interviews for survey.* Thousand Oaks, California: SAGE.
Olsson, R. (2008). Risk management in a multi-project environment: An approach to manage portfolio risks. *The International Journal of Quality & Reliability Management.* **25**(1), pp.60-71.
OpenSolver. (2011). *OpenSolver for Excel: The Open Source Optimization Solver for Excel.* Retrieved from http://opensolver.org/
Orasanu, J. and Connolly, T. (1993). The Reinvention of Decision Making. In: Klein, G.A., et al. eds. *Decision Making in Action: Models and Methods.* New Jersey: Ablex Publishing Corporation.
Othman, R. and Sheehan, N. T. (2011). Value creation logic and resource management: a review. *Journal of Strategy and Management.* **4**(1), pp.5-24.
Owusu, G., Voudouris, C., Dorne, R., Ladde, C., Anim-Ansah, G., Gasson, K. and Connolly, G. (2007). ARMS - Application of AI and OR methods to resource management. *BT Technology Journal.* **25**(3 & 4), pp.249-253.

Padhi, S. S., Wagner, S. M. and Aggarwal, V. (2012). Positioning of commodities using the Kraljic Portfolio Matrix. *Journal of Purchasing and Supply Management.* **18**(1), pp.1-8.

Panwalkar, S. S. and Iskander, W. (1977). A Survey of Scheduling Rules. *Operations Research.* **25**(1), pp.45-61.

Partington, D. (2005). Attributes and levels of programme management competence: an interpretive study. *International Journal of Project Management.* **23**(2), pp.87-96.

Patanakul, P. (2004). *A Decision Support Model for Project Assignments*. Doctor of Philosophy thesis, Portlans State University.

Patanakul, P. (2009). Toward an Understanding of the Dynamic of Project Manager Assignments:An Empirical Study. In: *PICMET*: PICMET, pp.1260-1266.

Patanakul, P. (2013). Key Drivers of Effectiveness in Managing a Group of Multiple Projects. *IEEE Transactions on Engineering Management.* **60**(1), pp.4-17.

Patanakul, P. and Aronson, Z. H. (2010). Does team culture matter? An empirical study in multiple-project management settings. In: *Technology Management for Global Economic Growth (PICMET), 2010 Proceedings of PICMET '10: 18-22 July 2010*, pp.1-9.

Patanakul, P. and Milosevic, D. (2006). Assigning new product projects to multiple-project managers: What market leaders do. *The Journal of High Technology Management Research.* **17**(1), pp.53-69.

Patanakul, P. and Milosevic, D. (2008). A competency model for effectiveness in managing multiple projects. *The Journal of High Technology Management Research.* **18**(2), pp.118-131.

Patanakul, P. and Milosevic, D. (2009). The effectiveness in managing a group of multiple projects: Factors of influence and measurement criteria. *International Journal of Project Management.* **27**(3), pp.216-233.

Patanakul, P., Milosevic, D. and Anderson, T. R. (2003). Assigning Project Managers in a Multiple-Project Management Environment: A Pilot Study of a Decision Support Model. In: *Technology Management for Reshaping the World (PICMET), 2003, Proceedings of PICMET '03.*IEEE, pp.236-245.

Patanakul, P., Milosevic, D. and Anderson, T. R. (2004). Criteria for Project Assignments in Multiple-Project Environments. In: *Proceedings of the 37th Hawaii International Conference on System Sciences*, *Hawaii*. IEEE, pp.1-10.

Patanakul, P., Milosevic, D. and Anderson, T. R. (2007). A Decision Support Model for Project Manager Assignments *IEEE Transactions on Engineering Management.* **54**(3), pp.548-564.

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods*. Thousand Oaks: California, SAGE.

Payne, J. H. (1995). Management of multiple simultaneous projects: a state-of-the-art review. *International Journal of Project Management.* **13**(3), pp.163-168.

Payne, J. H. and Turner, R .J. (1999.) Company-wide project management: the planning and control of programmes of projects of different type. *International Journal of Project Management.* **17**(1), pp.55-59.

Pellegrinelli, S. (2002). Shaping Context: the role and challenge for programmes. *International Journal of Project Management.* **20**(3), pp.229-233.

Pellegrinelli, S. and Bowman, C. (1994). Implementing Strategy Through Projects. *Long Range Planning.* **27**(4), pp.125-132.

Pellegrinelli, S., Partington, D., Hemingway, C., Mohdzain, Z. and Shah, M. (2007). The importance of context in programme management: An empirical review of program practices. *International Journal of Project Management.* **25**(1), pp.41-55.

Pennypacker, J. S. and Dye, L. D. (2002). Project portfolio management and managing multiple projects: Two sides of the same coin? In: Pennypacker, J.S. and Dye, L.D. eds. *Managing Multiple Projects.* New York: Marcel Dekker, pp.1-10.
Pettersen, N. (1991a). Selecting Project Managers: An integrated list of predictors. *Project Management Journal.* **22**(2), pp.21-26.
Pettersen, N. (1991)b. What do we know about the effective project manager? *International Journal of Project Management.* **9**(2), pp.99-104.
Phillips, E. M. (1992). *How to Get a PhD.* 1st ed. New York: McGraw-Hill Education.
Phillips, E. M. (1993). *How to get a PhD.* 2nd ed. New York: McGraw-Hill Education.
Phillips, E. M. and Pugh, D. S. (2005). *How to get a PhD: A Handbook for students and thier supervisors.* New York: McGraw-Hill Education.
Pinto, J. K. and Kharbanda, O. P. (1996). How to fail in project management without really trying. *Business Horizons.* **35**(4), pp.45-53.
Pinto, J. K. and Prescott, J. E. (1987). Changes in Critical Succes Factor Importance Over the life of a Project. *Academy of Management Best Paper Proceedings.* pp.328-332.
Pinto, J. K. and Slevin, D. P. (1987). Critical Factors in successful project implementation. *IEEE Transactions on Engineering Management.* **EM-34**(1), pp.22-27.
Pinto, J. K. and Slevin, D. P. (1989a). Critical success factors across the project life cycle. *Project Management Journal.* **19**(3), pp.67-74.
Pinto, J. K. and Slevin, D. P. (1989b). Critical success factors in R&D projects. *Research Technology Management.* pp.31-35.
Platje, A. and Seidel, H. (1993). Breakthrough in multiproject management: how to escape the vicious circle of planning and control. *International Journal of Project Management.* **11**(4), pp.209-213.
Platje, A., Seidel, H. and Wadman, S. (1994). Project and portfolio planning cycle: project - based management for the multiproject challenge. *International Journal of Project Management.* **12** (2), pp.100-106.
PMBOK. (2008). *Project Management Body of Knowledge.* PMI.
PMBOK. (2013). *A Guide to the Project Management Body of Knowledge (PMBOK Guide).* 5th ed. PMI.
PMI. (1996). *National Competency Standards for Project Management.* Sydney, Australia: Institute of Project Management
PMI. (2004). *A Guide to the Project Management Body of Knowledge.* Newtown Square:PA: Project Management Institute.
PMI. (2006). *Project Manegement Body of Knowledge.* 5th ed. PMI.
PMI. (2007). *Project Manager Competency Development Framework.* Newtown Square:PA: Project Management Institute.
PMI. (2008). *A Guide to the Project Management Body of Knowledge* Newtown Square:PA: Project Management Institute.
Posner, B. Z. (1987). What it takes to be a good project manager. *Project Management Journal.* **18**(1), pp.51-53.
Powell, W. B., Sheffi, Y., Nickerson, K. S., Butterbaugh, K. and Atherton, S. (1988). Maximizing Profits for North American Van Lines' Truckload Division: A New Framework for Pricing and Operations. *Interfaces.* **18**(1), pp.21-41.
Proverbs, D. and Gameson, R. (2008). Case study research. In: Knight, A. and Ruddock, L. eds. *Advanced research methods in the built environment.* Chichester: Wiley-Blackwell.
QSR. (2012a). *Framework matrices.* Retrieved from http://www.qsrinternational.com/support_faqs_detail.aspx?view=1057.
QSR. (2012b). *The NVivo Workbook.* USA: QSR International Pty Ltd.

Ragin, C. C. and Becker, H. S. (1992). *What Is a Case? Exploring the Foundations of Social Inquiry* Cambridge: Cambridge University Press.
Ragsdale, C. T. (2003). *Spreadsheet Modeling and Decision Analysis.* 4th ed. New York: South-Western College Pub.
Ragsdale, C. T. (2004). *Spreadsheet Modeling and Decision Analysis: A Practical Introduction to Management Science.* 4th ed. New York: Thompson South-Western.
Ragsdale, C. T. (2011). *Managerial Decision Modeling.* 6th ed. International Edition: United Kingdom: Cengage Learning.
Ragsdale, C. T. (2015). *Spredsheet Modeling and Decision Analysis: A Practical Introduction to Business Analytics.* 7th ed. Stamford: USA: Cengage Learning.
Raiden, A. B. (2004). *The development of a strategic employee resourcing framework (SERF) for construction organizations.* PhD thesis thesis, Loughborough University.
Raiden, A. B, Dainty, A. R. J. and Neale, R. H. (2006). Balancing employee needs, project requirements and organizational priorities in team deployment, *Construction Management and Economics*, **24** (8), pp. 883-895.
Raiden, A. B, Dainty, A. R. J. and Neale, R. H. (2004). Current barriers and possible solutions to effective project team formation and deployment within a large construction organization, *International Journal of Project Management*, **22** (4), pp. 309-316.
Raiden, A. B, Dainty, A. R. J. and Neale, R. H. (2001). Human resource information systems in construction: are their capabilities fully exploited? In: Akintoye, A. (Ed.), *17th Annual ARCOM Conference*, 5-7 September 2001, University of Salford. Association of Researchers in Construction Management, Vol. 1, pp. 133-142.
Ribeiro, C. C. and Urrutia, S. (2005). An application of integer programming to playoff elimination in football championships. *International Transactions in Operational Research.* **12**(4), pp.375-386.
Rich, M. and Patashnick, J. (2002). Narrative research with audiovisual data: Video Intervention/Prevention Assessment (VIA) and NVivo. *International Journal of Social Research Methodology.* **5**(3), pp.245-261.
Richards, L. (1999). *Using NVivo in Qualitative Research.* London: SAGE.
Richards, L. (2002a). Qualitative computing—a methods revolution? *International Journal of Social Research Methodology.* **5**(3), pp.263-276.
Richards, L. (2005). *Handling Qualitative Data.* London: SAGE.
Richards, L. (2009). *Handling Qualitative Data: A Practical Guide.* 2nd ed. London: SAGE.
Richards, T. (2002b). An intellectual history of NUD*IST and NVivo. *International Journal of Social Research Methodology.* **5**(3), pp.199-214.
Richardson, K. A., Tait, A., Roos, J. and Lissack, M. R. (2005). The coherent management of complex projects and the potential role of group decision support systems. In: Richardson, K.A. ed. *Managing Organizational Complexity: Philosophy, Theory, and Application.* pp.433-458.
Riessman, C. K. (2008). *Narrative Methods for the Human Sciences.* Los Angeles: CA: SAGE.
Ritchie, J. and Lewis, J. (2003). *Qualitative research practice: A guide for social science students and researchers.* London: SAGE.
Ritchie, J. and Spencer, L. (1994). *Qualitative data analysis for applied policy research.* London: SAGE.
Roberts, S. M. and Escudero, L. F. (1983). Scheduling of plant maintenance personnel. *Journal of Optimization Theory and Applications.* **39**(3), pp.323-343.

Robson, C. (2002). *Real World Research: A Resource for Social Scientists and Practitioner-Researchers.* 2nd ed. Malden: USA: Blackwell Publishing.
Rogers, M. (2001). Engineering Project Appraisal. USA: Blackwell Science, Inc, p.256.
Rossman, G. B. and Wilson, B. L. (1985). Numbers and Words: Combining Quantitative and Qualitative Methods in a Single Large-Scale Evaluation Study. *Evaluation Review.* **9**(5), pp.627-643.
Rowe, C. (1995). Clarifying the use of competence and competency models in recruitment, assessment and staff development. *Industrial and Commercial Training.* **27**(11), pp.12-12.
Rowe, G. and Wright, G. (1999). The Delphi technique as a forecasting tool: issues and analysis. *International Journal of Forecasting.* **15**(4), pp.353-375.
Rubinstein, J. S., Meyer, D. E. and Evans, J. E. (2001). Executive control of cognitive process in task switching. *Journal of Experimental Psychology:Human Perception and Performance* **27**(4), pp.763-797.
Russell, R. K. and Tippett, D. D. (2008). Critical Success Factors for the Fuzzy Front End of Innovation in the Medical Device Industry. *Engineering Management Journal.* **20**(3), pp.36-43.
Ryan, G. W. and Bernard, H. R. (2003). Techniques to Identify Themes. *Field Methods.* **15**(1), pp.85-109.
Saaty, T. L. (1980). *The Analytic Hierarchy Process.* New York: McGraw-Hill.
Saaty, T. L. (1986). Axiomatic Foundation of the Analytic Hierarchy Process. *Management Science.* **32**(7), pp.841-855.
Saaty, T. L. (2000). *The Fundamentals of Decision Making and Priority Theory With the Analytic Hierarchy Process.* RWS Publication.
Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences.* **1**(1), pp.83-98.
Saaty, T. L. and Alexander, J. M. (1981). *Thinking with models : mathematical models in the physical, biological, and social sciences.* Oxford: Pergamon Press.
Saldana, J. (2011). *Fundamentals of qualitative research* New York: Oxford University Press.
Sato, Y. (2004). Comparison between multiple-choice and analytic hierarchy process: measuring human perception. *International Transactions in Operational Research.* **11**(1), pp.77-86.
Schoemaker, P. J. H. and Russo, J. E. (1993). A Pyramid of Decision Approaches. *California Management Review.* **36**(1), pp.9-31.
Seboni, L. and Tutesigensi, A. (2014a). Allocating project managers to projects in a multi-project environment In: *Proceedings of the 30th Annual ARCOM Conference,* 1-3 September 2014, Portsmouth, UK. Association of Researchers in Construction Management, pp.825-834.
Seboni, L. and Tutesigensi, A. (2014b). Development and verification of a conceptual framework for project manager-to-project (PM2P) allocations in multi-project environments. In: *Proceedings of PICMET '14, 27-31 July 2014, Kanazawa, Japan*. IEEE, pp.2477-2496.
Seboni, L. and Tutesigensi, A. (2015a). A mathematical model for allocating project managers to projects. In Raiden, A. (Ed.) and Aboagye-Nimo, E. (Ed.), *Proceedings of the 31th Annual ARCOM Conference*, 7-9 September 2015, Lincoln, UK, Association of Researchers in Construction Management, pp. 3-12.
Seboni, L. and Tutesigensi, A. (2015b). Project manager-to-project allocations in practice: an empirical study of the decision-making practices of a multi-project based organization. In Hughes, W. (Ed.) and Raiden, A. (Ed.), *Construction Management and Economics*, **33**(5-6), pp.428-443.

Seboni, L.Tutesigensi, A. and Bower, D. (2013). Managerial decision making regarding the allocation of project manager resources to projects: The case of Botswana. In: *Technology Management in the IT-Driven Services (PICMET), 2013 Proceedings of PICMET '13:, July 28 2013-Aug. 1 2013*, pp.487-510.

Sebt, M. H., Akrami, A., Banki, M. T. and Shahhosseini, V. (2009). Optimized Allocation of Expert Human Resources to Project. In: *Third Asia International Conference on Modelling & Simulation (AMS 2009), May 25-May 29, Indonesia*. IEEE Computer Society, pp.386-391.

Sebt, M. H., Shahhosseini, V. and Rezaei, M. (2010). Competency Based Assignment of Project Managers to Projects. In: *2010 UkSim 12th International Conference on Computer Modelling and Simulation (UKSim 2010), 24-26 March 2010 Cambridge, UK*. IEEE Computer Society, Los Alamitos, CA, USA, pp. 311-316.

Sekaran, U. (2000). *Research Methods for Business: A Skill-Building Approach.* 3rd ed. Chichester: John Wiley & Sons.

Shapiro, S. and Spence, M. T. (1997). Managerial intuition: A conceptual and operational framework. *Business Horizons.* **40**(1), pp.63-68.

Sheehan, N. T. (2005). Why old tools won`t work in the `new` knowledge economy. *Journal of Business Strategy.* **26**(4), pp.53-60.

Shehu, Z. and Akintoye, A. (2009). Construction programme management theory and practice: Contextual and pragmatic approach. *International Journal of Project Management.* **27**(7), pp.703-716.

Shenhar, A. J. (2001). One Size does not Fit All Projects: Exploring Classical Contingency Domains. *Management Science.* **47**(3), pp.394-414.

Shenhar, A. J., Dvir, D., Levy, O. and Maltz, A. C. (2001). Project Success: A Multidimensional Strategic Concept. *Long Range Planning.* **34**(6), pp.699-725.

Shenhar, A. J. and Thamhain, H. J. (1994). A New Mixture of Management Skills: Meeting the High-Technology Managerial Challenges. *Human Systems Management.* **13**(1), pp.27-40.

Shoemaker, P. J. H. and Waid, C. C. (1982). An Experimental Comparison of different approaches to determining weights in additive utility models. *Management Science.* **28**(2), pp.182-196.

Silver, C. and Lewis, A. (2010). *Computer Assisted Qualitative Data Analysis*. 3rd ed. London: SAGE.

Silverman, D. (2013). *Doing Qualitative Research.* 4th ed. London: SAGE.

Simons, H. (2009). *Case Study Research in Practice.* London: SAGE.

Sirmon, D. G., Hitt, M. A. and Ireland, R. D. (2007). Managing firm resources in dynamic environments to create value: looking inside the black box. *Academy of Management Review.* **32**(1), pp.273-292.

Skabelund, J. (2005). Are Nonperformers Killing Your Bottom Line? *Credit Union Executive Newsletter.* **31**(13).

Slevin, D. P. and Pinto, J. K. (1986). The Project Implentation Profile: New Tool for Project Managers. *Project Management Journal.* **17**(4), pp.57-70.

Smyth, H. J. and Morris, P. W. G. (2007). An epistemological evaluation of research into projects and their management: Methodological Issues. *International Journal of Project Management***, 25** (4), pp.423-436.

Song, M. and Noh, J. (2006). Best new product development and management practices in the Korean high-tech industry. *Industrial Marketing Management.* **35**(3), pp.262-278.

Sparkes, A. C. (2001). Myth 94: Qualitative Health Researchers will Agree about Validity. *Qualitative Health Research.* **11**(4), pp.538-552.

Spencer, L. M. J. and Spencer, S. M. (1993). *Competence at Work: models for superior performance.* New York: John Wiley & Sons.

Srivastava, A. and Thompson, S. B. (2009). Framework Analysis: A Qualitative Methodology for Applied Policy Research. *Journal of Administration and Governance.* **4**(2).

Ssegawa, J. K., and Ngowi, A. B. (2009). *Challenges in Delivering Public Construction Projects: A Case of Botswana.* Dudweiler Landstr, Saarbrücken, Germany: Lambert Academic Publishing.

Stake, R. E. (1995). *The Art of Case Study Research.* London: SAGE.

Stevenson, D. H. and Starkweather, J. A. (2010). PM critical competency index: IT execs prefer soft skills. *International Journal of Project Management.* **28**(7), pp.663-671.

Stoecker, R. (1991). Evaluating and rethinking the case study. *The Sociological Review.* **39**(1), pp.88-112.

Strauss, A. L. and Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques.* London: SAGE Publications.

Stockman, C. (2015). Achieving a Doctorate Through Mixed Methods Research. *The Electronic Journal of Business Research Methods.* **13**(2), pp.74-84.

Sun, B. and Luo, H. T. (2010). Selection method of risk response schemes for mining project based on fuzzy preference relations. *Journal of Coal Science and Engineering (China).* **16**(2), pp.221-224.

Tabachnick, B. G. and Fidell, L. S. (2013). *Using Multivariate Statistics* 6th ed. Boston, USA: Pearson Education, Inc.

Tagg, C. (2002). Merging and its procedures in QSR software. *International Journal of Social Research Methodology.* **5**(3), pp.277-287.

Tashakkori, A. and Teddlie, C. (2003). *The past and future of mixed methods research: from data triangulation to mixed model designs.* Thousand Oaks, CA: SAGE.

Tatikonda, M. V. and Rosenthal, S. R. (2000). Technology Novelty, Project Complexity and Product Development Execution Success: A Deeper Look at Task Uncertainity in Product Innovation. *IEEE Transactions on Engineering Management.* **47**(1), pp.74-87.

Teddlie, C. and Tashakkori, A. (2003). *Major issues and controversies in the use of mixed methods in the social and behavioral sceinces.* In Handbook of mixed methods in social and behavioral research, eds. Tashakkori, A. and Teddlie, C., pp. 3-50. Thousand Oaks, CA: SAGE.

Teddlie, C. and Tashakkori, A. (2009). *Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioural Sciences* London: SAGE.

Thamhain, H. J. (1991). Developing Project Management Skills. *Project Management Journal.* **22**(3), pp.39-53.

Thompson, G. M. (1997). Assigning Telephone Operators to Shifts at New Brunswick Telephone Company. *Interfaces.* **27**(4), pp.1-11.

Tinkler, P. and Jackson, C. M. (2004). *The Doctoral Examination Process.* London: McGraw-Hill Education.

Titscher, S., Meyer, M., Wodak, R. and Vetter, E. (2002). *Methods of Text and Discourse Analysis.* London: SAGE.

Tobis, I. and Tobis, M. (2002). *Managing Multiple Projects.* New York: McGraw-Hill.

Towle, T. W. (1990). Determining Staffing Requirements for Managing a Large Capital Improvement Program. *Cost Engineering.* **32**(10), pp.15-18.

Tractinsky, N. and Jarvenpaa, S. L. (1995). Information Systems Design Decisions in a Global versus Domestic Context. *MSI Quarterly.* **19**(4), pp.507-534.

Triantaphyllou, E. (2000). *Multi-Criteria Decision Making Methods: A Comparitive Study.* Dordrecht: Kluwer Academic Publishers.

Turner, J. R. and Cochrane, R .A. (1993). Goals-and-methods matrix: coping with projects with ill defined goals and/or methods of achieving them. *International Journal of Project Management.* **11**(2), pp.93-102.
Veal, A. J. (2005). *Business research methods: A managerial approach.* Frenchs Forest: Australia. Pearson Education.
Vergne, S. (2012). Conflict, Misunderstanding and Other Project Realities. *Engineering Momentum, Auxilium.* Retrieved from http://engineeringmomentum.com/?p=211.
Vidal, L. A. and Marle, F. (2008). Understanding project complexity: implications on project management. *The International Journal of Systems and Cybernetics.* **37**(8), pp.1094-1110.
Walkenbach, J. (2010). *Excel 2010 Power Programming with VBA.* Hoboken, New Jersey: John Wiley & Sons.
Waller, R. (1997). A project manager competency model. In: *28th Annual Seminar & Symposium, Chicago, Illinois*. PMI.
Wetterling, S. (2012). Why the PMP Credential (Project Management Professional) Isn't Enough. *Engineering Momentum, Auxillium.*
Whetten, D. A. (1989). What Constitutes a Theoretical Contribution? *Academy of Management Review.* **14**(4), pp.490-495.
Williams, T. (2002). *Modeling complex projects.* West Sussex, UK: John Wiley & Sons.
Williams, T. M. (1999). Need for new paradigms for complex projects. *International Journal of Project Management.* **17**(5), pp.269-273.
World Bank Group (2015) Ministry of Finance and Development Planning, Government of Botswana, Country Strategic plans, Gaborone, Botswana.
Wright, J. (1992). *Selection, supervision and the academic management of research leading to the degree of PhD*. PhD thesis thesis, University of Nottingham.
X-Pert Botswana. (2011). Project Management Framework. High Performance Organization. X-Pert Academy.Company document, May 2011, Version 1,Gaborone, Botswana.
Yasin, M. M., Martin, J. and Andrew, C. (2000). An empirical investigation of international project management practices : the role of international experience. *Project management journal.* **31**(2), pp.20-30.
Yin, R. (1994). *Case Study Research: Design and Methods.* 2nd ed. Newbury Park, CA: SAGE.
Yin, R. (2009). *Case study research: Design and methods.* Thousand Oaks: California: SAGE.
Young, M. and Conboy, K. (2013). Contemporary project portfolio management: Reflections on the development of an Australian Competency Standard for Project Portfolio Management. *International Journal of Project Management.* **31**(8), pp.1089-1100.
Zavadskas, E. K.Turskis, Z., Tamošaitienė, J. and Marina, V. (2008). MULTICRITERIA SELECTION OF PROJECT MANAGERS BY APPLYING GREY CRITERIA. *Technological and Economic Development of Economy.* **14**(4), pp.462-477.
Zimmerer, T. and Yasin, M. (1998). A leadership profile of American project managers. *Project Management Journal.* **29**(1), pp.31-38.

Bibliography

Anderson, J. and Poole, M. (2001). *Assignment And Thesis Writing*. 4th ed. New York: John Wiley & Sons Australia, Ltd.

Brause, R.S. (2000). *Writing Your Doctoral Dissertation: Invisible Rules For Success*. London: Falmer Press.

Clark, J. L. and Murray, K. E. (2012). *Schorlarly Writing: Ideas, Examples and Execution.* 2nd ed. Durham: Carolina Academic Press.

Cremmins,E. T. (1996). *The Art Of Abstracting*. 2nd ed. Virginia:Information Resources Press.

Debswana Annual Report. (2013). Report to Stakeholders. Retrieved from http://www.debswana.com/Media/Reports/Report%20to%20Stakeholders%202012.pdf.

Dellestrand, H. and Kappen, P. (2011). Headquarters Allocation of Resources to Innovation Transfer Projects within the Multinational Enterprise. *Journal of International Management.* **17**(4), pp.263-277.

De Wit, A. (1988). Meaurement of Project success. *Project Management Journal.* **6**(3), pp.164-170.

Fabb, N. and Durant A. (1993). *How To Write Essays, Dissertations and Theses In Literary Studies.* London: Longman Publishing.

Fowler, F. F. (1984). *Survey research methods.* Beverly Hills, CA: SAGE.

IPMA. (2006). *IPMA Competence Baseline.* Zaltbommel, NL: Van Haren Publishing. retrieved from www.ipma.world/assets/ICB3.pdf.

Johnson, E. L. (2011). Profiles in Operations Research: Pioneers and Innovators. In: Gass, S.I. and Smith, R.H. eds. *International Series in Operations Research and Management.* New York: Spinger.

Levin, P. (2011). *Excellent dissertations.* 2nd ed. New York: Open University Press.

Mancuso, J. C. (1990). *Mastering Technical Writing*. Massachusetts: Addison-Wesley Publishing Company.

Matthews, J. R., Bowen, J. M. and Matthews, R. W. (1996). *Succesful scientific writing: A step-by-step guide for the biological and medical sciences.* New York: Cambridge University Press.

Mort, S. (1983). *How To Write A Successful Report*. London: Business Books Ltd.

Murray, R. (2002). *How to Write a Thesis.* 1st ed. New York: Open University Press.

Murray, R. (2006). *How to Write a Thesis.* 2nd ed. New York: Open University Press.

Murray, R. and Moore, S. (2006). *The Handbook of Academic Writing: A Fresh Approach.* New York: Open University Press.

Pirie, D.B. (1985). *How to Write Critical Essays.* 1st ed. London: Routledge.

Price, J. H. and Murnan, J. (2004). Research Limitations and the Necessity of Reporting Them. *American Journal of Health Education.* **35**(2), pp.66-67.

Robinson, J. B. L. (1991). Delphi Technology for Economic Impact Assessment. *Journal of Transportation Engineering.* **117**(3), pp.335-349.

Shields, P. and Rangarjan, N. (2013). *A Playbook for Research Methods: Integrating Conceptual Frameworks and Project Management*. Stillwater, OK: New Forums Press.

Appendices

Appendix A

Publications based on this thesis

Seboni, L. and Tutesigensi, A. 2014a. Allocating project managers to projects in a multi-project environment In: *Proceedings of the 30th Annual ARCOM Conference,* 1-3 September 2014*,* Portsmouth, UK. Association of Researchers in Construction Management, pp.825-834.

Seboni, L. and Tutesigensi, A. 2014b. Development and verification of a conceptual framework for project manager-to-project (PM2P) allocations in multi-project environments. In: *Proceedings of PICMET '14, 27-31 July 2014, Kanazawa, Japan*. IEEE, pp.2477-2496.

Seboni, L. and Tutesigensi, A. 2015a. A mathematical model for allocating project managers to projects. In Raiden, A. (Ed.) and Aboagye-Nimo, E. (Ed.), *Proceedings of the 31th Annual ARCOM Conference*, 7-9 September 2015, Lincoln, UK, Association of Researchers in Construction Management, pp. 3-12.

Seboni, L. and Tutesigensi, A. 2015b. Project manager-to-project allocations in practice: an empirical study of the decision-making practices of a multi-project based organization. In Hughes, W. (Ed.) and Raiden, A. (Ed.), *Construction Management and Economics*, **33**(5-6), pp.428-443.

Seboni, L.Tutesigensi, A. and Bower, D. 2013. Managerial decision making regarding the allocation of project manager resources to projects: The case of Botswana. In: *Technology Management in the IT-Driven Services (PICMET), 2013 Proceedings of PICMET '13:, July 28 2013-Aug. 1 2013*, pp.487-510.

Appendix B

Questionnaire survey (fieldwork 1)

Nature of PM2P Practice (Independent variables)	**Survey questions (only positively worded questions measured on 5 point scale included here as components of the index)**	**Average scores**	**Index scores (%)**
RV1: Extent of formality	The way in which my superior allocates me to projects is prescribed (e.g., formal, proper, official)?		
	To what extent does your superior use documentation to guide his/her decision making process in relation to your allocation to projects?		
RV2: Extent of objectivity	To what extent does your superior use management tools to guide his/her decision making process in relation to your allocation to projects? I think my superior uses clear guidelines & necessary documentation to arrive at a consistent decision regarding which projects I get allocated to? The approach used by my superior to assign me to projects is such that he/she will arrive at the same decision as before, if he/she were to do it again?		
	The approach used by my superior to assign me to projects is such that a different superior will reach the same decision?		
RV3:Extent of match between project manager and project	There is a good match between my competencies & the project requirements, for all the projects that I am allocated to? The types & complexity of projects that I get allocated to match my competency level?		
RV4: Extent of comprehensiveness	My superior considers the correspondence level before making a decision of which projects I get allocated to?		
	My superior considers my own personal growth before deciding which projects I get allocated to?		
	My superior considers my career advancement before deciding which projects I get allocated to?		
	My superior considers the impact of my own motivation in relation to a decision on which projects I get allocated to?		
	My superior considers the impact of my own likely performance on the projects before making allocation decisions? My superior considers the impact of his/her allocation decision on project success, for all the projects I get allocated to?		
	My superior considers the impact of his/her allocation decision on my future career choice, for all the projects I get allocated to? My superior considers the impact of his/her allocation decision on my promotions, for all the projects I get allocated to?		
	My superior uses documentation to guide his/her allocation decisions?		

Appendix B *(continued)*

Performance of PM2P Practice (Dependant variables)	**Survey questions (only positively worded questions measured on 5 point scale included here as components of the index)**	**Average Scores**	**Index scores (%)**
RV5: Project manager performance	My superior considers the impact of my own likely performance on the projects before making a decision of which projects I get allocated to?		
	The project manager-to-project allocation decisions made by my superior have a positive impact on my performance?		
RV6: Project manager motivation	The way in which I am allocated to projects has a positive impact on my motivation?		
RV7: Project success	The project manager-to-project allocation decisions made by my superior have a positive impact on project success, for all the projects that I get allocated to?		
RV8: Project manager rewards (promotions, performance bonus & career advancement)	The project manager-to-project allocation decisions made by my superior have a positive impact on my rewards?		

Key: RV = research variable

Appendix C

Measurement of response bias (fieldwork 1)

Data set for Project Heads

Response bias (RB) Variables	**Survey questions (only 2 questions used per variable) to measure response bias, using the 5 point scale**
RB1	9d. I re-arrange existing allocations to free up the most competent project manager & allocate him/her to the new strategically important project?
	9e. I do not re-arrange existing allocations to free up the most competent project manager & allocate him/her to the new strategically important project?
RB2	9a. I rely only on my judgement, experience & gut feel to allocate a project manager to a project?
	9b. I do not rely only on my judgement, experience & gut feel to allocate a project manager to a project?

Appendix D
Data collection log

Description	Reference	Mode of collection	Date	Source	Category	Position/Business Unit	Company site
Preliminary meeting	N/A	Face to face (notes)	02/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	15/04/2013	AVJ	SLE	Group Manager (Mineral Resource Management)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	19/04/2013	TM	SLE	Strategy Manager (Business Improvement)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	30/04/2013	RW	SLE	Strategy Manager (Short-term)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	05/05/2013	BS	SLE	Group Manager (Strategy)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	07/05/2013	NS	SLE	Strategy Manager (Business Improvement)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	15/05/2013	CN	SLE	Financial Controller (Projects & prioritization)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	18/04/2013	KB	SLE	Technical Director (Strateg	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	22/04/2013	MRT	SLE	Mineral Resource Manager (Long-term Planning)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	22/04/2013	NM	SLE	Group Manager (Human Resource)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	18/04/2013	LD	SLE	Group Manager (Long-term Mine Planning)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	06/05/2013	MR_1	SLE	Strategy Manager (Short-term)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	23/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Interview transcript	N/A	Face to face (audio recorded)	30/04/2013	MM	PH	PMO Manager	Site 2 (Projects Office)
Interview transcript	N/A	Face to face (audio recorded)	06/05/2013	MR_2	PH	PMO Manager	Site 2 (Projects Office)
Interview transcript	N/A	Face to face (audio recorded)	22/04/2013	PK	PH	PMO Manager	Site 3 (Projects Office)
Draft Competency Dictionary	N/A	Email (attachment)	08/05/2013	DT	N/A	HR Manager	Site 1 (Head Office)
Prioritization template	N/A	Email (attachment)	07/05/2013	NS, CN	SLE	Strategy and Business Improvement	Site 1 (Head Office)
Pipeline templates	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
HPO Update - CEO's presentation	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
PMS	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
Executive Meeting Effectiveness Tool	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
Management Operating System	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
Information Management Report	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
Flash Report	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
Process Maps	N/A	Email (attachment)	07/05/2013	NS	SLE	Strategy and Business Improvement	Site 1 (Head Office)
Project Management Job Profiles	N/A	Printout	29/04/2013	MA	N/A	HR Business Partner	Site 1 (Head Office)
Treatment Plant (Report, 03/13)	MER -2012	Email attachment	29/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Project Study Requirements	GP-PM-FW-202	Email attachment	29/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Group Projects Management Framework	GP-PM-FW-100	Email attachment	29/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Project Management of Projects	GP-PM-FW-200	Email attachment	29/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Guideline for Project Development	GP-PM-FW-201	Email attachment	29/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Month Progress Reports (Projects)	477	Email attachment	29/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Mine Expansion Project (2012 Report)	Proj 192	Email attachment	29/04/2013	JR	PH	Group Manager (Projects)	Site 1 (Head Office)
Long-term Mine Planning presentation	N/A	Presentation (note)	22/05/2013	DD	N/A	Long-term Mine Planning	Site 2 (Projects Office)
Tour of Site 1	N/A	Hand written notes	21/05/2013	DM	N/A	Plant Manager	Site 1 (Head Office)
Tour of site 2	N/A	Hand written notes	21/05/2013	TS	N/A	Mine Engineer	Site 2 (Projects Office)
Meetings with Project managers	N/A	Field notes	27/05/2013	Various	PMs	Project Managers (Site 2 M	Site 2 (Projects Office)

Appendix E

Research instrument (fieldwork 2)

Interview schedule for Project Directors	**Interview schedule for Senior Level Executives**
RECOGNITION OF CONSTRAINTS PROCESS	PROJECT PRIORITIZATION PROCESS
Q1. How important are the following (conceptual model factors for recognition of constraints process) in your process of recognizing constraints that influence your PM2P allocation decision, on a scale of 1 to 9 (1=Not important, 5 = average importance, 9 = Very important)? **[Theme 1]**	Q1. How important are the following (conceptual model factors) in your project prioritization process, on a scale of 1 to 9 (1=Not important, 5 = average importance, 9 = Very important)? **[Theme 1]**
Q2. How is the importance of each input reflected in your recognition of constraints process? **[Theme 2]**	Q2. How is the importance of each input reflected in your project prioritization process? **[Theme 2]**
Q3.How do you determine the importance level of each constraint?.What tools and techniques do you use to do that? **[Theme 2]**	Q3. How do you determine the priority of each project for implementation? What tools and techniques do you use to do that?[Explanation of your tools and techniques to show how you actually do the process] **[Theme 2]**
Q4. Who is involved in giving input to the recognition of constraints process? **[Theme 2]**	Q4. Who is involved in giving input to this project prioritization process? **[Theme 2]**
Q5. How many business functions and people in total are involved in this process? **[Theme 2]**	Q5. How many business functions and people in total are involved in this process? **[Theme 2]**
Q6. What are these people's job titles and positions in the organizational hierarchy? **[Theme 2]**	Q6. What are these people's job titles and positions in the organizational hierarchy? **[Theme 2**]
Q7. How do you account for the constraints that have been recognized? What tools and techniques do you use to account for the impact of those constraints in your PM2P decision making process? **[Theme 2]**	
Q8. How often do you respond to the recognition of constraints in your PM2P allocation decision? **[Theme 2]**	Q7. How often do you prioritize projects? **[Theme 2]**
Q9. What comes out of your process of recognizing constraints (all types/forms of constraints) that influence your PM2P allocation decision? **[Theme 3]**	Q8. What comes out of this prioritization process? **[Theme 3]**
Q10. How is this outcome used? (e.g., where does the outcome go?) **[Theme 4]**	Q9. How is it used? (i.e. where does the outcome go?) **[Theme 4]**
REPEAT OF ABOVE QUESTIONS FOR PROJECT MANAGER-TO-PROJECT MATCHING PROCESS	

Appendix F

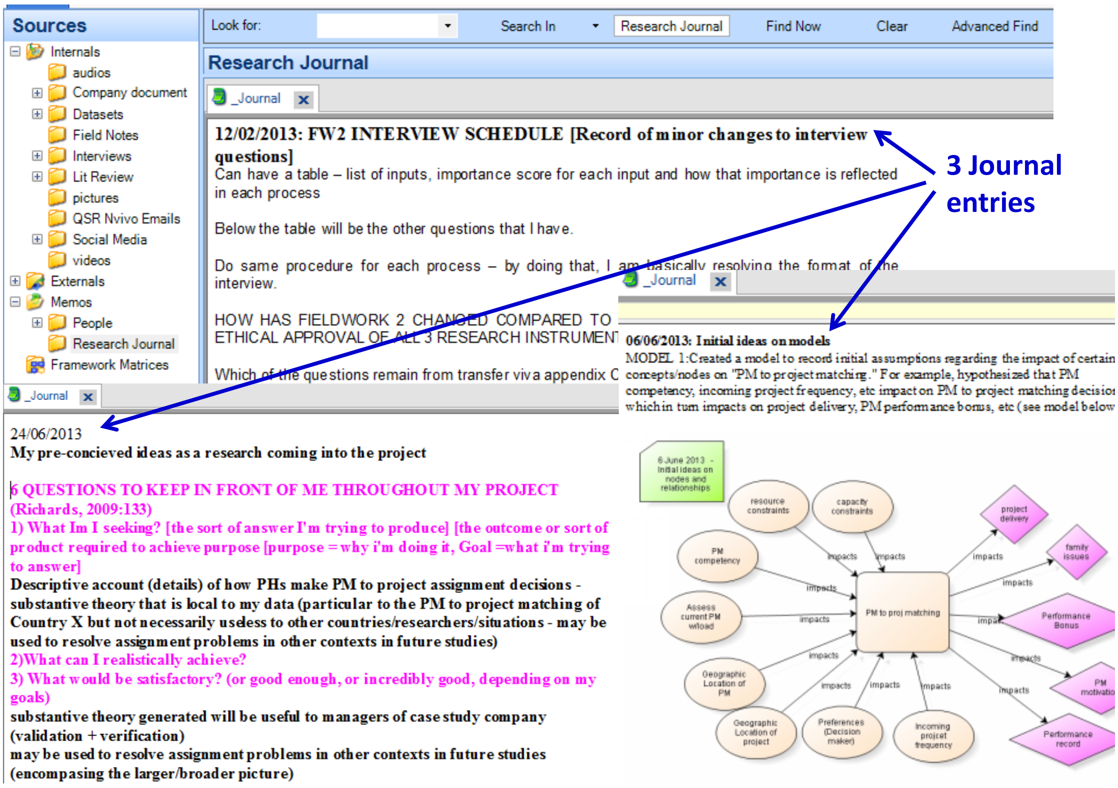
Categories of memos and descriptions

Memo categories /groupings	Description
1. Operational	Preparatory tasks involving formulation of interview schedule and format, including minor changes or updates made.
2. Conceptual	Picking different text segments and grouping them on the basis of similarities to pre-existing themes during stage 1 coding under data management.
3. Analytic	Tasks that involve a shift from data management to analysis or interpretation (e.g., identifying similarities and differences or patterns in the data, from comparing coding applied to cases and themes).
4. NVivo visual displays	Diagrammatic displays that illustrate either initial conceptual ideas or output of interpretations regarding patterns in the data (e.g., matrix displays).

Adopted from Bringer (2002) PhD thesis - modified by Seboni (2013)

Appendix G

Snapshot of the research journal within NVivo 10



Appendix H

Research instrument (fieldwork 3)

Testing technical solution to the problem (under gap in knowledge)

Q1. Please indicate your judgement in terms of the likely change/improvement between the current status quo and the proposed solution by allocating a number from -5 (maximum negative change/improvement) through 0 (No change/improvement) to +5 (maximum positive change/improvement), for each of the following variables?

Variables	Ranking score for Change	Explanation
Extent of formality		
Extent of objectivity		
Extent of match between project managers and projects		
Extent of comprehensiveness		
Impact on project manager motivation		
Impact on project success		
Impact on project manager rewards		
Impact on project manager performance		

Q2. Is the proposed solution likely to be a suitable alternative to what is currently in place in your Organization as regards the effectiveness of the approach/process used in allocating project managers to projects?

Q3. Please explain why or why not?

Practical test for implementation issues

Q4. What do you think are the timelines/implementation schedule required to adopt the proposed system in the context of your Organization's situation?

Q5. The cost to implement the proposed system is estimated at $9,235/P86,070.20, as at 23 June 2014. This cost is made up of purchasing commercially available software ($7,695/P71,717.40) and annual support for software, which includes free upgrades and tech support for one year ($1,540/P14,352.80). Please comment on this cost in relation to the potential benefits of the proposed system?

Q6. What problems do you envisage in implementing the proposed system (both during and after implementation)?

Q7. When do you think you will be in a position to implement the system?

Appendix I

Research ethics and approvals

Performance, Governance and Operations
Research & Innovation Service
Charles Thackrah Building
101 Clarendon Road
Leeds LS2 9LJ
Tel: 0113 343 4873
Email: j.m.blaikie@leeds.ac.uk

UNIVERSITY OF LEEDS

Lone Seboni
School of Civil Engineering
University of Leeds
Leeds, LS2 9JT

MEEC Faculty Research Ethics Committee
University of Leeds

30 March 2012

Dear Lone

Research title	**Optimizing the process of matching project managers to projects: The Case of Botswana's multiproject environments**
Ethics reference	**MEEC 11-037**

I am pleased to inform you that the application listed above has been reviewed by the MaPS and Engineering joint Faculty Research Ethics Committee (MEEC FREC) I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	*Version*	*Date*
MEEC 11-037 Research Ethics Application Form_Lone Seboni.pdf	1	27/03/12
MEEC 11-037 Research Ethics Application Form_Signature Page_Lone Seboni.pdf	1	27/03/12
PARTICIPANT INFORMATION SHEET FOR FIELDWORK 1 INTERVIEWS_Lone Seboni.pdf	1	27/03/12
PARTICIPANT INFORMATION SHEET FOR FIELDWORK 2_Lone Seboni.pdf	1	27/03/12
PARTICIPANT INFORMATION SHEET FOR FIELDWORK 3_Lone Seboni.pdf	1	27/03/12
PARTICIPANT CONSENT FORM_ALL INTERVIEWS_Lone Seboni.pdf	1	27/03/12

Document	*Version*	*Date*
Official Supporting Letter_Ministry of Minerals Energy and Water Resources.pdf	1	27/03/12
Office of the State President.pdf	1	27/03/12
Leeds support letter_Seboni.pdf	1	27/03/12
INTERVIEW SCHEDULE FOR FIELDWORK 1_PROJECT MANAGERS_Lone Seboni.pdf	1	27/03/12
INTERVIEW SCHEDULE FOR FIELDWORK 1_PROJECT HEADS_Lone Seboni.pdf	1	27/03/12
Government Research Permit_Ministry of Minerals Energy and Water Resources.pdf	1	27/03/12
Government Research Permit_MINISTRY OF INFRASTRUCTURE SCIENCE AND TECHNOLOGY.pdf	1	27/03/12
Government of Botswana Research Permit_Ministry of Finance and Development Planning.pdf	1	27/03/12
General letter_Seboni.pdf	1	27/03/12
Fieldwork Approval_Lone Seboni.pdf	1	27/03/12
FIELDWORK 1 QUESTIONNAIRE_PROJECT MANAGERS_Lone Seboni.pdf	1	27/03/12
FIELDWORK 1 QUESTIONNAIRE_PROJECT HEADS_Lone Seboni.pdf	1	27/03/12

Committee members made the following comments:

- Far too much detail was provided in some sections which made it difficult to review. For example A9 is not a short summary of the research.

- **Such fast turn-around of applications cannot be guaranteed, it would be appreciated if in future you could apply in good time. You should allow six weeks for the ethical review process to take place.**

Please notify the committee if you intend to make any amendments to the original research as submitted at date of this approval, including changes to recruitment methodology. All changes must receive ethical approval prior to implementation. The amendment form is available at www.leeds.ac.uk.

Please note: You are expected to keep a record of all your approved documentation, as well as documents such as sample consent forms, and other documents relating to the study. This should be kept in your study file, which should be readily available for audit purposes. There is a checklist listing examples of documents to be kept which is available at
http://researchsupport.leeds.ac.uk/index.php/academic_staff/good_practice/other_inf

Yours sincerely

JBlaikie

Jennifer Blaikie
Senior Research Ethics Administrator, Research & Innovation Service
On behalf of Professor Gary Williamson, Chair, MEEC FREC

CC: Student's supervisor(s)

Performance, Governance and Operations
Research & Innovation Service
Charles Thackrah Building
101 Clarendon Road
Leeds LS2 9LJ Tel: 0113 343 4873
Email: ResearchEthics@leeds.ac.uk

UNIVERSITY OF LEEDS

Lone Seboni
School of Civil Engineering
University of Leeds
Leeds, LS2 9JT

MEEC Faculty Research Ethics Committee
University of Leeds

7 March 2013

Dear Lone

Research title **Optimizing the process of matching project managers to projects: The Case of Botswana's multiproject environments**
Ethics reference **MEEC 11-037**

I am pleased to inform you that the amendment to the application listed above has been reviewed by a delegate of the MaPS and Engineering joint Faculty Research Ethics Committee (MEEC FREC) and I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	*Version*	*Date*
INTERVIEW SCHEDULE FOR FIELDWORK 2_Lone Seboni[1].pdf	1	06/03/13
INTERVIEW SCHEDULE FOR FIELDWORK 3.doc	1	06/03/13
FIELDWORK 1 QUESTIONNAIRE_PROJECT HEADS_Lone Seboni.pdf	1	27/03/12
FIELDWORK 1 QUESTIONNAIRE_PROJECT MANAGERS_Lone Seboni.pdf	1	27/03/12
Fieldwork Approval_Lone Seboni.pdf	1	27/03/12
General letter_Seboni.pdf	1	27/03/12
Government of Botswana Research Permit_Ministry of Finance and Development Planning.pdf	1	27/03/12
Government Research Permit_MINISTRY OF INFRASTRUCTURE SCIENCE AND TECHNOLOGY.pdf	1	27/03/12
Government Research Permit_Ministry of Minerals Energy and Water Resources.pdf	1	27/03/12
INTERVIEW SCHEDULE FOR FIELDWORK 1_PROJECT HEADS_Lone Seboni.pdf	1	27/03/12
INTERVIEW SCHEDULE FOR FIELDWORK 1_PROJECT MANAGERS_Lone Seboni.pdf	1	27/03/12
Leeds support letter_Seboni.pdf	1	27/03/12
MEEC 11-037 Research Ethics Application Form_Lone Seboni.pdf	1	27/03/12
MEEC 11-037 Research Ethics Application Form_Signature Page_Lone Seboni.pdf	1	27/03/12
Ministry of Agriculture.pdf	1	27/03/12
Ministry of Communications and Transport.pdf	1	27/03/12
Ministry of Education.pdf	1	27/03/12
Ministry of Environment Wildlife and Tourism.pdf	1	27/03/12
Ministry of Finance and Development Planning.pdf	1	27/03/12
Ministry of Foreign Affairs and International Cooperation.pdf	1	27/03/12

Ministry of Lands and Housing.pdf	1	27/03/12
Ministry of Local Government.pdf	1	27/03/12
Ministry of Youth Sports and Culture.pdf	1	27/03/12
Office of the State President.pdf	1	27/03/12
Official Supporting Letter_Ministry of Minerals Energy and Water Resources.pdf	1	27/03/12
PARTICIPANT CONSENT FORM_ALL INTERVIEWS_Lone Seboni.pdf	1	27/03/12
PARTICIPANT INFORMATION SHEET FOR FIELDWORK 1 INTERVIEWS_Lone Seboni.pdf	1	27/03/12
PARTICIPANT INFORMATION SHEET FOR FIELDWORK 2_Lone Seboni.pdf	1	27/03/12
PARTICIPANT INFORMATION SHEET FOR FIELDWORK 3_Lone Seboni.pdf	1	27/03/12

Please notify the committee if you intend to make any further amendments to the original research as submitted at date of this approval, including changes to recruitment methodology. All changes must receive ethical approval prior to implementation. The amendment form is available at http://ris.leeds.ac.uk/EthicsAmendment.

Please note: You are expected to keep a record of all your approved documentation, as well as documents such as sample consent forms, and other documents relating to the study. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at http://ris.leeds.ac.uk/EthicsAudits.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

J Blaikie

Jennifer Blaikie
Senior Research Ethics Administrator, Research & Innovation Service
On behalf of Professor Gary Williamson, Chair, MEEC FREC

CC: Student's supervisor(s)

UNIVERSITY OF LEEDS

Fieldwork Approval Form (To Be Completed by Head of School / Service or Fieldwork Leader)

The following individual

Name (Print)	Lone Seboni

has requested approval to undertake fieldwork activities,

Location	Gaborone, Botswana
Date(s)	Fieldwork 1: Between 01/04/2012 and 28/05/2012 Fieldwork 2: Between 01/09/2012 and 01/07 2013 Fieldwork 3: Between 01/09/2013 and 01/09/2014

To carry out the following fieldwork activity:

Interview and questionnaire surveys in relation to the practice of assigning project managers to projects in multi-project organizations in Botswana.

A Fieldwork Risk Assessment has been completed and a copy is attached

The main issues arising from the assessment are:

The researcher is travelling to his native country for fieldwork activities within Government air conditioned offices and is familiar with the country and fieldwork sites. The only issues arising from the assessment are the need for the following:

- observing and abiding by the familiar road traffic regulations when driving to and from sites (e.g. speed limits, seat belt, carrying a valid driving license at all times);
- ensuring car roadworthiness (e.g. tyres, air pressure, fluid levels, wipers, and lights); and
- ensuring personal safety (e.g. seeking a shade when outdoors, exercising caution during air-travel such as luggage contents, etc).

The fieldwork activity has been approved and they have undergone all relevant training and briefing required for the trip.

Should the nature of the fieldwork change during this period, a further risk assessment will be carried out.

Name:	Professor Nigel Smith
Signature:	
Date:	22/3/12

To be completed by Employee/Student

I have carried out or been briefed on the content of the Fieldwork Risk Assessment and the associated documentation and by my Faculty/School/Service. I agree to comply with the arrangements set out in the risk assessment and acknowledge that my approval for the fieldwork will be withdrawn if I am found in to be working outside the agreed arrangements.

Name:	Lone Seboni
Signature:	
Date:	21/03/2012