The Impact of Project Management Process Quality on Construction Project Performance: A Structural Equation Model

Sambo Lyson Zulu

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Abstract

This research contributes to the understanding of the relationship between project management and construction project performance. The aim of the research was to evaluate the nature and significance of the relationship between project management process quality (PMPQ) and construction project performance. A review of literature showed that the direct effect of project management factors on project performance has dominated the examination of the relationship between project management critical success factors and project performance. This research departed from this and took a structural model perspective that was intended to shed light on both the direct and indirect effects as well as the individual and collective impact of project management factors on performance. A quality management framework was used to analyse the effect of project management on construction project performance. Although some studies have shown an interest in examining the integration of quality management principles to the project management field, no study has empirically evaluated the relationship between PMPQ, as defined in this research, and construction project performance. The PMPQ model developed was an adaptation of a quality award model and presented as a web of dependence relationships. The main conclusions from the findings was that, while not all postulated relationships were found to be statistically significant, there is a positive relationship between PMPQ and construction project performance. The main implication of the findings was that project management influencing factors should be seen as having both direct and indirect influences as well as individual and collective impact on construction project performance.

Dedication

To my late dad, Lyson Juliel Zulu

Acknowledgements

I would like to thank Dr Andrew Brown of the School of the Built Environment, Heriot Watt University for supervising this piece of work; my wife Esther and my son Temwisha Joel for keeping me going; my late sister Idah and her husband the late Samuel Nguni, mum and my brothers without whom, I guess, would not have reached this far.

I would also like to acknowledge all companies and organisations who responded to the questionnaire without whom there would have been no data to complete this piece of work.

God bless you all.

'And unto the King eternal, immortal, invisible be honour and glory for ever and ever amen'

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CHAPTER ONE

Introduction to the Research

1.0 Introduction

This chapter introduces the aims and objectives of the research project. It also provides justification of the research examining the relationship between quality of the project management process and construction project performance. There has been an ongoing debate concerning the influence of project management processes on project performance. This research uses a quality perspective to empirically examine the *relationship between project management processes and construction project* performance, and therefore contributes to the understanding of the influence of project management processes on performance.

The chapter is divided into four sections. Section One explores the background to the study and in particular outlines the purpose of construction project management with respect to the influence of project management processes on project performance. Section Two discusses the justification for a quality perspective to the evaluation of the relationship between project management and construction project performance. Section Three outlines the research aims together with the research methodology. Section Four provides a brief overview of the chapters in the thesis.

1.1 Section One: Background

1.1.1 Value of Project Management

The purpose of project management on a construction project is undoubtedly to add value to projects by delivering successful projects in terms of agreed project objectives. Generally, project management literature suggests that project management processes are geared towards the delivery of successful projects. The Construction Industry Council (2007), for example, describe the purpose of construction project management as intending to add significant value to the project delivery process through the use of management principles suited to projects. They further advocate that project management processes are suited to provide better value to construction projects than any other processes. This suggests that the use of project management processes should lead to successful construction projects.

Many definitions of project management also assert that project management processes are geared towards the delivery of successful projects in terms of achieving the required project objectives.. For example Walker (2002: 5) defines project management as

> *'the planning, co-ordination and control of a project from inception to completion on behalf of a client requiring the identification of the clients objectives in terms of utility, function, quality, time and cost, and the establishment of relationships between resources, integrating, monitoring and controlling of the contributions to the project selecting alternatives in pursuit of the clients satisfaction with the project outcome'.*

It can be assumed from this definition that the primary goal of project management is the satisfaction of the Client with the project outcomes. Similarly Kerzner (1998), and the Project Management Institute (PMI) (2004) among others, define project management in terms of achieving specific goals and objectives, which traditionally can be in terms of time, cost and quality performance criteria. However, indications are that project management in construction (Brown and Adams 1999) and in general (The Standish Group 1997; and The International Standards Organisation (ISO) 2002)) has failed to consistently deliver projects successfully. Brown (1996) and Brown and Adams (1999), in examining the causal effect of building project management upon project performance based on the time, cost and quality criteria, concluded that project management in construction fails to consistently deliver successful results and therefore does not represent added value for clients. Similarly the International Standards Organisation (ISO) (ISO 2003) in the ISO 10006, guide to quality in project management document acknowledges that project management has failed to consistently deliver successful results. These findings are inconsistent with the primary objective of project management, which is the delivery of successful projects.

The continued use of project management despite the failure of project management to deliver successful projects as acknowledged above, demands an examination of the value of using this approach to deliver successful construction projects. This need has been one of the major concerns in project management literature. Crawford and Pennypacker (2001) posit that with the increase in project management application, there is need to demonstrate the value of applying project management in organisations. This would help justify the increased investment in project management efforts. Ibbs and Kwak (2000) and Ibbs *et al* (2001) also argued for research to demonstrate the value of project management. Cook-Davies (2003) in his article on the value of project management posed four critical questions, which need to be answered for the understanding of project management. These included:

i. *How does improving project management capability lead to improved organisational results?*

ii. *If we invest in improving specific aspects of our project management capability, will we obtain value for money?*

iii. *Does a specialist project management department or project management office add value to an organisation? And if so how big should it be?*

iv. *Given that every project needs managing, are there any guidelines as to the optimal relationship between the cost of managing a project and the cost of executing the project tasks?*

Although not necessarily addressing the issues raised by Cook-Davies (2003), a number of studies have been undertaken to address the relationship between project management and performance. Example studies include among others Ibbs and Kwak (2000), Brown and Adams (1999) and Crawford and Pennypacker (2000). Ibbs and Kwak (1999) used capability maturity modelling to examine the influence of project management processes on return on investment. They found out that higher maturity levels correspond to higher return on investment. On the other hand Brown and Adams (2002), as discussed above, used path analysis as an evaluation method to examine the causal influence of building project management on performance. They concluded that although project management has an influence on time and cost, its influence on quality performance was not statistically significant. This to an extent questioned the role of building project management in delivering construction projects successfully.

Project management literature stresses the advantages of using project management structures over the traditional structures. The general consensus is that project management organisation structures are better suited to deliver successful project results than the traditional forms (Kerzner 1998). However, although it is agreed in theory, the use of project management does not guarantee project success. This has prompted much research to examine how project management influences project results.

In an effort to understand the impact of project management processes on performance, many studies have examined project management critical success factors. These can be interpreted as factors that would influence the success or failure of a project. One of the key studies was by Pinto and Slevin (1988) who designed a project implementation profile. They found out that there are certain factors that would influence the success of the project. This study and many others (Kog *et al* 1999; Belout and Gauvreau 2004; Pheng and Chua 2006; and Fortune and White 2006) are discussed in detail in Chapter Two. It is evident, however, that there has been much effort to understand the influence of project management on performance.

This research contributes to this debate and uses a project management quality perspective to understand the relationship between the use of project management processes and construction project performance. The quality of the project management process is examined as a possible significant contributor to the performance of construction projects. This is based on the argument that increasing the level of quality in the process increases the chances of better performance (Dale 1999). An examination of research in the quality management field, generally show that there is a linkage between quality management effort and performance (Ahire *et al* 1996; Samson and Terziovski 1999; and Anderson *et al* 1998). This research therefore argues that increasing the quality of the project management process should increase the likelihood of better construction project performance. No empirical study to date is known to have been conducted using an approach that evaluates the relationship between project management process quality and performance. The approach used in this research is described in Section Three and Four of this chapter.

1.1.2 Quality in Project Management: Definitions

Before focusing on quality in project management it is necessary to provide a working definition of quality with respect to project management processes. Studies have shown the applicability of quality management principles in project management (Barad and Raz 2002; Bryde 2004; and Cicmil 2000). It can therefore be argued that a generic definition of quality is fitting for project management.

Quality has been defined from several perspectives. For example quality has been defined as '*meeting customer requirements*' (Griffith 1990), or as '*characteristic that can be used to determine the degree of excellence of a process or product*' (Wideman 2001). The International Standards Organisation (ISO) defines quality as '*... degree to which a set of inherent characteristics fulfils requirements*'. (ISO 2000: 7)

Shepperd (1998) argued that such a definition is all embracing and therefore it is important to provide a contextual definition of quality. He points out that the first step in providing such a definition might be to establish three factors which include quality attribute, object of interest and perspective. In this respect quality in project management can be defined in terms of the quality attributes as defined by the project management quality indicators, in the project management process, which is the object of interest as perceived by the different project stakeholders, including the project manager, project team, and the customer. Such a definition provides a contextual definition of quality in the project management environment. This is consistent with current thinking in project management concerning the multi-stakeholder approach in the definition of project success. The multi-Stakeholder approach focuses on the definition of success from the perspective of different stakeholders on the project (Shenhar and Wideman 2000).

Turner (1999) used a five-element model to depict total project quality. This includes quality of the product, quality of the management process, quality assurance, quality control and people's attitudes. The model distinguishes between product quality and management quality. This distinction is also recognised in the project management body of knowledge (PMI 2000) and in ISO 10006 (ISO 2003). The Project Management Institute (PMI 2000) in distinguishing between project management processes and product-oriented processes defined project management processes in terms of the activities that describe, organise and complete the work of the project while product oriented processes in terms of the activities used to specify and create the projects product.

Arditi and Gunaydin (1998) also distinguished between product quality and process quality and defined product quality as the quality of elements directly related to the physical product itself while process quality as relating to achieving quality of organisation and management of the project in the three phases of design, construction and operation. Similarly, Wideman (2001) distinguished between the quality of the process and the quality of the product by defining the quality of a process in terms of the standard by which the project's deliverables are produced while the quality of the product is defined in terms of the standard that the deliverables meet the specified requirements. It is evident from the foregoing discussion on the definition of quality in projects that the quality of the (project management) process is a factor worth considering.

This distinction between (project management) process quality and product quality implies that there are two perspectives of quality, which can influence the overall outcome of the project. It is recognised, therefore, that based on this distinction, quality in both the product and the (project management) process, should be managed to the highest level, since neglecting one perspective would affect the outcome of the other perspective. Thus quality of the (project management) process is likely to influence the outcome of the product. This provides ground for increased efforts to manage the process, as it is the 'process that creates the product' (Collier 1995).

However the emphasis in research on quality in construction has been on the quality of the product while the quality of the management process has received lesser attention (Zulu & Brown 2001). Behara and Gundersen (2002) noted that empirical research in quality management has concentrated on the manufacturing industry while little has been done in the services industry. This reflects the trends in research concentrating on the product quality and not on management quality (Orwig and Brennan 2000). This is also reflected in project management literature where debates on quality have focused on using project management to implement quality management (Gupta and Graham 1997) or on using project management to assure the quality of the project (Shenner 1997). Orwig and Brennan (2000) also noted that academia has directed scant attention toward the effect quality management might have on the project management process. The relatively low number of studies focussing on quality of the project management process is against the recognition that neglecting any one of the quality perspectives on a project would likely impact on project outcomes (ISO 1998 and Turner 1999). This research recognises the importance of quality of the project management process as a possible significant contributor to the success of a construction project.

1.1.3 Past Studies Investigating the Influence of Quality Management Effort on Performance

A review of literature suggests that there is a positive relationship between quality management efforts and performance. Some of the studies that have examined this relationship are presented below. Anderson *et al* (1998), for example, analysed the influence of quality management on logistics performance and used quality management factors as measure of quality. Further details of this piece of work are discussed in Chapter Three. Anderson *et al* (1998) used the Malcolm Baldrige National Quality Award (MBNQA) criteria and developed quality constructs to analyse their proposed causal networks. Constructs are those variables that cannot be measured directly, but are measured by some indicator variables. The MBNQA is a quality award criteria in the United States of America designed to be used to award companies that represent best practice in quality management (National Institute of Standards and Technology 2003).

Anderson *et al* (1998) developed twenty hypotheses of which five were hypothesised to have a direct effect on operational performance. They postulated that the five constructs, which included training, teamwork, information, supplier management and morale, were significant positive direct causes of operational results. However, they found out that only training, information and supplier management had significant positive relationships with operational results while teamwork and morale had a very small direct effect on operational results. The significance of this finding to this research is that it shows that while there are many quality variables that are generally accepted as impacting on performance, they do not have the same weight of influence. It is important therefore to understand which project management quality variables have significant influences on construction project performance.

Samson and Terziovski (1999) also examined total quality management practices and operational performance of manufacturing companies. They also concluded that there is a positive relationship between quality management effort and performance. Similarly, Madu *et al* (1996) examined the influence of quality dimensions on organisational performance, while Kuei *et al* (2001) examined the relationship between supply chain quality management practices and organisational performance. Ahire and Dreyfus (2000), Claver *et al* (2003), Hendricks and Singhal (2000), Morrow (1997) and Pannirselvam and Ferguson (2001) also examined the relationship between quality and performance. These studies also show that there is a significant positive relationship between quality efforts and performance.

However, it is noted in most of these studies, that factors used to measure quality have a relative differing level of influence on performance. Another significant issue in these studies is the common methodology used to evaluate the relationship. They each use quality award frameworks, such as the MBNQA discussed above, as a basis for defining the relationship between quality and performance. For example Anderson *et al* (1998) used the MBNQA as a basis for the development of a model that linked quality and performance for logistics processes. This method has an advantage in that it is possible to examine both the direct and indirect relationships since the model is presented as a set of causal relationships between various different quality areas. Unlike analyses based on single relationships, using such an approach provides better insight into the intricate interrelationships between quality variables and performance. A detailed discussion of these studies is given in Chapter Three.

The possibility of extending a similar evaluation between quality and performance has been shown in project management research. This is seen in studies by Westerveld (2003), Barad and Raz (2000) and Bryde (2003). These studies attempted to show the relationship between quality in project management and project performance. They all developed quality measurement frameworks, which can be used to measure quality in project management. Barad and Raz (2000), for example, assessed the impact of quality management efforts in project management and found that, in common with studies in other industries, there are significant direct relationships between some quality constructs relating to project management and operational performance.

Westerveld (2003) developed a project management excellence model that shows the linkage between critical success factors and project management performance. It should be noted that while Westerveld (2003) used the term *'excellence'*, Dale (1999) argued that reference to 'excellence' is synonymous with *'quality'*. Although Westerveld (2003) developed a measurement model for project management performance, he did not show empirically the significance of the relationships between quality management constructs in project management and performance. Bryde (2003) too developed a similar evaluation model of project management but did not show empirically the significance of the relationship between project management quality and performance. Although these studies show that it is possible to determine the direct and indirect effects of project management quality variables on performance, there is still a need to empirically examine the validity of the assumptions in these models.

One of the major concerns with quality models, such as the MNBQA used in the Anderson *et al* (1998) study, has been the need to validate the theoretical assumptions underpinning them. The assumptions in these models were questioned and this prompted many researchers to examine the validity of these models. Ahire *et al* (1996) for example validated Total Quality Management (TQM) constructs showing that the interrelationships depicted in the TQM model were valid. Similarly there have been studies that have used the European Foundation for Quality Management Business Excellence (EFQM) model. The principles of this model are similar to the MBNQA's as cited earlier. The Europa report (Europa 1999) showed the relationship between application of EFQM principles and performance. Their analysis was based on correlations, which showed only the linkage between adoption of the EFQM methodology and performance. The EFQM, like the MBNQA, portrays linkages between quality constructs. The model presupposes that business results are as a result of leadership, people management, strategy and policy and stakeholder management acting through process management (EFQM 2005). This is further discussed in Chapter Five. However the Europa study did not attempt to empirically validate the assumed interrelationships in the model. The concept of TQM and EFQM models are discussed in detail in Chapter Five.

This research adopts a similar approach to studies that have been based on the EFQM and MNBQA models. The use of the quality management based models to evaluate the relationship between project management quality and construction project performance is a step further in project management research as it provides a sound theoretical framework. However there remains a need to empirically validate such models. Both Bryde (2003) and Westerveld (2003) did not show the empirical validation of the underlying relationships in their models. Barad and Raz (2000) examined the correlation between quality constructs and performance but did not evaluate the interrelationships between the quality variables and how these collectively relate to project performance. The present investigation builds on these studies and empirically examines the nature and significance of the relationship between project management quality and project performance in construction projects. This research takes a similar approach as in many other quality management studies that examined both the collective and individual impact of project management quality variables on project performance. This is further discussed in Section Two.

1.2 Section Two-Research Justification

1.2.1 Quality Management and Project Management: An Overview

In order to analyse the relationship between quality in project management and construction project performance, it is appropriate to examine the perspectives from which the relationship between project management and quality have been evaluated in literature. Such an examination shows that there is need for a research that examines empirically the impact of project management process quality and construction project performance.

There are several perspectives from which the relationship between quality management and project management has been evaluated. For example, project management has been used to implement quality management initiatives (Hides *et al* 2000; Lo and Humphreys 2000). Studies have also shown the complimentary nature between the use of project management and application of quality management initiatives (Orwig and Brenan (2000). Stamatis (1994) and others (Ramabadron 1997; Armad and Sein 1997; and Cammarano 1997) have examined the influence of project management on quality factors, in part or as a whole, of products or services. Studies have also shown that it is possible to integrate quality management principles into project management (Pzernica 2000; Fennessy 2001; MacAdam 2000; Bryde 1997; Bryde 2003; Barad and Raz 2000; Lazlo 1999; Westerveld 2003; Cicmil 2000; and Goulet and Azodekon 2001). Of significance also is the interest shown by the presence of quality in project management Special Interest Groups (SIG) in project management professional organisations such as the Project Management Institute (PMI 2006) and the Association of Project Management (APM 2006).

The International Project Management Association (IPMA) has also developed an award model based on TQM principles (IPMA 2005) to recognise excellence in project management. As noted earlier, reference to excellence can be treated as synonymous with quality (Dale 1999). Significantly also is the recognition in literature that quality in project management befits attention. This is clearly seen in the differentiation of project management process quality and project product quality (Turner 1999, PMI 2000 and BSI 2002) as discussed in Section One above.

There have been studies, also noted in Section One, which have attempted to show the relationship between quality.in project management and performance. Notable among these include Barad and Raz (2000), Bryde (2003) and Westerveld (2003). Barad and Raz (2002) based their work on project management in the Hi-tech and Software industry in Israel. This is a significant piece of work in that it shows empirically the contribution of quality management practices in project management on project performance. Barad and Raz (2000) aimed to adapt global quality management practices to suit project management's needs. Although their original research did not focus on quality management practices, they used cluster analysis to group project management practices into quality categories. These categories were developed from two other studies, which include Ahire *et al* (1996) and Flynn *et al* (1994). They concluded that the global quality management tools, as depicted in the Ahire and Flynn studies, can be adapted to project management needs. Having categorised the project management practices into quality clusters, they examined the effect of these quality practices on project management performance based on correlation statistics. However the study only examined the direct effect of these quality management tools on performance.

Although Barad and Raz (2000) evaluated the relationship between quality management tools in project management and performance, their approach differs with the present research. Firstly the present research focuses on construction project management with respondents based in the UK. The application of a similar approach to project management in construction is expected to have notable differences. Curkovic *et al* (2000) noted that such an approach that restricts its analysis to a particular industry permits the control of several potential variables that would often differ between industries, in terms of the scope and complexity of quality issues. Secondly and most significant is the method of evaluation used. Barad and Raz (2000) used correlation as a method to analyse the relationship. However this has the weakness in that only the direct effect of the individual relationship between the quality management factors and performance was evaluated. This research developed this further and implements an evaluation method that makes it possible to evaluate the direct and indirect influences, as well as the individual and collectively impact of project management process quality variables, on construction project management performance.

Bryde (2003) mainly focused on soft project management (i.e. change management projects) in organisations and proposed a project performance assessment model. Bryde (2003) proposed the model based on the European Foundation for Quality Business excellence Model (EFQM). Despite proposing an evaluation model, Bryde (2003), did not evaluate the causal relationship between the different quality constructs and with performance. However his work provides a basis for developing a framework that can be used to empirically assess the impact of project management quality on construction project performance.

Westerveld (2003) also presented a project management evaluation model based on the EFQM. However the evaluation of the causal influence between quality in project management and performance was not one of the purposes of the study. Westerveld (2003) developed constructs based on project management literature on critical success factors and project success failure. These factors were built into the project management excellence model. However in this study there is no evidence of an attempt to evaluate the strength of the relationship between the different quality indicators and also between the quality constructs and project performance. A detailed literature review concerning the above three studies in particular and concerning quality in project management in general is presented in Chapter Three.

1.2.2 Justification of the Present Research-Summary

The above discussion has shown the potential for a quality perspective to the understanding of the relationship between project management processes and construction project performance. Four aspects provide justification for such an approach. Firstly, there is a general consensus that there is need to show the value of project management. A number of studies have been carried out in this regard. This research would contribute to this debate by providing a different perspective, concerning this relationship.

Secondly, studies in critical success factors have lacked a theoretical framework to define the linkages between success factors and performance (Westerveld 2003). Clarke (1999), in arguing that project management is not an end in itself but a means to an end, identified key success factors that a project manager needs to focus on to produce successful projects. Her argument was that whilst there is a clear understanding of the need to achieve the required time, cost and quality objectives, there is little published on how these objectives can be met. Morris (2000) also argued for the need for a sound theoretical basis on the evaluation of the influence of project management on successful project delivery. He argued that there is need for project management research underpinned by a sound theoretical framework, which would demonstrate how the project management discipline works to influence projects successfully. Taking a quality perspective provides a theoretical framework through which the linkage between project management variables and construction project performance can be evaluated. This is further explained in Chapter Five.

Thirdly, most research examining the influence of project management on performance have done so based on single relationships based on correlation statistics. While single relationships provide an insight into the possible relationship between project management variables and performance, it does not provide the whole picture, as it does not show the inter-linkages between variables and how this would collectively impact on performance. It has been noted in Section Two of this chapter that there have been studies that have used quality management based models, which show the inter-linkages between quality variables and performance. Taking such an approach for project management research will provide an opportunity to examine the direct and indirect relationships between project management variables to performance.

Fourthly, there have been studies that have attempted to examine the use of quality award based models in project management research. However no empirical study is known to have been undertaken which examined the nature and significance of the relationship between project management process quality variables and construction project performance. The present research takes a quality perspective, and in particular uses existing quality frameworks to define the relationship between project management variables and construction project performance.

1.2.3 Focus of this Study

This research builds on previous studies, in particular Barad and Raz (2000), Bryde (2003) and Westerveld (2003), to understand the nature and strength of the relationship between project management quality variables and project performance, as a way of establishing the causal influence of the project management processes on project performance. The focus of the research is to evaluate the direct and indirect contribution of project management process quality variables on construction project performance. The research develops further the work by Barad and Raz (2000) by examining the direct and indirect effect of project management quality variables on performance. It further extends the work of Bryde (2003) and Westerveld (2003) by empirically evaluating the strength of the relationship between project management quality and construction project performance.

1.3 Section Three: Research Objectives and Methodology

1.3.1 Research Objectives

The primary aim of this research is to investigate the nature and significance of the relationship between project management process quality variables and construction project performance. This is achieved by examining the direct and indirect impact of project management process quality variables on construction project performance. The following are the main objectives of this research:-

i. To review the philosophy and practices concerning quality in the project management process.

ii. To evaluate the significance of the relationship between project management process quality and construction project performance.

iii. To draw conclusions concerning the nature and significance of the relationship between project management process quality and construction project performance.

1.3.2 Contribution to Knowledge

This research examines the causal relationship between the use of project management processes on construction projects and project performance. In particular it focuses on the quality of the project management process as a significant factor that can influence construction project performance. In seeking to examine the impact of quality of the project management process on construction project results, this research contributes to the understanding of the relationship between project management processes and construction project performance.

There are many perspectives from which the impact of project management on project performance has been examined before, however the use of a project management process quality perspective adopted in this research, adds a different dimension to the understanding of the causal relationship between the use of project management and construction project performance. Further an examination of literature reveals that a significant proportion of studies on the relationship between project management and performance focuses on the individual contribution of project management variables on project performance (see Section 2.4), however the evaluation approach taken in this study examines both the individual and collective influences of the project management variables on construction project performance. This evaluation approach therefore also adds a different dimension to the understanding of the causal relationship between project management and project performance in construction.

1.3.3 Theoretical Proposition

The argument in the literature as stated in Section One is that improving the quality of the process increases the chance of better performance. It is therefore argued that increasing the quality of the project management process should increase the chance of better construction project performance. In this respect the following theoretical proposition is examined:

There is a significant positive relationship between project management process quality and construction project performance.

In order to evaluate both the direct and indirect relationships between the project management process quality variables and construction project performance, the above proposition was further developed into specific hypotheses. These are discussed in more detail in Section 5.4 of Chapter Five.

1.3.4 Methodology

General Research Approach

Figure 1.1 below shows the sequence of the research activities. Firstly literature was reviewed, to ground the research. This was followed by the development of a project management process quality (PMPQ) measurement model, which was used as a research instrument. Having developed the measurement model a questionnaire survey was used to collect data to test the research hypotheses.

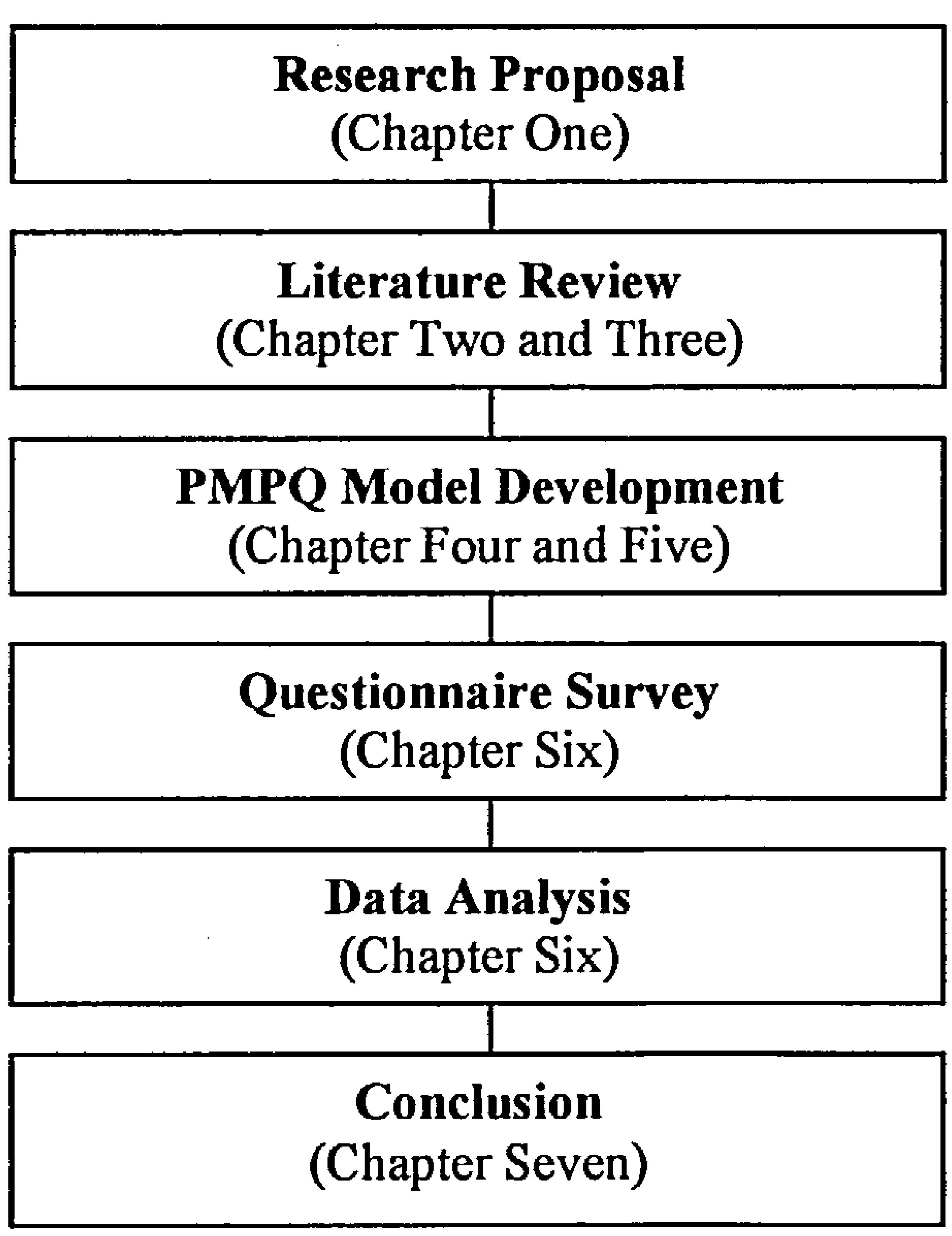

Figure 1. 1: General Research Strategy

The evaluation of the significance of the relationship between the project management process quality and construction project performance postulated in the theoretical proposition was conducted using Structural Equation Modelling (SEM). SEM enabled the evaluation of both the direct and indirect or individual and collective contribution of project management process quality variables to construction project performance. Similar studies have used this approach to evaluate the effect of quality management efforts on performance. See for example Anderson *et al* (1998), Ahire *et al* (1996) and Pannirselvam and Ferguson (2001) in Chapter Three.

Model Development

Studies that have linked quality and project management have used Total Quality Management (TQM) based theoretical models to define the variables. Such frameworks include the Malcolm Baldridge National Quality Award (MBNQA) and the European Foundation for Quality Management (EFQM) business excellence model. Dale (1999) noted that these models are an interpretation of the TQM. This research took a similar approach and used quality management based models as a theoretical basis to develop the project management process quality model. This is a similar approach to models used by Westerveld (2003) and Bryde (2003). Further as discussed in Section 1.1.1 on Page 4, there have been a significant number of studies linking critical success factors and project success. This provided a framework from which project management process quality related variables were captured from, and fed into the project management process quality model.

Method of Evaluation

The aim of this research was to investigate the nature and significance of the relationship between project management quality and construction project performance by examining the individual and collective impact of construction project management quality factors and project performance. An examination of multivariate statistical techniques demonstrated that SEM was deemed most suited for this task as it is an approach suitable for examination of dependence relationships with multiple relationships between dependent and independent variables (Hair *et al* 1998).

Hair *et al* (1998: 583) define SEM as *'a multivariate technique which combining aspects of multiple regression and factor analysis to estimate a series of inter-related dependence relationships simultaneously'*. SEM may be used as an alternative to multiple regression, path analysis, factor analysis, time series analysis and analysis of covariance as it is able to test relationships simultaneously (Garson 2002). SEM differs from many of the techniques such as multiple regression, factor analysis, multivariate analysis of variance, discriminant analysis and other multivariate techniques that provide researchers with analytical tools to examine relationships between variables. These methods have a weakness in that they fail to analyse multiple relationships simultaneously between variables but are limited to the analysis of only single relationships at a time. SEM extends from the multivariate methods such as regression and factor analysis and is able to be used to examine a series of dependant relationships simultaneously.

Unlike many other multivariate techniques SEM was deemed suitable for this research in that made it possible to evaluate the individual and collective relationships between project management process quality factors and construction project performance simultaneously. To aid the evaluation, AMOS (Analysis of Moment Structures), a specialised SEM software package was used for this purpose. A detailed discussion of the evaluation method, including the reasons for using SEM, is presented in Chapters Four and Five.

1.4 Section Four: Chapter Synthesis

The remainder of the thesis is divided into six chapters as follows:

Chapter Two: Review of Literature- Project Management and Performance

This provides a review of literature concerning the influence of project management processes on construction project performance. Firstly an overview of measurement of project performance is given. Secondly literature is reviewed concerning trends in evaluating the relation between project management and project performance, including critical success factors, capability maturity modelling and causal modelling. This chapter also provides a review of literature concerning alternative methods that have been used to evaluate the relationship between project management and project performance. An evaluation method suitable for this research is also provided in this chapter.

Chapter Three: Review of Literature-Quality and Project Management

This chapter provides a review of literature concerning the convergence of views between quality and project management. Literature concerning the linkage between quality and project management is reviewed. A review of literature concerning the linkage between quality in project management process quality and project performance, is also presented.

Chapter Four: Research Method

The chapter provides a discussion of the methodology used and includes discussions on structural equation modelling as the evaluation tool. Research issues with respect to research strategy, data collection and sample size are also considered in this chapter.

Chapter Five: The Conceptual Model

This chapter provides a discussion of the Project Management Process Quality (PMQ) model, including the rationale for choice of model variables. The postulated individual and collective causal relationships between the project management process quality variables and construction project performance are also presented.

Chapter Six: Empirical Results

This chapter presents a discussion of the empirical results from the survey. This relates to the relationship between project management process quality and construction project performance. The acquisition of data, questionnaire design, population identification and questionnaire administration issues are considered prior to the discussion of the results.

Chapter Seven: Conclusion

This provides the conclusions of the research in particular with regards to two aspects. These are the relationship between project management process quality and construction project performance and the use of the PMPQ measurement model. Limitations of the study and future research considerations are also presented.

1.5 Chapter Summary

This chapter has provided grounds for the research. Firstly it has been recognised that there is need to continually justify the use of project management processes. A number of studies have been undertaken, including studies on the value or project management and studies on factors affecting the success of projects. However a quality management perspective to this relationship will add to the understanding of the relationship. Secondly the approach taken in this research is different from many of the studies including those studies that have attempted to link quality and project management. The focus of this research is to examine both the direct and indirect influences of project management variables (from a quality perspective) on construction project performance. The approach taken in this research adds a different perspective to the understanding of the relationship between project management and construction project performance.

CHAPTER TWO

Project Management and Performance: A Review of Literature

2.0 Introduction

The primary purpose of this research was to examine the influence of project management process quality on construction project performance. It contributes to the understanding of the relationship between project management and performance. A review of literature concerning the relationship between project management and performance puts the present study into context. The value of project management was briefly discussed in Section 1.1.1. One of the issues noted was the need to understand how project management influences project results. Studies that have examined this issue are discussed. It was also noted in Section 1.1.3 that there have been studies that have examined the relationship between quality in project management and project performance. These studies are also discussed in this chapter.

The discussion in the chapter is divided into three sections. Section One provides an overview of project management in construction. This provides the context in which project management is discussed in this study. Section Two discusses the definition of project performance. A review of literature is presented which culminates in an operational definition of construction project performance, appropriate for the current research. This is necessary as it is this component to which project management processes are linked to in Section Three. Section Three explores literature concerning the influence of project management on project performance. Central to this review, was literature concerning the different models and methodologies that have previously been used to examine this relationship. A quality management perspective of the relationship between project management and project performance is also examined.

2.1 Section One: Project Management in Construction

2.1.1 Overview of Evolution of Project Management

Construction project management was defined in Section 1.1.1 as

> *'the planning, co-ordination and control of a project from inception to completion on behalf of a client requiring the identification of the clients objectives in terms of utility, function, quality, time and cost, and the*

establishment of relationships between resources, integrating, monitoring and controlling of the contributions to the project selecting alternatives in pursuit of the clients satisfaction with the project outcome' (Walker 2002: 5).

Project management as a specialised discipline can be traced back to the 1930's and 1950's in the United States of America (USA) defence programmes. The Manhattan project is cited by many as a notable example of the early use of project management techniques (Morris 1994, Ritz1990, Adams 1989 and Harrison, 1985). The contribution of the United States Air Force (USAF), where the Programme Evaluation Review Technique (PERT) and the Critical Path Method (CPM) were first used, is also noted as having contributed significantly to the development of project management (Adams 1989).

Morris (1994) recounts project management as started in the USA between the 1930's and 1950's and attributed the development to three factors. These were; the development of systems engineering in the United States of America defence/aerospace industry and to engineering management in the process industry; developments in modern management theory, in particular developments in organisational design and team building and; the evolution of the computer on which project management's planning and control systems are now integrated.

The growth of computer capabilities and affordability of personal computers is credited to be one of the contributors to the development of project management (Adams 1998). Computers provided a platform for integration of planning and control tools, which were complex using manual processes. Also contributing to the expansion of project management was the recognition of project management as much more than a set of computerised tools but as a management philosophy different from the general management theory. This is evidenced by the growing recognition of project management in many industries.

2.1.2 Project Management in Construction

It is considered that the construction industry is one of the oldest industries to management business by projects. However, project management as a specialised discipline has developed over the last thirty to forty years (Zulu 1999). The growing use of project management as a procurement management option in construction projects is recognised by Latham (1994) in his report, *Constructing the Team.* Latham (1994: 48) reports that

> *'there is increasing acceptance that project management and a separate discipline of project managers are permanent and growing features of the construction scene'.*

The use of project management as a management approach in construction projects can be seen to be significantly different from other management forms when it is compared to alternative management structures. Traditionally there is a separation between design and management of projects. Although there are many options to the management of projects, most aiming to improve the delivery of projects, project management is used to integrate the two functions of design and management, providing the client with a single point of responsibility.

Although in smaller projects the management and the design functions may still be combined and performed by the leader of the design team, in large or complex projects, there is need for the separation of management from design and construction (Chartered Institute of Building 1996). The function of Project management is to provide a management function separate from the design function. This has become even more important with the increase in the number of organisations or people working in projects. Winch (2002) described project management as an organisational innovation, which involves the identification of a team or a person who will have responsibility for ensuring that the client's project mission is delivered successfully. With the complexity of projects and with many organisations and personnel involved in both the design and construction phase, the project management function of integration of the team has become increasingly important.

2.1.3 Project Management Processes

Literature reveals a number of project management processes in terms of project management functions or activities. Woodward (1997) presents the major tasks of a project manager as a plan-measure-control cycle. He notes that the major tasks of project management are the planning and control of the work being done. Planning is the first step in the process, which seeks to set out the work that is to be done. This sets the baseline upon which actual performance can be measured against and controlled.

This is similar to the BS-6079 project management process model of planning and control (BSI, 2002).

Kerzner (2000) recognises the project management responsibilities and skills as being similar to the general management functions but redefined to suit temporary organisations. He points out that although their fundamental meaning remain the same, their applications are different. He recognised the following as the management functions: planning, organising, staffing, controlling and directing.

The Project Management institute's project life cycle (PMI, 2001) approach divides the project management process into five processes. These include initiating processes; planning process; executing process, controlling process and closing processes. These process groups are linked and are applicable to any phase of the project life cycle.

The ISO 10006 model divides the project management processes into ten sub processes which include, strategic processes, interdependence processes, scope related processes, time related processes, cost related processes, resource related processes, personnel related processes, communication processes, risk management processes, and purchasing related processes. This differs from the general project life cycle approach in that the process groups can be applied to any project phase. Elbeik and Thomas (1998) modelled classic project management and divided it into six distinct activities comprising project definition, planning, control and review. These activities are supported by communication and team building activities.

Walker (2002) takes a systems approach to analysing the process of managing projects. He distinguishes between two systems in the construction process. The first system he identifies is the operating system through which the project is achieved. The second system is the management system, which carries out the decision-making maintenance and regulatory activities that keep the operating system. The operation system is concerned with professional and technical tasks while the management system is concerned with integrating and controlling its work. Within the management system, Walker (2002) identifies the management activities as including the following; approval and recommendation, boundary control, monitoring and maintenance, and general and direct oversight. However he notes that general and direct oversight, although it is not a project management activity as such, is directly relevant to the effectiveness of the project management process.

2.1.4 Value of Project Management

In Section 1.1, the question of whether project management provides value to the client was considered. Notably the Construction Industry Council (2007) state that construction project management significantly adds value to the process of delivering projects and that such value is unique to project management which no other method or technique can achieve. The functions of project management are also clearly identified in its definition. See for example the definition of project management as cited in Section 2.1.1 on page 20.

Kerzner (1998) summarises the duties of a project manager on a construction project as comprising, planning, organising, directing, and controlling and defined project management in terms of achieving specific objectives. It is clear that the focus of project management as contained in these functions is the successful achievement of project objectives as cited in the definition of project management. It can therefore be argued that project management exists, or is employed, to deliver projects successfully.

The debate as to whether project management delivers tangible results or not has put the project management profession under scrutiny as the profession is forced to show its benefits to organisations. It is against a background of project failure and a need to improve processes in organisations, which the debate on the influence of project management on project performance rages on. Further, with the increased use of project management, there is a growing demand to demonstrate its tangible benefits (Ibbs and Kwak 1999, Morris 2000, and Crawford and Pennypacker 2000). There has been an increasing interest in demonstrating the value of project management. A number of studies have been conducted to examine this aspect. Project management research has looked at causes of project failure and also identification of best practices (Goldstein 2001). Notable among these include Ibbs and Kwak (1999 & 2000), Brown (1996), Cook-Davies (2002) and Crawford and Pennypacker (2001).

The call to demonstrate the value of project management has also been necessitated because of the perceived high failure rate of projects. It is evident from literature that project management has failed to consistently deliver successful project results (BSI, 2000). It is not uncommon to hear of projects finishing late, over budget and ultimately deemed a financial failure. It is evident from this that if project management is to be seen as an approach that brings value, there is a need to demonstrate that its use on construction projects helps in delivering projects to time, cost and quality as defined in the project management definition.

2.2 Section Two: Project Performance

In order to evaluate the influence of project management process quality on construction project performance, there is a need to define what is meant by construction project performance. Project performance in essence defines how one would measure the success or failure of the project. In this respect the measurement of project performance requires that one defines a criterion to use. Early work on the definition of project success has centred on the trio of time, cost and quality (Westerveld 2003). Thus a project, which has been completed on time, within budget and to the required quality standards, is deemed a successful project. The opposite also holds true that a project, which has been completed with time and cost overruns and the quality standards below expectations, then the project would be deemed a failure. Pockock et al. (1996), Pockock and Liu (1997), Brown and Adams (1999), Wright (1997), while recognising other criteria, advocated for use of this perspective in their respective studies.

However there have been continued calls for a multi-dimensional/ multi-criteria approach to the success/failure criteria (Shenhar et al 2001; Bryde 2003; Westerveld 2003; White and Fortune 2002; Wateridge 1995; Tukel and Rom 2001; and Dainty et al 2003). Despite several publications on project success criteria, there are no agreed set of performance criteria in literature (Westerveld 2003; Dvir 2003; Yu et al 2005; and Crawford 2000). Literature presenting perspectives from which project can be measured is examined below.

2.2.1 Perspective from the Definition of Project Management

The definitions of project management give an insight into the expectations of criteria to measure the performance of a project. It is clear from the definition that project management exist to achieve desired project goals. Kerzner (1998), for example, defines project management in terms of completing the specific objectives and goals. Walker (2002) also defines the purpose of project management as the pursuit of the client's satisfaction with the project outcomes. This implies therefore that the client would have set objectives or goals at the beginning of the project. It is clear from these definitions that the purpose of project management is to deliver projects to the expected tangible results.

The Project Management Institute (PMI 2004), The Association of Project Management (APM 2004) and the ISO (ISO 2002) take a similar perspective. The Project

Management Institute's Body of Knowledge, (PMBoK), defines project management in terms of meeting stakeholders' needs and expectations from a project which would include, scope, time, cost and quality (PMI 2004). The ISO (2003), also defines project management in terms of achieving project objectives while the British Standard Institute (2002) in the Guide to Project Management ((BS 6079) categorically defines the project objectives in terms of meeting time, cost, quality and performance requirements.

The implication of the above definitions is that it becomes paramount for one to understand the objectives of the project in order to define whether the project is successful or not. The Association for Project Management (2000) argues that it is important that the criteria to judge the success of the project (project performance criteria) should be clearly defined and agreed before the project proceeds. They defined a framework in which the criteria may be defined as including business objective, performance requirements and critical success factors or Key Performance Indicators (KPI's). They differentiate between critical success factors, which are those measurable factors which when, present in the project environment, are most conducive to the achievement of project success, and KPI's as measures upon which the project success or failure would be judged. Further they argue that KPI's should be determined at the beginning of the project, they should reflect directly on the key objectives of the project and they should provide a basis for project management trade-off decision during the course of the project. This therefore means that by using such indicators the performance, of a project can be measured at any particular point, in the project life cycle.

Although not all project management definitions are categorical about the definition of the expected outcome of project management, it is clear that the use of project management has to bring some desired outcomes in terms of the achievement of project objectives and goals. These objectives and goals have generated debate as to how project performance should be measured. Literature shows that there are in principle two main perspectives from which project performance can be measured. This includes the classical perspective of the Golden Triangle (Westerveld 2003), which focuses on the achievement of objectives in terms of time, cost and quality, and the multi dimensional perspective, which argues for a broader definition of project performance from different perspectives and contexts. These two perspectives are discussed below.

2.2.2 The Golden Triangle

The performance of projects in most of the early studies has been measured against time, cost and quality performance (Westerveld 2003) as depicted in the project triangle in figure 2.1. The use of this criterion is explicit in the BS6079 document as discussed in Section 2.2.1 above. There have been arguments against this approach as being too simplistic and that a broader criteria need to be used (Dvir 2005, and Munnas and Bjeirmi (1999) (This is discussed in section 2.2.3). However there is evidence of studies, which have used this approach as the basis for their studies.

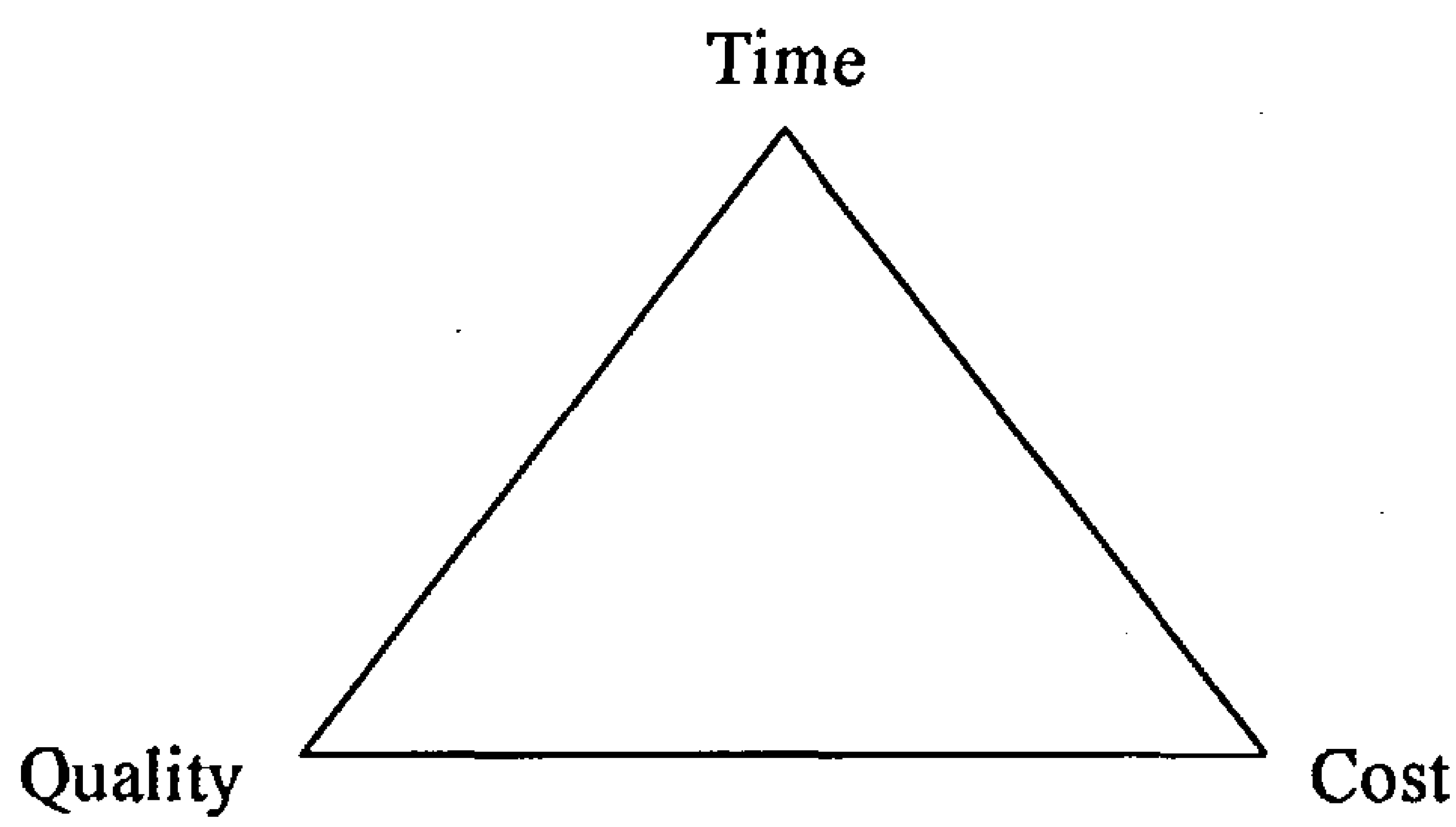

Figure 2. 1: Project Triangle

For example Pockock and Kim (1997) and Pockock *et al.* (1996) used cost, schedule and design modifications (and number of contract modifications) as measures of project performance. However they acknowledged that these criteria are not a complete set of success measures but that the four represented the criteria relevant in their research. In their study Pockock *et al* (1996) considered the use of other factors in addition to time cost and quality (measured by contract modifications). These included claim cost, value engineering savings, and safety information. However they found out that some of these measures were either often unavailable or were inconclusive when available, except for the trio cost, schedule and contract modifications. This prompted them to consider these as the most appropriate measures in their study, which would provide data for comparisons between cases.

Brown (1996) and Brown and Adams (2000), although acknowledging the existence of other criteria, also used the trio, time, cost and quality in measuring project success and argued that this was a criterion relevant to the needs of the client. They argued that project management is a practice that ought to focus primarily on the needs of the client. Therefore since the needs of the client are likely to be the achievement of a project on time, within budget and to the required quality, the trio can be viewed as the most appropriate measures to focus on. This is similar to Pockock *et al* (1996), who, in their justification for the trio, argued that these were measures of most concern to all parties in their study especially the owners representatives. Gowan and Mathieu (2005) also recognised other possible measures of project success, but used target date as a measure of information systems project performance. They cited the reason that this measure was highly measurable and highly specific to the project.

Moreover, Wright (1997) argues that clients are more interested in the delivery of projects to time and within budget. He agrees that there are other criteria that can be used but argues that it is not up to the project manager to decide which criteria is more important. This should be the client's preserve. However he contends further that the client is interested in the project manager delivering the project on time and on budget with quality implicitly assumed to be to the set requirements. Cook-Davies (2002) used time and cost as performance measures while Turner (1999) identified time, cost and quality (specification) as the standard criteria to measure the success of a project. Kerzner (1998), however, while accepting the time, cost and quality criteria as a standard measure, added client's satisfaction as an additional component to the success/failure criteria.

Indeed the importance of the trio as significant indicators of performance is reflected in the challenges for improvement posed to the construction industry. Egan (Rethinking Construction, 1998) set targets for the improvement of the construction industry in the United Kingdom. Among the key targets included reducing construction cost, time and improvement of quality (reducing defects). It is clear from these targets that the trio are measures that Clients are very concerned with. While the final outcome of the project may be judged by other measures, the challenges by Egan clearly indicates the expectations of clients from the construction industry.

Lord Fraser (Fraser 2004) in his report on the Scottish parliament (Holyrood project) focused on the three criteria of project failure including time, cost and quality. In fact one of the major concerns with the Holyrood project had been its failure to achieve time and cost expectations while quality expectations have been met (Fraser 2004). This suggests that time, cost and quality are still important criteria to clients to the measurement of project success or failure.

The arguments in the referred-to literature acknowledge that project performance can be measured from many angles. However they focus on the traditional measures primarily because these were measures most relevant to the particular study. It has become acceptable however to include customer satisfaction as the fourth factor to be considered in the criteria (see for example Kerzner 1998). However Pinto and Slevin (1988) argue that Client satisfaction may be a vaguer concept, measured often by surrogates such as number of complaints, supplementary cost of start-ups and cost overruns during the Clients take over. This therefore would favour the use of the trio of time, cost and quality as the more objective performance measures.

2.2.3 Multi Dimensional/Multi Criteria Perspective

Proponents of the multi-dimensional criteria argue that the traditional criteria of time, cost and quality are inadequate to capture the full dimension of success or failure of the project. For example de Wit (1988), arguing for a broader perspective for defining project success, distinguished between project management and project success. He defined project management success in terms of meeting time, budget and performance requirements while project success as meeting the technical performance of the project, satisfying key people in the parent organisation, project team and end users of the project effort. The implication of this multi dimensional approach is that, the definition of project success is dependant upon the individual or group defining project successes. This definition assumes that project participants, including the client, project team and other project stakeholders, would have different objectives. These different objectives would therefore influence the definition of project success.

Dvir *et al.* (2003) argued that the success criteria in terms of the golden triangle should be treated as only partial especially that success may mean different things to different people. They further argue that comprehensive criteria should reflect the interest of different stakeholders on a project thus argued for a multi-dimensional criterion, which reflects the success perception of different project stakeholders. This included success as perceived at three levels including, project manager level, end user level and contractor level. Table 2.1 lists the items included in each category. This approach assumes that the three stakeholders are likely to have differing views about the success of the project. It also implies that any measure of success, which uses only one stakeholder, is only partial. For example measuring success based on the project manager's perception only is incomplete as other stakeholders also have a view about the success of the project.

Munns and Bjeirmi (1996) in arguing for a change in the perspective of project success, also differentiated between project management success and project success. They defined project management success in terms of short-term goals such as the completion of the project on time, within budget and to the required quality while project success was measured in terms of long term including such issues as profitability, competition and marketability. They suggested, therefore that the control of time, cost and progress, which are the objectives of project management, should not be confused with measuring project success. However Walker (2002) argues that although the objectives must be broadly defined and long term, including client satisfaction, the objectives of project management processes should be those of the client and the role of the project manager should be to ensure that the project management process is geared to achieve the clients' objectives. The argument by Brown (1996) and Brown and Adams (2000) in the preceding section above indicated that the client expectation from the project manager is a project that is completed on time, within budget and to the required standard. Evidence from the Egan report (Rethinking Construction 1998) and the Lord Fraser report (Fraser 2004) on the Scottish Parliament also indicates the importance of time, cost and quality performance measures to clients.

Category	**Success Measure**
Project Manager Level- Meeting Planning Goals	Meeting functional requirements Meeting technical specification Meeting Schedule Meeting Budgets Meeting Procurement goals (number of items supplied compared t plan
End user benefits	Satisfy end user operational needs Project end product is in use Systems delivered to end user on time System has significant usable life expectancy Performance level superior to previous release End user capabilities significantly improved End user satisfied from project end-product
Contractor benefits	Profits exceeded plans Profit exceeded similar projects New market penetration Created new market Created new product line Developed new technologies and infrastructure Developed new knowledge and expertise Generated positive reputation Responded to business or competitive threat

Table 2. 1: Critical Success Factors (Dvir et al.(2003)

One of the arguments against the use of traditional perspective based on time cost and quality performance is that it is simplistic (Shenhar and Wideman 2000). Most contractual relationships for construction projects would include time, cost and quality (specification) parameters, which would form the basis for the definition of the success of the project. Based on the traditional criteria, it seems that a failure in any of the criteria would imply failure of the project. This seems simplistic especially that taking a longer term view, the criteria for success may change over time (Shenhar and Wideman 2000). Indeed Avots (1984) found out that the importance of performance targets as set out in contracts tends to diminish after completion and that meeting end user needs assumes greater importance.

This is demonstrated in Shenhar and Wideman (2000) who advocated for multi-dimensional criteria in the definition of success. Shenhar and Wideman (2001) like Munns and Bjeirmi (1996) and de Wit (1988) distinguished between two dimensions of project success. They distinguished between the project process success and the project product success. They defined project process success as on time, within budget and meet requirements while project product success as customer satisfaction. Shenhar et al (2000), like many others (Gray 2001; Westerveld 2003; Dvir 2005; Pinto and Mantel 1990; de Wit 1988; Lim and Mohamed 1999; Argarwal and Rathod 2006; Yu *et al* 2005; and Dvir 2005), proposed a multi dimensional view of project success. In particular they (Shenhar and Wideman, 2000) distinguished four categories of project success as shown in Table 2.2 and Figure 2.2 on page 33. They categorised project success criteria into four dimensions including internal project efficiency, impact on the customer, business and direct success and preparing for the future. The model shows that the definition of project success will vary with time. For example, in the immediate period between the conception of the project and the project completion stages the definition of project success will be based on the project efficiency measures related to time, cost and performance while the measures of success in the short to long term will be different.

The implication of this model, like many other multi dimensional models is two fold. Firstly, that the definition of project performance (success) is dependent upon the phase in which the performance of the project will be measured. Clearly it is likely, in construction projects, that the Project Manager's primary interest will be in the immediate phase (pre completion phase) and therefore the definition that would be most relevant to the project management team would be those issues that will be in this phase. Secondly, that the definition of project success during each subsequent phase will imply that the success definition at the preceding phase will be of less relevance. For example, if a project was delivered on time, within budget and to the required performance criteria, in the medium term, but the clients organisation fails to gain any business and or commercial recognition after completion of the construction of the project, or does not generate the expected profits, or fails to gain in the market share, then the project at that point would be defined as a failure. This definition therefore will not be consistent with the functions of project management on construction projects in that in the majority of cases, once the project is completed, the client assumes his own responsibility to attain his strategic business objectives. The influence on the clients' core business would not normally be in the realm of the construction project management functions.

Wateridge (1995) argued for a broader criteria to measure the success of IS/IT projects and found out in their research that six of the most important criteria included, meets user requirements, achieves purpose, meets time scale, meets budget, happy users and meets quality. Significantly Wateridge (1995) categorised the factors into those important to all projects, those important to successful projects and those important to failed projects. From a user perspective they found out that, meeting user requirements, happy user, meeting budget, meeting time, and achieving purpose where the most important criteria, while from the project managers point of view, meeting user requirements, commercial success, meeting time, meeting budgets and achieving purpose were the most important criteria to all projects. The implication of this approach is that success of the project should be considered from the perspectives of different stakeholders.

Barad and Raz (2000) in evaluating the impact of quality management practices in project management on project management performance, measured performance based on project process performance and operational outcomes. They measured process performance by examining three aspects including extent and frequency of plan changes, frequency of emergency meetings and ration of effort invested versus effort required while operational outcomes were measured by participants satisfaction, customer satisfaction and number of post delivery product changes. Post delivery product changes were used as a measure of product quality in terms of product errors. It is noticed that this research does not include time and cost as performance measures. However no particular reason is given for the omission of these parameters.

Primary Success Category	Measurable Key Success Indicators
Internal Project Efficiency (Pre-Completion)	• Meeting schedule • Completing within budget • Other resource constraints met
Impact Of The Customer (Short Term)	• Meeting functional performance • Meeting technical specifications & standards • Favourable impact on customer, customer gains • Fulfilling customer needs • Solving customer problem • Customer is using product • Customer expresses satisfaction
Business And Direct Success (Medium Term)	• Immediate business/commercial recognition • Immediate revenue & profits enhanced • Larger market share generated
Preparing For The Future (Long Term	• Will create new opportunities for the future • Will position customer competitively • Will create new market • Will assist in developing new technology • Will add/has added capabilities & competencies

Table 2. 2: Project Success criteria (Adapted from Shenner and Wideman 2000: 4)

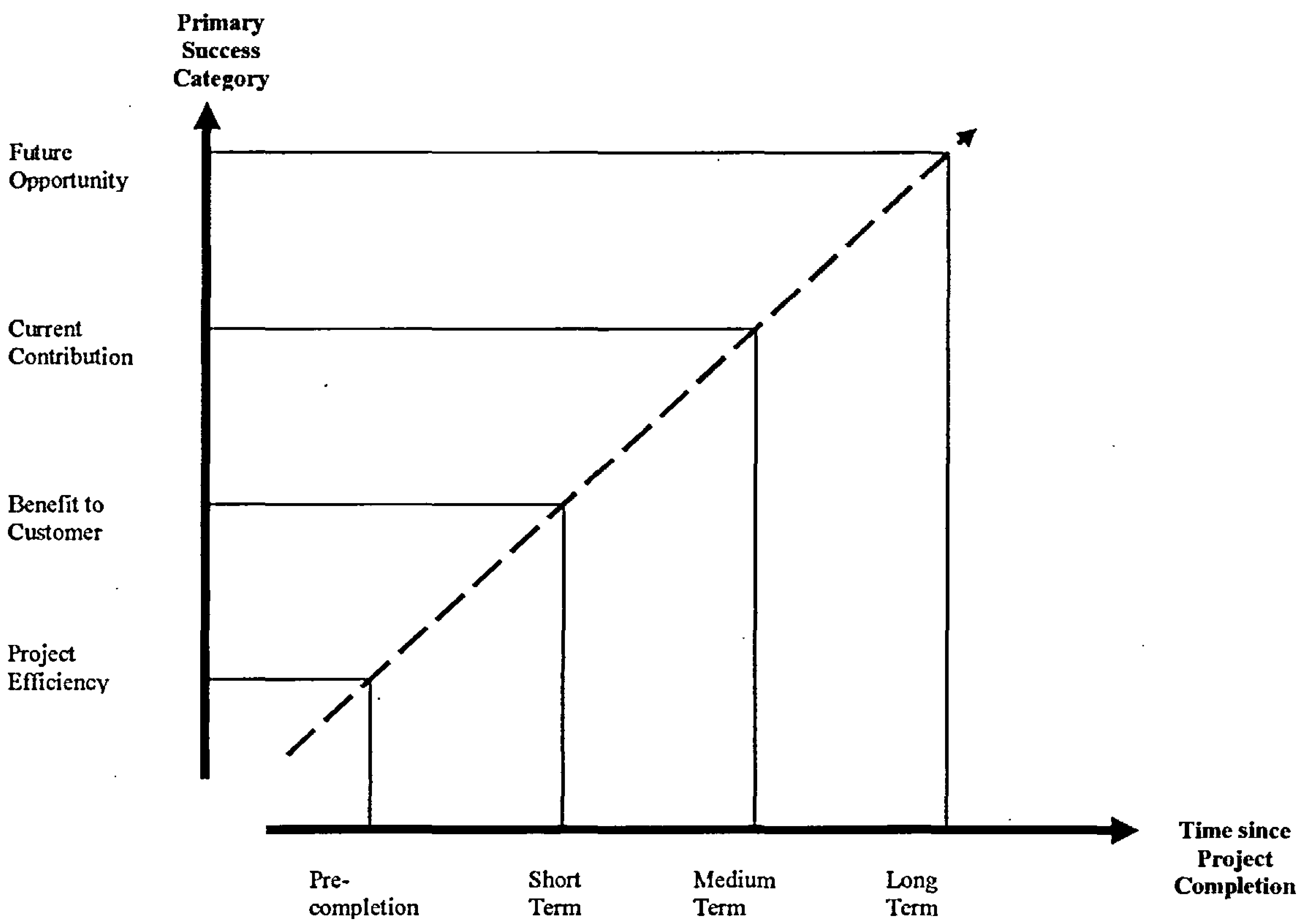

Figure 2.2: Project Success. (Source Shenner and Wideman 2000: 4)

Westerveld (2003) also argued that the definition of project success in terms of time cost and quality criteria should be looked at as a more narrow view. He argued that success criteria will differ from project to project as this may be dependent on many factors such as size, complexity and uniqueness. Westerveld (2003) on the other hand developed a multi dimensional criterion for project success. Because of the difficulty in generating a universal list of success criteria, he argued that a universal clustering of criteria is possible. Using other studies on success criteria he clustered them into six categories including, project results, which includes time, cost and quality dimensions, appreciation by clients, appreciation by project personnel, appreciation by users, appreciation by contracting powers and appreciation by stakeholders. This model is consistent with many other multi-dimensional models, which seek to measure success of a project from different stakeholder perspectives.

Pinto and Mantel (1990) identified three aspects of project performance. These included the implementation process, perceived value of the project and client satisfaction. The implementation process is view as the measure of internal efficiency and included, schedule, budget, meeting technical goals, smooth working relationships with team and parent organisations. Perceived value of project focused on project team's perception of the value and usefulness of the project while client satisfaction focuses on the client's perception of the effectiveness. These two components, perceived value of project and client satisfaction were measures of external effectiveness of project management.

Gary (2001) recognising that the question of measuring project success is complex, assessed project success for his study based on a broad overview, taking account of the time, cost, quality and stakeholder opinion on the success of the project. This is consistent with Kerzner (1998) who included customer satisfaction to the triad of time, cost and quality.

Wang and Huang (2006) developed a model for measuring success for Chinese construction projects. The defined success in terms of cost, time, quality, relationships between participants and overall success rate of the projects. In addition they included specific measures of success for each of the participants. Client related variables for success included procurement and supporting the project manager. Supervisor's organisations performance was measured against four criteria including technical performance, organisational performance, human performance and integration. Contractor's performance criteria included technical organisational, human and specification performance. This approach is similar to other multi dimensional models that measure success as perceived by different stakeholders on a project.

There are many other studies that have used the multi-criteria perspectives including Lim and Mohamed (1999), Atkinson (1999), and Chan and Chan (2004). Their models of project performance are summarised in Tables 2.3-2.5. They, like others cited above, all proposed broader criteria in defining the performance of a project. It is evident from these models that they include other success factors in addition to the traditional criteria of time, cost and quality performance.

Level	**Criteria**
Macro Level	Completion • Time Satisfaction • Utility • Operation
Micro Level	Completion • Time • Cost • Quality • Performance • Safety

Table 2. 3: Macro and Micro level performance criteria-Lim and Mohamed (1999)

Level	**Criteria**
Iron Triangle	Cost Quality Time
Technology	Maintainability Reliability Validity Information quality Use
Benefits to Organisation	Improved efficiency Improved effectiveness Increased profits Strategic goals Organisational leaning Reduced waste
Benefits to stakeholder community	Satisfied users Social and environmental impact Personnel development Professional learning Contractors profits Capital suppliers Content project team Economic impact to surrounding community

Table 2. 4: Project performance criteria-Atkinson (1999)

Category	Criteria
Objective Measures	Construction Time Speed of construction Time variation Unit cost Percentage net variation over final cost Net present value Accident rate Environmental impact assessment (EIA) scores
Subjective Measures	Quality Functionality End-user's satisfaction Client satisfaction Design team satisfaction Construction teams satisfaction

Table 2. 5: Key Performance Indicators-Chan and Chan (2004).

2.2.4 Performance Measures Adopted for the Research

This research recognises that a multi dimensional perspective in the measurement of construction project success is necessary. However the definition of project success in this research used performance measurement against project objectives in terms of time, cost and quality performance.

This research is a cross sectional study, which seeks to measure performance at a particular point in time and in particular it seeks to measure the performance of a project at the completion of a project. In this respect the performance aspects that would be most logical to measure would be those that examine the project immediately at the completion of the construction phase. One of the arguments of the multi perspective criteria is the recognition of changes in the definition of project success according to the project phase (Shennar and Wideman 2000). Taking such a perspective would not be logical with respect to the aims and objectives of the research, as a longitudinal study would have to be conducted.

It is recognised in literature that the definition of success on a project can be divided into project process and project product or project management and project. This research restricts itself to the project management realm of success as this would be most relevant to the project manager and therefore would be easily measured.

It is the intention of this research to focus on a criterion that would be of most interest to the Project Manager. Walker (2002) argued that 'the project manager's attention should be geared towards the client's objectives. These have been shown to be, in large part, the achievement of a project to time, cost and quality (Brown and Adams 1999). Indeed this will be in line with the challenges posed by Egan for the construction industry to improve on time, cost and quality performance (Egan 1999). It is also clear from the definitions of project management that it is the primary focus of a project manager to deliver a project to time, cost and desired quality (BSI 2000). Therefore taking this criterion to measure performance of a project will be most relevant for this research.

In addition to the trio of time, cost and quality, stakeholder satisfaction with the project outcomes, in particular the project managers' satisfaction will be used. This variable is hoped to capture the success perception of the project manager. This is consistent with the multi-criteria approach. Barad and Raz (2000) for example included participant satisfaction as one of the measures of success. However taking this approach including time, cost quality and project managers satisfaction is only a partial measure of success, when compared against the multi criteria approach discussed in Section 2.2.3.

2.3 Section Three: Influence of Project Management on Project Performance

Studies examining the influence of project management on project performance stem from the need to understand the value of project management. Several studies have been conducted in this area and these are reviewed below. However it is noted that none has been done consistent with the aims and objectives of this study. Primarily no study has attempted to evaluate both the direct and indirect influence of project management process quality variables on construction project performance in a manner consistent with the approach taken in the present research.

2.3.1 Critical Success Factors

A number of studies have been undertaken to investigate factors that are critical to the success of projects. For example Larson and Gobelli (1989), McCollum and Sherman (1991), Alacon and Ashley (1998), Pocock and Kim (1997), Klien *et al* (1996) and Deusch (1991) are concerned with organisational aspects of project management and how this influences project management results. While Clarke (1999), Pinto and Mantel (1990), Pinto and Slevin (1988), Sherman and Wideman (1997) and Baker *et al* (1983), model factors, within the project management processes and practices that would influence project results. These studies seek to understand the factors in project management that contribute to successful project performance. Some of the studies are discussed below.

Pockock *et al* (1997) examined the influence of the degree of interaction among project participants on project performance. Based on results from a regression analysis, they concluded that there is a modest but significant correlation between degree of interaction and project performance. In this case, degree of integration can be looked at as a critical success factor influencing project performance.

Larson and Gobelli (1989) on the other hand examined the significance of PM structure on project success. They identified five types of project management structures which include functional organisation, functional matrix organisation, balanced matrix organisation, project matrix organisation and project team oriented organisations. Apart from organisation structure they accounted for the possible impact of other contextual factors such as complexity, novelty, priority, adequacy of resources and defined objectives. Using multivariate analysis of variance they found out that success varies according to the project structure used even when other determinants are accounted for. However they noted that although the relationship was significant, project structure explained only a modest amount of success variance. This suggests that there might be more fundamental reasons why some projects fail while others succeed.

Deutsch (1991) presented a systematic empirical investigation into the factors that contribute to positive software project performance. The exploratory investigation was meant to examine the feasibility of a conceptual model and the examination of a postulated hypothesis that the residual management power factors, individually and in aggregate are strongly correlated to the technical performance and business performance outcomes of the project. The study characterised the factors of adversity that may be present in a project and the factors of intrinsic management skills that may be put forward to be managed and overcome. These were then related to both project technical performance and cost/schedule performance through the residual management power. The conceptual model developed has five parameter aggregates, project adversity, intrinsic management power, residual management power, technical performance and business performance. In this model the factors of project adversity combine in a cancellation effect with the intrinsic management power factors to produce the residual management power factors. These residual factors represent predictors of project performance (technical and cost/schedule). The major research issue of the model developed was whether project outcomes are dependent upon how effectively the power of the intrinsic management process negates the disruptive adverse attributes of the project.

Pinto and Mantel (1990) in their research 'the causes of project failure' aimed to determine if there exist patterns of causes of project failure depending on three contingent variables. These were:-

(i) The way in which failure is defined,

(ii) The type of project being studied and

(iii) The stage of the project's life cycle at the time it is assessed.

They developed three research hypotheses that:-

(i) The perceived causes of project failure will vary depending on which outcome measure is used to assess performance

(ii) The perceived causes of project failure will vary dependant on whether the project is in the strategic stage or tactical stage and

(iii) The perceived causes of project failure will vary depending upon the type of project assesses (Construction or Research and Development).

Their findings supported the hypotheses. They developed a project implementation profile model, a set of ten factors which where found to be generalisable to a wide variety of project type and organisations, to identify factors contributing to project success. Table 2.6 presents a list of factors from the Pinto and Mantel's project implementation profile. They found out that the project implementation critical factors used in the study accounted only for about 40% of the variance in causes of project failure. They concluded that there were certain other important causes of project failure that were not accounted for in the study.

Pinto and Kharbanda (1996) also examined factors that contribute to project failure. They identified factors that they considered as sure recipe for project failure. As opposed to critical success factors, these factors were viewed as those practices that would greatly contribute to project failure. Table 2.7 list the critical failure factors identified by Pinto and Kharbanda (1996)

Critical Factor Definition
• Project Mission-initial clearly defined goals and general direction
• Top Management support-willingness of top management to provide necessary resources and authority/power for project success
• Project Schedule/Plan-a detailed specification of the individual action steps for project implementation
• Client Consultation-communication, consultation and active listening to all impacted parties
• Personnel-Recruitment, selection and training for the necessary personnel for the project team
• Technical Tasks-availability of the required technology and expertise to accomplish the specific technical action steps
• Client Acceptance-the act of selling the final project to its intended users
• Monitoring and Feedback-timely provision of comprehensive control information at each stage in the implementation process
• Communication-the provision of an appropriate network and necessary data to all key actors in the project implementation
• Trouble Shooting-ability to handle unexpected crises and deviations from plan

Table 2. 6: Project Implementation Profile-Pinto and Mantel (1990)

Critical Failure Factors
• Ignore the project environment
• Push a new technology to market too quick
• Don't bother building a fall back option
• When problems occur, shoot the one most visible
• Let new ideas stave to death
• Don't bother conducting feasibility
• Never admit a project is failure
• Over manage project managers and team
• Never bother to understand project trade offs
• Allow political expediency and infighting to dictate crucial project decisions
• Make sure a project is run by a week project manager

Table 2. 7: Critical failure factors Based on Pinto and Kharbanda (1996)

Like Pinto and Kharbanda (1996), Yeo (2002), identified critical failure factors for information systems projects. They identified issues of influence under three main headings including, process driven factors, context driven issues and content driven issues. Under process driven issues they identified business planning, project planning and project management and control while under context driven issues they identified corporate culture, corporate management, users and politics. IT, business processes and system design, and IT/IS professional and knowledge were factors identified under the content driven issues. Under these factors they further identified critical failure factors.

The work of Cooke-Davies (2002) was cited earlier in Chapter One. Cooke-Davies argued that the understanding of success factors should be understood from three different perspectives. This includes factors critical to project management success, factors critical to success of individual projects and factors leading to consistently successful projects. Cooke Davies identified factors in each of the above categories as presented in Table 2.8.

Dimension	Critical Success Factors
Factors critical to project management success	• Adequacy of company wide education on the concept of risk management • Maturity of an organisation processes for assessing ownership of risk • Adequacy with which a visible risk register is maintained • Adequacy of up to date risk management plan • Adequacy of documentation of organisational responsibilities on the project • Keep project as far below 3 years as possible • Allow changes to scope only through mature scope change control process • Maintain the integrity of the performance measurement baseline
Factors critical to success of individual project	• As above 1-8 • Existence of effective benefits delivery and management process that involves the mature corporation of project management function
Factors leading to consistently successful projects	• Portfolio and programme management • A suite of project, programme and portfolio matrices • Leading from experience

Table 2. 8: Critical Success Factors (Cooke-Davies 2002)

Chan *et al* (2001) identified thirty one success factors for design and build projects which they grouped into six categories including, project team commitment, contractor's competencies, risk and reliability assessment, clients competencies, end user's needs and constraints imposed by end user. Milis and Mercken (2002) also identified critical success factors based on literature review and field research for

Belgian Banks and Insurance companies. They grouped into the following categories good selection and justification, project definition, project plan, management involvement, project team, change management, project resources and management relationships.

Kog *et al* (1999) also identified 27 project management factors that would influence schedule performance and grouped them into four categories including, project manager factors, project team factors, planning related factors and project controls factors. Belout and Gauvreau (2004) were concerned with the impact of human resources management on project performance. Jha and Lyer (2006) were concerned with critical coordination activities that have an influence on project success.

Pheng and Chua (2006) were concerned with environmental factors that affect project managers performance measured against time, cost, quality and customer satisfaction. They identified variables that were job condition related, project characteristics and organisational related as summarised in figure 2.3. They found out that nearly all variables were found to significantly affect project performance except for working hours and company size. While team-relationships was ranked as the most important variable affecting project performance.

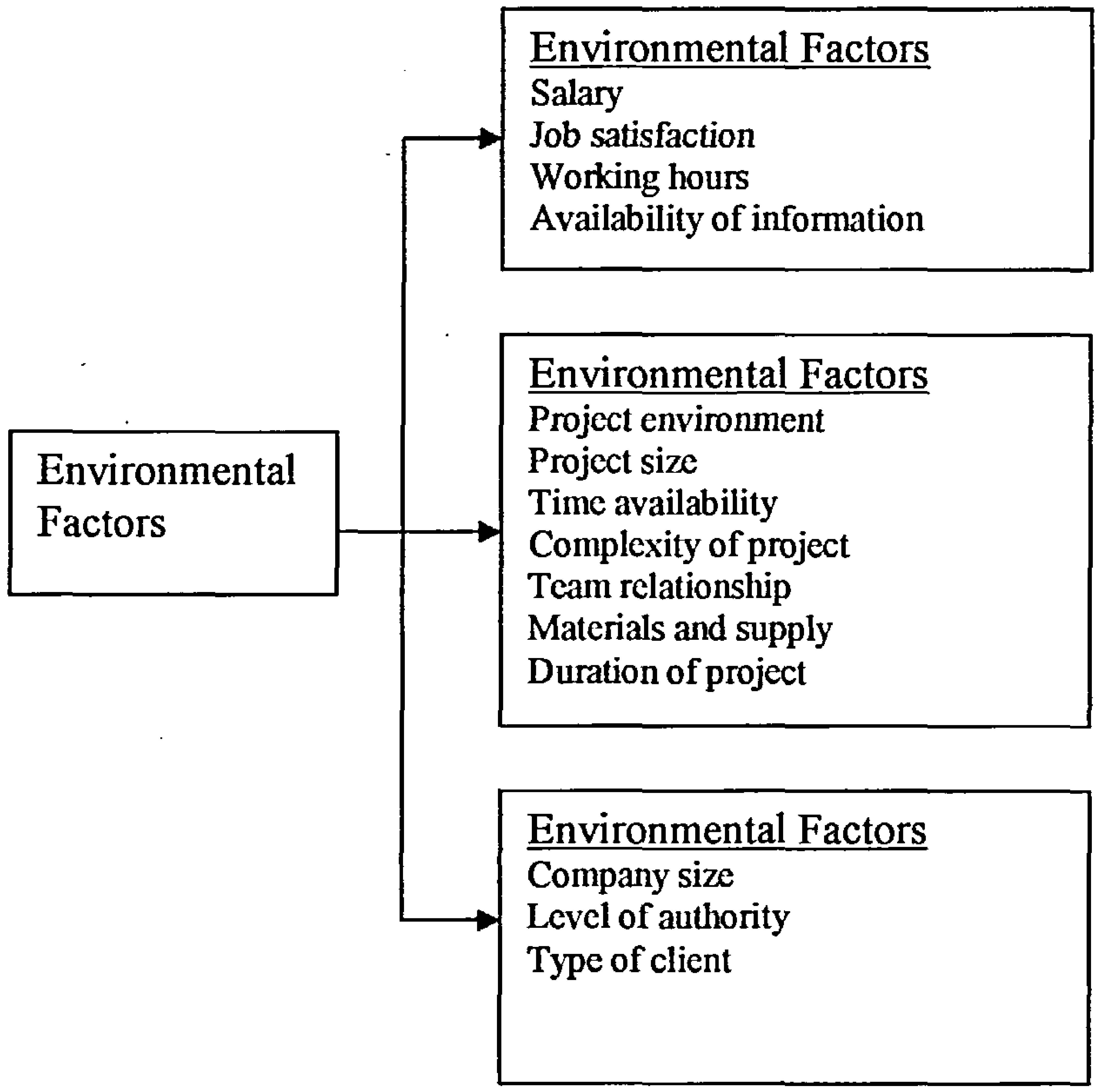

Figure 2.3: Work environment factors affecting performance of project managers (Pheng and Chua 2006)

Other studies include Olander and Landin (2005), Dvir (2005), Gray (2001) and Fortune and White (2006). Olander and Landin (2005) were concerned with the influence of stakeholders in the implementation of construction projects. Based on case studies they showed how stakeholders could affect the construction project, which may result in time and cost overruns. Dvir (2005) was concerned with effect of planning and preparation for commissioning on project success, while Gray (2001) was concerned with the association between project success and organisation climate measured by social and organisational climate.

Fortune and White (2006) in developing a systems model for critical success factors for IS projects, mapped success factors identified in literature onto their conceptual model. In developing the model they were concerned with the criticism with most of the work on critical success factors. Three main criticisms were cited. The first one was concerned with the lack of consensus on the list of factors in literature. The second criticism was concerned with the relationship between critical success factors and performance. The concern with the critical success factors literature is that most of it does not account for the interrelationships between the critical success factors and how this would have an impact on project performance. Thirdly that the factor approach taken in most studies tend to view implementation as a static process instead of a dynamic phenomenon and ignores the potential of varying degrees of importance at different stages of the project. In response to this they developed a system model that captures critical success factors as identified in various literature on critical success factors and presented these factors interlinked with each other. Further they argue that because they take a systems approach and that the model has to respond to the environment, the model can be viewed as able to cope with the dynamic nature of projects.

It is clear from the foregoing discussion that there have been efforts to understand factors in project management that influence project success. As stated on page 1, the Construction Industry Council (2007) argues that project management is unique from other management approaches. It is then important to understand how this unique management approach influences results. Of significance in these studies is that there is no uniform theoretical basis for the definition of success factors. This has resulted in a plethora of factors affecting project management and project performance.

The present research takes a similar approach and sets to understand project management influences on construction project performance from a quality perspective.

However the approach taken in the present research differs from these studies with respect to two issues. Firstly none of these studies uses a quality management framework to analyse the relationship between project management and construction project performance. The advantage of using the quality management framework is that the framework provides a uniform theoretical basis for the clustering of factors that would influence the success of the project. Secondly most of these studies are interested in the direct effect, of the different factors, on affecting project performance. However, the present study uses structural equation modelling, as discussed in Section 1.3.4 of Chapter One, which makes it possible to evaluate both the direct and indirect effect of factors affecting project performance. The approach also makes it possible to evaluate both the individual and collective impact of project management variables on construction project performance. The argument with this perspective is that while one factor may have little direct influence, it is possible that its indirect effect would be significant. Therefore it is important to find out how factors affect the performance of the project both directly and indirectly.

2.3.2 Capability Maturity Model

Ibbs and Kwak (2000) used a capability maturity model (CMM) to demonstrate the influence of project management processes and on project performance. The key objective of their study was to develop and provide managers with a procedure for measuring project management processes and the value of incorporating these processes in business practices. They developed a project management maturity model and an analysis methodology to assess the maturity of the project management process. Project management maturity refers to the level of sophistication of an organisation's current project management practice and processes. Kalantjakos (2001), Schlichter (2001) and Ibbs *et al* (2001) also use this approach to demonstrate the value of project management. Ibbs and Kwak (2000 and 2001) presented a five-level capability maturity model (CMM) which would help project managers to gauge how sophisticated their practices and processes are. They also link the level of maturity and project performance and conclude that there is a direct relationship between the level of maturity and performance. Performance was measured in terms of return on investment. Project results were obtained using project cost and schedule data Ibbs and Kwak (2000).

Hillson (2003) developed a Project Management Maturity Model (ProMMM) also designed to assess project management capability in organisations. He noted that there were over thirty project management maturity models with the majority of these assessing project management maturity against project management bodies of knowledge and testing the completeness of process covering. Kwak and Ibbs' (2001) Project Management process Maturity Model, for example adopted the PMI's PMBoK as a basis for defining project management processes. Another notable model is the Project Management Institute's Organisational Project Management Maturity Model (OPM3) (PMI 2003). Cooke-Davies and Arzymanow (2003) reports that other models have used the Baldridge National Quality Award (MBNQA) and the EFQM Business Excellence Model, to assess the maturity of project management processes as part of the assessment of the quality of organisations business processes. Hillson (2003) developed the ProMMM as a capability benchmark for project management. This model was developed drawing from capability maturity models and the EFQM business excellence model. The model was developed based on experience of its developer in providing project management consultancy (Hillson 2003). He argues that 'the lack of academic research base is not felt to be a disadvantage, as ProMMM represents the accumulated wisdom and expertise of project management professionals who are leading practitioners in the field. Further in relation to the present research, while the model provides an opportunity to benchmark project management, it does not provide empirical evidence of the relationship between project management maturity as defined in the model and project management performance.

CMM is one of the models that have been developed based on the view that improving the process maturity leads to improvement in performance (Cooke-Davies and Arzymanow 2003). However Voas (1999) suggests that increasing the maturity level of an organisation may not necessarily lead to improvements in the quality of processes. CMM in the project management industry has been borrowed from concepts of the Software Engineering Institute CMM (Rosenstock *et al* 2000). There is, however, no standard maturity model established for the industry (Rosenstock *et al* 2000). As noted above Hillson (2003) reported of over thirty project management maturity models. Cook-Davies (1999) argues that although CMM is not universally respected by all practitioners, it provides a platform from which organisations can be alerted to the practices that must exist for good procedures. Although Ibbs and Kwak (1999 and 2000) found that there is a direct relationship between capability maturity level and performance, Debou (1999) questions the relationship between a high CMM level and high (performance) quality in products.

The research in project management maturity models is important to the present research in relation to the relationship between maturity and performance and also in relation to the use of quality models as evaluation models for process maturity. The work of Ibbs and Kwak (2000) demonstrates the relationship between project management maturity and performance, however their evaluation approach is based on single linear relationships between maturity levels and performance. The present study extends the evaluation method to examine both the individual and collective influences of project management variables on construction project performance.

2.3.3 Causal Modelling

As noted by Fortune and White (2006) one of the criticisms of the critical success factor approach is the inability to account for the importance of the interrelationships between variables and how this impacts on project performance. Two of the studies noted below have used approaches that accounts for these interrelationships and ultimately project performance.

Brown (1996) and Brown and Adam (1999), used path modelling to investigate the nature of the influence of project management upon building project performance in terms of time, cost and quality outputs. They developed an evaluation model, which accounted for direct and indirect relationships between project management influencing variables and project performance. The model postulates that project management influence on project performance is a result of the direct influence of project management and the indirect effects through intervening variables. The intervening variables included in the model were, risk, technical complexity, variations and procurement. The quantification of project management was based only on whether consultant project management was employed or not. No specific project management practices were evaluated. Among their conclusions were that, the continuing poor record of projects in relationship to the delivery of project objectives suggests that project management is not yet implemented properly in relation to the body of knowledge or that the present project management discipline is inadequate for the task of managing projects. They also concluded that there is need to understand precisely the influence project management has upon performance and understand why project management apparently failed to produce expected results.

While the evaluation model developed by Brown (1996) examines the influence of project management, it cannot be used to evaluate adequately the efficiency of the project management process, as specific project management variables are not analysed separately in terms of their influence on project management. This is a significant difference with the present research that seeks to examine both the individual and collective impact of project management variables on project performance as Brown (1996) and Brown and Adams (1999) examined only the collective impact of project management practices on performance.

Their approach, although not taking a quality management perspective, takes a step further in the evaluation of project management influence of project performance. The methodology used is of particular interest to the current research in that path analysis used by Brown and Adams, is one of the components of structural equation modelling (Hair *et al* 1998). The limitations of path analysis would make it difficult to evaluate the relationship between project management processes and project performance in a manner consistent with the objectives of this research.

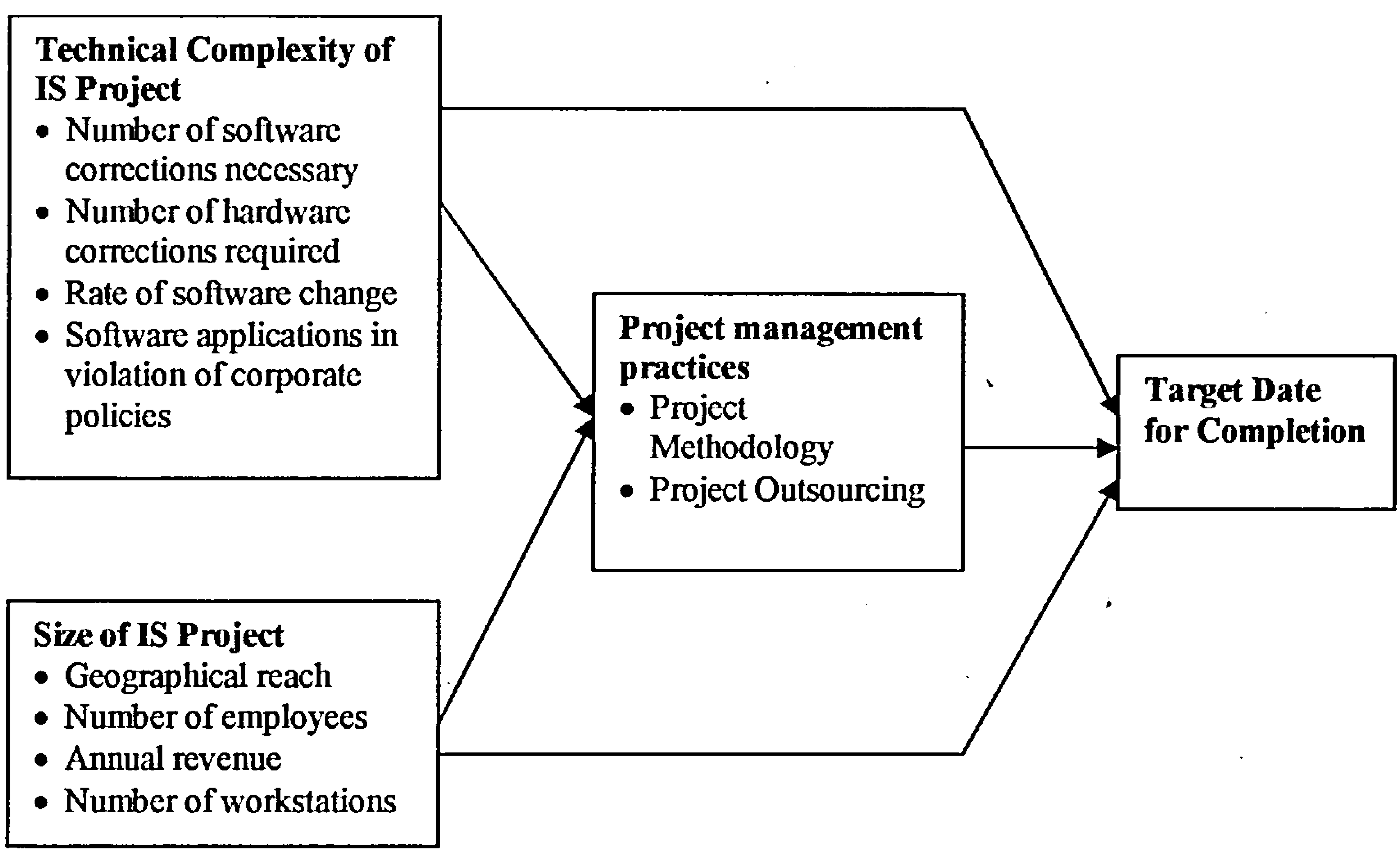

Figure 2.4: Project Performance Impacting Factors (Gowan and Mathieu 2005)

Gowan and Mathieu (2005) were concerned with management practices in Information Systems projects that impact on project performance measured against target date. They presented a conceptual model showing the interrelationships between the variables as shown in figure 2.4. Such a model implies that some factors have direct impacts on project performance while some would have indirect relationships. Using structural equation modelling they analysed the significance and strength of the direct and indirect relationships between the variables identified and project performance. Their findings were that technical complexity and project size did not directly affect meeting the project's target date, but rather it was the interaction of formal project management methodology that predicted the success of the project in terms of the target date. Similar to Brown (1996) and Brown and Adam (1999) this research did not examine the internal project management efficiency, consistent with the approach taken in the present study.

2.3.4 Project Management Quality

There have been some studies that have sort to link quality of the project management to project performance as discussed in Section 1.2 of Chapter One. Three of these studies are briefly discussed here. These include Barad and Raz (2002), Bride (2003) and Westerveld (2003).

Barad and Raz (2000) studied the contribution of quality management (QM) tools and techniques on project management performance in Hi-Tech and software industries. The objective of the study was to investigate the adoption of global QM tools in other industries to project management. In developing QM constructs they analysed principally the work of Ahire *et al* (1996) from automotive industry and Anderson *et al.* (1998) from the logistics industry. They compared the constructs in these studies and found out that these constructs can also be used in project management. Barad and Raz (2000) also analysed the impact that these QM practices have on performance. They measured project management performance using Project management process performance assessed by three outcomes variables, extent and frequency of changes, frequency of meetings and ratio of effort invested versus effort required. They also included operational outcomes measured by participant's satisfaction, customer satisfaction and quality of the product. Their findings are quite similar to the findings in the other two studies that not all QM components have the same level of influence on project outcomes (see for example Ahire *et al* 1996).

Bryde (2003) used the European Foundation for Quality Management (EFQM) Business Excellence model to develop a project management performance criterion. He shows that the business excellence principles can be tailored to the needs of project management. Bryde (2003) does not focus on construction environments but on soft projects in organisations with in house project management. This is different in construction and in particular in this research where most of project management services are contracted from outside the parent organisation. The findings in this study showed the plausibility of a project evaluation model based on the EFQM model. However this study did not evaluate the nature and strength of the causal relationships between PM quality constructs and project performance.

Westerveld (2003) discussed a project excellence model, adopted from the EFQM model to relate critical success factors to project success. He argued that there was no agreed suitable framework existed that could be used to link project management critical success factors and project success. Weserveld (2003) proposed an evaluation model that is developed based on the EFQM model. He (Weserveld 2003) developed constructs based on project management literature on critical success factors and project success failure. These factors were built into the project management excellence model. Westerveld (2003) demonstrated from PM critical success factor theory that there is a possible linkage between the constructs and performance. However there was no attempt to show empirically the strength of the relationship between project management quality constructs and project performance. It is the strength and nature of the relationship that the present study seeks to fully understand by conducting an empirical examination. Further discussion of Westerveld (2003), Bryde (2003) and Barad and Raz (2000) are presented in Chapter Three.

2.3.5 Summary-Influence of Project Management on Project Performance

It is evident from the discussion above that there is no study that has examined the relationship between project management and construction project performance in a manner consistent with the objectives of this research. Although there have been several studies that have examined critical success factors, most studies luck a defined theoretical framework to use to measure this relationship. Taking a quality management perspective provides a framework upon which to measure the influence of project management process on construction project performance. This approach is shown to be of benefit in studies that have taken a quality management perspective, however these studies have not been in consistent with the objectives of the current research. The path analysis approach taken by Brown and Adams (1999) provides a methodological similarity with the current study. However, this study used Structural Equation modelling, which is an advanced method and sheds more light into causal relationships (Hair *et al* 1998).

2.4 Section Four: Evaluation Approaches-Influence of Project Management on Performance

This present research concerns the evaluation of the direct and indirect relationships between project management process quality factors and construction project performance. An exploration of literature was conducted to examine the methodologies used in the evaluation of the relationship between project management factors and project performance. Some of the studies that have examined this relationship were cited in Section 2.3 above.

The range of methods used in the evaluation of the relationship between project management and performance ranges from simple ranking based on frequency of responses (Belassi and Tukel 1996) to Structural Equation Modelling (Gowan and Mathieu (2005). Other methods used include correlation analysis (Ibbs and Kwak 2000,;Shenhar *et al* 2001; Dvir *et al* 2003; Deutsch 1991; and Cooke-Davies 2002) simple regression analysis (Phua 2004; Ibbs and Kwak 2000; and Kuprenas 2003), multiple regression analysis (Beluot and Gauvreau 2004), multivariate analysis of variance (Larson and Gobelli (1999) and path analysis (Brown and Adams 1999).

Some studies on critical success factors have used basic statistics in classifying factors that are perceived to have significant impacts on project performance. For example Yeo (2002) used relative ranking of the factors of influence on IT project success by using mean scores. Similarly Belassi and Tukel also (1996) used ranking of factors based on frequency of the responses received as a basis for classifying factors that significantly affect project performance. Such a method whilst providing insights into issues affective project performance is a simplified method and does not explain the level of contribution to project performance nor does it account for direct and indirect relationships.

Studies on critical success factors have mostly used correlation analysis to determine which factors correlate significantly to project performance. For example Ibbs and Kwak (2000) tested for correlations between organisations project management maturity levels and actual project performance in terms of cost and schedule performance. They tested the hypothesis that there is a positive correlation between organisations project management maturity and project performance. Based on this they concluded that there is a relationship between organisations project management maturity and project performance. It is clear however from their model that such an analysis is concerned with only the direct relationships and does not account for indirect relationships in the project management process. They used the project management body of knowledge to classify processes, which they used in their model to assess the maturity levels. The project management body of knowledge, in the guide to project management, is represented as a defined interlinked set of processes. It is expected therefore that actions in one process is likely to affect the proceeding processes and ultimately affect project performance. An analysis of this kind of relationship is required, even in terms of maturity levels, in order to understand the full impact of process inter-linkages. The Project management maturity model as presented in Ibbs and Kwak (2000) therefore under estimates the power of this interlinked relationship by not accounting for the effect of the indirect relationships between processes and ultimately with project performance.

Deutsch (1991) developed a project management model, which relates the impact of residual management power factors, composed of intrinsic management power and project adversity power factors, on project performance. Project performance was measured by technical performance and business performance. While the model developed seems complex the relationship between the dependent variables (performance) and the independent variables (residual management power) was assessed based on correlation analysis. They tested the hypothesis that there should be significant correlation between performance and business and technical performance. While such an analysis provides incites into factors affecting success, the approach taken simplifies the analysis and foregoes the opportunity to examine the collective impact of the residual power factors. Cooke-Davies (2002), Shenhar et al (2001) and Dvir et al (2003), all used correlation analysis and therefore their studies suffers from the same disadvantages as the ones above in that the correlation analysis used focuses on direct relationships only.

Regression has also been used to examine the impact of project management on performance. Kuprenas (2003) used linear regression and correlation to quantify the management impacts on project performance, while Phua (2004) in exploring the determinants of multi-firm project success, also used regression analysis to model the project success. The use of simple regression analysis however only considers single linear relationships and does not provide an opportunity to analyse multiple dependence relationships simultaneously as required in the present study. The simultaneous analysis of multiple dependence relationships is necessary for this research as it is the aim of this study to analyse the individual and collective impact of project management process quality variables on project performance. The project management process quality model as presented in Section 5.3 is a web of relationships which would require advanced methods to be analysed simultaneously.

Belout and Gauvreu (2004) examined the impact of human resource factor on project performance. They used a model containing the independent variables of which personnel were one of the factors. In order to test the effect of the ten project management variables on project success, they conducted a Pearson correlation analysis of the independent variables and the dependent variable, project success. The general finding was that all independent variables were significantly related with project performance. Further they conducted a multiple regression analysis to evaluate the impact of each independent variable on the dependent variable. This method however also considered only direct effect of the different variables on project success. They do not account for the possible indirect influences of these variables or the effect of these variables on each other. Such an analysis would be helpful to project managers to understand how each variable influences the others and in turn influencing project success. Larson and Gobelli (1999) used multivariate analysis of variance to test the significance of the relationship between project structure and project success. Again such an analysis considers only the direct relationship. This approach however does not provide an opportunity to analyse multiple dependence relationships simultaneously as required in the present study.

Brown and Adams (1999) however, used path analysis to measure the effect of project management on construction project performance. Path analysis accounts for both the direct and indirect relationships. This analysis suits examination of a project management quality model, which contains both direct and indirect relationships. However Structural Equation Modelling (SEM), as discussed in Chapter One, is considered a better alternative to path analysis (Hair *et al* (1998). Gowan and Mathieu (2005) as discussed in Section 2.2.3 examined the influence of project management practices on project performance using Structural equation modelling as an evaluation too. The strength of this method was that it accounted for both direct relationships between variables and the interrelationships between the project management variables thereby accounting for the indirect relationships between variables and project performance.

Hair *et al* (1998) notes that when considering analysis of a dependence relationship, with multiple relationships of dependant and independent variables, structural equation modelling is a better suited method. However multiple regression, conjoint analysis, multiple discriminate analysis and linear probability models are suitable when one dependent variable in a single relationship are of interest while canonical correlation analysis and multivariate analysis of variance are recommended when several dependant variables in a single relationship are of interest.

It is clear from this, therefore, that the methods used, while appropriate for their purposes in each of the studies, would poses limitations to this study, which is interested in a myriad of relationships in a model. This research proposes to use similar approach to a number of quality management studies that have used quality models as a basis for evaluation (this was considered in Chapter One). These quality models are presented as causal models with multiple relationships of dependent and independent variables.

2.5 Chapter Summary

It is noted in this chapter that the use of project management on construction projects is intended to bring about successful projects. This is clearly seen in the various definitions of project management. However studies show that project management has failed to consistently deliver successful projects. This, coupled with the continued use of project management, has brought about the need to show the tangible benefits of this approach. Although there have been several studies that have examined the relationship between project management and project performance, this research brings in a new perspective to the understanding of this relationship. Critical to this research is the definition of project performance criteria. Two perspectives were acknowledged in literature. However this research uses the traditional criteria, which measures project performance based on time, cost and quality performance. In addition it was deemed appropriate to include a measure of satisfaction with project outcomes consistent with the multi-criteria approach. However, because this research is limited in scope, the satisfaction of project managers only, with the outcome of the project was included. The research recognises the need for multi-criteria perspectives approach in defining project performance, however taking such an approach would not be suitable for this present research.

Section Three provided literature on the influence of project management on performance. Although there have been several perspectives from which this relationship has been evaluated, non is consistent with the aim, objectives and approach of this present research. Significantly also was a review of methods used in the evaluation of this relationship. One of the major concerns with most of the studies is that they evaluate single relationship, ideally based on correlation statistics or simple linear regression, between the different project management success factors and project performance. Such an approach does not consider the possible indirect relationship that exists between these factors and project performance. The work by Brown and Adams (2000) uses path analysis, which considered both direct and indirect relationships. However this present research takes this further and proposes to use SEM, which will help evaluate both the indirect and direct relationships. The advantages of using SEM over path analysis are considered in Chapter Four.

CHAPTER THREE

Quality and Project Management: A Review of Literature

3.0 Introduction

This research examines the relationship between project management and construction project performance from a 'quality' perspective. In particular it examines the influence of quality of the project management process as a significant contributor to construction project success. As noted in Section 1.1.2, there has been some interest in the examination of quality in project management. However no empirical study has been conducted examining the relationship between project management process quality and project performance, consistent with the present research. A review of literature relating quality and project management provides a contextual platform from which the discussion of project management process quality is placed in the present study. Key issues with respect to quality dimensions in projects, quality management, impact of quality efforts on performance are discussed and further places the present research into context. The understanding of a quality definition for project management and current thinking with respect to the link between quality management and project management sets a platform for the discussion of project management process quality and subsequently the causal relationship between quality in project management and construction project performance. This is consistent with the aim of this research.

Section One gives an overview of quality including definitions, historical perspectives and some dimensions of quality. Section Two examines literature discussing the link between quality management and project management, while Section Three examines literature concerning the relationship between quality in project management and project performance. A review of literature, in other industries, examining the relationship between quality management efforts and performance is also presented in Section Three.

3.1 Section One: Quality Dimensions in Projects

It was discussed in Chapter One that the dimensions of quality in projects can generally be divided into management process quality and product quality. For example, Turner (1999) used a five-element model to depict total project quality. This includes quality of the product, quality of the management process, quality assurance, quality control and people's attitudes. It is implied from this model that although the quality of the product is the ultimate goal, the quality of the management process should be recognised as a significant contributor to product success. Turner's model distinguishes between product quality and project management quality. As cited in Section 1.1.2 many others distinguish between project management process quality and product quality (see for example PMI (2000), ISO (2003), Ardit and Gunaydin (1998) and Wideman (2001)). Figure 3.1 depicts the five-element quality model based on Turners model. This model recognises that there are two dimensions of quality, the product quality and the project management quality. These two dimensions are all affected by quality assurance and control measures. They are also impacted by attitudes to quality. Turner's Model suggests that a holistic approach to quality management on projects should be focussed on both the product quality and the management quality and that quality management techniques applied to product quality are applicable to project management process quality. Several authors have considered the application of quality management principles to project management (See for example Lazlo 1999; Orwig and Brennan 2000; Ramirez 2002; Bryde 2003; Barad and Raz 2000, and others discussed in Section 3.3 of this chapter).

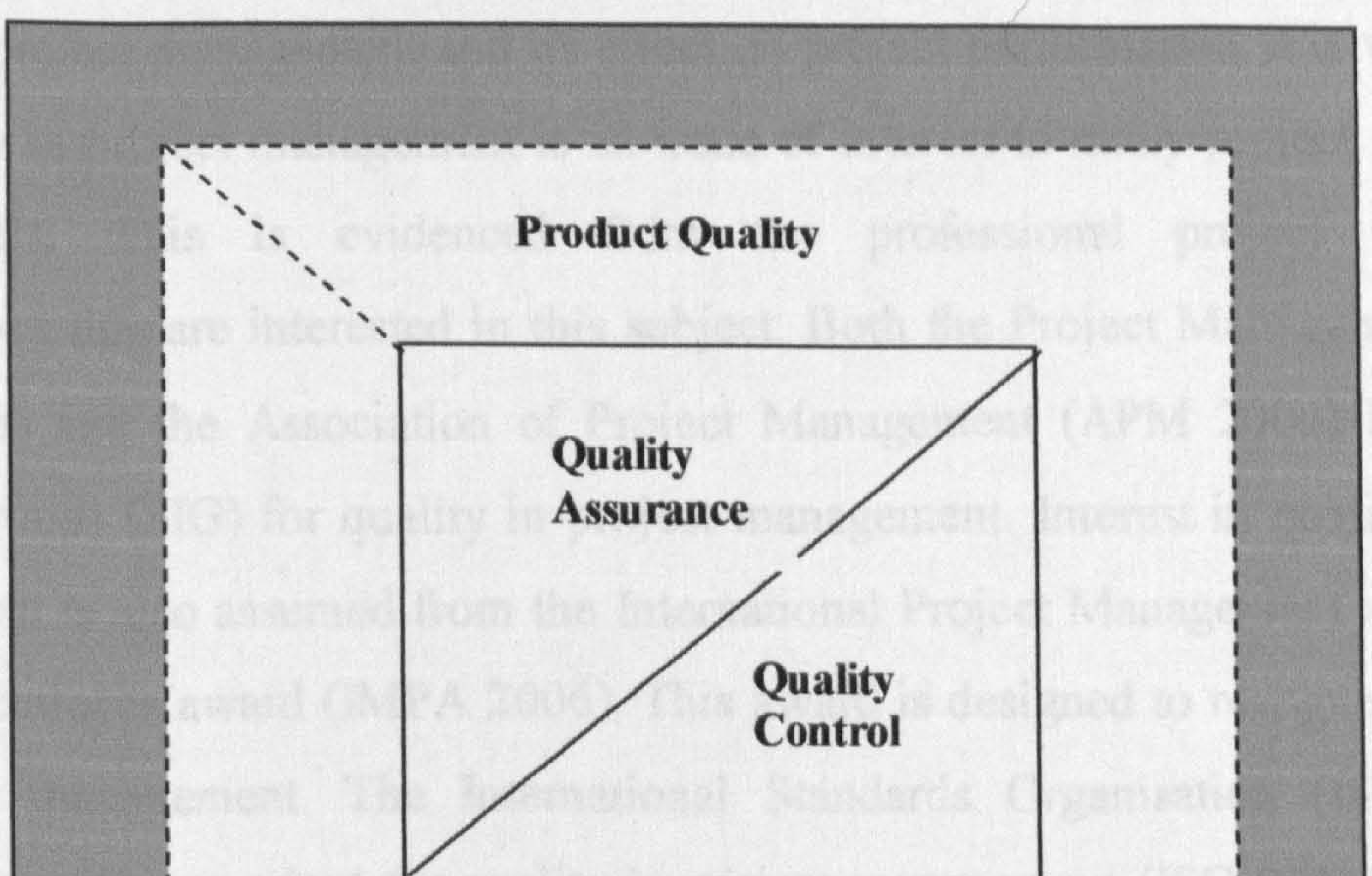

Figure 3. 1: Five-element model for project quality (Source: Turner 2000)

The understanding in quality management literature is that improving quality management efforts increases the chance of better performance. Although some studies have been conducted to establish the influence of project management quality on project performance, this is not very clearly demonstrated in literature (see for example Barad and Raz 2000, Westerveld 2003, and others discussed in Section 3.3). There is need therefore to empirically demonstrate the nature and significance of this relationship in construction project management.

There are three important observations made in this section. Firstly, that there is a distinction between quality of project management and quality of the project's product. Secondly, that there have been efforts to demonstrate the application of generic quality management practices in project management. Thirdly, that quality efforts are designed to improve performance. In Section 3.2 literature concerning the application of quality management practices to project management is reviewed, while Section 3.3 contains a review of literature concerning the effect of quality efforts on performance is considered in Section Three.

3.2 Section Two: Quality Management And Project Management

Although it has been observed that there has been relatively less research concerning quality in project management and its effect on project performance, it is worth noting that quality in project management is an issue of interest to many project management professionals. This is evidenced from the professional project management organisations that are interested in this subject. Both the Project Management Institute (PMI 2006) and the Association of Project Management (APM 2006) have Special Interest Groups (SIG) for quality in project management. Interest in quality of project management is also assumed from the International Project Management Association's project excellence award (IMPA 2006). This award is designed to recognise excellence in project management. The International Standards Organisation (ISO) also has designed a quality standard for quality in project management (ISO 2003). Indeed the literature review shows interest in this subject as shown in Section 3.2.1-3.2.3, which examines the convergence of thought between quality and project management processes.

3.2.1 Quality in Project Management

A number of studies have addressed quality in project management. These studies have attempted to show that quality management principles are applicable to project management. Orwig and Brannan (2000) presented an integrated view of project and quality management for project based organisations. They point out that while the convergence of views between quality management and project management has focused on the use of project management to implement quality management systems or on assuring the quality of the project outcomes and deliverables, academia has directed scant attention toward the effect that quality management would have on project management processes. This is also observed in an exploratory research by Zulu and Brown (2002) on the discussion, in refereed construction project management related journals, of quality in construction projects. Their findings (Zulu and Brown 2002) are that the emphasis in the discussion has been on quality of the end product while quality of the project management process has received lesser attention.

Orwig and Brannan (2000) considered two aspects with regards to quality in project management. Firstly they considered whether quality management and project management were synonymous in project based organisation and secondly they considered how the proper utilisation of quality management principles could provide valuable insights to project management firms. Thus they argued for an integrated view of the relationship between quality management and project management. Using three quality management principles customer focus, teamwork and continuous improvement they showed that these principles are also at the heart of project management and thus these two concepts could be seen as synonymous. In this respect they argued that formal project management is therefore formal quality management. Although there are contradictions concerning the effect of teamwork on performance (Pinto and Mantel 1990, Belout and Gauvreau 2004) project management theory still considers the project management function of project team integration as key to project management (Winch 2002). Pszenica (2001) and Feassy (2001) took a similar approach and showed the possibility of integrating project management methodology with quality management practices.

Lazlo (1999) examined the feasibility and practicality of applying a quality management approach to project management using the Canadian Awards for Excellence model (CAE). Lazlo (1999) used seven principles in the CAE programme including leadership, planning, processes, people, customers, suppliers and results and showed that such an approach can be applicable to project management. Ramirez (2002) in discussing quality in project management also demonstrated that quality management and project management complement each other. She showed that elements of quality management are applicable to project management. Daly (1997), McMichael (1999) and Kujala and Artto (2000), all take a similar view and show the possibility of utilising quality management principles in project management

The work by Wong and Evans (1997) argued for a holistic approach in addressing quality in project management. They argue that whilst there maybe many solutions to the problem of quality in the Australian construction industry, there was need to take a holist approach to quality management which applies the principles of quality management to the whole management of projects unlike the treatment of quality management to individual organisation. Although they did not look at project management in specific they argued that an approach is needed that will address quality even in the project management processes.

Other studies relating quality in project management include the following. Henderson and MacAdam (2000) examined management of quality in project based engineering network organisations. The purpose of their paper was to establish the importance of building quality into the project planning process of fragmented organisations. Although this did not deal with project management in its entirety, it is still important, as project planning is one of the main project management functions. (Bryde (1997) examined the role TQM plays in providing an environment in which organisations successfully utilise modern project management. His focus was on soft projects (e.g. business change) and not on hard projects. He used five fundamental quality principles based on ISO 10006 to discuss how these principles are applicable to project management. Bryde (2003) used the EFQM model to develop a project management performance criterion. He showed that the business excellence principles can be tailored to the needs of project management. Cicmil (2000) also examined quality in project environment and proposes a multi perspective approach to project management suggesting a generic total quality based project completeness framework to guide the implementation of quality management. He argued that there is so much emphasis on quality tools and techniques forgetting issues like attitudes, culture commitment and others, which in his approach are included.

There are several other studies linking quality management and project management include Saunders (2000) who described a project quality assessment tool, a process of making simple numeric quality measurements that can help predict success and allow early corrections. Briscoe *et al* (2000) established a quality assurance project review process, which can be used to determine whether the project processes are compliant or are 'at risk'. The work of Saunders (2000) and Briscoe et al (2000) are consistent with the assumption that increasing quality in the project management process increases chances of better performance.

The work of McMahon (2001), Armstrong (1999), Ofer (2002) and Goulet (1999) also recognised the application of the principles of quality management to project management. McMahon (2001) recognises the need for project managers to identify opportunities to utilise quality tools and techniques in managing projects. Armstrong (1999) showed the application of quality management to enterprise project management. Ofer (2002) examined the assessment of quality of project planning, while Goulet (2001) examined factors determining quality management practices in project management. It is clear from these reviewed studies that quality management principles can be used in project management processes. This being the case, it is therefore possible to examine the impact of quality management applications in project management on project performance, as it is perceived that increasing quality management efforts should increase chances of better performance (ISO 2003).

3.2.2 Assurance of Quality of Project Outcomes

The above review examined literature focusing on applications of quality management principles to project management processes. However, some studies have focused on the use of project management to achieve better project performance including quality performance. In Chapter two the question of project performance was raised. One of the criteria commonly used to measure performance, is based on the golden triangle, which includes time, cost and quality performance. It is clear from this that we can examine the influence of project management practices on project performance and in particular on quality performance. Example studies on critical success factors have evaluated the influence of project management factors on project performance including quality of the product or project outcome.

Some studies however have specifically examined project management as a vehicle for assurance of quality of the projects product or service. Chan and Tam (2000) examined factors affecting the quality of building projects in Hong Kong. They developed a framework of six sets of variables, which affected quality of projects, among which was project management action variables. Chan and Tam (2000) concluded that project management action was the most powerful predictor of client's satisfaction with project quality. Ireland (1992), examined the role of the project manager in ensuring customer satisfaction. Customer satisfaction can be seen as one of the measures of project success as observed in the work of Chan and Tam (2000).

Abdul-Rahman (1996) was concerned with the management of quality by professionals in the construction industry, while Bubshait and Abdulrazzak (1999) were concerned with design quality management activities. Chini and Valdez (2003) were concerned with the application and effectiveness of ISO 9000 in US construction firms. Other studies concerned with the general application of quality management in construction include Kumaraswany and Dissanayaka (2000), Pheng and Teo (2004) and Shamas-Toma *et al* (1998).

3.2.3 Service Quality

A number of studies on service quality with respect to services in construction projects have been undertaken. Although not necessarily examining project management services, they are relevant for this research because project management can clearly be classified as a service. Hoxley (2000) built on work on service quality such as the SERVQUAL model and the RESERV model and developed a twenty six (26)-item scale for assessing service quality in the UK construction professional services context. Although it provides necessary information on the measurement of service quality, it does not provide causal relationship between service quality and performance. The approach also is ideal for organisational level analysis and not at process level. It is not clear however from this study whether project managers were included. In another study, Hoxley (1999), who examined the relationship between competitive fee tendering and construction professional service quality. Again it is not clear from this research whether project managers where included in the study.

There are several other studies that have focussed on examining quality of service or quality in the service industry. For example Behara and Gundersen (2000) analysed quality management practices in the service industry as opposed to manufacturing, which has been a focus in many studies. Other works taking a service quality perspective include Maloney (2002), and Ardit and Lee (2003). These studies examined quality of the service as opposed to quality of the product. These studies are significant to this research as they examined quality of service as opposed to product quality. It can be argued that the examination of quality in the project management process is aligned towards examination of quality of service of the project management.

3.2.4 Implementation of Quality Management Systems Using Project Management

Some studies have examined the use of project management in the introduction or implementation of quality initiatives. Hides *et al.* (2000) examined the use of projects as a vehicle for adopting total quality principles. Stamatis (1994) took a project management approach to TQM and argued that using TQM steps, project management implementation should provide a higher level of desired outcomes, while Cammarano (1997) argued that project management is essential for successful continuous improvement a key quality management component. Lo and Humphreys (2000) concerned with obstacles, restrictions and difficulties of implementing ISO 9000 in small and medium enterprises (SME's) used project management techniques to develop a generic project network and resource lording profile for the implementation of ISO 9000. Other work include Ramabadron *et al* (1997) who were concerned with the use of projects as a vehicle to benchmarking, and Armad and Sein (1997) who were concerned with the construction project team factors that affect the success of TQM initiatives in construction projects. It is again seen in these studies that project management has been used to implement quality management systems.

3.2.5 Process Quality

Arditi and Gunaydin (1997; 1998; and 1999) also developed the concept of process quality in the building process and identified factors affecting construction process quality. They differentiated between product quality and process quality. The focus of their research was on process quality which includes among others project management processes in the whole project life cycle.

Example of other work in relation to process quality includes the following. Rounce (1998), looked at quality in architectural building design process, Chan and Tam (2000) identified factors affecting project quality and developed a model of quality performance impacting factors on building projects in Hong Kong, Tilley *et al* (1999), investigated a causal relationship between design and documentation quality on the construction process, Tan and Lu (1995) using a systems approach examined quality in engineering design projects in terms of a systems quality which can be viewed from four perspectives-quality of the input, quality of the design process, quality of the output from the design process and quality as perceived by the receiving subsystems.

3.2.6 Summary: Quality Management and Project Management

The above discussion has demonstrated the convergence of thought between project management and quality management. While academia has directed scant attention to quality of the project management process (Orwig and Brennan 1999), there is evidence of attempts to conceptualise quality in project management. Of interested is the illustration in literature that quality in project management can be defined. Literature in Section 3.2.1 demonstrated research examining quality in project management. It is therefore possible that quality in project management can be adequately evaluated to understand its influence on project performance consistent with the aims of the present research. Having examined literature that focused on quality in project management, the next section reviews literature concerning the influence of project management quality on project performance.

3.3 Section Three: Influence of Quality in Project Management on Performance

Section 3.2 and in particular Section 3.2.1 demonstrated the plausibility of applying quality management principles to project management. Consistent with the objectives of the research a review of literature was also conducted to examine studies that link application of quality management and project performance. Some of the studies include the following. The Europa (1999) research, examined quality in the construction sector. The research assessed the impact on company performance and implication of adopting quality schemes through the development of nine case studies. The analysis of the cases was based on the European Foundation For Quality Management business excellence model (EFQM). This is a similar approach to many others (for example Anderson et al 1998, Ahire et al 1996) who have assessed the impact of quality management on performance based on such quality award models. The main objective of the study was to show what quality means for nine European contractors and how they have steered their organisations through the new challenges presented. The major strength with this research is that it is based on the EFQM model, which is well developed and used widely in the European Union. However the study does not generalise the findings but restricts its application to the nine case studies. This study was also restricted to construction companies reflecting the continued emphasis of quality on the final product.

The work of Barad and Raz (2000) was cited in Chapters One and Two. Barad and Raz (2000) were concerned with the contribution of quality management tools and techniques on project management performance. The objective of the study was to investigate the adoption of global quality management tools applied in other industries to project management. They were concerned with quality management in organisations that were engaged in projects. They argued that there is not much empirical research demonstrating a linkage between quality management efforts in project management, as defined in the project management body of knowledge, and project management performance. This view does not differentiate between quality of the project management process and quality assurance for the project's product.

In demonstrating empirically a link between quality management practices and project management performance, Barad and Raz (2000) firstly adapted quality management constructs based principally on the research studies by Ahire *et al* (1996) from automotive industry and Anderson *et al.* (1998) from the logistics industry. They compared the constructs in these studies and concluded that these constructs were also potentially applicable in project management environments. Using correlation statistics, Barad and Raz (2000) analysed the impact that these quality management practices have on performance. They measured project management performance using project management process performance assessed by three outcomes variables including, extent and frequency of changes, frequency of meetings and ratio of effort invested versus effort required. They also included operational outcomes measured by participant's satisfaction, customer satisfaction and quality of the product. Their findings are quite similar to the findings in the other two studies that not all quality management components have the same level of influence on project outcomes.

Westerveld (2003) developed a project excellence model based on the EFQM model to link project management success factors and project management success criteria. He argued that despite advances n research on critical success factors and success criteria, there is no defined concept to link the two. Therefore a model such as the EFQM model provides a framework to link the two. The EFQM model is divided into two areas, which are the enablers, or organisation area and the results area. The argument in the EFQM model, like other models such as the MNBQA, is that there is a casual relationship between the enablers and the results areas. Westerveld (2003) also developed the project excellence model, which has two areas, including, the organisation areas and the results areas. He defined the organisation areas based on literature on critical success factors while the results areas based on literature o success factors. He argued that such a causal model could be used to set up, manage and evaluate a project. However Westerveld (2003 does not report of the significance of the causal inter-relationships between the organisational variables and project performance. Although this relationship seem plausible, there is need to validate such a model to examine empirically the nature and significance of the postulated casual relationships in the model.

Similar validation studies have been conducted for the MBNQA and the EFQM. Indeed this is important, as most studies concerning the relationship between success factors and success criteria have principally examined the direct effects only based on correlation. However this model is complex in that it has both direct and indirect relationships between the model's organisation variables and performance variables. As described in Chapters One and Two, Bryde (2003) also took a similar approach and developed a project management performance evaluation criteria based on the EFQM model. Again this model although providing a plausible framework to define a causal model between project management excellence and project performance does not evaluate the significance of this relationship.

Other studies include Shieh and Wo (2002) who examined the relationship between TQM activities and project performance in the architectural planning phase, and Holt and Rowe (2000) who examined the relationship between total quality orientation in public project management and the promotion of economic and public interest. Jung and Wang (2004) also examined the relationship between quality management and improvement of international project management. These studies although with a slight departure from the relationship between project management quality and project performance shows that there as an interest in literature to understand the relationship between quality management efforts in project management and performance as manifested in various forms.

The above gives a general overview of quality in project management and presents the different perspectives from which this subject has been examined. Although a number of studies have examined quality in project management processes and practices, it is clear that no attempt so far has been made to examine the significance of the relationship between quality of the project management process and construction project performance, in line with the aims stated in the present research. An empirical evaluation of the significance of the direct and indirect relationships between project management process quality variables and project performance is not evident from existing literature. It is clear, nevertheless, from the relevant literature that there is a general interest to understand the application of quality management practices in project management environments. Of direct relevance to this study are the studies by Bryde (2003), Barad and Raz (2000) and Westerveld (2003).

Barad and Raz (2000) based their study on Software and High-tech project management in Israel and evaluated the effect of quality management practices on performance. They demonstrated that it is plausible to empirically examine the casual relationship between quality in project management and project performance. Although Barad and Raz (2000) base there relationship on correlation linkages between the different variables, it is possible to examine the relation in more depth as exemplified in the work of Anderson *et al* (1998) on which their work was based. It is safe to say that this study was not based on construction project management. Moreover, the primary aim of the study was to find out if the generic quality constructs found in other studies could be applicable to project management environments. Unlike Barad ad Raz (2002) there is need to recognise the differentiation between quality practices towards project management and those towards the projects product.

Both Westerveld (2003) and Bryde (2003) developed a project management models based on the EFQM model. Both these studies recognise the importance of adapting the quality model to suit project management environment. Although they developed project management quality models there is need to validate their models by empirically examining the nature and significance of the postulated causal relationships. Westerveld (2003) used one case study to show how the model can be of use to project management. However, although case studies provide an insight into the application of the model, findings cannot be generalised (Ahire *et al* 1996). The present research therefore, although similar in the model development approach to the two studies, develops further the idea and examines empirically the direct and indirect impact of the different project management quality variables and construction project performance. Similar studies in other industries have been conducted and these are described below.

3.3.1 The Influence of Quality Management on Performance-Studies in Other Industries

There have been several studies in different industries that have examined the influence of quality management initiatives on performance. These studies have developed the idea further from a discussion of developing TQM measurement constructs to evaluating the possible causal relationships between the different TQM constructs and performance. The introduction of the MBNQA led to a strong interest among organisations from all industries in quality management (Saraph et al 1989; Black and Porter 1996; Flynn *et al* 1994; and Motwani 2001). While there was increase in the number of companies introducing quality management initiatives such as TQM, many questioned the value of such initiatives. This has led to many studies that have attempted to investigate the relationship between quality management initiatives and performance.

The quest to understand the relationship between quality management and performance has been in two phases. Firstly there were those studies that sort to define quality management constructs and define items to measure these constructs. These include Saraph (1989), Black and Porter (1995) and Ahire *et al* (1996). In a similar manner there were those studies that attempted to validate the quality award frameworks such as the MBNQA and the EFQM models. Example studies include Curkovic et al (2000), Pannirselvam and Ferguson (2000), Dijkstra (1997) and Badri *et al* (1993). The second wave of studies attempted to find the relationship between the different quality management constructs. These include Hendricks and Singhal (2000), Lin *et al* (2004), Samson and Terziovski (1999), Kuei *et al* (2001), Madu *et al* (1996), Anderson et al (1998), Kaynak (2003), Forza and Filipini (1998) and Prajogo and Brown (2004).

Ahire *et al* (1996) argued for the development of quality management theory by investigating the linkages among quality management strategies that were being implemented at the time, and identify the ones that are critical for improving product quality. They aimed to identify quality management constructs and develop scales for measuring them. Then using the measurement framework, they aimed to investigate the relationship among the quality management strategies. They identified eleven constructs with their associated measurement items including product quality, which can be related to the performance construct. They used correlation among constructs to examine the relationship. While they found out positive correlations among constructs, they found out that there are varying degrees of correlation between the individual constructs and product quality. Of significance also was the finding that various quality management constructs operate in synergy to affect product quality.

Curkovic *et al* (2000) were concerned with the validation of whether the MBNQA framework captures the major dimensions of TQM. They were motivated by the increased use of the MBNQA criteria by many organisations to perform self-assessment with respect to their performance in implementing TQM principles. The MBNQA framework contained seven constructs including, leadership, strategic planning, information and analysis, human resources, process management and business results (NIST 2006). The understanding in the model is that it can be divided into four subsystems. These include the strategic systems (leadership, planning and strategy), the operational system (human resources and process management), the information systems (information and analysis) and the results systems (business results). The model postulates that results are directly influenced by the operation system and indirectly affected by the strategic and information systems through the operational systems. They conducted a survey on managers in the automotive industries and concluded that the MBNQA framework captured the concept of TQM. Based on this finding therefore it can be conclude that there is a relationship between the business results construct and the other TQM constructs, whether direct or indirect.

Claver *et al* (2003) developed a measurement scale for TQM, based on the EFQM framework as an acceptable TQM framework. They developed a measurement instrument with eight critical quality factors, including leadership, quality planning, training, supplier management, process management, continuous improvement and learning, and three results factors including customer satisfaction, social impact and business results. They concluded that the measurement instrument was reliable and valid and therefore can be used in research. Of interest again is the inclusion of the 'results' area and the postulated linkage in the EFQM model of the relationship between the enabler area (critical quality factors) and the results area. This finding is consistent with the expectations in quality management literature that quality management efforts are rewarded by better performance in many areas including, high degree of differentiation, increased customer satisfaction, stronger brand image and cost, time and quality advantages (Claver *et al* 2003).

Hendricks and Singhal (2000) presented evidence of the impact of effective TQM implementation of financial performance in public traded organisations. Their research was motivated by the need to demonstrate the value of effective TQM implementation at the time when TQM principles are in question by many business press. In examining this relationship they used stock price as a measure of financial performance and the winning of a quality award as a measure of effective implementation. They found evidence that firms that implemented TQM effectively outperformed those which did not fall in this category. Clearly, they concluded that when TQM is implemented effectively, financial performance improves drastically. This research provides some empirical justification of the relationship between quality initiatives and performance.

Madu (1996) tested the significance of association between quality dimensions and organisational performance. Their aim was to validate or refute some of the claims made in quality management cycles about the importance of quality management initiatives to organisational performance. They collected perception responses from managers in both manufacturing and service firms. Although the study did not establish causal relationships between the dimensions and performance, the explored relationships provided an insight into the possible causal linkages between quality dimensions and organisational performance. Their findings in general were that there is a statistically significant positive correlation between changes in organisational performance and changes in the quality dimensions for both the manufacturing and the service firms. This finding supports the general perception that there is a relationship between quality management practices and organisational performance. Studies by Kaynak (2003), Kuei *et al* (2001) and Lin (2004) all support this general conclusion about the relationship between quality management practices and performance.

Anderson *et al* (1998) explored the relationship between quality management factors and performance. They developed quality management constructs and a causal model as a basis for assessment of improvement efforts in the logistics industry, based on the MBNQA model. Their primary aim was to determine whether there were causal linkages between quality management factors and performance. The model developed had ten quality management factors, two of which were performance related including operational results and customer satisfaction. The other factors included, leadership, teamwork, training, benchmarking, work measurement, supplier management, information and analysis and morale. Further they developed twenty causal hypotheses to depict the postulated causal relationships between constructs. Eight of these hypotheses were concerned with the effect of some quality management factors on operational results and or customer satisfaction. They found out that not all hypotheses were supported. For example they found out that the hypotheses about the direct effect of teamwork on operational results and morale on operational results were not statistically significant. However their model showed a general acceptance of the theory that there is a relationship between quality management factors and performance, although it is clear in this research that there are varying degrees of influence of the quality factors on performance.

This is a similar finding to Samson and Terziovsk (1999) who examined the collective and individual effect of quality management practices on operational performance in large manufacturing companies. Their findings were that although the general notion of the impact of quality management on performance was accepted, they found out that the different quality factors had varying degrees of power of prediction on operational results.

These studies show that there is a general acceptance of the relationship between application of quality management practices and performance. Motivated by the need to show the value of applying quality management initiatives, many researchers have shown the possible linkages. The conclusions in the empirical studies have two major implications for construction project management research. Firstly it can be argued that there is a relationship between quality management practices in project management processes and project performance. This assumption however needs to be empirically tested. Many of the studies cited above were motivated by the need to validate or refute the general assertion of the relationship in literature. Secondly studies that examined the causal relationships between quality management constructs and performance concluded that there were varying degrees of influence of these quality factors on performance. This can be similarly argued for project management quality factors that it is expected that project management process quality factors would have varying degrees of influence on project performance be it direct or indirect. It is the aim of this research to examine these issues in detail with respect to construction project management process quality and its impact on construction project performance.

3.4 Chapter Summary

This chapter intended to build on the case for a quality perspective in understanding the relationship between project management and construction project performance. The primary consideration for this argument is that it is expected that increasing quality levels in the project management process should increase chances of better construction project performance. However to understand this relationship, it was important firstly to define the parameters of quality in project management providing a working definition upon which to conduct the research. Significant to this research was the review of literature on current thinking on the convergence of views between quality management and project management. It was noted that, while there has been many perspectives from which this relationship has been described, there is a general recognition that there is a difference between quality of the project management process and quality of the projects product. It was also noted that there has been interest in the application of generic quality management principles to project management processes. Further it was noted that there has been studies that have linked quality in project management and project performance. However none is consistent with the objectives and approach taken in the present research with respect to the evaluation of the significance of the direct and indirect relationships between project management quality variables and construction project performance. Evidence of the relationship between quality initiatives and performance in other industries was presented. This strongly supported the notion that improving the quality initiatives has an impact on performance. In relation to project management it is expected therefore that increasing project management process quality would increase chances of better construction project performance. It is the intent of this research to use some of these studies in other industries and in project management field, as a platform from which to extend the understanding of the relationship between project management process quality and construction project performance.

CHAPTER FOUR

Research Methodology

4.0 Introduction

The preceding chapters have reviewed literature in relation to the present investigation. In Chapter Two a review of literature concerning the relationship between project management and project performance was presented. It was noted that an empirical study of this relationship using a quality perspective would add a dimension to the understanding of the relationship between project management and construction project performance. In Chapter Three a review of literature concerning quality in project management and in particular the relationship between quality in project management and performance was forwarded. It was noted that there has been significant interest amongst researchers, in the link between quality and project management. It was also noted that there has been studies that have attempted to show the relationship between quality in project management and performance. However, no empirical study is known to have been conducted that examined the relationship between project management process quality and construction project performance in a manner consistent with the aims and objectives of this present research. This research aims to empirically examine the direct and indirect impact of quality variables in project management process on construction project performance.

This chapter introduces the methodology used in the empirical evaluation of the direct and indirect relationships between project management process quality variables and construction project performance. Section One of the chapter explains the general research approach used and provides an overall map of the research. Section Two provides a discussion of the appropriate modelling tool for the present investigation. Section Three, include research considerations for the appropriate research strategy, data collection method and sample size issues.

4.1 Section One: General Research Design

4.1.1 Research Approach

Consideration was given to approaches to be taken in this research. Both qualitative and quantitative methods were considered. Fellows and Liu (2003) defined quantitative approaches as those that 'tend to seek to gather factual data and to study relationships between facts and how such facts and relationships accord with theories'. Such methods require quantifiable data from which quantitative deductions can be made. Based on this, conclusions about the data in light of the theory are made. On the other hand they (Fellows and Liu 2003) defined qualitative approaches to research as those seeking 'insight and to understand peoples perceptions of 'the world''. Qualitative methods gather data which is largely unstructured from which the results obtained are not quantifiable.

The present study seeks to understand the nature and significance of the relationship between project management process quality and construction project performance. As such it seeks an empirical evaluation of the relationship. Therefore the use of the quantitative approaches which would yield quantifiable data and results was considered better suited to this research.

4.1.2 Research Design

The primary aim of this research focuses on the empirical evaluation of causal relationship between project management process quality and construction project performance. In order to achieve this aim, there is need to define a framework upon which such a relationship will be evaluated. Ahire *et al* (1996) in the paper on developing and validating a TQM model proposed a five-stage process for the development of sound theory. These include exploration, construct development, hypothesis generation, hypothesis testing for internal consistency and hypothesis testing for external validity. Although this research does not propose to develop theory it takes a similar approach in the evaluation of the theoretical model. In particular this research focuses on the identification of a project management process quality model by identifying quality variables for project management processes, evaluating the scales used to measure these variables and then examining the direct and indirect relationships between the project management quality variables and project performance. This approach is consistent with many other similar studies such as Anderson *et al* (1998), Barad and Raz (2000) and Black and Porter (1996) as earlier described in Chapters Three and Four.

This research takes a Structural Equation Modelling (SEM) approach in evaluating this relationship. Although other evaluation criteria can be used, SEM was deemed the most appropriate method. Hair *et al* (1998) provided a framework (see Appendix A), which can be useful when deciding the appropriate multivariate technique as an analysis tool. Under this framework, firstly one needs to consider the kind of relationship being evaluated. This can either be a dependence or interdependence relationship. For this research the relationship being investigated is a dependence relationship between project management quality and project performance. Secondly, having decided on the dependence relationship, one has to examine the number of variables being predicted. The choice is between; one dependent variable in a single relationship in which multiple regression, conjoint analysis, multiple discriminant analysis and linear probability models are candidate models; several dependant variables in a single relationship in which canonical correlation analysis and multivariate analysis of variance are recommended; and multiple relationships of dependant and independent variables in which structural equation modelling is recommended (Hair *et al* 1998).

This research used structural equation modelling as a recommended approach because the dependence relationship being examined involved multiple relationships of dependent and independent variables. It took a similar approach to other studies in quality management research, which examined both the direct and indirect relationships between quality variables and performance. Structural equation modelling is a multivariate analysis technique different from many of the multivariate techniques such as multiple regression, factor analysis, multivariate analysis of variance, discriminate analysis, which provide researchers with analytical tools to examine relationships between variables. These methods fail to analyse multiple relationships between variables simultaneously and are limited to the analysis of single relationships at one time. SEM extends these techniques and provides for a mechanism for the examination of a series of dependant relationships simultaneously (Hair *et al* 1998).

In Chapter Three examples of studies that have evaluated the relationship between quality management and performance were given. Some of these studies including Curkovic et al (2000), Pannirselvam and Ferguson (2000), Lin *et al* (2004), Samson and Terziovski (1999), Anderson *et al* (1998) and Kaynak (2003) used structural equation modelling to examine the multiple relationships in their models. A more detailed discussion of the suitability of structural equation modelling is further given in Section Two of this chapter.

Figure 4.1 represents the general research approach taken. First, a theoretical model for the relationship between project management quality and project performance is defined. This provided a working definition of the relationship between project management quality variables and project performance. Second, appropriate data was collected which is fed into the evaluation model to be tested. Based on this, results from the model evaluation exercise, appropriate conclusions were made.

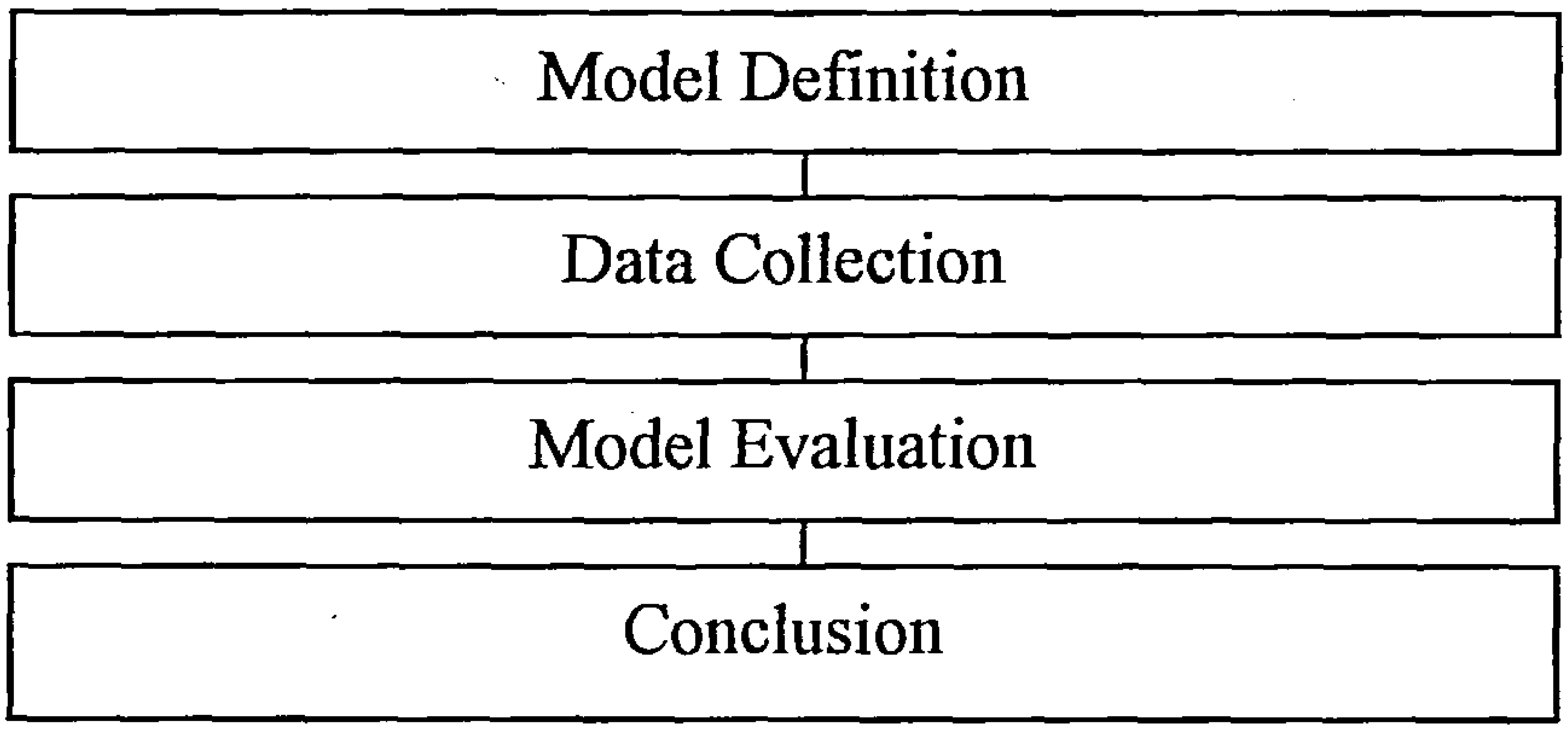

Figure 4. 1: General Research Model

4.2 Section Two: Structural Equation Modelling

Hair *et al* (1998:583) defines SEM as *'a multivariate technique combining aspects of multiple regression and factor analysis to estimate a series of interrelated dependence relationships simultaneously'*. Bryne (2001) defines SEM as a statistical methodology that takes a confirmatory approach to the analysis of a structural theory bearing on some phenomenon and states that this conveys two issues. Firstly, that the causal relationships under study are represented by a series of structural equations and secondly that these structural relationships can be modelled pictorially to enable a clearer conceptualisation of the theory under study. SEM provides a method for statistically testing hypothesised relationships between variables simultaneously to determine the extent to which the model is consistent with the data. This simultaneous analysis of the relationships in the model is one of the advantages of SEM when compared to other multivariate techniques, such as multiple regression, path analysis, factor analysis, time series analysis and analysis of covariance (Garson 2002). Other advantages include; that it takes a confirmatory rather than an exploratory approach to the analysis of data; that it provides explicit estimates of error variance parameters which other methods are incapable of allowing; that, while other methods use observed measurements only, it incorporates both unobserved and observed variables; and that it allows for the assessment of indirect effects (Bryne, 2001).

There are principally two characteristics that distinguish SEM from other multivariate techniques (Hair *et al* 1998). Firstly, SEM provides a tool to incorporate multiple interrelated dependence relationships. SEM provides an approach to estimate a series of separate but interrelated, multiple regression equations simultaneously. In principle one specifies the relationships between dependent and independent variables based on underlying theory. Unlike other multivariate approaches, a dependant variable, in SEM, could become an independent variable in a separate relationship. These relationships are then translated into a series of structural equations for each dependent variable. This feature distinguishes SEM from other techniques, which only allow a single relationship between dependent and independent variables.

Secondly, SEM provides for the incorporation of latent variables. Latent variables are variables that are unobserved and can only be approximated by observed or measured variables (Hair *et al* 1998). In most of the multivariate techniques it is assumed that there is no error in the measurement variables. However it is logically expected that there is always some degree of error in measuring a concept. Hair *et al* (1998) argue that, because dependence relationships between variables are based on correlation between them, accounting for the correlation attributed to the measurement errors would help strengthen the correlations used in the dependence relationship. It has been noted above that SEM uses theoretical concepts as constructs, measured by observed indicators, in its depiction of relationships. It is however inherent that there are bound to be some errors in the design of variables to measure these constructs. However the use of SEM makes it possible to incorporate reliability measures into the statistical estimation and improve the dependence model. This is achieved by incorporation of the assessment of the contribution of each observed indicator, as well as incorporating the degree to which the indicators measure the latent constructs with the estimation of the relationship between the dependent and independent variables.

4.2.1 Components of a Structural Equation Model

The general SEM model can be divided into two sub-models. These are the measurement model and the structural model. The measurement model can be defined as that which defines the relationship between the observed and unobserved variables while the structural model as that which defines the relationship between the unobserved variables in the model (Byrne 2004 and Hair *et al* 1998). As latent variables are theoretical constructs that cannot be measured directly, there is a need to operationally define the latent variables in terms of observed or indicator variables. This linking of observed variables as representative manifestations or indicators of latent variables makes it possible to measure these latent variables (Byrne 2004). In essence the measurement model represents a confirmatory factor analysis model while the structural model represents the regression model. Figure 4.2 shows an example of a composition of an SEM.

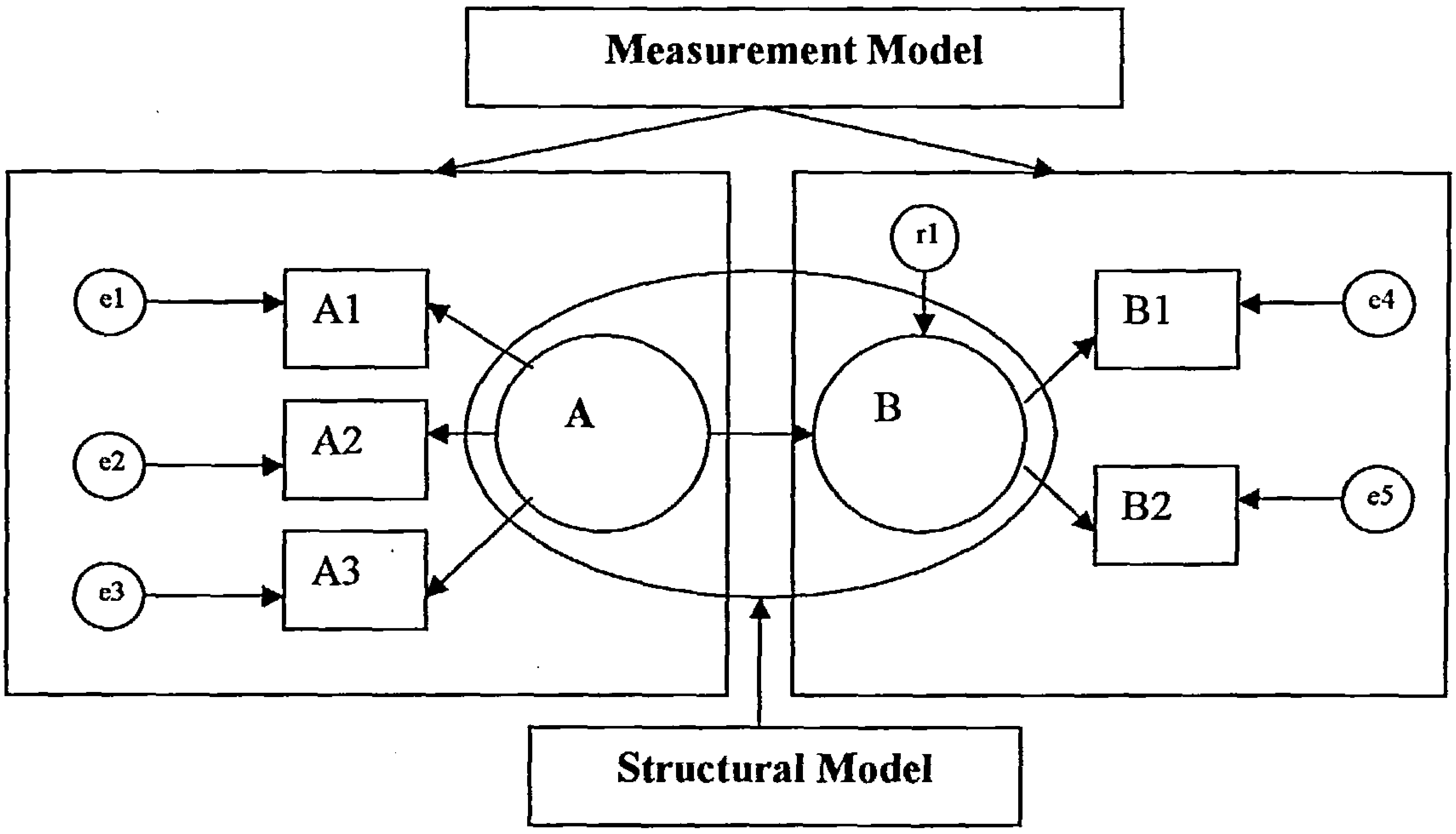

Figure 4. 2: Composition of an SEM (Source: Bryne 2004: 13)

In the model, ***A*** and ***B*** are model constructs or unobserved variables. These are conceptually defined based on theory. The constructs represent variables that cannot be measured directly. The depiction of the relationships between ***A*** and ***B*** is a representative of a structural model. It is observed also in the figure that both ***A*** and ***B*** have a set of indicator variables. These in essence are the observed variables that can be used to be measurable variables of the construct. For example construct ***A*** is perceived to be measured by ***a1, a2*** and ***a3*** while ***b1*** and ***b2*** are measurement variables of the ***B*** construct. These two components will form the measurement sub model of the model. As discussed on page 73, SEM incorporates estimates of error variances. It is expected that all indicator variables have an element of error in them therefore the inclusion of error terms ***(e1-e5)*** to each of these indicator variables. It will be noted also that construct ***B*** has an error term. This also indicates that while the model postulates that ***B*** is predicted by ***A***, there is bound to be a degree to which there is an error and therefore the inclusion of ***r1*** which represents an error term for construct ***B***.

4.2.2 Steps in Structural Equation Modelling

Hair et al (1998) recommended a seven-step process in SEM. These steps are: -

(i) Developing a theoretically based model;

(ii) Constructing a path diagram of causal relationships;

(iii) Converting the path diagram into a set of structural equations and measurement equations;

(iv) Choosing the input matrix type and estimating the proposed model;

(v) Assessing the identification of the model equations;

(vi) Evaluating the results of goodness-of-fit and;

(vii) Interpreting and making the indicated modifications to the model if theoretically justified.

These steps, as in figure 4.3, are detailed below. A similar SEM process is found in Schumacker and Lomax (2004) and Byrne (2004). However, these authors describe the steps as comprising model specification, model identification, model estimating, model testing and model modification. The explanation of the steps in Hair *et al* (1998) is provided below.

4.2.3 Developing a Theoretically Based Model

The first step in SEM is to specify a model based on theoretical justification of the relationships in the model. Shumacker and Lomax (2004) described specification as the process of specifying the variables included in the model and how these relate to each other. This in essence represents a statistical statement concerning the relationships between variables (Levin *et al* 2005). Levin *et al* (2005) also referred to specification as the translation of a theory into a structural model which specifies the relationships between variables stated. This dependence on a theory based modelling approach is recommended in SEM as a necessity (Hair *et al* 1998). It is recognised that SEM takes a confirmatory approach. This therefore implies that the theoretically justified model would ideally be fully specified by the researcher. Hair *et al* (1998) contends that the strength and conviction with which causal relationships between variables can be attributed, relies strongly on the justification provided in the underlying theory. The dependence on a theory based model therefore provides a strong basis for the assumptions of causal relationships in SEM.

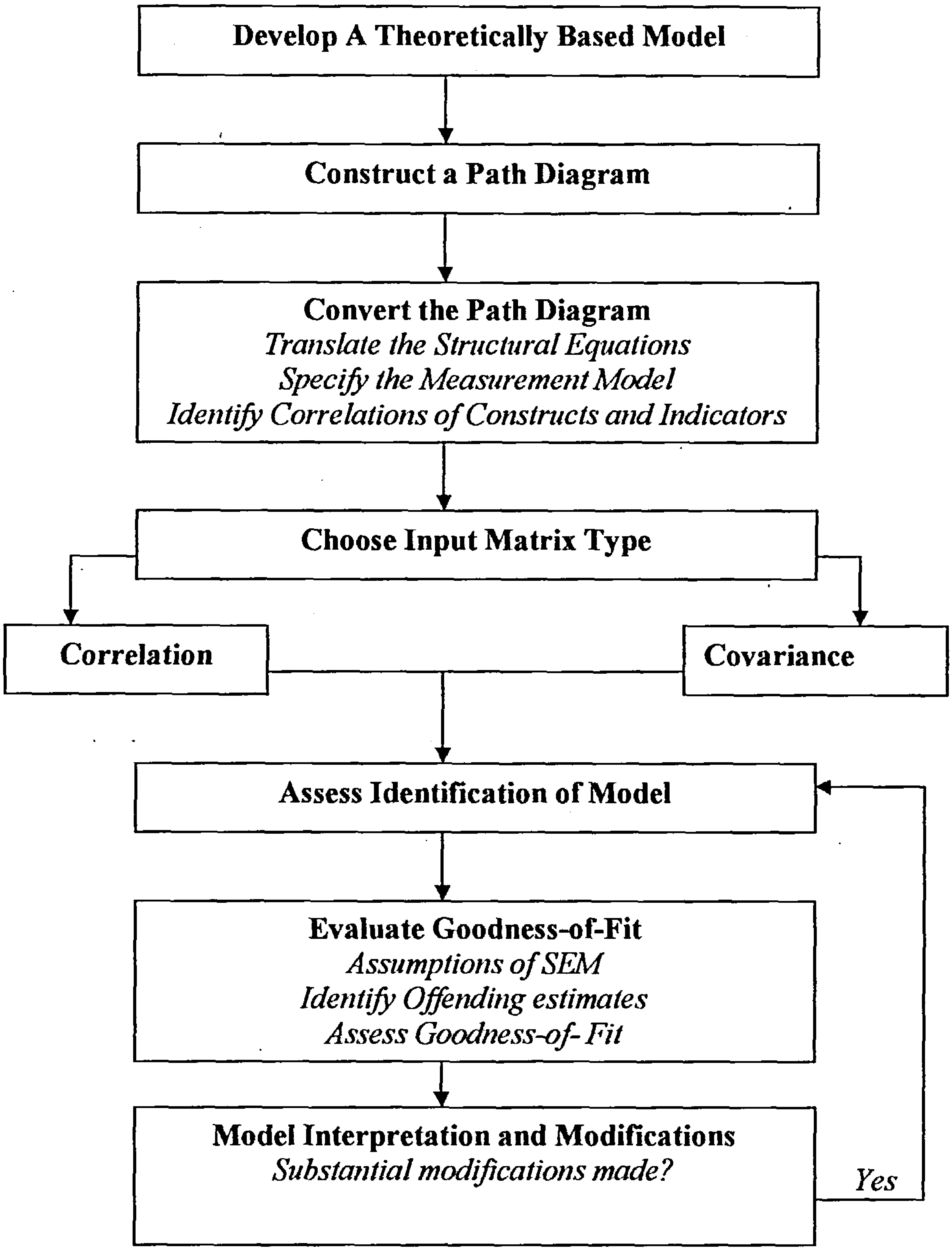

Figure 4. 3: Steps in SEM (Source: Adapted from Hair et al 1998)

Similar to other studies of this nature, which empirically evaluated the relationship between quality constructs and performance, this research required to develop a theoretically sound project management process quality model that would be used to evaluate the relationship between quality in project management and construction project performance. In Chapter Three it was observed that there have been many studies that have shown the application of quality management principles in project management. It was also observed that in studies by Barad and Raz (2000), Bryde (2003) and Westerveld (2003) possible models for evaluating the relationship have been designed. Building on these studies and on studies in other industries examining the quality versus performance relationship, a project management process quality model (PMPQ) for the research was developed. This is presented in detail in Chapter Five.

4.2.4 Constructing a Path Diagram of Causal Relationships

A path diagram can be defined as a visual representation of the causal relationships between variables or a graphical equivalent of mathematical equations of a set of relationships between variables (Bryne 2001). Construction of a path diagram follows after the development of a theory based model of the causal relationships between variables. Figure 4.4 is an example of a path diagram.

In the diagram ***A***, ***B***, ***C*** and ***D*** are latent variables measured by indicator or observed variables ***a1***, ***a2*** and ***a3***, ***b1***, ***b2*** and ***b3***, ***c1***, ***c2*** and ***c3*** and ***d1***, ***d2*** and ***d3*** respectively. As discussed above SEM contains constructs and measured or indicator variables. The constructs can either be presented as an exogenous variables or an endogenous variable. However in SEM an endogenous construct can predict other endogenous constructs. Thus in one relationship a construct can be dependent while in another relationship it becomes independent. This was pointed out as one of the distinguishing features of SEM.

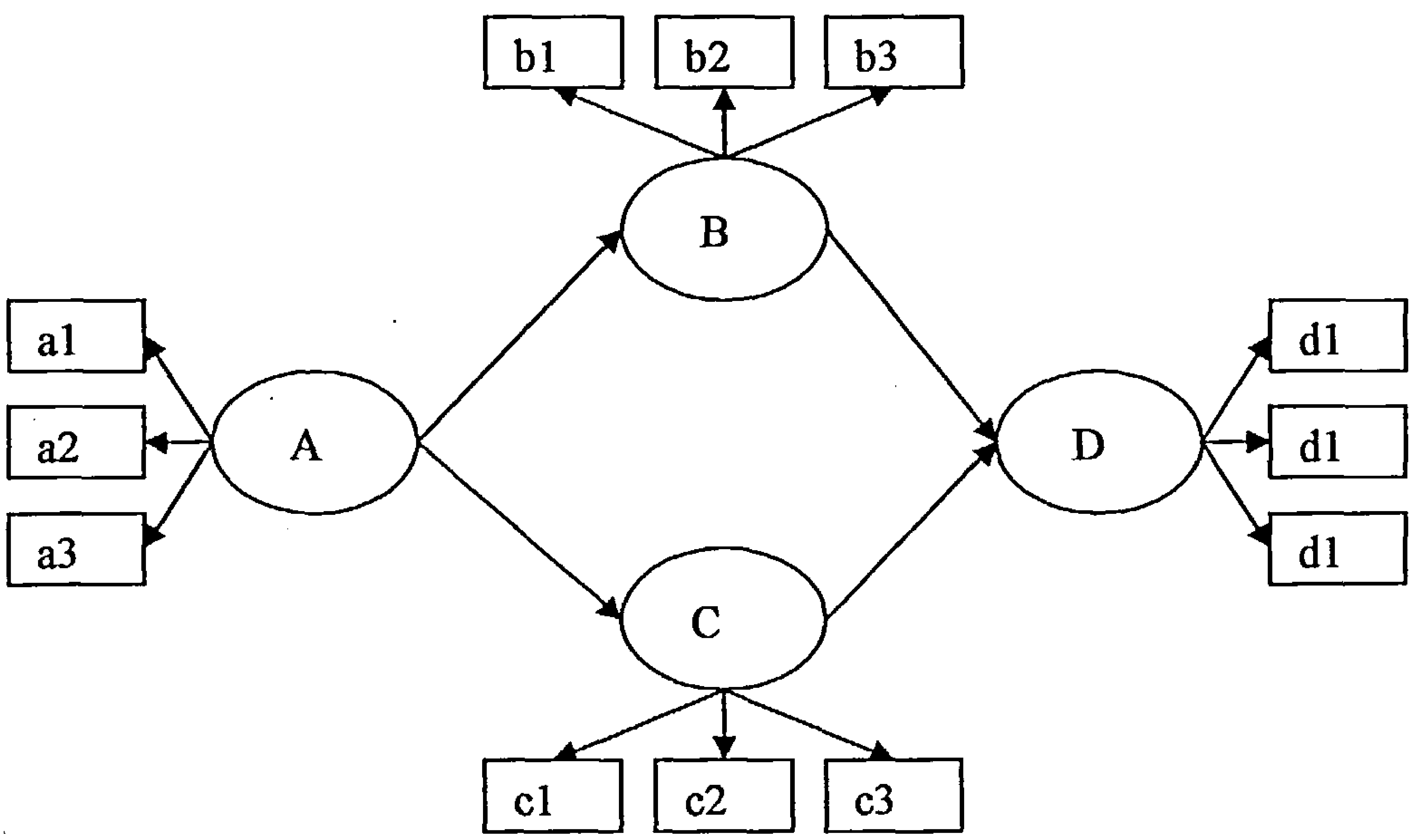

Figure 4. 4: Example path diagram

There are some governing conventions used when constructing of path diagrams (Byrne 2001). This concerns the use of lines to indicate direction of relationship and also the use of circles and boxes to differentiate between constructs and indicator variables. Straight arrows are used to show direct causal relationship from one variable to the other while a curved line between variables indicate a correlation between variables. Eclipse or circle shaped variables are constructs while rectangular shaped variables are observed or measured variables. Error terms have been omitted from figure 4.4. However as discussed in Section 4.2.2, the indicator variables and all endogenous constructs will have an error term.

4.2.5 Converting the Path Diagram into a Set of Structural Equations

The next step in SEM, after developing the theoretical model and depicting it in a path diagram, is the conversion of the specified structural model into a series of equations defining the two relationships between variables in the model. Hair *et al* (1998) suggested some rules in translating the path diagram into equations. Table 4.1 shows the translation of the path diagram in figure 4.4 above into structural equations. Each endogenous construct is the dependent variable in a separate equation. For each equation a structural coefficient (b_m) and an error term (e_i) are included. In the path diagram in figure 4.4 there are three endogenous variables, ***B***, ***C*** and ***D*** and one exogenous variable ***A***. These are translated into three equations as shown below. For example, it is postulated in the model that, endogenous variable ***B*** is a affected by exogenous variable ***A*** multiply by its structural coefficient b_1 plus error term e_1. Using this process, structural equations can be defined and used later simultaneously to evaluate the multiple interrelationships between variables.

	Endogenous Variable	Exogenous variable	Endogenous variable		Error
	B,C, D	A	B	C	e_i
1	B =	b_1A			$+ e_1$
2	C =	b_2A			$+ e_2$
3	D =		$b_3B + b_4C$		$+ e_3$

Table 4. 1: Translating path diagram into structural equations

4.2.6 Specifying the Measurement Model

Once the structural model has been defined the next step is to specify the measurement model. This defines the observed or manifest variables that are used to measure the latent constructs. Byrne (2001) notes that the measurement model is similar to confirmatory factor analysis as opposed to the commonly used exploratory factor analysis. This is because in exploratory principle component factor analysis the researcher does not have control over the loading. However in the measurement model, the researcher has complete control in deciding which variables load on to each constructs. The approach taken in defining a measurement model requires that the researcher indicates which variables load on to a particular construct, a similar approach as in confirmatory factor analysis. It is not very clear from literature what the recommended number of indicators per variable is. However it is generally recognised that three indicators per variable is the preferred minimum and that the maximum number should be determined by theoretical justification (Hair *et al* 1998; Bollen 1989; Baumgartner and Homburg 1996). However, it is also generally accepted that there should be as many indicators per variable as possible (Hair *et al* 1998; Baumgartner 1996). Hair *et al* (1998) recommends that five to seven indicators should be the optimum per construct as too many indicators can result in a non-parsimonious measurement model.

Once the measurement model is specified the researcher has to examine the reliability of the indicators. Hair *et al* (1998) noted two approaches in which reliabilities can be incorporated. The first method estimates reliabilities empirically. Thus one specifies the loading matrix, together with an error term for each indicator variable. When the structural and measurement models are estimated, the loading coefficients will provide estimates of the reliabilities of the indicators and the overall constructs. The second method involves fixing the reliabilities. However, Hair *et al* (198) note that this is only appropriate when using (1) single item measures (2) previously established scales with known reliabilities or (3) a two-stage analysis estimating first the measurement model and the structural model.

4.2.7 Choosing the Input Matrix Type and Estimating the Proposed Model

Type of Input Matrix

There are two matrices that can be used in SEM as the basis for its input data. These are the variance/covariance or correlations matrices (Byrne 2001; Hair *et al* 1998). A decision has to be made between the two types. Hair *et al* (1998) contended that covariances have the advantage of providing valid comparisons between different populations or samples. However, they point out that the interpretation of results can be difficult, as coefficients must be interpreted in terms of the units of measurement for the constructs. However they suggest that correlation has a common range that makes possible direct comparison of the coefficients within a model. Because of these factors, Hair *et al* (1998) instead recommend the use of correlation matrices. It should be observed however that most SEM analysis is performed using computer programmes. The advantage of using computer programmes is that although individual scores can be entered into the programmes, they are converted into one of the two types of matrices.

Estimating Technique

Once the structural and measurement models are specified and the input data matrix has been selected, the researcher must choose the estimating technique and computer program for estimation of the model. Estimating deals with methods for estimating the parameters in the model (Schumacker and Lomax 2004). Alternative estimating techniques include Weighted Least Squares (WLS), Generalised Least Squares (GLS), Asymptomatic Distribution Free (ADF) and Maximum Likelihood Estimating (MLE) (Hair *et al* (1998; Byrne 2001; and Bollen 1989). MLE is the most common technique and has been found to provide valid results with small samples. Levin et al (2005) support this argument and state that 'Maximum Likelihood (ML) is the most efficient and widely used' technique of all.

Selected Computer Program

Although there are many computer programs that can be used for SEM analysis, such as EQS, LISREL and AMOS (Kline 1998), the AMOS programme was used in this research. The reason for the use of this software was that it was the only one available to the researcher. AMOS was developed by A Dr James Arbuckle (Bryne 2001). AMOS has two alternative approaches to model specification. One is to use a graphics interface and the other is to use a text interface called AMOS basics. The difference between the two is that in AMOS graphics one works directly from the path diagram while in AMOS basics one works directly from equation statements. Owing to the wide range of drawing tools which have all been carefully designed with SEM conventions and the ease and speed with which publication quality path diagrams can be formulated, most researchers opt for AMOS graphics approach to analyse SEM (Bryne (2001). However, whichever method, there is no difference in terms of the results that are obtained.

4.2.8 Estimation Strategy

There is need also to decide the method of analysis. There are principally two methods of analysis. These include the single step analysis where both the measurement and structural models are estimated simultaneously and the two step analysis were the measurement model is estimated prior to the simultaneous estimation of both the structural and measurement models (Hair *et al* 1998). Hair *et al* (1998) recommended the single step method when the model contains strong theoretical basis and high reliability measures. As will become apparent in Chapter Five, the model developed has a strong theoretical basis and therefore the single step process was considered suitable for this research. However Scumacker and Lomax (2004) and Bryne (2001) recommended the two-step approach as it provides the opportunity to check the validity of the measurement model even though the model might be based on sound theory.

4.2.9 Assessing the Identification of the Structural Model

Model identification refers to the degree to which a unique set of parameters is consistent with the data obtained (Byrne 2002)). There are three solutions in SEM with respect to identification (Schumacker and Lomax 2004). Thus a model can either be (1) over-identified, (2) just-identified or (3) under-identified. In SEM the primary goal is to have a model that is over-identified (Hair *et al* 1998). The *order condition* and the *rank condition* are some of the necessary rules, which can be used to assess the identification of a model (Hair *et al* 1998 and Schumacker and Lomax 2004). Under the *order condition* the degrees of freedom must be greater than or equal to zero. The three solutions for identification would therefore be that; (1) where the degrees of freedom are equal to zero the model is just identified; (2) where the number of degrees of freedom is greater than zero, the model is over-identified and; (3) where the number of degrees of freedom is less than zero the model is under identified. The rank condition requires each parameter to be uniquely identified. However, this method can be complex. Therefore, it is recommended to use proxy measures, which can be determined using two 'rules' (Hair *et al* 1998). The first proxy is the three-measure rule, which asserts that any construct with three or more indicators will always be identified. The second rule is the recursive model rule, which asserts that recursive models, with identified constructs (using the three indicator rule) will always be identified. Using these two conditions the model identification can be assessed.

4.2.10 Evaluating Model Fit

Having completed the estimation process, the next step is to assess the fit of the model in comparison to the data obtained. Hair *et al* (1998) proposed a process of checking the fit of the model, which includes; first, the need to perform some initial checks against all SEM assumptions. These assumptions include; (1) independent observations (2) measurement model (3) linearity of all relationships. Second, having checked that these assumptions are met the researcher should then go on to check if there are any offending estimates. These would be estimated coefficients in the model that exceed acceptable limits. Examples of offending estimates would include, negative or non significant error variances for constructs, standardised coefficients exceeding or very close to 1.0 and very large standard errors associated with any estimated coefficient. And thirdly having ascertained that there are no offending estimates, the researcher can then go on to check the fit of the model. There are three levels of model fit that need to be checked. These include (1) overall model fit (2) measurement model and (3) structural model.

4.2.11 Overall Model Fit

The fit of the model to the data can be assessed using goodness of fit indices. These measure the correspondence of the actual input matrix with that predicted from the model. Hair *et al* (1998) categorises the goodness of fit measures into three groups. These include: -

(i) Absolute fit measures which can be used to assess the overall fit (both structural and measurement models) collectively with no adjustment for the degree of over fitting that may occur. These include measures such as the likelihood chi square statistic (x^2), goodness-of-fit index (GFI), root-mean-square residual index (RMR) and the root-mean-square error of approximation (RMSEA)

(ii) Incremental fit measures which compare the proposed model with the null model to determine degree of improvement over the null model. Measures under this category include; Tucker-Lewis Index (TLI) also known as the nonnormed fit index (NNFI), normed fit index (NFI), comparative fit index (CFI), and the adjusted goodness of fit index (AGFI).

(iii) Parsimonious fit measures which adjust the measures of fit to provide a comparison between models with different numbers of estimated coefficients with the aim of determining the amount of fit achieved by each estimated coefficient. The measures under this category include normed chi-square (NC), parsimonious goodness-of-fit index (PGFI), and parsimonious normed fit index PNFI).

There is, however, no agreed single measure, which can be used to judge the fit of a model. It is therefore recommended that one or more measures from each class be employed to judge the fit of the model (Hair *et al* 1998). It is recommended that one should apply multiple measures from each type of measures to gain a better consensus across types of measures as to the acceptability of the proposed model (Hoyle 1995; Schumacher and Lomax 2004; Hair *et al* 1998). Table 4.2 on, Page 87, summarises these indices including the acceptable fit level based on the work of Hair *et al* (1998) and others. It should be noted that only a selection of commonly used indices has been included here.

4.2.12 Measurement and Structural Models Assessment

The assessment of the fit of the measurement model focuses on three issues. These include the uni-dimensionality, validity and reliability of the measurement of model (Hair *et al* 1998). One of the common methods is to use reliability measures such as the Cronbach Alpha. However it should be recognised that this does not include a measurement of uni-dimensionality but only assumes that it exits (Hair *et al* (1998). The assessment of the structural model is ideally based on the examination of the statistical significance of estimated coefficients.

4.2.13 Interpreting and Modifying the Model

There are two possible outcomes based on the model fit data. It is either the model is confirmed or it is rejected. MaCallum and Austin (2000) stressed the point that confirmation of a model does not necessarily mean that the model is true but only that the model is not rejected as it is possible that there are other possible models which can fit as well. They further argue that 'there is no true model', and that, finding a good fitting model does not mean that a model is correct or true, but that the model is only plausible. On the other hand if a model is deemed unacceptable based on the fit statistics one then has the option of either completely discarding the model or making possible modifications to the model so as to improve model fit. Such modifications should ideally be based on sound theoretical justification (Hair *et al* 1998). An appropriate specification search method should be utilised (Shumacker and Lomax 2004). The AMOS software has advantages in that it provides modification indices, which suggest ways for improving results.

Fit Index	Description	Acceptable fit
Absolute Fit		
Chi-Square Statistic (χ^2)	Tests the statistically significant differences between the observed and estimated matrices. Non significant χ^2 is desired as a significant χ^2 indicate probability that differences are due to sampling variations.	$p > 0.05$
Goodness of fit index (GFI)	GFI represents an overall degree of model fit. However it does not account for degrees of freedom	≥ 0.90
Root mean square residue (RMR)	This is the square root of the mean of the squared residuals. No absolute threshold has been established.	Close to 0
Root mean square error of approximation (RMSEA)	Similar to the RMR above but measures discrepancy in terms of the population and not just the sample	≤ 0.05 to 0.08
Incremental Fit		
Comparative Fit index (CFI)	Compares the estimated model against the null or independence model. It is more appropriate for a model development strategy or when smaller sample is used (Hair et al 1998). Values range from 0-1	≥ 0.90
Incremental Fit Index (IFI)	Incremental Fit Index compares estimated model with null or independence model	≥ 0.90
Normed fit index (NFI)	Provides a relative comparison of the proposed model to the null model. Values range from 0 to 1	≥ 0.90
Non-normed Fit index or the Tucker Lewis index (NNFI/TLI)	This combines a measure of parsimony into a comparative index between the proposed model and the null model. Values range from 0-1	≥ 0.90
Adjusted Goodness-of-fit index (AGFI)	AGFI adjusts the GFI by the ratio of the degree of freedom for the proposed model to the degrees of freedom fro the null model. Values range from 0-1	≥ 0.90
Parsimonious Fit		
Normed Chi-square (CP=χ^2/df)	Calculated by dividing the Chi-Square Statistic by degrees of freedom *(df)*	≤ 2 to 5
Parsimonious normed fit index (PNFI)	It is a modification of the NFI, and takes into account the number of degrees of freedom which is used to achieve a level of fit. It is useful in comparing competing models.	No recommendation however, differences of 0.06-0.09 proposed as substantive difference
Parsimonious Goodness-of-fit index (PGFI)	This modifies the GFI and adjusts for the number of estimated parameters. Values between 0 and 1.0 with higher values indicating greater parsimony	≥ 0.90

Table 4. 2: Fit Indices

4.2.14 Modelling Strategy

Hair *et al* (1998), acknowledges three modelling strategies. These include the 'strict confirmatory approach', the 'model development approach' and the 'competing models approach'. The confirmatory approach refers to a situation were a researcher specifies a single model and SEM is used to assess its statistical significance. In this case one either rejects or fails to reject the model and does not perform any further modifications to the model to improve its fit (Byrne 2001). This, MaCallum and Austin (2000) suggest, is 'highly restrictive' as only one model is investigated which if rejected leaves no option for improvement. Indeed Byrne (2001) argues that 'it would be a rare researcher who would terminate his/her research on the basis of a rejected hypothesised model'.

In the 'model development approach', a model is proposed with the purpose of improving the model through modifications of the structural and or measurement model (Hair *et al* 1998). This is an appropriate method where, having proposed a model, if it is rejected on the basis of poor fit to the data, one proceeds to modify the model. The purpose of such modifications becomes the determination of a model that better fits the data (Byrne 2001). Macallum and Austin (2001) argue that the model development method is potentially misleading and easily abused as modifications sometimes lack validity. They suggested three conditions for use of this method which include that; it should be acknowledged that results are in part data driven; modifications must be substantively meaningful and; the modified model must be evaluated by fitting it to an independent sample. This method is however the most common method used in research (Byrne 2001 and Hair *et al* 1998).

The 'competing models approach' involves the specification of alternative models based on the understanding that there are numerous models that may provide equal or better fit to the sample data. These models may be developed from alternative theoretical frameworks (Hair *et al* 1998). It is the purpose of this method that a representative model will be selected based on the results of the analysis (Byrne 2001). MaCallum and Austin (2000) are supportive of using this modelling approach as an alternative to the other two as it provides alternative information about the data thereby providing an alternative to the confirmation biased method of the strictly confirmatory approach and also providing alternative models instead of the likely subjective modification of models once rejected as provided for in the model development approach.

This research, while recognising the strengths and weaknesses of all the modelling methods, adopted the 'model development approach'. Although the 'strict confirmatory approach' would be ideal based on the understanding that there is a strong theoretical basis for the model developed in chapter five, there is still chance that the model would not perfectly fit the data. Therefore, other than completely rejecting the model and discarding the research, once the model is rejected possible modifications are made to find a model that would suit the data. Appropriate care will be used for all possible modifications.

4.2.15 Reporting Results

The presentation of results in SEM is an important issue. McCollum and Austin (2000) recommended the following guidelines in reporting findings in SEM. These include; a clear and complete specification of models and variables; clear listing of the indicators of each latent variable; clear statement of type of data analysed with presentation of the sample correlation or covariance matrix (or making such data available upon request); specification of the software and method of estimation; and presentation of complete results (multiple measures of fit). Levin *et al* (2005) recommend the inclusion of the path diagram but that such should only include the latent factors. They also recommended the inclusion of statements on the modelling strategy used in addition to the discussion on the matrix and the algorithm used. This reporting framework is used in Chapter Six of this report.

4.3 Section Three: Research Strategy Considerations

Literature reveals that there are different strategies that can be used in research. Blaxter *et al* (2001), lists four types namely; case study, experiments, surveys and action research, while Denscombe (2003) adds ethnographic research to this list. On the other hand Dane (1990) and Gil and Johnson (1991) list five categories including, experiments, quasi-experiments, surveys, field research and archival research. It is clear however that although researchers have used different names to describe the types of research, there are vast similarities and overlaps between these categories. The categories found in Fellows and Liu (2003) will be considered here. They considered five categories of research specified as action research, ethnographic research, surveys, case studies and experiments.

Considering that there is no 'one right' method but that a method should be selected to suit the specific investigation (Denscombe 2003), consideration was given to issues important for this present research to make the method 'fit for purpose'. These key characteristics include; the need for empirical results; the size of the sample or cases as dictated by the SEM approach adopted; and practicality of the approach including nature of the investigation, time and cost considerations and expected obstacles. The possible research strategies are discussed below and their suitability for this present research are evaluated.

4.3.1 Research Strategies

Action Research

This is a process were the researcher is actively involved in the process under study. Elliot (1991) considered action research as the study of a social situation with a view to improving the quality of the process. Fellows and Liu (2003) argue that this is most appropriate were there is need for change in a process but the solution and the problem has not been identified. Blaxter *et al* (2001: 67) suggests that the strategy is *'well suited to the needs of people conducting research in their work places, and who have a focus on improving aspects of their own and their colleagues practices'* Some of the distinguishing features of this approach are that; the researcher is practically involved in the identification of the problem and solutions to the problem; and that it is a cyclic process in which research, action and evaluation are interlinked (Blaxter *et al* 2001). The involvement of the investigator in the research process as a participant in the change process provides a practical perspective to the solutions generated. However, the nature of this strategy precluded it from its use in the present study as no active participation of the researcher was possible or desirable. Moreover the research was intended to investigate projects that have already been completed, therefore in principle there is no practical opportunity for the researcher to be involved. As noted in Section 4.3 above, one of the key considerations in this research is the need for a large sample size as required by the SEM approach. Action research strategy would not be amenable to the collection of data from a large sample size. It was therefore concluded that this method would not be appropriate for this research.

Ethnographic Research

Ethnographic research has its origins in early anthropology research concerned with providing detailed and permanent characteristics of peoples and cultures of small tribes

(Denscombe 2003). This is similar to action research but has a less degree of interference in the processes under study by the researcher. Although the researcher becomes part of the group under study, he is merely there to gain insights in to what, how and why the pattern of behaviour (Fellows and Liu 2003). As the principle focus of the strategy is on 'peoples and cultures' (Denscombe 2003) it was not considered appropriate in this present research as the focus was not on the behaviour of those involved in project management but on the project management processes. Moreover the need for the researcher to spend considerable time in the field precluded it from being used in this research. The strategy was also disqualified from being used as large sample size was required. This method, like action research, would not be amenable to the collection of data fro a large sample size with limited resources and time.

Case studies

The use of case studies provides the researcher with an opportunity to investigate an issue at greater depth than most research strategies. Usually a single case or a small numbers of cases are used with the aim of providing an in-depth understanding of the events, relationships, experiences or processes in the particular case. Case studies, however, although they provide an in-depth outlook of a case have the disadvantage that its results lack empirical or statistical generalisation (Fellows and Liu 2003). Descombe (2003) however argued that careful considerations can be made to make it possible to make justification for generalisation of the case study results. It is clear however from Descombe's (2003) argument that the degree to which the results will be generalised would still be limited when compared to research based on surveys. Further the nature of case studies mean that only a few cases can be studied in detail. However the requirements of the SEM method as adopted in this research requires a large sample size. (See discussion in Section 4.3.3). It was also recognised that negotiating permission to study particular cases in detail would be involving and if such permission were declined the research would be derailed. Considering the number of cases, of at least 100, that were required for this present study, it was concluded that this approach would not be practical given the time and resource constraints. These issues therefore precluded the use of case studies in this present.

Surveys

Survey techniques usually involve methods in which participants are asked questions directly. This is a method of collecting information based usually using pre-formulated set of questions to a sample representative of the population (Hutton 1990). The major advantage of this method is that, since the strategy is based on responses from a representative sample of respondents, its findings can be generalised to be representative of the whole population under consideration (Blaxter *et al* 2001). This therefore provides the needed requirement for empirical or statistical generalisation of the results. One of the disadvantages of surveys is that it relies on breadth of study and not on the depth for its validity. However, it was considered that the method would be advantageous to this study, as it would provide a platform for collection of data from a large sample as required in the research (See Section 4.3.3). This method was considered appropriate for this research, as surveys can be used to collect quantitative data, required for this research, within a short time than most other methods.

Experiments

This approach includes methods designed to test or understand causal relationships. Blaxter *et al* (2001) described this method as one involving manipulation of an independent variable by the investigator in tightly defined and controlled conditions or by natural occurrence. This ability to manipulate variables suspected of producing change is a key distinguishing feature of this strategy. This method was considered not practical for this research and was not considered appropriate, as no experiments were required. The research data also required information about projects that had already been completed, therefore no manipulation of processes was required.

Summary and Choice of Strategy

Considering the key characteristics of the research a survey research method was considered most appropriate. First, because of its wide and inclusive coverage, it is possible to generalise the findings as those representative of the whole population. Second, survey studies, when based on appropriate data collection methods provide a platform for empirical research by measuring and recording responses. This would be amiable to SEM statistical analysis and future replication. Third, survey research will provide a platform for the collection of data for the needed large sample size dictated by the SEM approach adopted. Although case study research could provide the required data, it was considered inadequate to provide the necessary number of cases for the study. Last, for practical reasons, by their very nature methods such as action research, ethnographic research and experiments are simply not practical for this present research, as the researcher in this particular study would not be required to be on site as in action research, nor will there be need for manipulation of processes as in experiments.

4.3.2 Method of Data Collection

A number of data collection methods were identified in literature. However in deciding the method to be used in this present research a key consideration was given to a method that would maximise the sample size. This is dictated by the large sample size requirement of the SEM evaluation method as detailed in Section 4.3.3. Therefore each data collection method was scrutinised for its robustness in providing the needed sample size. Also considered was the practicality of the method with regard to avoidance of obstacles that would jeopardise the progress of the research. The following methods, as considered by Denscombe (2003), applicable to survey research, were considered.

Interviews

Gray (2004) described an interview as a conversation between people were one of them assumes the role of a researcher. There are a number of situations in which the use of interviews to collect data is most appropriate. These include among others; the need to attain highly personalised data; the existence of opportunities to probe further; a requirement for a good response rate; and were respondents are not fluent in native language or were respondents are not good with written language (Gray 2004). There are different formats of interviews. This may include face-to-face interviews which involving direct contact between researcher and the respondent or telephone interviews were the discussion is done over the telephone. Denscombe (2003) notes some of the disadvantages of interviews as a data collection method including; that it is time consuming in terms of analysis of data-need for transcription; that it tends to produce non structured answers; that there is likely to be an impact of interpersonal effect; and that the cost of interviewers time, travel and of transcription can be considerable if respondents are geographically widespread. Based on the need to maximise number of responses this method would not be the most beneficial to this research as the geographic setting of potential respondents the case of the present research is the whole of the United Kingdom. The data required for the research was quantitative, therefore structured interviews would have to have been used. However the questionnaire survey approach as below was considered better suited to collect such data within the given time and resource constraints.

Questionnaire Survey

This is a method of collecting information based on asking respondents to complete a questionnaire containing pre-formulated set of questions in a pre-determined sequence. The use of questionnaire is one of the most common methods especially justified were despite a low response rate, a sufficient number of responses will be achieved to provide sufficient data for analysis. This method can be grouped into two categories. These include; postal questionnaire where questionnaires are sent by the post to selected respondents; and self administered questionnaires where, similar to face to face interview, the researcher is in direct contact with the respondents and reads through the questions to the respondents. There are other types of surveys, which can be considered including internet surveys, and email based surveys.

Gray (2004) notes that standardised questionnaire are more powerful than interviews, where large numbers of respondents must be reached and where more reliable data is desired. Denscombe (2003) noted some of the advantages of questionnaires including; that it provides a wide coverage; that it is low cost in terms of time and money; that it provides an opportunity for pre-coding data and supplying standardised answers which can simplify the analysis of data; and, unlike the interview method, eliminates the effect of interpersonal interaction with researcher. However he also noted the disadvantages of the method, which include; poor response rate; incomplete or poorly completed answers; biased findings towards researchers view rather than respondents by limiting and shaping the nature of answers; and that it provides little opportunity to check truthfulness of answers. Despite these known and recognised disadvantages, based on the need to acquire a large number of responses in a relatively short time, this method was deemed most suitable for this research. As noted above, while interviews can be used to collect data, it was considered that questionnaires would be better placed to acquire the required data within the given time and resource constraints.

Documentary Research

This research method involves the use of documentary sources to capture required data. Although it is inevitable that all research will to some extent use documents in the research, for example in literature review, the focus here is on research that bases its data entirely on documentary sources such as company reports, financial reports, employment statistics, websites, letters and memos and government publications and official statistics. This method is not suited for this present research as it is the intention in this research to collect primary data. Although it is possible to collect data from project records, the shear number of projects that would have to be evaluated makes the approach not practical. The process for collection of data through documentary research would have required, firstly, gaining permission to check through documents. However most project information is sensitive information and therefore it was considered that to get permission from at least 100 firms (as required by the SEM approach adopted in this research) would be difficult to achieve. Therefore the method was considered inappropriate for the study.

Observation

Observation, as a data collection research method, involves the researcher watching, recording and analysing events of interest. It draws on direct evidence of the eye to witness events first hand and can either be; systematic observations, where all observations are based on an observation schedule which acts as a check-list for items to be observed; or participant observation where the observer participates in the process or activity under study, whether openly or in disguised role. The nature of the present study precludes this method from use, as it is not practical to observe multiple projects throughout their project cycle. As discussed in Section 4.3.3 the required sample size was considered to be at least 100 cases. Observations of all these cases given the time and resource constraints would not have been practical and therefore the method was precluded from being used. It was the intent of this research to gather data about projects over their whole project life cycle from inception of the project to completion.

Summary and Choice of Data Collection Method

The use of questionnaires as a method to collect data was considered most appropriate for this study. Although other methods exist for collection of data, such as interviews, and documentary research, the use of postal questionnaire was concluded to be most appropriate for this research, principally based on two strength points for questionnaires. First, the nature of this investigation suits questionnaire survey as it is able to collect large amount of data in a shorter time than interviews (Kumar 1996 and Burns 2000). Second, the geographical setting of the respondents throughout the United Kingdom implies that the use of questionnaires would be most appropriate method for the present investigation. Documentary research and observations were also considered. However by their very nature, they would not be appropriate for use with the present research. Collection of data from at least 100 project documents (as required by the SEM approach) was considered a potential limitation to the present study. Similarly the use of observations was considered inappropriate, as the nature of the data required would not be possible to be observed.

4.3.3 Sample Size Consideration

The question of an adequate sample size in structural equation modelling has been an issue of debate. However, although there are no specific guidelines on the number of cases to be investigated when using structural equation models (Bollen 1989 and Byrne 2001), it is important to have as many cases per variable. Bentler and Chou (1985) suggested having five (5) cases per parameter estimate or fifteen (15) cases per measurable variable, while Collier (1996) suggested 3-6 cases per variable. Hair et al (1998) while acknowledging that there is no correct sample size, noted issues to be considered when deciding the sample size, as these issues will have an impact on the required sample size. These include, model misspecification; model size, departures from normality and estimation procedures. They recommend that where there is concern for specification error, the sample size should be increased. The absolute minimum sample size is impacted by the size and complexity of the model and therefore the sample size should be at least greater than the number of covariances or correlations in the input data matrix with, a ratio of between 5 to 10 respondents per each estimated parameter. They further recommend that as the data departs from normality there is need to increase the number of respondents per parameter estimate to generally 15 respondents per parameter; and that although 50 responses has been used to provide valid results using maximum likelihood estimating method, they recommend that the sample size should be between 100 and 200 with 200 as the critical sample size.

Despite these 'rules of thumb' MaCullum and Austin (2000) found that small samples of fewer than 100 individuals are not uncommon. While reluctant to suggest a rule of thumb, they suggest that small samples may not be large enough for complex models and suggested that small samples should be used only with simpler models. Thus the more complex the model the larger the sample required. Baugartner and Homburgh (1996) in their study of the application of SEM in marketing and consumer research found out that sample sizes were often lower than the recommended 'rules of thumb' with, 30% to 41%, of models investigated, with a ratio for number of cases to number of parameters of 5:1. They also found out that the median number of parameters to be estimated was 29 and the median sample size was 178. This is less than the recommended critical sample size of 200 as defined by Hair *et al* (1998).

The above shows that while there are rules of thumb available in literature, there seems to be no clear-cut rule as to the exact adequate sample size. However, the somewhat vague guidance is that sample size should be 'large enough'. It was anticipated that by careful design sample requirements will be met. Generally questionnaires have low response rates. Denscomb (2003), for example, suggest that any researcher will be lucky to get as many as 20% of the questionnaires returned and further recommended that for any meaningful statistical analysis there should be at least thirty people or events. Burnes (2000) also notes the relative low response rates in questionnaires and suggests that the use of questionnaire surveys has a low response rate, which may be between 15-50 percent.

In the case of this research, it was anticipated that the targeted minimum of at least 100 cases would be achieved. With an anticipated response rate of between 15% and 50% the number of questionnaires required to achieve the required number of cases of at least 100 cases, would be between 200 and 667 with 484 as the median. It is expected therefore that if 200-667 questionnaires were sent to potential respondents the required minimum of 100 responses (15-50%) would be achieved.

4.4 Chapter Summary

This chapter has defined the methodology used in the research including details for research strategy, method of evaluation, and data collection considerations. Section one provided the general research approach, which showed the suitability of the SEM evaluation approach for the research. SEM principles were further discussed in section two. The discussion on the SEM showed that the modelling approach provides an opportunity to explore the relationship between project management process quality factors and construction project performance measures. A theoretical model of the relationship between project management process quality and construction project performance would provide useful insights into the understanding of the relationship. Section Three dealt with the research strategy. Owing to the nature of SEM requiring large sample size, it was deemed fit to use survey research as this would enable collection of data from a large sample size than most other methods. Section four considered data collection issues and sample size considerations. A questionnaire survey was considered as the most appropriate technique to collect data, as it would enable collection of data from a large sample size economically. However the weaknesses of questionnaire surveys were noted. It was also noted that there is no agreed set standard for the correct sample size in SEM. However there is a general consensus that large data set is considered suitable for the validity of the research.

Having examined all of these issues here, the next step was to develop a theoretical model that was used to examine the relationship between project management process quality and construction project performance. The recommendations in SEM are that such a model should ideally be based on theory or evidence from empirical research. With a strong theoretical base from project management literature linking project management and project performance together with literature from a quality management framework a project management process quality performance model was developed. This is further discussed in detail in the next chapter.

CHAPTER FIVE

The Conceptual Model

5.0 Introduction

Chapter Four discussed structural equation modelling as the evaluation method to be used in this research. The seven steps involved in the method were discussed which included:-

(i) Development of a theoretically based model;

(ii) Construction of a path diagram;

(iii) Converting the path diagram into a set of structural equations;

(iv) Choosing the input matrix type;

(v) Assessment of the identification of the model;

(vi) Evaluation of goodness-of-fit and;

(vii) Interpretation of the model (Hair *et al* 1998).

This chapter is concerned with the first three steps. It includes the development of a Project Management Process Quality (PMPQ) model that will be used to evaluate the causal relationship between project management process quality and construction project performance. Central to this is the theoretical justification of both the structural model, which defines the relationships between the PMPQ constructs and the measurement model, which identifies the items used to measure the constructs. In order to justify the model used, alternative models that were eligible to be used are discussed together with the chosen theoretical framework. Afterwards the structural model and the measurement models are themselves discussed. Lastly, the causal hypotheses developed from the model are stated. These are used in Chapter Six to evaluate the relationship between PMPQ and project performance.

5.1 Section One: The theoretical framework

5.1.1 Review of Quality Measurement Theoretical Models

Early writings on quality management identified factors that are critical to quality management. W. Edward Deming, Joseph Juran and Philip Crosby are some of the major contributors to the identification quality management factors (Kerzner 1998). Many other studies (Saraph *et al* 1989; Back and Porter 1995; Ahire *et al* 1996; Anderson *et al* 1998; Baldri and Davis 1995; and Samson and Terzioski 1999) have also attempted to further understand or conceptualise quality management by proposing factors that contribute to effective quality management. The general consensus is that critical elements of quality management include top management leadership, employee involvement, and employee training and supply chain management. There has been, in literature, a search for a framework to define these critical elements of quality management. Saraph *et al* (1989) and Baldri and Davis (1995) argued that there is need to provide a systematic method of organising and synthesising the various factors of quality management. One of the common frameworks used in many studies is the Total Quality Management (TQM) framework. The British Standards Institute, (1997:1) define TQM as

> *'an innovative approach to business management, embracing advanced concepts and working methods to ensure an effective, efficient way of running an organisation. It is a practical application of the philosophy that the most efficient methods of working are those which produce and deliver the intended product and/or service, at the quality required by the customer, without waste of materials, time or energy.'*

Dale (2003) identified the important aspects of TQM as including Customer focus, top management leadership and commitment, continuous improvement, fast response, actions based on facts, employee participation, and a TQM culture.

The work of Saraph *et al* (1989) is one of the early attempts to organise and synthesise the critical factors of quality management. Saraph *et al* (1989) developed a set of critical elements of quality based on literature review. In particular they used the work of Deming, Juran, Crosby and Ishikawa among others to define elements critical to quality management in organisations. They gathered one hundred and twenty items, which they grouped, into eight factors based on the judgement of the researchers and a group of quality professionals. The set of factors was further subjected to statistical validation. The result of this research was a development of a set of critical factors for quality management. Such factors could then be used to judge the degree of implementation of quality management programs.

Badri *et al* (1995) used an instrument developed by Saraph *et al* (1989) to gain a better understanding of quality management and also to assess the instrument developed in

Saraph et al (1989). Badri and Davis (1995) argued about the relevance of their study as stemming from the need to provide a rationale for the selection of the critical factors and the need to provide reliability and validity tests on the variables. Ahire *et al* (1996) also were concerned with the lack of justification in literature between the various TQM constructs and the inability of prior studies to systematically develop scales used in the studies, and their subsequent validation. They aimed, in their study, to identify quality management strategies and develop scales for measuring the constructs, validate the scales and conduct investigation among the quality management constructs. While the critical quality factors are generally similar to other studies, they attempted to show the linkages between these constructs.

The argument in the above studies is the need to be systematic in the identification of factors that would represent quality. The current research attempts to define quality in the project management process and also to evaluate the causal relationships between the quality factors and between the quality factors and construction project performance. The work of Ahire *et al* (1996) would provide a similar mechanism that would be of use to the current research in that it provided a causal model.

Many other studies have used standard quality management models to examine critical factors of quality management. Among such quality models include the Malcolm Baldrige National Quality Award in the USA, The European Foundation for Quality Management (EFQM) business excellence model in Europe and the Deming prize in Japan as the three major frameworks (Tan 2000). These models are designed to award companies that represent best practice in quality management. Claver *et al* (2003) noted that these standard models provide a guide for implementation of quality management systems or are used to provide a self-assessment model for companies to assess their quality management practices. Further, these models are generally accepted TQM models (Black and Porter 1995; and Claver *et al* 2003). The models address TQM principles, and reflect a certain bias in the focus of TQM in different regions. For example the EFQM model is geared for quality management in Europe, while the MBNQA and the Deming Prize are geared for the United States of America and Japan respectively (British Standards Institute 1997).

There are several other TQM based national quality award models. However these seem to be a variant of the major models as listed above. Tan (2000) notes that many other national quality award models are modelled based on the three main award models.

Further, Tan (2000), in a comparative analysis of the award models, found that there are great similarities in the composition of these quality models.

As discussed in Chapter Three, there have been several attempts in project management literature that have applied quality management principles to the project management area. Some of these studies have based their approach on the TQM principles (see for example Barad and Raz 2000; Pszenica 2001; Feassy 2001; Jung and Wand 2004; Cicmil 2000; Mcmichael 1999; Rmstrong 1999; Orwig and Brennan 2000; Connelly 1993; Shieh and Wu 2002; Hides and Irani 2000; Henderson and McAdam 2000; Lo and Humphreys 2000; Westerveld 2003; and and Bryde 2002).

Table 5.1 list the models in both general quality management literature and project management specific literature together with some of the associated authors. Although, there are various models that are discussed in literature, not all models are presented here. The grouping is non-standard but is made here to simplify the discussion. The models are spilt into three groups. These include the MBNQA, the EFQM business excellence model, and TQM and other models.

Model	Authors
Malcolm Baldrige National Quality Award (MBNQA)	Black and Porter (1995; 1996); Anderson and Jerman (1998); Michael 1999; Barad and Raz (2000); Kujala and Artto (2000); Curkovic *et al* (2000); and Pannirselvam (2001).
European Foundation for Quality Management (EFQM)	Dijkstra 1997; Europa (1999); Behara and Gundersen (2001); Westerveld (2003); Bryde (2003); and Claver et al (2003)
TQM and Other Quality Models	Stevens (1996); Bryde (1997); Ahire *et al* (1996); Forza and Fillippini 1998; Samson and Terziovski (1999); Hendricks and Singhal (2000); Motwani (2001); Sheih and Wu (2002); Kaynak (2003); Prajogo and Brown (2004); Singh and Smith (2004); and Jung and Wang (2004)

Table 5. 1: Summary of literature-Quality Measurement Models

5.1.2 Studies Based on the MBNQA Model

The Malcolm Baldrige National Quality Award (MBQA) was introduced in the USA in 1987, to provide a framework for total quality auditing (Oakland 2001). The award is presented to the best-in-class companies annually. The award criteria are used in three main ways including, for making awards, organisational self-assessment, and for giving feedback to applicants (National Institute for Science and Technology (NIST) 2005). The criteria is based on the following concepts including; visionary leadership, customer driven excellence, organisational and personal learning, valuing employees and partners, agility, focus on the future, managing for innovation, management by fact, social responsibility, focus on results and creating value and systems perspective (NIST 2005). These concepts are embodied into the seven categories including leadership, strategic planning, customer and market focus, measurement, analysis and knowledge management, human resource focus, process management and business results. The inter-linkages between these categories are depicted in Figure 5.1. Table 5.2 summarises the criteria with associated sub criteria. These are further broken down into specific items needing consideration.

Although the work of Anderson and Jerman (1998), Barad and Raz (2000) and Kujala and Artto (2000) was discussed in Chapter Three, they will be discussed again here with respect to the measurement of quality. Anderson and Jerman (1998) analysed the influence of quality management on logistics performance and used quality management factors as measure of quality. They used the MBQA quality criteria and developed nine constructs to analyse their proposed causal networks. The MBNQA provided a basis for construction of a causal model for analysing the influence of quality management practices in logistics industry, on performance.

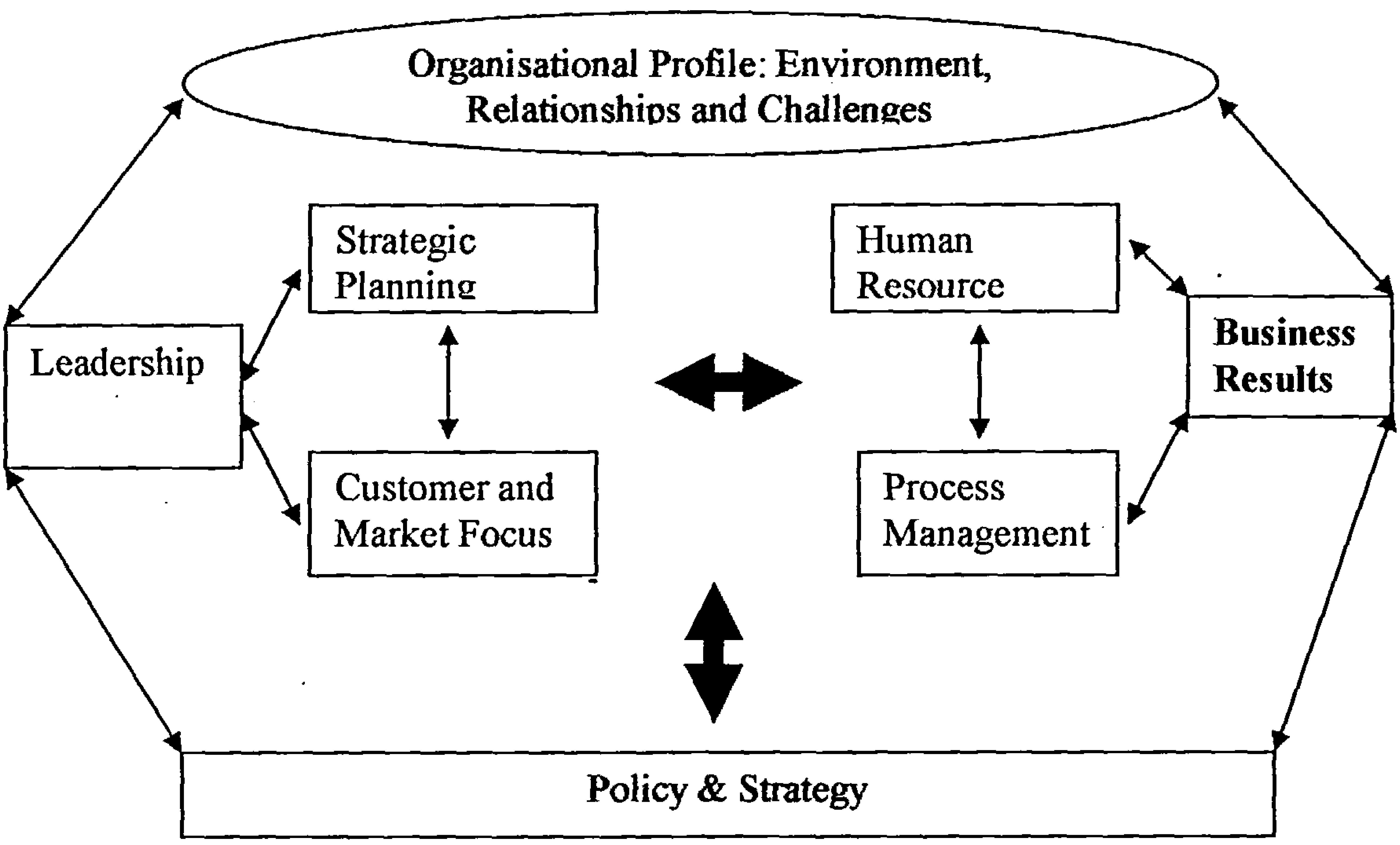

Figure 5. 1: The MBNQA Criteria (Source: NIST 2005).

Barad and Raz (2000) studied quality management in project management in the Hi-Tech and software industries in Israel. Their work was specifically looking at the contribution of quality management tools and practices to project management performance. They compiled thirteen quality management practices, which they used to assess the contribution to the project management process. Their work developed constructs using quality constructs from Ahire *et al* (1996) and Andersen *et al* (1998) and applied these concepts to the project management industry.

Other studies include Kujala and Artto (2000) who argued for the integration of quality management principles (based on the MBQA model) into the management of individual projects. Black and Porter (1995, 1996) also used the MBNQA model to analyse the relationship between quality and performance.

Criterion	Sub Criteria
1. **Leadership**-*Examines how organisation's senior leaders address values, directions and performance expectations as well as a focus on customer and other stakeholders, empowerment, innovation and learning. Also includes how organisations address public and community responsibility*	• Organisational Leadership • Organisational Challenges
2. **Strategic Planning**-*Examines how organisations develop strategic objectives and action plans. Also include how organisations' chosen objectives and action plans are deployed and progress measured*	• Strategic Development • Strategic Deployment
3. **Customer And Market Focus**-*Examines how organisations determine requirements, expectations and preferences for customers and markets; examines how organisations build relationships with customers and determines the key factors leading to customer acquisitions, satisfaction, loyalty etc*	• Customer And Market Knowledge • Customer Relationships and Satisfaction
4. **Measurement, Analysis And Knowledge Management**-*Examines how organisations selects, gathers, analyses and improves its data, information and knowledge assets*	• Measurement and Analysis of Organisational Performance • Information and Knowledge Management
5. **Human Resource Focus**-*Examines; employee work systems, employee learning, motivation, efforts to build and maintain a work environment, employee support network etc*	• Work Systems • Employee Learning and Motivation • Employee Well Being and Satisfaction
6. **Process Management**-*Examines the key aspects of organisation's process management including key product, services and business processes for creating customer and organisational value and key support process.*	• Value Creation Processes • Support Processes
7. **Business Results**-*Examines Organisations performance and improvement in key areas including; customer satisfaction, product and service performance, financial and market performance, human resources results, operational performance and governance and social responsibility*	• Customer Focused Results • Product and Service Results • Financial and Market Results • Human Resource Results • Organisational Effectiveness Results • Government and Social Responsibility Results

Table 5. 2: The MBNQA Criteria (Source: NIST 2005)

5.1.3 Studies Based on the EFQM Business Excellence Model

The EFQM excellence model is based on TQM principles. These include results oriented, customer focus, leadership and consistency of purpose, management by processes and facts, people development and involvement, continuous learning, innovation and improvement, partnerships and corporate social responsibility (EFQM, 2003).

The model has two components the enablers and the results. Enablers represent the organisations activities and the results represent what results, are achieved. The model is based on the premise that excellent results with respect to performance, customer, people and society, are achieved through leadership driving policy and strategy that is delivered through people, partnerships and resources and processes (Dijkstra (1997).

Figure 5.2 is a graphical representation of the model. The structure shows that leadership drive policy and strategy, people management and resources, which in turn drive processes. The enablers in turn determine people satisfaction, customer satisfaction and impact on society, which delivers business results. Dijkstra (1997) although arguing that the model cannot be conceived as a detailed specific empirical model, asserts that the framework can be interpreted as at least partly a causal model.

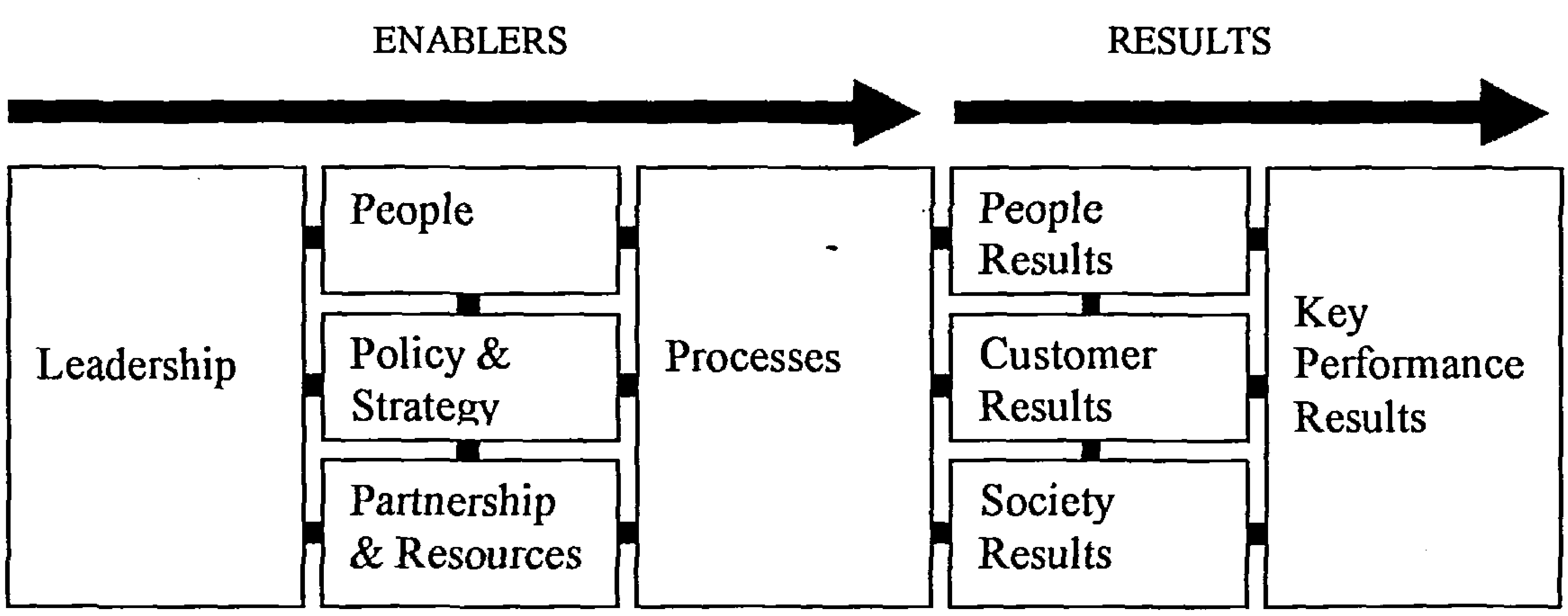

Figure 5. 2: The EFQM Model (Source: EFQM)

Table 5.3 summarises the explanation of variables in the EFQM excellence model as cited in the EFQM's 'Introducing Excellence' brochure.

Criterion	Sub Criteria
Leadership	• Leaders develop the mission, vision and vales and are role models of a culture of excellence • Leaders are personally involved in ensuring the organisation's management system is developed implemented and continuously improved • Leaders are involved with customers partners and representatives of society • Leaders motivate, support and recognise the organisations people
Policy And Strategy	• Policy and strategy are based on the present and future needs and expectations of stakeholders • PS are base on information from performance measures, research, learning and creativity related activities • PS are developed reviewed and updated • Policy ad strategy are deployed through a framework of key processes • PS are communicated and implemented
People Management	• People resources are planned, managed and improved • Peoples knowledge and competencies are identified, developed and sustained • People are involved and empowered • People and the organisation have a dialogue • People are rewarded, recognised and cared for
Partnerships And Resources	• External partnerships are measured • Finances are managed • Building, equipment and materials are managed • Technology is managed • Information and knowledge are managed
Process Management	• Processes are systematically designed and managed • Processes are improved, as needed, using innovation in order to fully satisfy and generate increasing value for customers and other stakeholders • Products and services are designed and developed based on customer needs and expectations • Products and services are produced delivered and serviced • Customer relationships area managed and enhanced
Customer Result	• Perception measures • Performance indicators
People Results	• Perception measures • Performance indicators
Society results	• Perception measures • Performance indicators
Key performance results	• Key performance outcomes • Key performance indicators

Table 5. 3: The EFQM Model (Source: EFQM)

The EFQM model has been used in several studies including Europa (1999), Behara and Gundersen (2001), Westerveld (2003) and Bryde (2003). The Europa (1999) study in the construction industry as cited in Chapter One, was based on the EFQM model. The research assessed the impact on company performance and implication of adopting quality schemes through the development of nine case studies. The analysis of the cases was based on the European foundation for quality management (EFQM). Behara and

Gundersen (2001) also used the same approach to analyse quality in services and developed eleven quality constructs. However they note that different studies have come up with different quality constructs therefore argue that there is need for continued quality management theory building.

Although the use of award-based models is popular, it has been recognised that the use of such, is suitable for analysis only at an organisational level (Westerveld 2003) and not at the process level. However attempts have been made to adopt these models to process and/or project management analysis. For example Bryde (1997) used TQM principles while in a later paper (Bryde 2003), he contextualised the EFQM model to suit project management environments. Westerveld (2003) also, recognising the inappropriateness of the EFQM model in its original form for use in project management, developed a project excellence model based on the EFQM model.

The International Project Management Association (IPMA) has also developed a Project Excellence Model, used to assess best practice project management. The IPMA project excellence model was developed by the German Project Management Association, in 1997, based on the EFQM model to judge the annual project management awards (IPMA 2006). This was subsequently adopted by the International Project Management Association to judge project excellence.

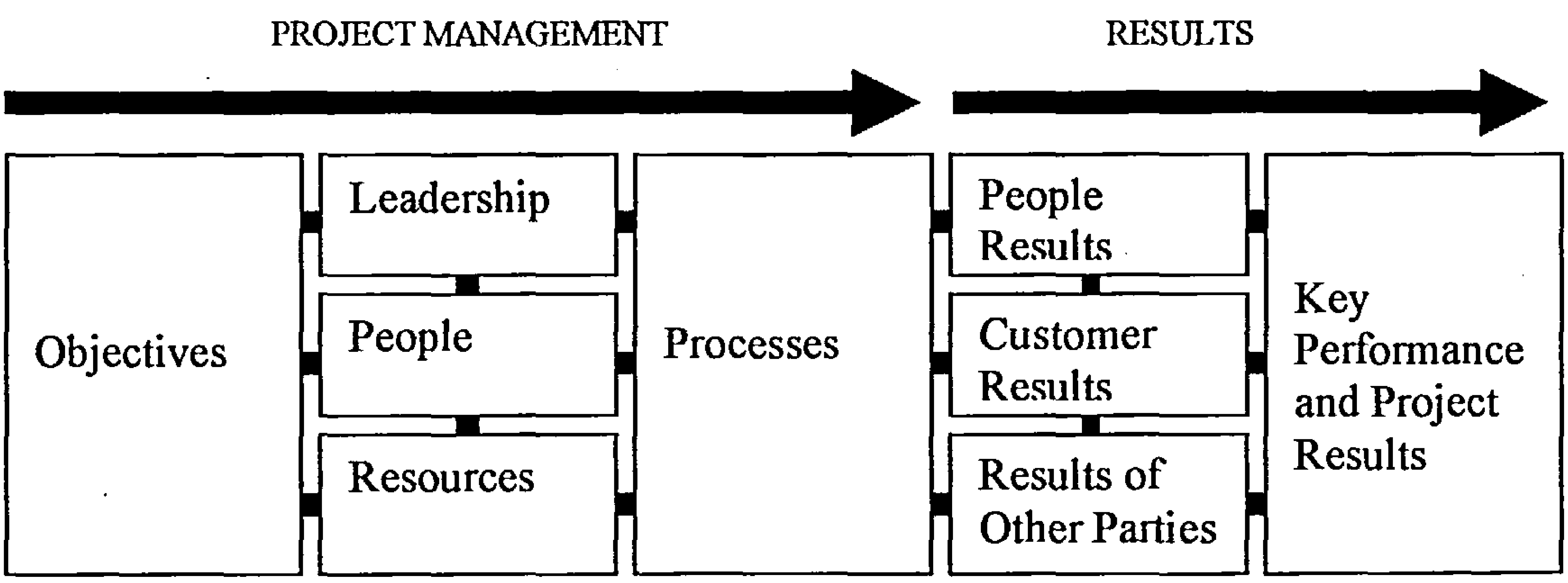

Figure 5. 3: IPMA Project Excellence Model (IPMA 2006)

Similar to the EFQM model the IMPA model takes a cause/results approach in that it is divided into two parts as in figure 5.3. The right hand side contains the project management approach while the left hand side contains the results component. Based on this, it can be said that the project management component should be seen as the cause of project results. The IPMA recognises this and states that the award is given to the project team that achieves the best results, making them the most successful representatives of project management (IPMA 2006). This seems to suggest that it is not possible to separate achieving project management excellence from project results.

Although based on the EFQM model, it differs slightly in terms of the constructs used. The EFQM model like many other national quality award models recognises the role of leadership as the driving force in excellence. However, the IPMA's project excellence model has project objectives as the driving force behind all constructs. Table 5.4 shows the areas that need to be measured in assessing project excellence. Again these differ from quality award models such as the MBNQA and the EFQM, which ultimately consider leadership as the driving force which influences all other factors.

Construct	Items to prove
PROJECT MANAGEMENT	
OBJECTIVES-how the project formulates, develops, checks and realises its objectives based on extensive information about the demands of its parties involved	Expectations and demands of parties identified
	The project objectives are developed, as well as how competitive interest are integrated on the basis of extensive and relevant information
	Project objectives are imparted, realised, checked and adapted
LEADERSHIP-how behaviour of all managers of and within the project 'project excellence' inspires, support and promotes	Set a credible example for project excellence, effectively promote and actively support improvement within project
	Care for clients, suppliers and other organisations
PEOPLE- How project team members are involved, how their potential is seen and used.	The employees' potential is seen, used to achieve the project results, maintained and developed
	The employees are involved, participate and are authorised to take independent action.
RESOURCES- How existing resources are used effectively and efficiently	Financial resources
	Information
	Suppliers and their services
	Other resources.
PROCESSES- How important processes within the project are identified, checked and changed, if necessary	The processes needed for project success are identified systematically, managed, checked, adapted and optimised
	Project management methods and systems are effectively adopted, how they are used and improved
	The project prepares and documents past and current experiences so that other projects can benefit.
PROJECT RESULTS	
CUSTOMER RESULTS- What the project achieves concerning customer expectations and satisfaction. It has to prove how customers judge the project in its achievements and results	Directly Indirectly, taking into account further measurements
People Results-What the project achieves concerning expectations and satisfaction of the employees involved. It has to prove how employees and managers judge the project, the teamwork within the project, the achievements and project results	Directly Indirectly, taking into account further measurements
Results of Other Parties Involved- What the project achieves concerning expectations and satisfaction of other interested parties. It has to prove how the other interested parties affected by the project	Perceive the project directly Judge the project indirectly, taking into account further measurements
Key Performance and Project Results- What the project achieves concerning the intended project results	It has to prove to what extent the project achieves the objectives (75%). It has to prove the "performance" of the project

Table 5. 4: IPMA Project Excellence Model (IPMA 2006)

Although this model is now used by the IPMA to assess awards for excellence, there is little literature, which supports its arrangement or which supports the validity of the supposedly causal relationships. Moreover, since it is based on the EFQM model, like others discussed below, it does not provide the only framework to assess project excellence.

The EFQM model is based on TQM principles and provides a framework in which these (TQM) principles are defined in a meaningful way, which would allow elements of the model to be easily understood. However Bryde (2003) acknowledges the need to modify the EFQM model to suit project environments. He developed a project management performance analysis (PMPA) model as presented in figure 5.4 (page 106). The model replaces the EFQM nomenclature with those that are relevant to project environments. Table 5.5 presents some of the variables used to reflect the different constructs.

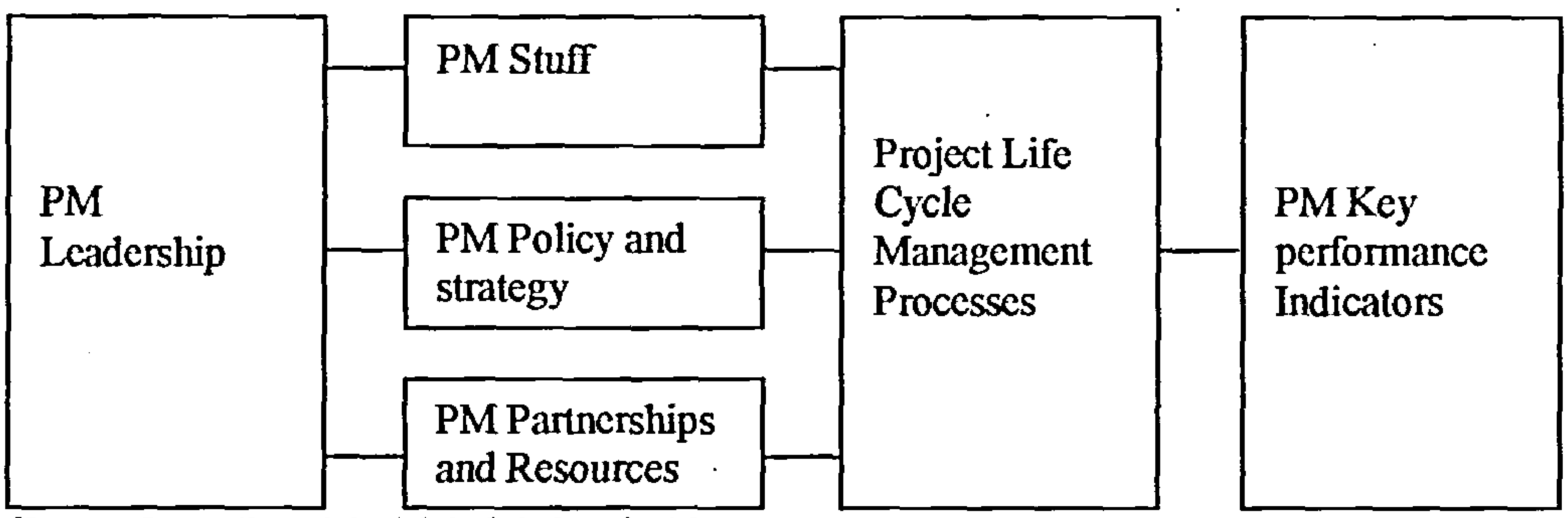

Figure 5. 4: The PMPA Model (Bryde 2003)

Construct	Indicators
PM Leadership	• Promulgation of awareness of PM • Supporting projects culture
PM Stuff	• Planning & managing (training and career development) • Rewarding staff-appraisal
PM Policy and Strategy	• How project management is introduced
Pm partnerships and Resources	• Partnering (customers and other project stakeholders)
Project Life Cycle management Process	• Customer focussed processes • Clear, concise and comprehensive description of the processes
PM Key performance indicators	• Multi-Stakeholder perspective

Table 5. 5: PMPA Constructs with associated indicators (Bryde 2003)

Westerveld (2003) discussed a project excellence model, adopted from the EFQM model to relate critical success factors to project success. He argued that there was no agreed suitable framework that could be used to link project management critical success factors and project success. Weserveld (2003) proposed an evaluation model that is developed based on the EFQM model. He (Weserveld 2003) developed constructs based on project management literature on critical success factors and project success failure. These factors were built into the project management excellence model. Westerveld (2003) demonstrated from project management critical success factor theory that there is a possible linkage between the constructs and performance.

Westerveld (2003) also recognised the need to adapt the EFQM constructs to project environments. Figure 5.5 shows the project excellence model adapted from the EFQM model. It is seen from the model that the project management excellence model is similarly arranged as the EFQM model distinguishing between the organisational areas and the results areas. However, he uses slightly different nomenclature. Notably Westerveld (2003) combined leadership and team as the driving force and separated the partnership and resource construct which was replaced by stakeholder management, resource category, and contracting. These variables are recognised in Bryde (2003) as being part of the partnership and resource category.

Westerveld (2003) identified critical success factors being the organisational area (enablers) while the project success criteria being the results area. As discussed in Chapter Three, Westerveld (2003) used one case study to show the usefulness of the model in improving project performance. The argument in the model being that improving the organisational area would result in improvement in the performance area.

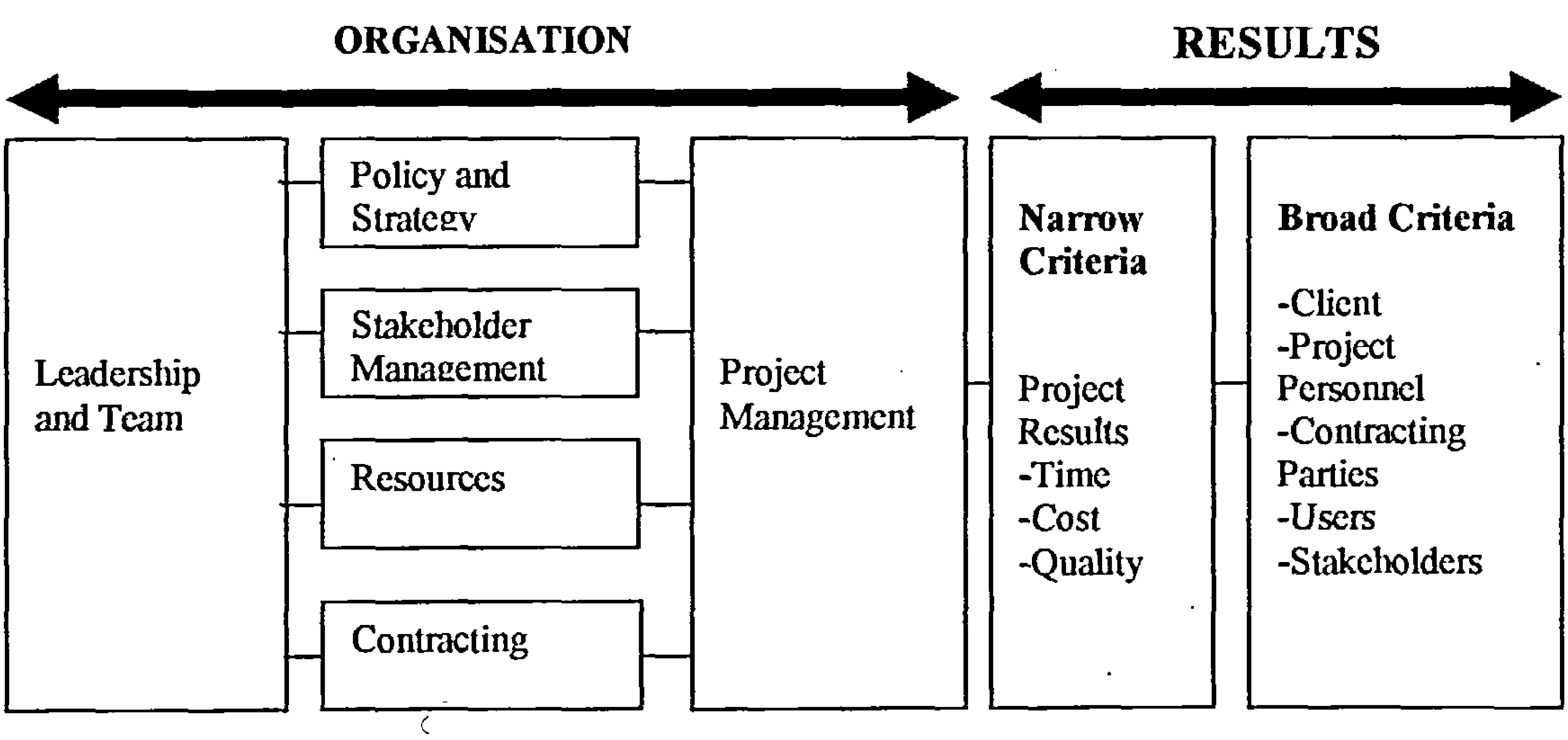

Figure 5. 5: Project Excellence Model (Westerveld 2003)

5.1.4 Studies Based on TQM and other Quality Models

Apart from the studies by Badri and Davis (1995) and Ahire *et al* (1996) as cited in the last section above, other studies which used the TQM framework to examine quality management critical factors include Stevens (1996) who developed a model to measure project quality based on TQM elements and Bryde (1997) who applied quality management principles based on TQM to project management. Other models have also been used to examine quality. For example Lazzlo (1999) used the Canadian quality award. Similarly, Prajogo and Brown, (2004), Lin *et al* (2004), Kaynak (2003), Samson and Terzioski (1999), Madu *et al* (1996), Curkovic *et al* (2000), Llusar and Zornoza (2000), Hendricks and Singhal (2000) and Pannirselvam (2001), used quality models in their respective studies.

ISO 10006 is another of the models that has application to project management quality. The ISO (2003) argue that quality management principles (as specified in the ISO 9000:2000) should be applicable to the project management process. It is difficult however from the document (ISO 10006) to track the eight quality management principles in the project management process.

5.1.5 Summary-Measurement Models

The discussion above shows that there have been many studies that are based on generic quality management principles to define criteria to identify and measure quality management elements. In particular most of the models are based on TQM principles. A plethora of award systems also are based on TQM principles (Dale 2003). Research shows that there are similarities between the different award frameworks. The ISO (1998) suggests that the models are tailored according to the biases towards TQM in the different regions. One of the advantages of using the award frameworks is that they define quality management principles in a systematic away providing a platform to measure quality. The use of these models to measure quality is at the heart of these models as they are used to award companies that show best practice in quality management. Further these models provide a platform for systematically linking different quality elements. To some extent these can be viewed as causal models.

5.2 Section Two: The Conceptual Project Management Process Quality Model

Literature review shows that the measurement of quality has been dominated by the use of quality constructs. This is because quality cannot be measured directly. These constructs have been primarily developed from quality management systems or quality awards (see or example, Ahire *et al* 1996; Anderson *et al* 1998; Pannirselvam and Ferguson 2001; Bryde 1997; Bryde 2003; and Westerveld 2003). The most common of these are Total Quality Management (TQM) and the self-assessment models such as the American Baldrige quality award (MBQA) and the European excellence (EFQM) model. However Dale (2003) points out that the use of these quality models provides a general definition and description of quality management within a defined framework. The literature review herein has shown that there is no agreed framework of quality constructs to use to measure quality. However an analysis of the different models shows the similarities of the measurement constructs despite the different names given to them. An approach that has been used to decide which model to use has mostly been based on the popularity of the model in particular environments. For example researchers in the USA are likely to use the MBQA model while researches in Europe are likely to use the EFQM model.

Because these models can be interpreted as a depiction of quality management within a defined framework, any of these frameworks can be utilised to base a model that can be used to measure quality of the construction project management processes. However, it is worth noting that these models were developed for analysis at an organisational level. Researchers have recognised this and have attempted to adapt these models for project environment. See for example Bryde (2003), Westerveld (2003) and Lazlo (1999).

5.2.1 The Selected Theoretical Framework

This research adopted the quality award framework to define a construction project management process quality (PMPQ) model. There have been a number of studies that have examined quality in project management using the award-based model and therefore taking an award-based framework would enable comparison with other similar studies. These models have a strong theoretical foundation based on TQM principles. In particular the model adopted in this research is based on the EFQM principles. The adoption of the EFQM model as a base model is based on the following four considerations.

First, the study was based in UK so it is only proper that since all subjects were UK based a quality framework that is widely accepted in the UK should be used. The EFQM business excellence model is a European based model and therefore appropriate to be used in this research. Second, comparability of the research was taken into consideration. Of the key studies that have been examined two of these are based on the EFQM model. This will provide a benchmark to compare findings despite limitations of these studies as discussed in the previous section. Third, there is need for a defined theoretical framework to base the project management quality model. Dale (2003) argues that the use of the award models provides a framework to examine TQM. Therefore regardless of which framework is used, there is sufficient theoretical justification to suit SEM requirement of a strong theoretical background. It was noted in Chapter Four that structural equation modelling is very much dependant on the provision of models with sufficient theoretical underpinning. Lastly, the suitability of the framework was also considered a major factor in deciding upon which model to use. Although the EFQM provides a general framework, this research has tailored the instrument to construction project management processes. It is noted that the model has been used largely to group the critical project management factors as reported in other studies. Hence the use of a framework to assign the different critical factors (as reported in other studies) provides sufficient theoretical justification suitable for the SEM analysis.

5.3 Section Three: The PMPQ Model

Figure 5.6 depicts the conceptual Project Management Process Quality (PMPQ) Model based on the EFQM Criteria. It is noted that the model contains constructs named suitably for recognition as project management related constructs. The model replaces leadership, people, policy and strategy, partnership and resources, and processes with project management leadership, project team, project management policy and strategy, project partnerships and resources and project management processes. The results area in the PMPQ model are represented by one construct, project results. This model is based on the EFQM model and reflects constructs in a way that is meaningful to construction project management processes. These PMPQ constructs with their related indicator variables are explained later in this chapter.

It was noted, in Chapter Four, that an SEM is composed of two parts, which include the structural model and the measurement model. These sub-models for the PMPQ conceptual model are discussed below.

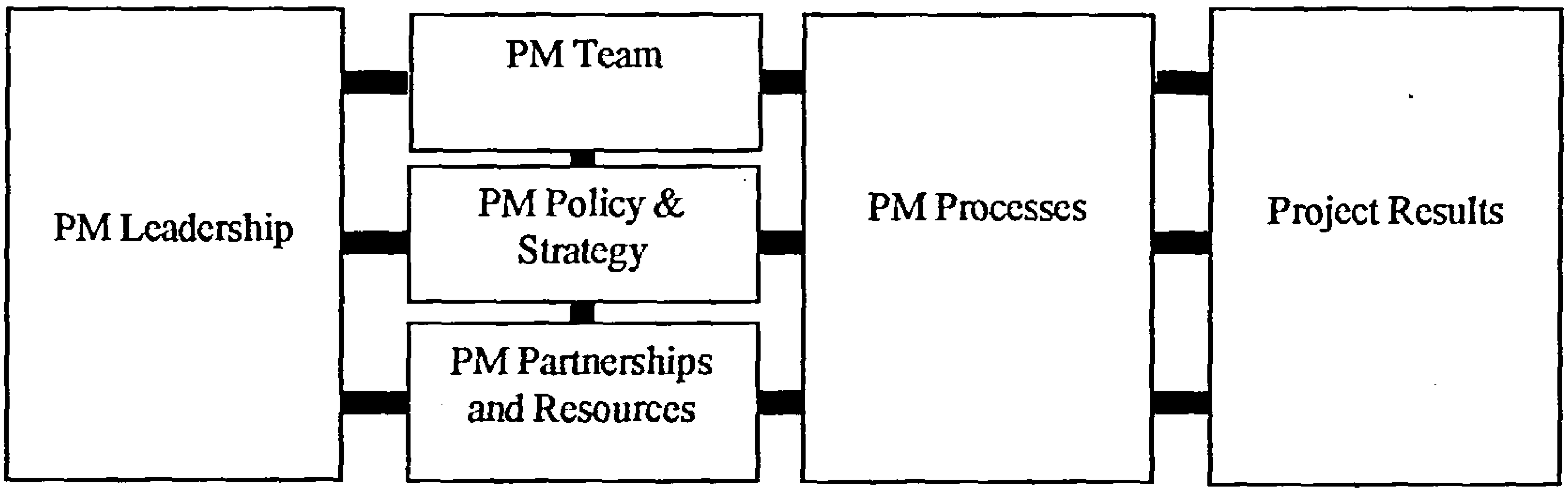

Figure 5.6: The PMPQ Model

5.3.1 The Structural Model

The interpretation in the model is that project performance is as a result of project management leadership driving project team, project management policy and strategy project partnership and resources and project management processes. This is a similar interpretation of the EFQM model, which portrays a causal relationship that performance is a result of leadership driving people, policy and strategy, partnership and resources and processes. Indeed this is one of the reasons that such models in research have been used to test or validate the causal relationship between quality management factors and performance.

Figure 5.7 shows the path diagram of the structural model showing the inter-linkages between the constructs.

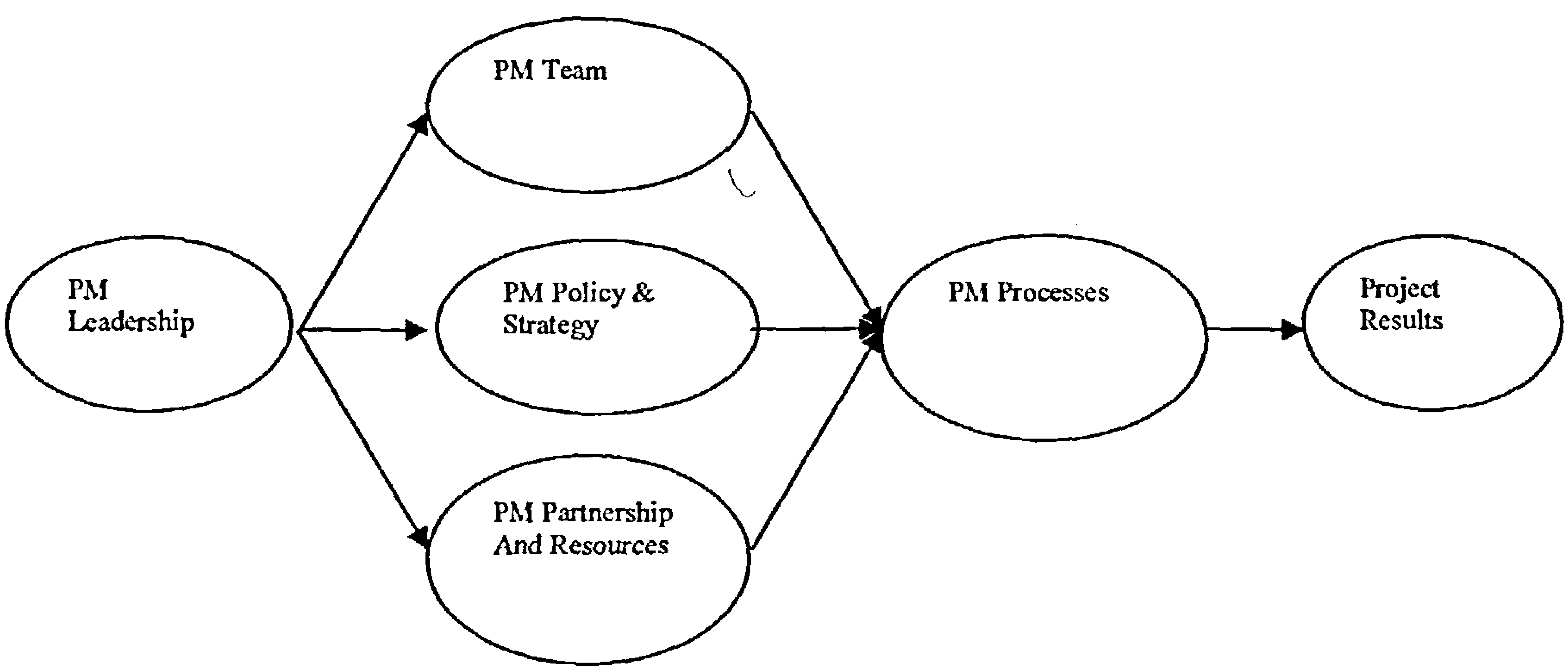

Figure 5.7: PMPQ Structural Model

Project management leadership refers to project management's role in fostering a culture of quality in project management processes. The fostering of a quality culture is considered to be the key role of project management. Project management team refers to the project management human resource management practices influencing the quality of the project management process while Project management policy and Strategy refers to the strategies and policies for the management of a project. It also reflects how these (policies and strategies) affect the quality of the project management process. Anderson and Merna (2003) differentiated between Project management strategy which refers to the strategy for the management of a project and Project strategy which refers to the high level plan for achieving a given projects objective. The focus in this case is on project management strategy.

Project management partnerships and resources refer to management of stakeholders and resources, of which one of the major resource considerations is communication. Consideration is also given to how this construct impacts on the quality of the project management process. Project management process management is concerned with project management process and practices that affect the quality of the project management process. It is also concerned with the setting up of a process that adequate controls the project plan and ensures the management of its execution in a consistent and coherent manner. In Chapter Two, consideration was given to the criteria for measuring project performance. It was concluded that although other criteria exist to measure the performance of projects, this research was restricted to the traditional trio of time, cost and quality performance as the most relevant to the present research. In addition Project Manager's satisfaction with project outcomes was included. Justification of this approach to measure performance is provided in Section Two of Chapter Two.

5.3.2 The Measurement Model

The identification of indicator variables for each of the constructs in the model was based on literature on critical success factors, an approach similar to Westerveld (2003). However, Westeveld (2003) did not list the indicator variables in his paper. The table in Appendix C presents a list of the indicator variables associated with each construct based on literature, which examines critical success factors. This is a global list of factors that can be considered. However for the purpose of this research, there was need to select appropriate indicators for each construct. The following section discuses the choice of indicator variables selected for the research.

Measurement of Project Management Leadership

There are a number of factors that can be used to measure the project management leadership construct in project management. For example, Odusami (2003) identified project leader's qualifications, project leader's style as some of the project leadership factors that would influence performance. One of the critical functions in project leadership is concerned with designing organisation structures. Project managers are concerned with the conceptualisation and designation of the projects organisation structure to align the people and the resources to facilitate the accomplishment of the vision Cleland (1995). Critical to the project leadership is the appointment of a project manager who is competent for the job. Turner and Müller (2003) argue that the owner should appoint a project manager who is qualified with appropriate professional credentials. They also argued that the project manager needs appropriate levels of authority entrusted by the client.

Winch (2002) on the other hand identified three aspects needing consideration in project leadership. These include the capability of the leader, the task facing the organisation and the expectations of those who are being led. It is seen in this that the capability of the project manager is thought to be an issue that would have an impact on project performance. The influence of top management support in quality management literature is considered to be an essential requirement for successful quality management initiatives (Cook-Davies and Arzmanow 2003; Cash and Fox 1992; Kerzner 2001; and Munns and Bjeirmi 1996). In project management it is recognised as a factor that would affect project management performance. Cooke-Davies and Arzmanow (2003) identified organisational leadership including commitment of upper management as measures of project management maturity. They also identified degree of authorisation with respect to the level of empowerment necessary to deliver agreed project strategy and capability of project manager, which is reflected in the competency of project management staff, as possible measures of project management maturity. Cooke-Davies (2002) in defining factors that affect project management success included adequacy of documentation of organisational responsibility on the project as a variable.

Kog *et al* (1999), in examining management factors that would impact on schedule performance identified a number of organisational levels between project manager and craftsmen, years of education after high school and experience as factors critical to project success. Experience was measured using factors such as total years of construction experience, total years of project management experience, experience as project manager on similar projects, experience as project manager on similar projects, experience other than project management on similar projects (cost and duration) and experience other than project manager on similar projects. They found out that project manager experience on projects with similar scope was one of the five key determinants of schedule performance.

Cash and Fox (1992) identified experience of project manager as critical to success. Turner (2004) in summarising the conditions necessary for project success (developed) from work done by Wateridge (1995) and Müller (2003) identified the need for the project manager to be appropriately empowered to carry out his duties. They argued that the project manager should be empowered, with the owner giving guidance as to how they think the project should be best achieved, but allowing the project manager flexibility to deal with unforeseen circumstances as they see best.

Munns and Bjeirmi (1996) also identified the following leadership factors as being critical to Project management success. These include, wrong person as project manager, top management unsupportive and lack of commitment to project. Pinto and mantel (1990) also identified top management support in terms of the willingness of top management to provide the necessary resources and authority/power for project success.

Nicholas (1989) identified some factors critical to project success. These can be related to project management leadership and include; top management support, level of authority given to project manager (to have control over developing plans, and schedule, making additions or changes and fulfilling them), experience and capability of project manager and clarity of project management responsibilities. It is observed from this that there is need to have the right person to lead the project team. Weak project leadership was identified by Thamhain (2004) as one of the factors contributing to poor project performance. Kerzner (2001) included selection of the right person as project manager and upper management supportive as factors necessary for effective project management. Other factors included authority, delegation, management interest, direction and project organisation. The selected indicator variables for the project management leadership are summarised and presented in table 5.6. These were later used to measure the leadership construct. The path diagram for this construct is presented in figure 5.8.

Construct	Indicators
Project Management Leadership	• Definition of roles and responsibilities of the project manager • Definition of project management goals • Authority given to project manager by client • Experience of the project manager • Project managers competence • Project organisation structure • Project managers qualification • Project manager's leadership style • Client support to project manager

Table 5. 6: Project Management Leadership Measurement Model

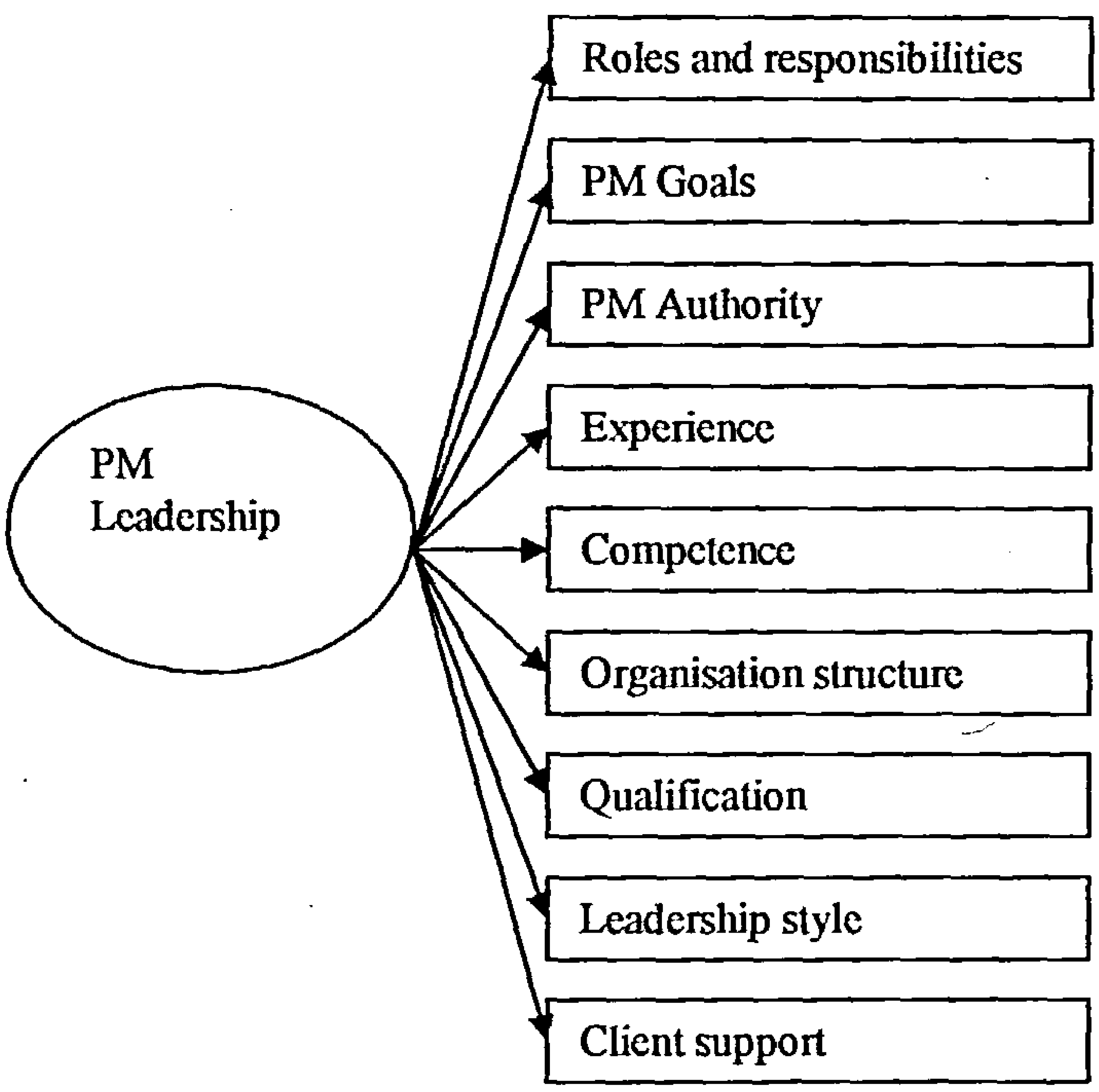

Figure 5. 8: PM Leadership Measurement Model

Measurement of Project Management Policy and Strategy

Project management methodology, definition of project success/failure criteria, project management process performance reviews, formal feedback mechanism, project manager's involvement in the project brief process, awareness of the project's requirements by all parties and quality and detail of project management plan/strategy were identified as suitable indicators of the project management policy and strategy construct.

Turner and Müller (2003) pointed out that the Project Manager, as chief executive of a project is responsible for formulation of objectives and strategy for the project and through the purpose of the project, to link those objectives and strategy to the objectives and strategy of the parent organisation. Anderson and Merna (2003) argued that poor management, particularly at the front end during strategy formulation rather than poor management down stream is the cause of poor project performance. However, most project management literature concentrates on the execution tools and techniques rather than the effective development and deployment of project management strategy within a total process concept.

Anderson and Merna (2003) differentiated between project management strategy which refers to the strategy for the management of a project and project strategy which refers to the high-level plan for achieving a given projects objective. They presented a project management domain model, from which a project management strategy can be created. These domains include requirements management, process management, team management, environmental management, procurement management, change management, finance and schedule management, knowledge management, uncertainty management, decision management and crisis management.

Dvir *et al* (2003) examined the relationship between project planning and project success. Their findings suggest that project success is insensitive to the level of implementation of management processes and procedures, while project success is positively correlated with investment in requirements definition and development of technical specifications. They observed that although planning does not guarantee project success, a lack of planning would probably lead to project failure. They examined the relationship between degree of planning and degree of success achieved. Planning was measured using three measures including, requirements definition, development of technical specifications and Project management processed and procedures.

Cooke-Davies (2002) distinguished between project success and project management success. He identified factors critical to project management success (measured against the traditional measures of performance-time, cost and quality) including adequacy of company wide education on the concepts of risk management, maturity of an organisation's processes for assigning ownership of risk, adequacy with which a visible risk register is maintained, adequacy of an up to date risk management plan, adequacy of documentation of organisational responsibility on the project, keep project as far below 3 years as possible.

Turner (2004) summarised the conditions necessary for project success (developed) from work done by Wateridge (1995) and Müller (2003). These factors included the need to agree the success criteria with all stakeholders before the start of the project. Nicholas (1989) also identified the following issues identified as critical to project success include, project management and systems development process, complete and clear definition of scope, objectives and work done, project responsibility and requirements are understood by all, quality and depth of planning, good control and reporting systems in place. Kerzner (2001), identified inadequate defined tasks as one of the major cause of project failure. It is observed from the above discussion that there are a number of indicator variables that can be used to measure the project policy and strategy construct. Table 5.7 presents the selected indicator variables to measure project management policy and strategy and figure 5.9 is the path diagram for this construct. Thus project policy and strategy can be represented by project management methodology, definition of project success/failure criteria, existence of a project management process performance reviews strategy, formal feedback mechanism, involvement of the project manager in the project brief process, awareness of the project's requirements by all parties, quality and detail of project management plan/strategy.

Construct	Indicators
Project Management Policy And Strategy	• Project management methodology • Definition of project success/failure criteria • Project management process performance reviews strategy • Formal feedback mechanism • Project manager's involvement in Project brief process • Awareness of the project's requirements by all parties • Quality and detail of project management plan/strategy

Table 5. 7: Project Management Policy and Strategy Measurement Model

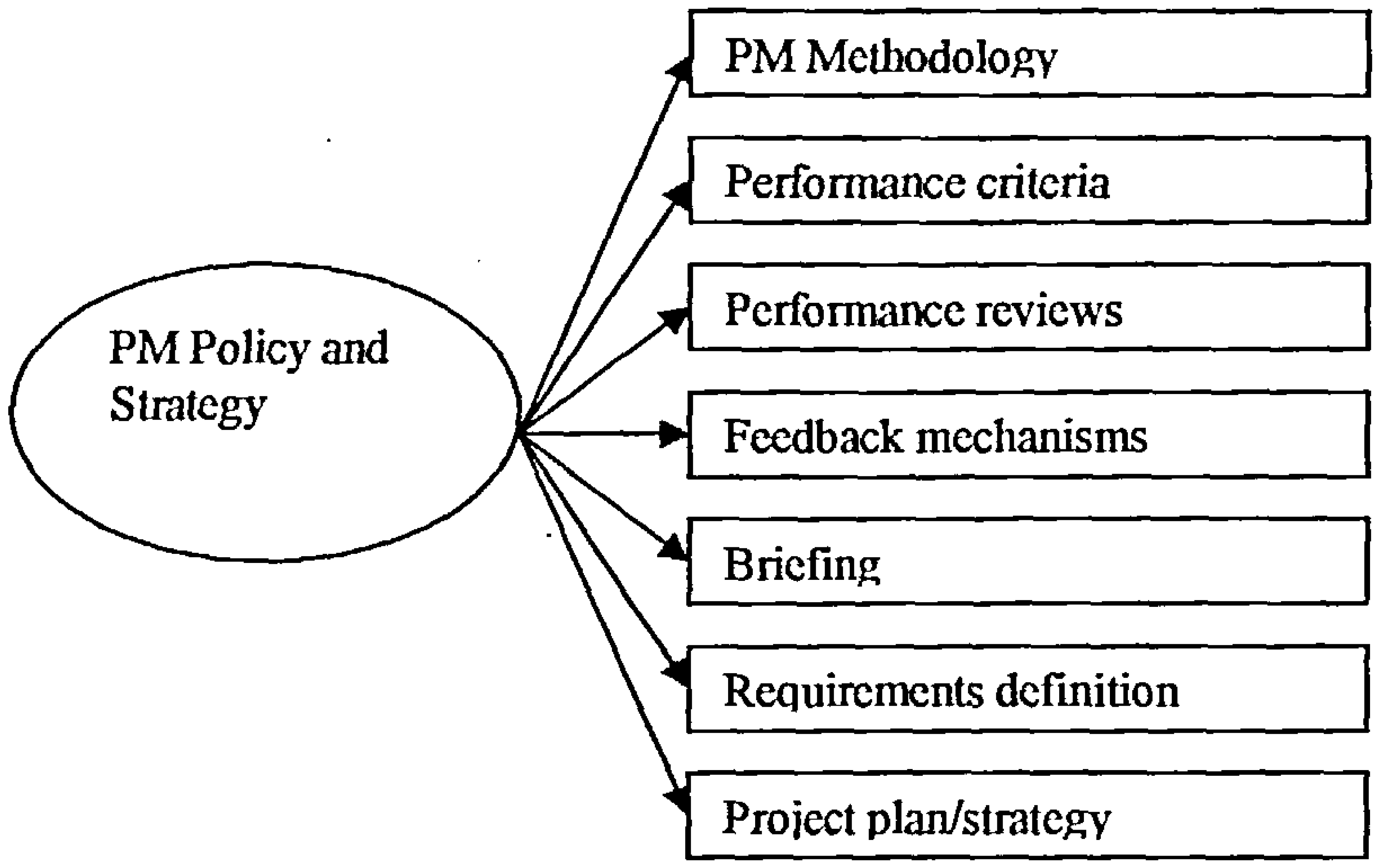

Figure 5. 9: Project Management Policy and strategy Measurement Model

Measurement of Project Team

A number of project team issues were identified from literature as appropriate indicators of this construct. These include project team's skills and knowledge, cooperation among project team members, experience of project team members, project participants', understanding of the functional and technical performance requirements, project participants understanding of their roles and duties in the project, project participant's project goals, degree of trust between project team members, management of conflicts, project team members' commitment to project and project management process, team building, project management training, motivation, capability of project management staff, personal friendship between project participants, teamwork, project team members' interdependent and interface effectively.

The project team construct largely represents the human resource function in project management. There has been debate about the influence of the human resource function in project management. Belout and Gauvreau (2004) for example found out that the personnel factor had only a marginal effect on project success. This is a similar finding to Pinto and Prescot (1996). However, all the quality models discussed in Section 5.2 include this construct as an important management function.

The literature below discusses some of the variables that have been used in literature to evaluate the project team issues. Chan *et al* (1999) identified eight measures of inter-organisational teamwork which included, the need for a shared and clear understanding of the functional and technical performance required by all participants, all project participants understood fully their roles and duties in the project, all project participants accepted the changes of their roles and duties in the project, all project participants shared common project goals, all project participants cooperated fully, adequate channels of communication among all project participants existed, a high degree of trust was shared by all project participants and project participants resolved conflicts quickly.

Thamhain (2004) recommended some measures for effective team management. These included, involvement of team in project planning, early in the project life cycle, definition of work processes, interface and team structure, staffing and organising the project team, building a high profile image, stimulating enthusiasm, excitement and professional interest. Other factors included creating proper reward systems, ensuring senior management support, building and maintaining commitment, management of conflicts and problems, conducting team building sessions, providing proper direction and leadership and fostering a culture of continuous support and improvement.

Kuprenas (2003) argued that project management is well established as a means to improve cost, schedule and quality performance of design and construction. He examined the influence project management structure, project management training and frequency of design team meetings on design cost performance. He found out that design team meeting frequency and frequency of reporting were found to be statistically factors in reducing design cost performance while project management training and the use of project management structures did not create statistically significant impact in lowering the design cost performance index.

Pinto and Mantel (1990) included personnel factors in their model and measured personnel factors using recruitment, selection and training of the necessary personnel for the project team as indicators. Phua (2004) identified good communication between project firms and clients, corporation between colleagues of own firm, corporation between project firms, and personal friendship between project participants. Nicholas (1989) included committed to project and project management process, teamwork, clear responsibilities/defined roles and delegated authority and responsibility as indicators of good teamwork.

Kerzner (2001) identified some issues that characterise effective project teams. These included, high performance and task efficiency, innovative/reactive behaviour, commitment, professional objectives of team members coincide with project requirements, team members highly interdependent, interface effectively, capacity for conflict resolution, effective communication, high trust levels, results oriented, interest in membership, high energy levels and enthusiastic, high morale and change oriented.

Hameri (1997) & Hameri and Hikkilä (2003) identified ignorance on what other teams are doing, and diverse views on what are the objectives of the project as factors that would contribute to the failure of projects.

It is again evident that there is a plethora of factors that can be used as indicator variables for the project team construct. However based on the discussion above ten variables were selected as indicator variables for the project team construct. These are summarised in table 5.8. The path diagram for this construct with its indicator variables is presented in figure 5.10.

Construct	Indicators
Project Management Teams	• Defined roles and responsibilities of all project team members • Skills and knowledge • Cooperation among project team members • Experience of project team members in executing similar projects • Commitment of Project team to project and project management process • Shared understanding of the functional and technical performance required • Capability of project team • Working relationship among project team members • Trust between project participants • Conflict between team members

Table 5. 8: Project Team Measurement Model

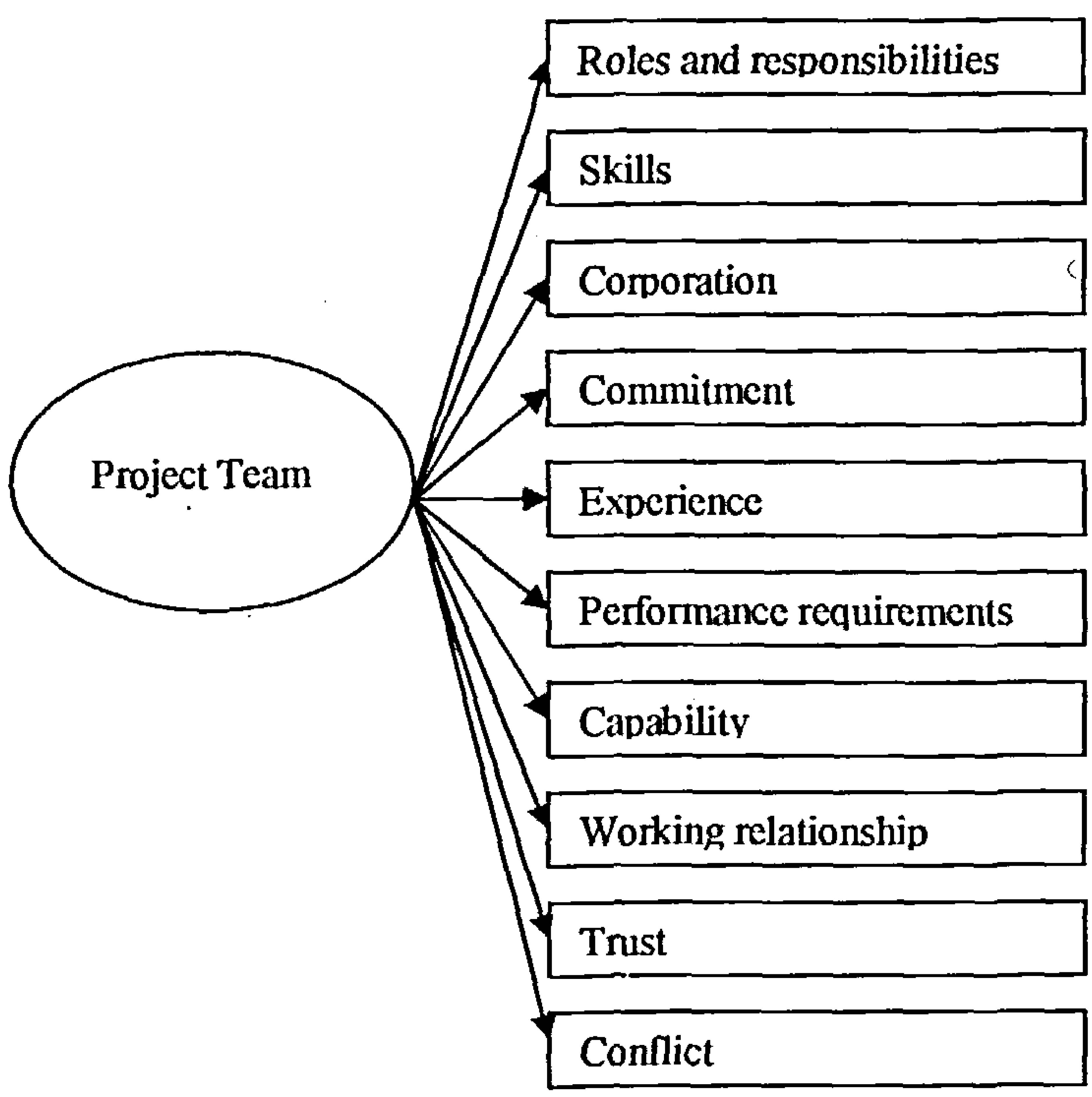

Figure 5. 10: Project Team Measurement Model

Measurement of Partnership and Resources

This construct has two domains. The first domain is concerned with the management of stakeholder relationships while the other domain is the management of resource of which one of the major components is the communication resource component.

Stakeholders

Cleland (1995) identified one of the concerns of the project manager as being the gaining the commitment of stakeholders to support the project leader's initiatives in the attainment of goals. Some of the factors identified as critical to this stakeholder relationship with the project management team include the level of corporation with project participants including the client (Phua 2004). Kerzner (2001) also considered client support as being critical to achieving project success and identified some of the issues that need addressing including working relationship with client, client support and commitment, regular meetings with client, and conflict within client organisation. A significant factor that may affect working relationships is the experience different stakeholders have had in working with each other.

Cleland (1995) also discussed the gaining of commitment of the stakeholders to support the project leader's initiatives in attainment of goals as being critical to the success of projects. Other factors include good project track record of firms, appropriate project procurement system, and fair contractual terms for all parties (Phua 2004). Bryde (2003) identified partnering, and procurement as being an important factor in managing partnerships. The measurement variables selected for the stakeholder construct are presented in Table 5.9.

Project Stakeholders Management	• Partnering arrangements • Collaboration between client and project manager • Number of times client has engaged the project management firm for project management services • Number of times the project manager's firm has worked with project team members' firms on other projects • Suitability of project procurement system used on the project to successfully deliver project goals

Table 5. 9: Project Stakeholder Measurement Model

Communication

A number of variables can be used to measure the project communication construct. Communication is an important project management function. Cleland (1995) argued that one of the project manager's concerns is the identification, development and communication of a vision for the project stakeholders, who the leader wishes to lead. Pinto and mantel (1990) identified communication as the provision of an appropriate network and necessary data to all key actors in the project implementation. Müller (2003) identified three aspects of communication, which were used in his research. These included frequency of communication, communication content and communication media. Frequency of communication represents the number of communication events taking place between project manager and sponsor e.g. daily, weekly, monthly or variable intervals. Communication content includes information exchange between project manager and sponsor at any formal communication event and by the use of any media e.g. status and achievement, changes to the project, issues and open item lists, definition of next step in project, analysis of trends and quality and progress measures. Communication media is concerned with the way a message is conveyed from project manager to sponsor e.g., written media, face to ace meetings and formal communication events.

Thomas *et al* (1998) however grouped the measures of communication into six groups. These included accuracy of information, communication procedures, communication barriers, understanding, timeliness of communication and completeness. Accuracy of information can be measured by frequency of conflicting information, poor communications and lack of coordination. Communication procedures are represented by the existence, use and effectiveness of formally defined procedures outlining scope, methods etc. While communication barriers can be measured by presence of barriers e.g. interpersonal, accessibility logistics etc and interference of communication. Understanding is concerned with the understanding of information expectations with supervisors and other groups, while timeliness of communication is concerned with the timeliness of information received including design and schedule changes. The completeness of information can be represented by the amount of relevant information received.

Nicholas (1989) identified some issues identified as critical to project success including project information system (project manager responsible for setting up communication channel), and communication and information sharing and exchange (which include continuous and clear communication between parties, quality and quantity of face to face meetings, frequent and regular meetings to exchange information and data and instructions concerning project goals, status, policies and changes. Kerzner (2001) also included effective communication as one of the issues characterising effective project teams.

The measurement scale in Thomas *et al* (1998) was adopted in this research and is presented in Table 5.10. Figure 5.11 shows the path diagram for the partnership and resources construct, which is an amalgamation of the project stakeholder and communication's domain.

Project Management Communication	• The existence, use and effectiveness of formally defined communication procedures • Adequacy of information passing among project team members • Timeliness of communication among project team members during design and construction phases • Suitability of the methods of communication among project team members • Frequency of communication among project team members • Accuracy of information passed among project team members

Table 5. 9: Project Management Communication Measurement Model

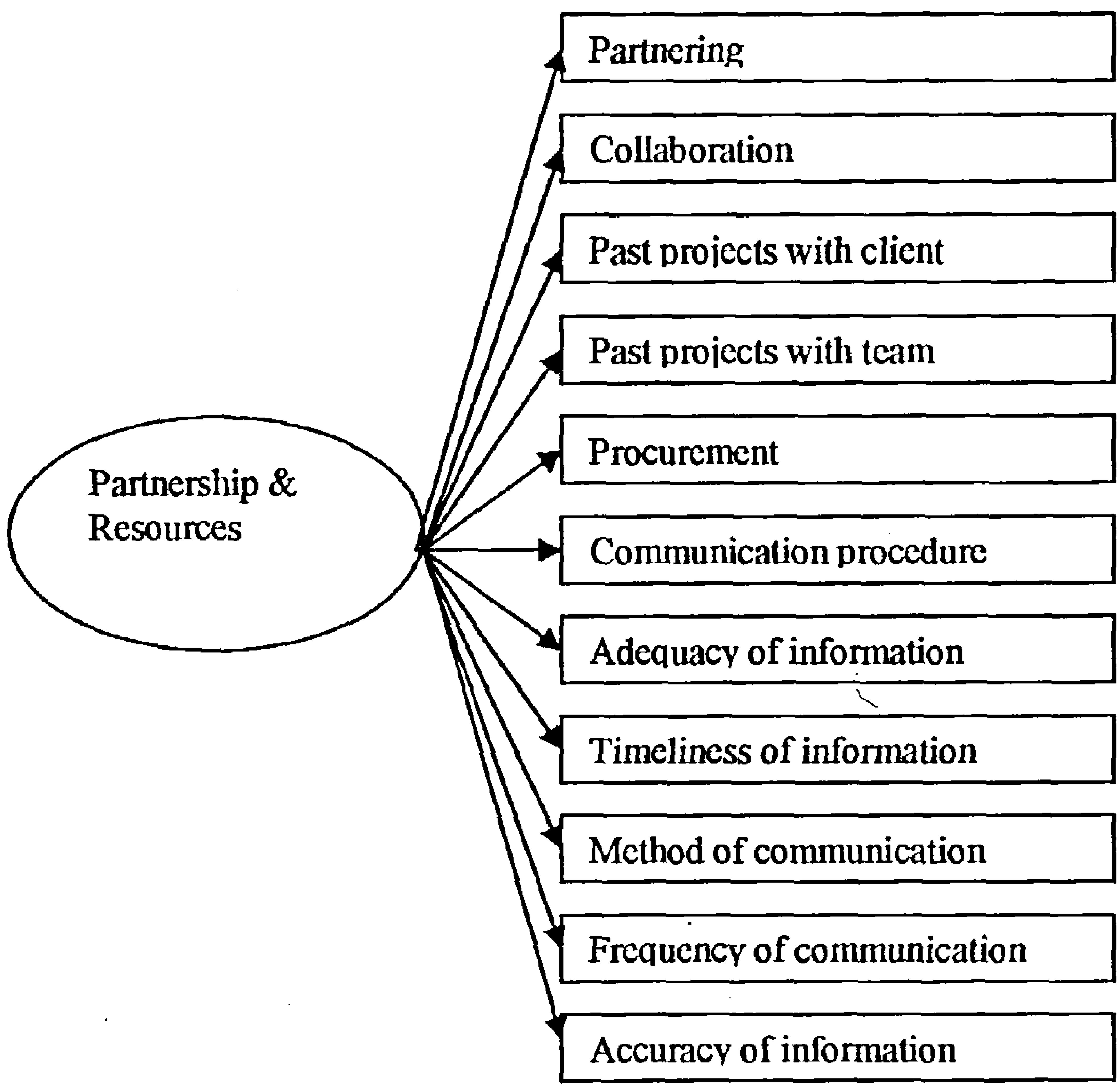

Figure 5. 11: Partnership and Resources Measurement Model

Measurement of Project Management Processes

Variables identified as being suitable indicators of this construct include, risk management, implementation of project management methodology, project monitoring and control, documentation of project management processes and procedures, change management process, project management tools and techniques, progress reporting, project planning, implementation of management processes and procedures and monitoring and feedback.

Kog *et al* (1999) identified project planning factors affecting schedule performance as including; percentage of detailed design complete at construction start; number of activities in project execution plan; percentage of contingency budgeted for project; level of prefabrication and modularisation on project; implementation of construction programme. Further Kog *et al* (1999), identified project manager factors affecting schedule performance as including; number of progress inspection per month during construction; number of formal quality inspection per month during construction; number of formal safety inspection per month during construction, control system budget for project; frequency of control meetings per month during engineering phase; frequency of control meetings per month during construction phase; frequency of project schedule updates per year; and frequency of project budget updates per year.

The work of Dvir *et al* (2003) although discussed earlier, when examining indicator variables for project leadership is also significant here. One of the project management processes related issue identified in their work is the implementation of the project management process and procedures which was measured by a number of variables including, systems engineering, engineering design, risk management, resource and schedule planning, financial management, contract management, procurement management, quality and reliability management, test and inspection management, end user relationship management, configuration management, change management, team management, meeting and decision making management, reporting and communications and transfer to production. These are undoubtedly significant items in the project management process.

Hameri (1997) & Hameri and Hikkilä (2003) in identifying some of the reasons for project failure include some factor related to project management process. These included lack of discipline in design change control, rigid project planning and scheduling routines, and poor ability to react on sudden changes in the project environment.

Cash and Fox (1992) identified the need for project plan to identify activities, tasks, resources and dependencies, effective reporting system and formal change management procedure as being critical to project success. Other factors that would affect project success include management techniques, implementation process and project administration, (Munns and Bjeirmi 1996). Pinto and Mantel (1990) identified technical tasks (availability of the required technology and expertise to accomplish the specific technical action steps), monitoring and feedback (timely provisions of comprehensive control information at each stage of the implementations process) and trouble (shooting-ability to handle unexpected crises and deviations from plan) as critical to project success.

Nicholas (1989) also identified some of the issues critical to project success include, complete and clear definition of scope, objectives and work done, project responsibility and requirements are understood by all, quality and depth of planning and good control and reporting systems in place. Kerzner (2001) noted that some of the major causes of project failure include, misused management techniques and project termination that is not planned.

The selected indicator variables for this construct are summarised in table5.11. Figure 5.12 (page 129) presents the path diagram for the construct. Although the list is non-exhaustive, it captures some of the main factors identified above and therefore, the measurement model for the construct can be considered as theoretically adequate.

Construct	Indicators
Project Management Process Management	• Risk management • Implementation of project management methodology on the project • Project management processes were monitoring and control • Implementation of project management processes and procedures as documented in the project management strategy/plan • Change management process • Project management tools and techniques • Control meetings • Project planning • Project management processes and procedures • Frequency of feedback to client about project progress

Table 5.11: Project Management Processes Measurement Model

Measurement of Construction Project Performance

As discussed in and in Section 2.2.4 of Chapter 2, the construction project performance measurement model adopted in this research includes the golden triangle of time, cost and quality. In addition Project Manager's satisfaction, as a surrogate for participant satisfaction with project outcomes was included. This is presented in figure 5.13 (page 128)

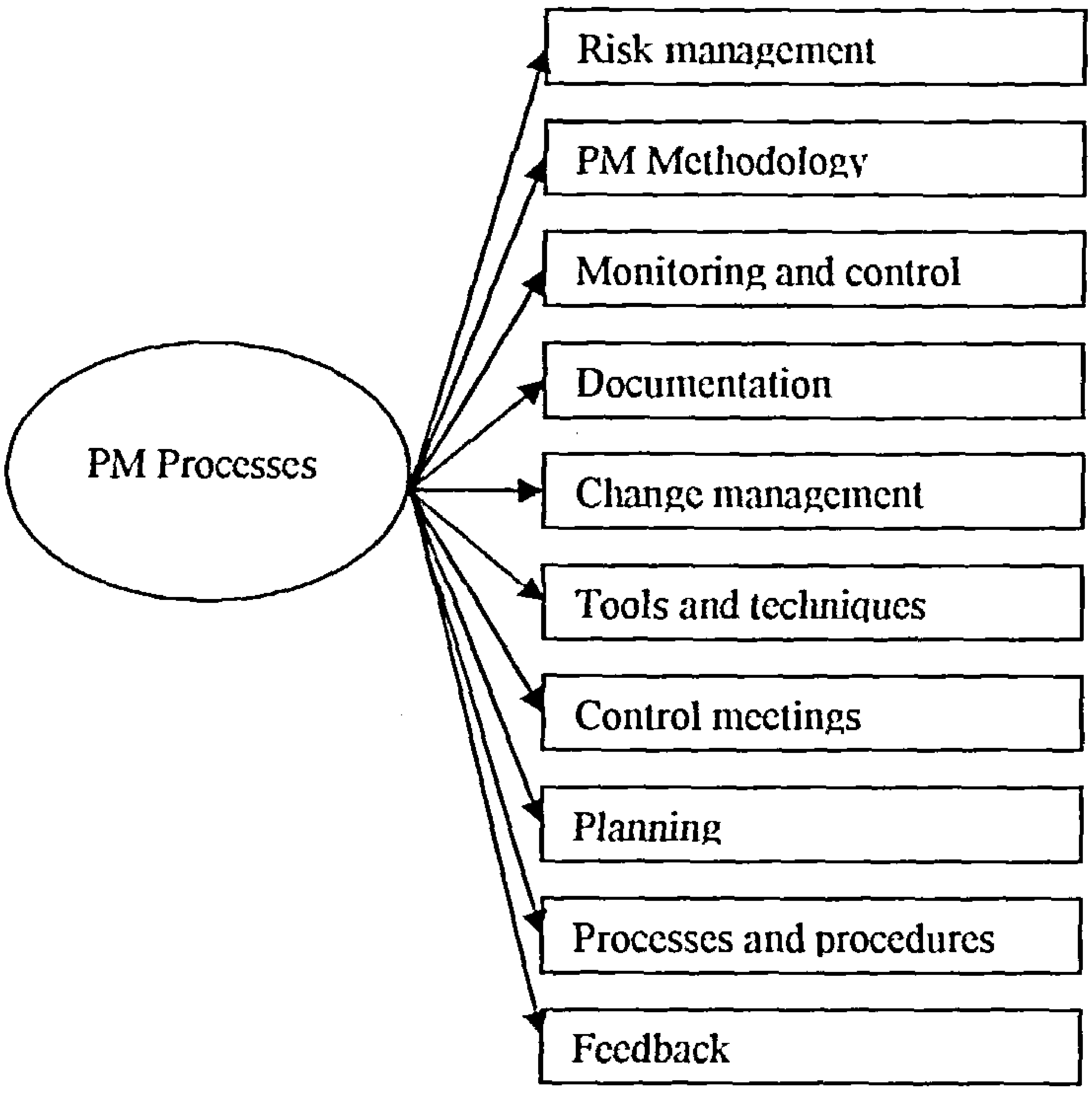

Figure 5. 12: PM Processes Measurement Model

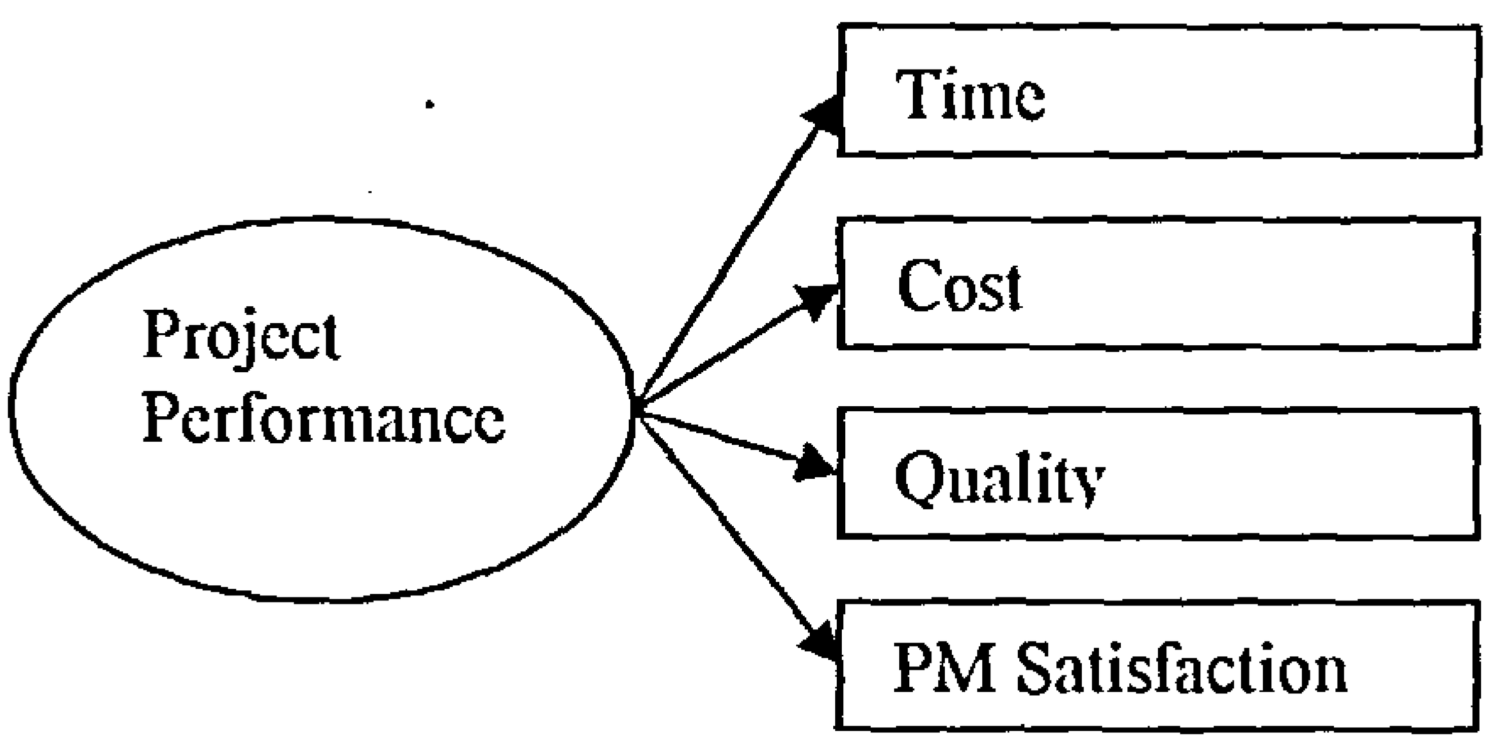

Figure 5. 13: Project Performance Measurement Model

5.3.3 PMPQ Measurement Model Summary

The discussion above has identified some of the criteria that can be used as indicator variables for the various constructs. The selection of these indicator variables is based on justification in literature on critical success factors. It is clear, therefore, that there is sound theoretical justification for inclusion of these indicator variables into the PMPQ model. The purpose of this research as cited in Chapter One is to evaluate the significance of the relationship between project management quality variables and project performance. Using the PMPQ model described in Section 5.2.4, provides an opportunity to evaluate direct and indirect relationships. The importance of these variables here is that they are the manifest or indicator variables of the quality constructs as described in Section 5.2.4. Appendix C presents a summary of the selected indicator variables for each construct.

5.4 Section Four: Research Hypotheses

Several studies have shown the possible linkages between the quality constructs and between quality constructs and performance. Similar to the work of Anderson et al (1999) and Pannirselvam and Ferguson, (2001) causal relationships can be postulated from the PMPQ model. Figure 5.7 on page 114, shows the relationships between the constructs as they have been defined for the PMPQ model.

From figure 5.7 the following hypotheses are generated about the relationship between quality in project management, as defined by the five PMPQ quality constructs and construction project performance.

H1: Project performance is positively directly related to project management processes while it is indirectly related to project management leadership, project management strategy, project management communication and project management team.

H2: Project team management is positively directly related to project management leadership

H3: Project communication is positively directly related to project management leadership.

H4: Project management strategy is positively directly related to project management leadership

H5: Project management process management is directly positively related to project team management

H6: Project process management is positively directly related to project communication

H7: Project process management is positively directly related to Project strategy

H8: Project performance is positively directly related to project process management

The evaluation of these hypotheses in Chapter Six provided an insight into the direct and indirect influences of project management process quality variables on construction project performance. This was consistent with the aims and objectives of the present research as indicated in Section 1.3 of Chapter One.

5.5 Chapter Summary

The use of a quality award based framework to evaluate the relationship between quality variables and performance is demonstrated in literature. A review of literature shows that there are several models, however the majority are based on TQM principles. This implies therefore that irrespective of which model is used, there is bound to be a relationship between quality practices and performance. Of significance also with the use of these models is that they organise factors impacting on performance in a systematic way as they are based on theoretical understanding. The application of the use of such models in project management environment was demonstrated. This research uses a similar method and defines a quality award based model to define PMPQ variables and how this relates to construction project performance. Section 5.2 detailed the PMPQ model based on the EFQM model. Section 5.3 examined further the PMPQ model and discussed both the structural model and the measurement model. Section Four developed further the research hypothesis stated in Chapter One into specific sub hypotheses. These are intended to examine the significance and strength of the relationship between project management process quality and construction project performance.

CHAPTER SIX

Presentation of Data and Fitting the Model

6.0 Introduction

Chapter Four discussed the seven steps involved in SEM. These included, (i) the development of a theoretically based model, (ii) construction of a path diagram, (iii) the converting the path diagram, (iv) choosing the input matrix type, (v) assessment of the identification of the model, (vi) evaluation of goodness-of-fit and, (vii) interpretation of the model (Hair *et al* 1998).

Chapter Five concerned itself with the first three steps. A theoretical PMPQ model, derived from a review of literature was presented in Sections Two and Three of Chapter Five. A path diagram for the PMPQ model was presented in figure 5.4 on Page 114 of Chapter Five and the framework for the selection of suitable measurable variables for particular PMPQ constructs was discussed in Section 5.3.2. Further the path diagram was presented as a set of research hypotheses in Section 5.4. These represented the structural equations that needed to be analysed with respect to the research aim. This chapter is concerned with the remaining four stages. In the main, it is concerned with the empirical evaluation of the model with respect to the relationship between project management process quality and construction project performance.

Section One of this chapter presents the data acquisition process while the remaining sections are concerned with the presentation of the data collected and the subsequent details of the results. Section Two presents the general characteristics of the sample, while Section Three is concerned with the general characteristics of projects reviewed. Section Four presents the empirical results with respect to analysis of the goodness-of-fit of the model and determination of the causal influence of project management process quality constructs on construction project performance.

6.1 Section One: Acquisition of Data

In Chapter Four questionnaire survey was discussed as the appropriate method for data collection based on its ability to be used for collection of data from large samples. Chapter Five discussed the project management process quality (PMPQ) model. The model as discussed in Section 5.3 contains the structural model, which describes the relationships between PMPQ constructs, which are the latent variables, and also the measurement model, which describes the indicator variables that can be used to measure these constructs. This Section is concerned with the acquisition of data for the project management process quality indicator variables identified in Section 5.3.2. In particular it is concerned with the development of the questionnaire, which was used as the survey instrument, the data acquisition processes including population identification, choice of sample and questionnaire administration.

6.1.1 Questionnaire Development-The Survey Instrument

The questionnaire was designed to collect principally two sets of data. This included firstly data concerning the indicator variables in the PMPQ model and secondly project performance data. This was consistent with the objectives of the research, which principally was concerned, with the evaluation of the relationship between project management process quality and construction project performance.

6.1.2 Questionnaire Design

A number of decisions had to be made concerning the design of the questionnaire. This was important so as to maximise the response rate and also the quality of the responses. The following issues discussed below were considered.

Questionnaire Layout

The Questionnaire was divided into three categories. The first section was for general information. This was designed to gather general company information including respondent's details. The second section was designed to collect construction project performance information while the third section was designed to collect data concerning the indicator variables for the PMPQ constructs. This included questions about the perception of respondents concerning the level of application of the project management quality variables identified. These are the indicator variables for each of the PMPQ constructs identified in Section 5.3.2 of Chapter Five.

In order to help respondents answer correctly, necessary instructions were provided at the beginning of each section explaining the requirements. Further more a covering letter was included at the beginning of the questionnaire with information about the research. The questionnaire and the covering letter are included in Appendix D.

PMPQ Data-Use of Likert Scale

The design of the questionnaire for PMPQ data instructed respondents to indicate the level of application of quality indicator variables on the projects they worked on based on a 5-point likert scale, with *(1)* indicating very low and *(5)* indicating very high. However, a pilot questionnaire survey was conducted and sent to ten (10) respondents. The responses from the original questionnaires indicated that there was less variability in the answers given. It was concluded that a 7-point likert scale be used to increase variability of responses (Cummings 2000). The use of a 7-point likert scale is suitable and provides a more reliable scale than a five-point scale (Cummings 2000).

Project Performance Data

Chapter Two concluded that the most appropriate performance criterion for this research was the traditional criteria which measures the success of the project based on time, cost and quality performance and project manager's satisfaction with project outcomes. In addition Project Manager's satisfaction with the project outcomes was also included as a measure of participants' satisfaction. This criterion for performance measurement was justified in Chapter two. Consideration was given on how these variables can be measured. This research took the same approach as that taken in Brown (1996) and Brown and Adams (1999) in measuring the first three performance variables. The quantification of time performance was based on the comparison between estimated project duration at the time of tender and the actual duration at the end of the contract. However in order to accommodate respondents who were involved on projects that had not yet been completed, the comparison was made between the estimated time at tender and the estimated final duration at any point during the execution of the project. This therefore required the inclusion of questions to capture the estimate at tender and the actual final duration at completion or the estimated final duration. Similarly cost performance data required to compare the estimate at tender and final cost upon completion. In a similar manner to the time performance criteria, were projects had not yet been completed respondents were required to give estimated final cost. The quantification of quality performance data was problematic. However similar to Brown (1996) number of defects was used as a representative indicator of this criteria. In order to capture the level of defects respondents were asked to indicate on a scale of *1-5* the level of defects with *(1)* being low and *(5)* being high. This provided a measure of the quality performance of the projects. The quantification of satisfaction of the project manager was based on four measures. This included satisfaction with time performance, cost performance, quality performance and overall satisfaction. These were measured on a 5-point likert scale. An analysis of responses from the pilot survey for these questions indicated that there was sufficient variability in the scores between respondents. Therefore it was concluded that the 5-point likert scale for these questions be maintained.

6.1.3 Population Identification and Choice of Sample

As the research required specific project information concerning the application of project management quality variables, the target sample was project management firms. The sample population was drawn from construction project management consulting firms in the UK. Targeted firms were drawn from dedicated project management firms, architectural consulting firm, engineering consulting firms and quantity surveying firms providing project management services. The criterion for selection was based on the firm's description of its services. Companies in the construction that listed project management as one of their main services were selected. It was hoped that by expanding the definition of project management firms, the number of possible respondents would increase therefore increasing the sample population to achieve the required minimum sample size.

6.2 Section Two: General Characteristics of the Sample

6.2.1 Sample Size

A total of 400 potential respondents were identified based on the criteria described in Section 6.1.3. The survey was administered in two stages. In the first stage, a covering letter explaining the purpose of the survey and a survey questionnaire including a postage-paid envelope where sent to the 400 potential respondents. The second stage involved sending an email to respondents who had not yet answered the questionnaire after four weeks. A total of 67 completed questionnaires were received back representing a 17% response rate. This is within the expected response rate in questionnaire surveys (Burns 2000; and Denscomb 2003). Of these, four questionnaires were rendered unusable because they were largely incomplete or the answers were deemed to be inconsistent with the perceived pattern of answering. The remaining 63 (16%) were used in the subsequent analysis.

In Chapter Four, the issue of sample size was considered. It was noted that there was no clear recommendation as to the required minimum, though that there is need to have as many cases as possible. It was anticipated that at least 100 cases would be achieved (See Section 4.3.3). Therefore the response rate of 63 cases was below the expected minimum of 100. Although it is considered that the sample size of 63 was below the 100-200 recommended responses, it was still within the sample found in other studies. As noted in Chapter Four Section 4.3.3, small samples of fewer than 100 are not uncommon (McCullum and Austin 2000). Based on this, the sample size was considered as at least adequate to proceed with the use of SEM to evaluate the relationship between PMPQ and construction project performance.

The effect of sample bias was also considered with respect to the significant number of non-responses. However as noted in Section 6.1.3, the sample was drawn from firms who offered project management services. Based on this, it was considered that all potential respondents had the same characteristics and that both the firms that responded and those that did not respond had the same characteristics and therefore no non-response bias was expected. This is reflected in the analysed data as presented in table 6.2 (page 138) which shows that 61 out of the 63 respondents were project managers on the projects evaluated. Further as discussed in Section 6.1.3, the sample frame were drawn from multi disciplinary firms who offer project management as part of their services and therefore considered themselves as project managers. The data in table 6.3 (page 138), shows that a significant number of firms (81%) considered themselves as project management firms. This is despite being multidisciplinary firms. It was expected therefore that all respondents would have similar characteristics being the provisions of project management services. Therefore the effect of non-response bias was considered non significant in the research as the characteristics of all potential respondents were similar with respect to the provision of project management services.

6.2.2 Respondents Characteristics

The general section of the questionnaire included questions on the characteristics of respondents. One of the characteristics considered was the disposition of the respondents. Of the 63 respondents 31 (49%) of these were Directors, Associate Directors or Partners of the companies they represented, 16 (25%) of them were Senior Project Managers, 11 (18%) were Project Managers and five (10%) occupied other positions. Table 6.2 presents the demographic distribution of the respondents by their disposition. Of all the respondents 97% were Project Managers on the projects analysed as table below. Only 3% were not project managers on the projects they analysed (see table 6.2). It was deemed necessary in the questionnaire to request that project managers, for the projects to be analysed, were preferred respondents as they were deemed key to the projects. The statistics above indicate that the expected quality of the respondents would be credible as project managers involved on the projects were the respondents.

6.2.3 Type of Firms

Table 6.3 below shows that the respondent's firms were mostly dedicated project management firms. The table shows that of the 63, 81% of them classified themselves as Project Managers while of course offering other services. 6% classified themselves as Quantity Surveyors, 3% as Engineers, 2% as Management Contractor and Architects and others were 6%. This is significant as the results presented show that most of the firms considered themselves as project management firms. However it must be stated that though 19% classified themselves as being other than project management firms, they too offered consultant project management as a key service. It is also possible that some of these firms, while being multi-disciplinary firms, have dedicated project management departments and therefore would consider themselves as project management firms.

Disposition	Frequency	Percent	Cumulative Percent
Director/Partner	31	49.2	49.2
Senior Pm	16	25.4	74.6
Project Manager	11	17.5	92.1
Other	5	7.9	100.0
Total	63	100.0	

Table 6.1: Disposition

Role as PM	Frequency	Percent	Cumulative Percent
Yes	61	96.8	96.8
No	2	3.2	100.0
Total	63	100.0	

Table 6.2: Role as Project Managers

Category	Frequency	Percent	Cumulative Percent
Quantity Surveyors	4	6.3	6.3
Project Managers	51	81.0	87.3
Architects	1	1.6	88.9
Engineers	2	3.2	92.1
Contractors	1	1.6	93.7
Other	4	6.3	100.0
Total	63	100.0	

Table 6.3: Category of firms

6.2.4 Experience as Project Managers

The respondents were also asked to rate their experiences in project management. The respondents experience in providing project management services varied from a range of 1-5 years to more than ten years experience. The majority of firms have been providing project management services for more than five years with a total of fifty seven firms (91%) in this category. Forty three of these (68%) have been providing project management services for more than ten years. (See table 6.4).

Years	Frequency	Percent	Cumulative Percent
1-5 Years	6	9.5	9.5
5-10 Years	14	22.2	31.7
>10 Years	43	68.3	100.0
Total	63	100.0	

Table 6.4: Experience-Number of Years as Project Manager

Another factor that was used to assess the level of experience in providing project management services was the number of projects that the firms had handled in the project management capacity. The number of projects handled in the firm also varied from 2-5 to over ten projects in the last two years. Table 6.5 shows that forty one firms (65%) have provided project management services on more than ten projects, thirteen (21%) have worked on at least five to ten projects and nine of the firms (14%) have at least worked on two to five projects. This data shows that respondents are relatively experienced in providing project management services. This should therefore provide a greater level of confidence in the data obtained.

Number of Projects	Frequency	Percent	Cumulative Percent
2-5	9	14.3	14.3
5-10	13	20.6	34.9
>10	41	65.1	100.0
Total	63	100.0	

Table 6.5: Number of Projects

6.2.5 Size of the Companies

The questionnaire was also used to gather data on the size of the companies in which the respondents worked. Two measures were used to indicate the sizes of the firms. These included turnover and number of employees in the firm. It was observed from the results that the majority of the firms are small to medium sized firms reflecting the structure of construction industry. In terms of turnover (see table 6.6) the majority of the firms (40) have annual turnover of less then ten million representing sixty four (64%) while only three (representing 4.8%) of the respondents had an annual turnover of over three hundred million. This is also reflected when the number of employees is considered as a reflection of the size of the firm (see table 6.7). Forty four percent (44.4%) of the respondents were from firms with less than twenty five employees while eleven percent was from firms with over one thousand employees. However it must be mentioned that most of these organisations with over 200 employees, are global organisations with offices in most of the UK cities and in the major cities of the world.

Turnover	Frequency	Percent	Cumulative Percent
0-10M	40	63.5	63.5
10-25M	9	14.3	77.8
25-50M	6	9.5	87.3
50-100M	1	1.6	88.9
100-300M	4	6.3	95.2
>300M	3	4.8	100.0
Total	63	100.0	

Table 6. 6: Turnover

No of Employees	Frequency	Percent	Cumulative Percent
1-25	28	44.4	44.4
25-50	8	12.7	57.1
50-200	15	23.8	81.0
200-500	3	4.8	85.7
500-1000	2	3.2	88.9
>1000	7	11.1	100.0
Total	63	100.0	

Table 6. 7: Number of Employees

6.3 Section Three: General Project Characteristics

Respondents were asked to review their project management practices on specific projects where they had provided project management services. It was noted that the majority of respondents were actively involved in these projects as project managers. In Sections 6.2.3 to 6.2.5 it was noted that the majority of respondents were from experienced project management firms. Tables 6.8 to 6.11 present general information about the projects evaluated. Most of the projects reviewed were building projects (71%) while 13% were civil engineering projects, 5% services engineering projects and 11.1% as other. Contract sum for the projects ranged from less than one million pounds to over fifty million pounds with 56% of the projects having a contract sum of less than £5 million (see table 6.9). The contract period range was from less than five months to over 20months. The design period was also considered. This also ranged from less than five months to over twenty months (see table 6.10 and 6.11)

Type	Frequency	Percent	Cumulative Percent
Civil Engineering	8	12.7	12.7
Building	45	71.4	84.1
Services	3	4.8	88.9
Other	7	11.1	100.0
Total	63	100.0	

Table 6. 8: Type of Project

Contract Sum	Frequency	Percent	Cumulative Percent
<1M	12	19.0	19.0
1-5M	23	36.5	55.6
5-10M	8	12.7	68.3
10-50M	16	25.4	93.7
>50M	4	6.3	100.0
Total	63	100.0	

Table 6. 9: Contract Sum Range

Contract Period	Frequency	Percent	Cumulative Percent
<5months	11	17.5	17.5
5-10months	16	25.4	42.9
10-15moths	15	23.8	66.7
15-20months	9	14.3	81.0
>20months	12	19.0	100.0
Total	63	100.0	

Table 6. 10: Contract Period Range

Contract Period	Frequency	Percent	Cumulative Percent
<5months	27	42.9	42.9
5-10months	24	38.1	81.0
10-15months	7	11.1	92.1
15-20months	3	4.8	96.8
>20months	2	3.2	100.0
Total	63	100.0	

Table 6. 11: Design Duration Range

6.4 Section Three: Empirical Results

6.4.1 Graphical Representation of the model

In Chapter Five the PMPQ model was presented. Figure 6.1 is the graphical representation of the model showing the structural model, which depicts the postulated causal relationships between project management process quality factors and construction project performance.

The model shows that it has five project management process quality constructs, including project management leadership (leadership), project management policy and strategy (strategy), project management team (team), project management partnerships and resources (partnership and resources) and project management processes (processes), which aggregately impact on project performance (performance). The measurement variables relative to each construct are omitted from the figure for clarity.

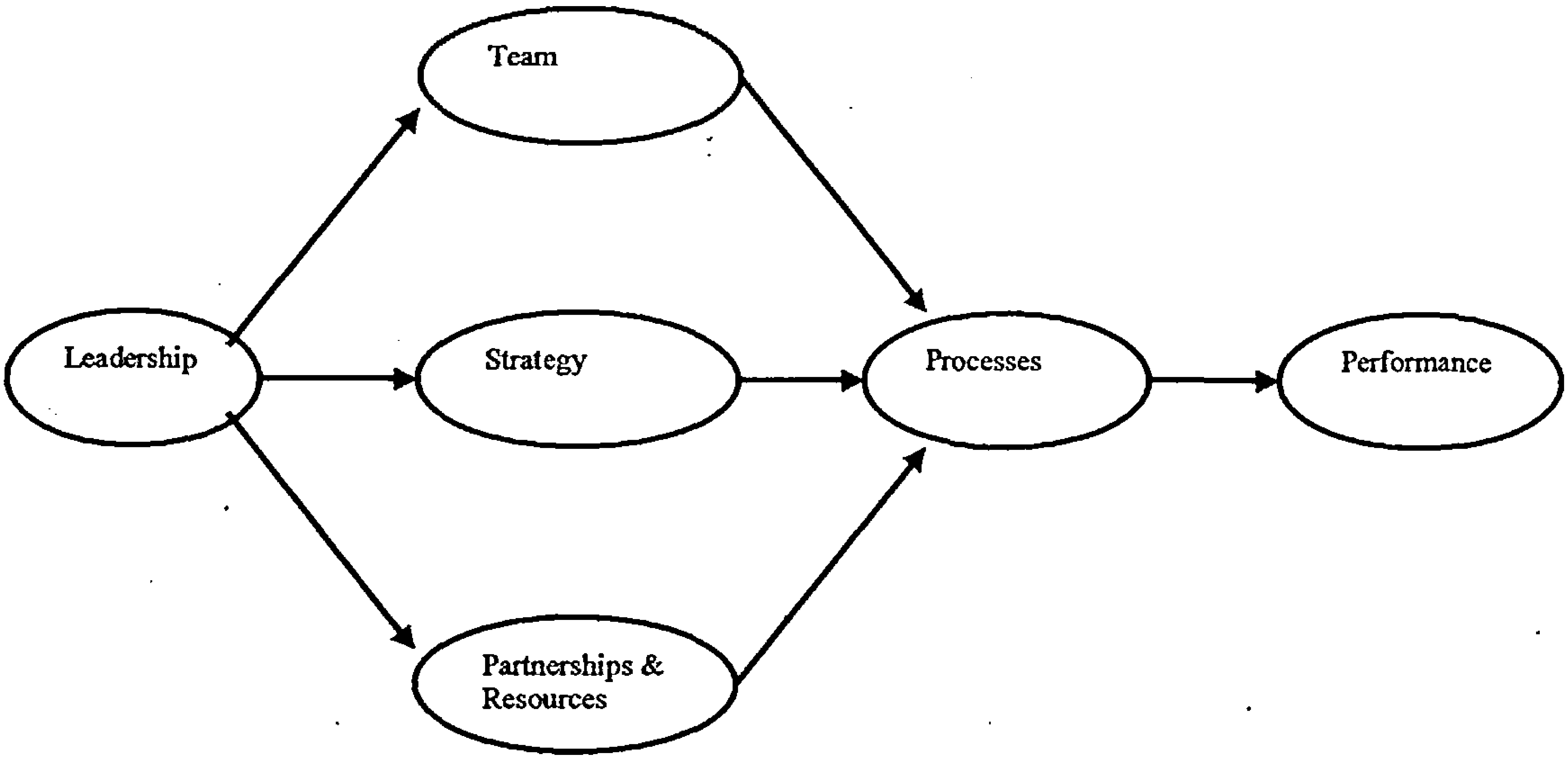

Figure 6. 1: Hypothesised PMPQ Model (a)

6.4.2 The Research Hypotheses

In Chapter One, the theoretical proposition was stated that

> *There is a significant positive relationship between project management process quality and construction project performance.*

In order to examine this proposition further, the PMPQ model was developed which links PMPQ factors as representing project management process quality and construction project performance factors as represented in figure 6.2.

Based on this, eight hypotheses were postulated *apriori* in Section 5.4 of Chapter Five. These are re stated below, that:

> *H1: Project performance is positively directly related to project management processes while it is indirectly related to project management leadership, project management strategy, project partnerships and resources and project management team.*

> *H2: Project team management is positively directly related to project management leadership*

> *H3: Project partnerships and resources is positively directly related to project management leadership.*

H4: Project management policy and strategy is positively directly related to project management leadership

H5: Project management processes is directly positively related to project team

H6: Project management processes are positively directly related to project partnerships and resources

H7: Project management processes are positively directly related to Project management policy and strategy

H8: Project performance is positively directly related to project management processes

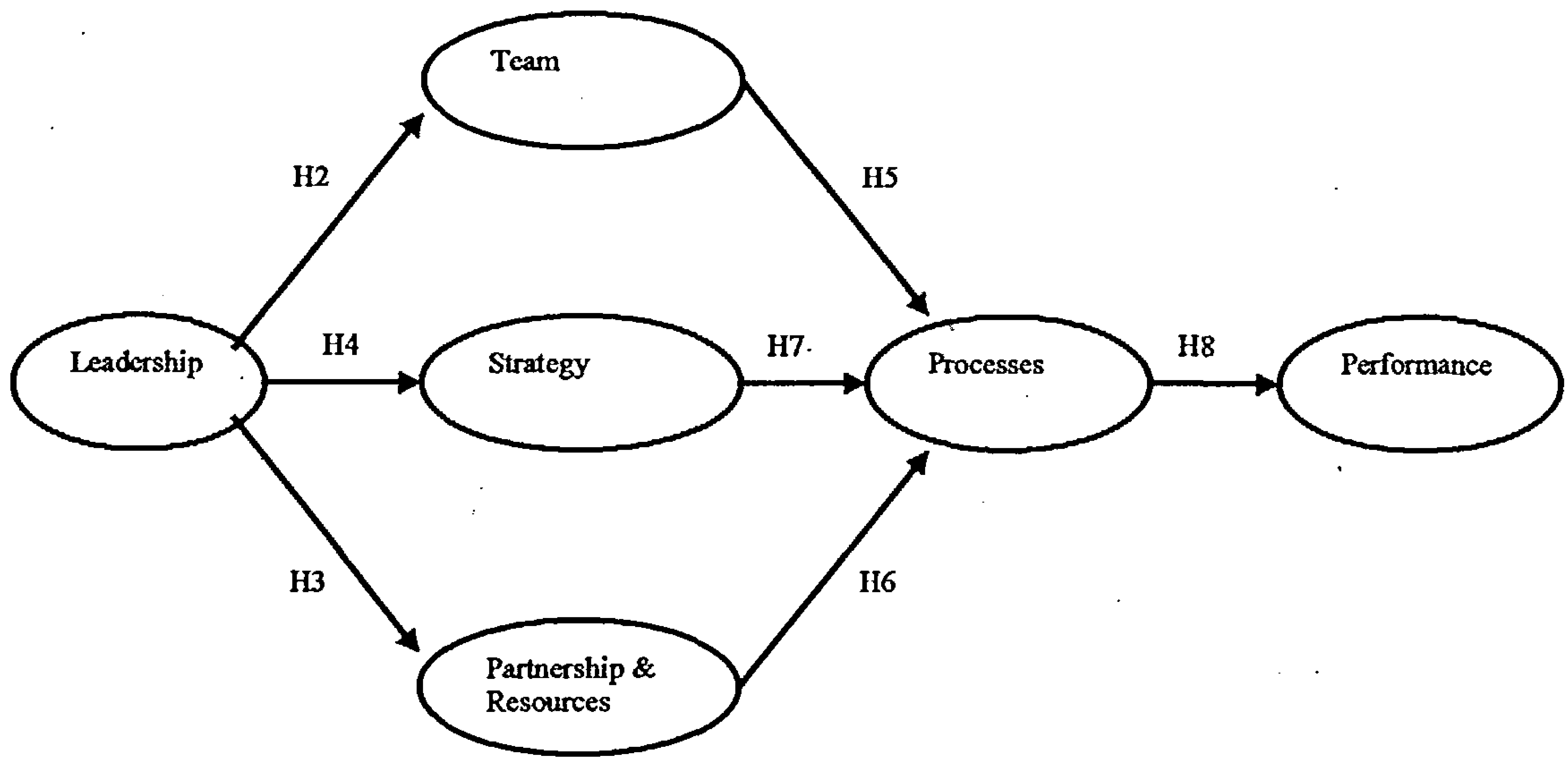

Figure 6. 2: Hypothesised PHPQ Model (b)

As stated earlier in Section 1.3.1 of Chapter One, the primary aim of the research was to evaluate the strength of the relationship between project management quality variables and construction project performance. It was noted in Section 5.1.3, that such as evaluation model, as depicted in figure 6.1, could be construed as a causal model based on quality models. Using the PMPQ model it is seen that the influence of leadership, strategy, team and partnership and resources on performance is indirect through project management processes. This research therefore was aimed at evaluating the significance of this web of relationships upon construction project performance as depicted in figure 6.2. The foregoing enabled the assessment of the direct and indirect relationships between project management process quality factors and construction project performance.

6.4.3 Assessment Strategy

The approach taken in the assessment of the overall model is based on a two-stage process (Schumacker and Lomax 2004 and Byrne 2001). This involves firstly testing the factorial validity of the measurement model. Once the measurement model is deemed acceptable then the structural model is assessed. This provides an opportunity to check the measurement model and modify if necessary.

In Section 4.2.14 of Chapter Four, potential modelling strategies were discussed. These included the 'strict confirmatory approach', the 'model development approach' and the 'competing models approach' (Hair *et al* 1998). As already discussed in the aforementioned section the approach selected in this research was the 'model development approach', which involve proposition of a model with the purpose of improving the model through modifications of the structural and/or measurement model if the preliminary analysis indicates a poor model fit.

6.4.4 The Measurement Model-Testing For Factorial Validity

The first step in the assessment of the model was the assessment of the measurement model by testing the factoral validity of the measurement model. However before SEM analysis could be performed, it was deemed prudent to reduce the number of measurement indicators per construct. This was based on the argument that, the more complex the model, the larger the sample size required. Seeing that the number of measurement items increases the complexity of the model, reducing the number of measurement items would simplify the model thereby reducing the effect of sample size on the results. This is consistent with MaCullum and Austin (2000) who suggested that small samples should be used with simpler models only.

However before reduction could be achieved it was deemed necessary to evaluate the reliability of the original measurement scale. The total number of measurement or indicator variables in the model is fifty-one. Nine measurement variables for the project management leadership construct, seven for the project management strategy, ten for project management team, ten for project management processes, eleven for project partnerships and resources (five for project partnership, six for project management communication) and four for project performance. In order to reduce the number of measurement variables, it was considered necessary to restrict the number of measurement variables per construct to three, except for the performance construct. This would significantly reduce the total number of variables from fifty-one to nineteen measurement variables. This significantly reduces the complexity of the model as the more variables there are the more complex the model.

Preliminary Analysis of Measurement Model

Preliminary analysis of the measurement model based on factor analysis was used to test the reliability of the measurement scales. This measures the internal consistency of the measurement model. Table 6.12 (page 146) presents the results of reliability analysis. It will be noted from the table that the Construction project performance construct was not subjected to factor analysis as this measurement scale is highly supported in literature as a measure of project performance. This was discussed in Section 2.2.4.

Both the Cronbach alpha values and inter-item correlations were considered. Cronbach alpha values of > 0.70 were considered to represent an acceptable measurement model for each particular construct (Pallant 2001). Pallant (2001) notes that this statistic is quite sensitive to the number of items in a scale and recommends that where the scale contains less than ten items, low values of 0.5 are not uncommon. It is recommended that in such a case the mean inter-item correlation for the items should be reported. Items with values of less than 0.30 inter-item correlation would suggest that the items are measuring something else and therefore potentially should be considered for deleting if the Cronbach alpha is less than 0.70 (Pallant 2001).

The results from the analysis showed that the PMPQ constructs' measurement scales have generally good internal consistency based on the Cronbach alpha values except for the Partnership and Resources construct, which had a value of 0.661. This is below the 0.70 thresholds. Further examination of the corrected inter-item correlations, for all the constructs, showed that the measurement scales for project management leadership and partnership and resources could be further improved, by deleting items with a corrected inter-item score of less than 0.30. In the Project leadership constructs, project manager's qualification had an inter-item correlation value of 0.10. Once this item was deleted the Cronbach alpha value increased from 0.716 to 0.770. This still shows a good measurement scale.

Construct	Measurement Variable (Corrected item-total correlation)	Cronbach alpha
Leadership	• Roles and responsibilities of pm (0.568)	0.716
	• Definition of clear goals (0.587)	
	• Level of authority given to pm (0.588)	
	• Experience of pm (0.298)	
	• Competence of pm (0.363)	
	• Suitability of organisation structure (0.435)	
	• Qualification of pm (0.10)	
	• Leadership style (0.474)	
	• Client support (0.334)	
Strategy	• Pm methodology (0.768)	0.898
	• Clear definition of success criteria (0.729)	
	• Project reviews (0.782)	
	• Feedback mechanism (0.756)	
	• Pm involvement in briefing (0.621)	
	• Awareness of project requirements (0.616)	
	• Quality of plan/strategy (0.684)	
Team	• Roles and responsibilities of project team (0.541)	0.869
	• Team skills and knowledge (0.729)	
	• Corporation between team members (0.721)	
	• Experience of team members (0.279)	
	• Commitment of team members (0.667)	
	• Shared clear vision of goals (0.634)	
	• Capability of team (0.742)	
	• Working relationship in team (0.71)	
	• Level of trust in team (0.645)	
	• Level of conflict (0.341)	
Processes	• Risk management strategy (0.699)	0.915
	• Implementation of methodology (0.775)	
	• Degree of monitoring and control (0.768)	
	• Implementation of pm processes and procedures (0.778)	
	• Change management (0.64)	
	• Tools and techniques (0.585)	
	• Frequency of control meetings (0.722)	
	• Quality of planning (0.743)	
	• Appropriateness of pm processes and procedures (0.773)	
	• Frequency of feedback to client (0.582)	
Partnership and Resources	• Partnering (0.12)	0.661
	• Collaboration (0.281)	
	• Past projects with client (0.154)	
	• Past projects with team (0.096)	
	• Procurement (0.287)	
	• Communication procedures (0.464)	
	• Adequacy of information (0.384)	
	• Timelines of communication (0.456)	
	• Methods of communication (0.64)	
	• Frequency of communication (0.575)	
	• Accuracy of information (0.556)	

Table 6. 12: Reliability Analysis-Original Scales

Construct	Indicators	Cronbach Alpha
Project Management Leadership	• Definition of roles and responsibilities of the project manager • Definition of project management goals • Authority given to project manager by client • Experience of PM • Project managers competencies • Project organisation structure • Project manager's leadership • Client support to project manager	.770
Project Management Policy And Strategy	• Project management methodology • Definition of project success/failure criteria • Project management process performance reviews • Formal feedback mechanism • Project brief process • Awareness of the project's requirements by all parties • Quality and detail of project management plan/strategy	.0898
Project Management Teams	• Defined roles and responsibilities of all project team members • Skills and knowledge • Cooperation among project team members • Commitment of Project team to project and project management process • Shared understanding of the functional and technical performance required • Capability of project team • Working relationship among project team members • Trust between project participants • Conflict between team members	0.880
Project Management Processes	• Risk management • *Implementation of project management methodology on the project* • Project management processes were monitoring and control • Implementation of project management processes and procedures as documented in the project management strategy/plan • Change management process • Project management tools and techniques • Control meetings • Project planning • Project management processes and procedures • Frequency of feedback to client about project progress	0.915
Project Partnership and Resources (Communication)	• The existence, use and effectiveness of formally defined communication procedures • Adequacy of information passing among project team members • Timeliness of communication among project team members during design and construction phases • Suitability of the methods of communication among project team members • Frequency of communication between project team members • Accuracy of information passed among project team members	0.865

Table 6. 13: Reliability Analysis-Adjusted Scales

Examination of the Partnership and Resources construct shows that all items related to the stakeholder sub-construct should be deleted from the scale. When these items were deleted the Cronbach alpha value significantly improves to 0.865. This again shows a very good measurement scale for the construct. Subsequently this construct was renamed project management communication (communication) to reflect the content of the measurement model. This is the term used in the rest of this thesis. The refined measurement model is presented in table 6.13 (page 147) showing satisfactory Cronbach Alpha values for all the constructs.

Item Parcelling

While the model developed shows that each of the constructs is measured by at least six items except for the performance construct and that the preliminary factor analysis was based on this loading matrix, it was considered prudent to reduce the number of indicator variables per construct. Because of the small sample size achieved, it is considered wise to use fewer items per construct as sample size and complexity are some of the major factors that affect the validity of results (Hair *et al* 1998). Reducing the number of items simplifies the model. The use of composite item parcelling is recommended in literature as a way of reducing the number of indicator variables (Schumacher and Lomax 2004 and Hau and Marsh 2004). Item parcelling involves forming composite items from a number of items, thereby reducing the number of items while still accounting for all.

Landis *et al* (2000) identified six different approaches to forming item parcels in SEM. This includes single factor analysis, which involves pairing off items with highest and lowest loadings as first composites based on a single factor solution. The next set of items would be the second highest and the second from the bottom. This procedure continues until all items have been parcelled. The second method is the correlation method, which involves pairing items based on inter-item correlation. Items with the highest correlation will be selected as the first pair. The next highest set will form the second parcel. This again continues until all the items are paired. The third method is the random method, which involves randomly assigning items to parcels. The fourth method is the content method, which involves creating composites items based on rational grouping of items based on their content.

Construct	Variable	Factor Loading	New Variable
Leadership	Definition of clear goals	0.82	Lead1
	Roles and responsibilities of the project manager	0.81	Lead2
	Level of authority given to the project manager	0.73	Lead3
	Client support	0.64	Lead3
	Suitability of organisation structure	0.56	Lead2
	Leadership style	0.54	Lead2
	Competence of the project manager	0.42	Lead1
	Experience of the project manager	0.36	Lead1
Strategy	Project reviews	0.85	Strat1
	PM methodology	0.84	Strat2
	Feedback mechanism	0.83	Strat3
	Clear definition of success criteria	0.81	Strat3
	Quality of plan/strategy	0.77	Strat3
	Project manager's involvement in briefing	0.72	Strat2
	Awareness of project requirements	0.70	Strat1
Team	Capability of team	0.84	Team1
	Team skills and knowledge	0.80	Team2
	Cooperation between team members	0.79	Team3
	Working relationship in team	0.78	Team3
	Commitment of team members	0.76	Team3
	Level of trust in team	0.75	Team2
	Shared clear vision of goals	0.69	Team2
	Roles and responsibilities of project team	0.65	Team1
	Level of conflict	0.44	Team1
	Experience of team members	0.36	Team1
Communication	Timelines of communication	0.84	Com1
	Accuracy of information	0.79	Com2
	Methods of communication	0.79	Com3
	Adequacy of information	0.75	Com3
	Frequency of communication	0.75	Com2
	Communication procedures	0.72	Com1
Process	Appropriateness of pm processes and procedures	0.84	Proc1
	Implementation of pm processes and procedures	0.82	Proc2
	Degree of monitoring and control	0.82	Proc3
	Implementation of methodology	0.82	Proc3
	Quality of planning	0.81	Proc3
	Frequency of control meetings	0.80	Proc2
	Risk management strategy	0.74	Proc2
	Change management	0.70	Proc1
	Frequency of feedback to client	0.68	Proc1
	Tools and techniques	0.66	Proc1

Table 6. 14: PMPQ Item Parcelling Based on Single Factor Analysis

Construct	Item Parcel (New Variable Name)	Variables
Leadership	**Lead1**	Definition of clear goals Competence of the project manager Experience of the project manager
	Lead2	Roles and responsibilities of the project manager Suitability of organisation structure Leadership style
	Lead3	Level of authority given to the project manager Client support
Strategy	**Strat1**	Project reviews Awareness of project requirements
	Strat2	PM methodology Project manager's involvement in briefing
	Strat3	Feedback mechanism Clear definition of success criteria Quality of plan/strategy
Team	**Team1**	Capability of team Roles and responsibilities of project team Level of conflict Experience of team members
	Team2	Team skills and knowledge Level of trust in team Shared clear vision of goals
	Team3	Cooperation between team members Working relationship in team Commitment of team members
Communication	**Com1**	Timelines of communication Communication procedures
	Com2	Accuracy of information Frequency of communication
	Com3	Methods of communication Adequacy of information
Process	**Proc1**	Appropriates of pm processes and procedures Change management Frequency of feedback to client Tools and techniques
	Proc2	Implementation of pm processes and procedures Frequency of control meetings Risk management strategy
	Proc3	Degree of monitoring and control Implementation of methodology Quality of planning

Table 6. 15: PMPQ Item Parcels

Exploratory factor analysis and empirical equivalent are the last two methods. Exploratory factor analysis method involves creating composites based on results from exploratory factor analysis while the equivalence method involves creating composites with equal means, variances and reliabilities. Landis *et al* (2000) concluded that composites of all types yielded the required results. The single factor analysis was used in this study.

Hair *et al* (1998) recommend the use of three items per construct as a minimum. Therefore reducing the number of items to three per construct would be within the acceptable limits. The single factor analysis procedure as recommended by Landis *et al* (2000) was followed. However the requirement as noted above was to have three composite items per construct. Examination for items, for example, leadership factors, reveal that there are eight items, which if only two items were paired would form four constructs. In order to achieve the required three composite items per construct, three to four items were paired following the same procedures for Single factor analysis. Table 6.14 (page 149) list the items with their associated factor loadings and the new composite items. Table 6.15 (page 150) presents the summary of these composite items. The item parcels and their new names are used in subsequent analysis in place of the individual indicator variables.

Testing Factorial Validity of the Measurement Model

In order to test the validity of the measurement model it is important to check the factor loadings for each construct. Byrne (2001) recommended the use of factor analysis to test the factorial validity of the measurement model. The path diagram in figure 6.3 shows that the PMPQ measurement model is composed of Project Management Leadership (Leadership), Project Management Team (Team), Project Management Policy and Strategy (Strategy), Project Management Resources-Communication (Communication), Project Management Processes (Process) and Project Performance (Performance) as latent variables with associated measurement items. The indicator variables used are the item parcels as presented in table 6.15 (page 150), except for the construction project performance indicator variables. These were not subject to item parcelling and therefore the original indicators are used, including time, cost, quality and project manager's satisfaction (SAT.). The model also shows that the measurement model items are also affected by error terms, which are unobserved and act as exogenous variables.

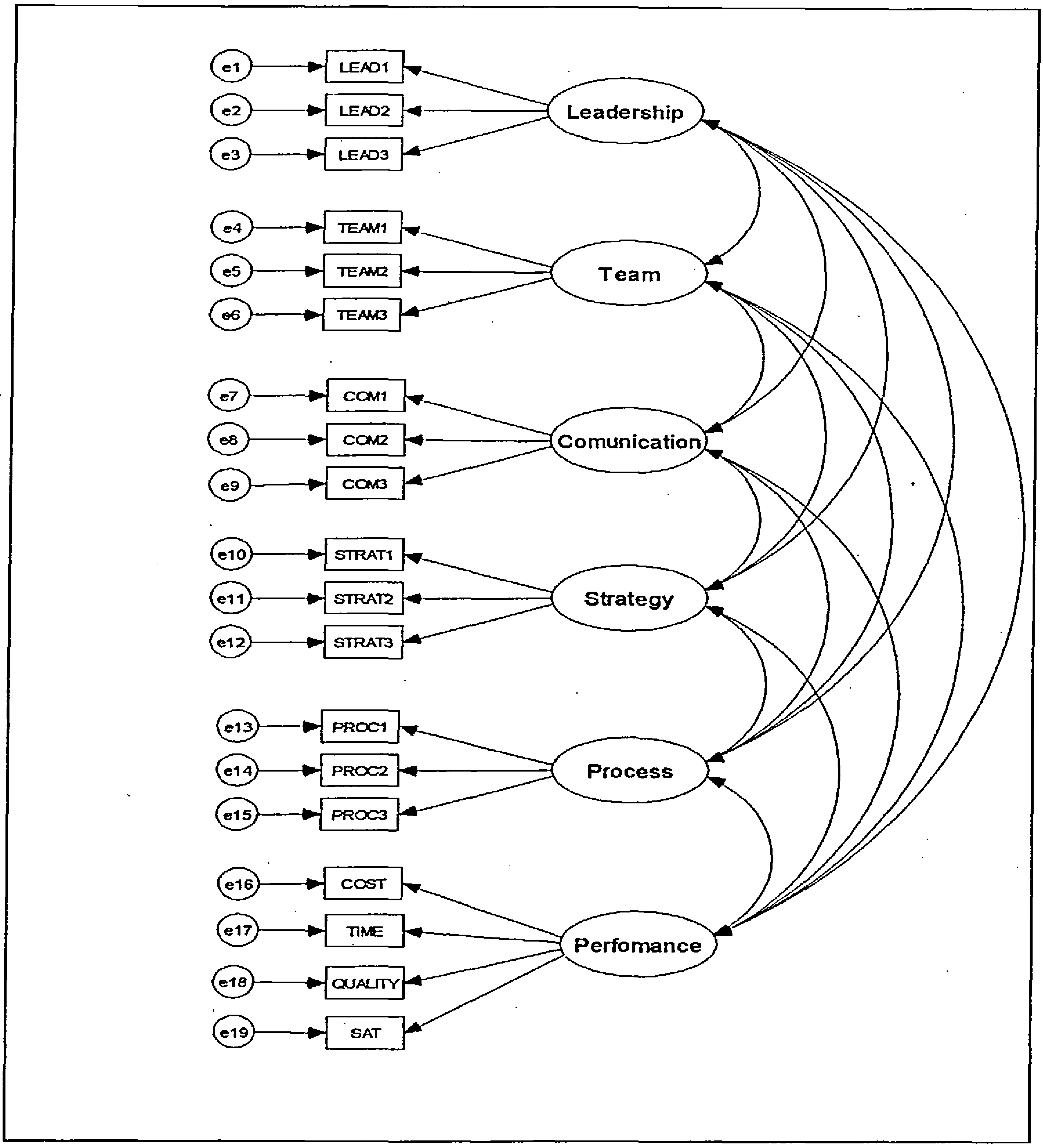

Figure 6. 3: PMPQ Measurement Model

Estimating Technique

Among the estimating techniques available include weighted least squares (WLS), generalised least squares (GLS), asymptomatic distribution free (ADF) and maximum likelihood estimating (MLE) (Hair *et al* 1998, Byrne 2001 and Bollen 1989). MLE was used. Most of the authors above agree that MLE is the most common technique and has been found to provide valid results with small samples. Indeed Levin *et al* (2005) support this argument and state that 'Maximum likelihood (ML) is the most efficient and widely used' technique of all. (See Chapter Four for a detailed discussion). In addition Hair *et al* (1998) acknowledged that sample size as low as fifty had provided valid results using Maximum Likelihood Estimating. Therefore the use of MLE was deemed appropriate for this research.

Data Input and Computer Programme

As earlier stated in Chapter Four, the computer programme used in this research was AMOS (version 6) as it was the only dedicated SEM software available to the researcher. (See Chapter Four for a discussion of the AMOS programme on page 82). Covariance was used as the input matrix. Although data input was done using SPSS version 12, the AMOS programme was used to convert this into a covariance matrix.

Discussion of Results

This section includes a discussion of the results of the structural equation modelling of the measurement model. Consideration is given to three issues critical to the assessment of SEM. Theses include (a) the model, parameters and estimation (b) model assessment including, parameter estimates, feasibility of estimates, appropriateness of standard errors and statistical significance and (c) assessment of the model as whole. This considers the goodness-of-fit statistics and (d) interpretation of results. Consideration is also given to the potential modification of the model to define a better model that would fit the data.

Model, Parameters and Estimation Summary

A preliminary analysis of the model, with respect to the inspection of the model, parameters and estimates is recommended as a first step in the analysis of SEM results (Bryne 2001). The AMOS programme generates output necessary for analysis of the model. Table 6.16 (page 154) shows that the data is consistent with the path diagram, presented in figure 6.3, as all observed variables operate as depended variables in the model, while all factor and error terms are unobserved and operate as independent variables in the model.

The identification of the model was also assessed and the results show that the model is identified. In Chapter Four assessment methods of the model were discussed. It was observed that model identification results can either be (1) under-identified, (2) just-identified or (3) under-identified. However the primary goal in SEM is to have a model that is over-identified (Hair *et al* 1998). Two methods can be used to assess this. The first method is the *order condition* where the degrees of freedom must be greater than or equal to zero for a model to be identified. It is clear from the results in table 6.17 and table 6.18 that this model is accepted based on the order condition, as there are 137 degrees of freedom.

Summary of Variables in the Model	
Observed, endogenous variables	Unobserved, exogenous variables
Lead3	Leadership
Lead2	e3
Team1	e2
Strat3	Team
Strat2	e4
Strat1	Strategy
Proc3	e12
Proc2	e11
Time	e10
Cost	Process
Team2	e15
Quality	e14
Team3	e17
Lead1	e16
Com3	e5
Com1	Performance
Com2	e18
Proc1	e6
PM Satisfaction	e1
	e9
	Communication
	e7
	e8
	e13
	e19

Table 6. 16: Summary of Variables in the Model

Computation of Degrees of Freedom	
Number of distinct sample moments:	190
Number of distinct parameters to be estimated:	53
Degrees of freedom (190 - 53):	137

Table 6. 17: Computation of degrees of freedom

Result
Minimum was achieved Chi-square = 170.69 Degrees of freedom = 137 Probability level = .03

Table 6. 18: Results

The second method is the rank condition, which requires each parameter to be uniquely identified. However it was noted that this method could be complex, therefore, it is recommended to use proxy measures, which can be determined using two 'rules' (Hair *et al* 1998). The first proxy is the three measure rule, which asserts that any construct with three or more indicators will always be identified. The second rule is the recursive model rule, which asserts that recursive models with identified constructs will always be identified. The model shows that there are three measurement items per each construct. Further the results show that the model is recursive. Based on this it can be concluded that the model is identified. The initial assessment so far therefore indicates that the model is plausible and therefore the next step of analysis should be conducted. Table 6.18 also indicate that the minimum is achieved, further indicating the model is plausible.

Model Assessment

Here the model was assessed to determine how well it fits the sample data. The analysis of the fit was based on two criteria, including (a) parameter estimates and (b) the model as a whole. These are considered below.

Parameter estimates

The assessment of the parameter estimates is based on three issues including (a) feasibility of estimates, (b) appropriateness of standard errors and (c) statistical significance of the parameter estimates, as discussed below.

Feasibility of estimates

This is the initial step in assessment of the model. The viability of the estimates is determined by examining the sign and size of the estimates, and the consistence with underlying theory. Byrne (2001) suggest that all estimates falling outside the expectations would indicate that the model is wrong or the input matrix lacks sufficient information. Further she suggests that parameters exhibiting unreasonable estimates are correlations >1.00, negative variances and convariances or correlations that are not positively defined. Examination of tables 6.19-6.22 (page 157-158) indicates that the model is acceptable as all estimates are of the correct size and sign.

Appropriateness of standard errors

The indication of poor model fit is the presence of standard errors that are excessively small or large. Inspection of the data in tables 6.19-6.22 show that the model is within acceptable limits. Therefore the model can be said to be plausible.

Statistical Significance of Parameter Estimates

Having established that the estimates are all of the correct sign and size, the next step was to assess the significance of the parameter estimates. The test statistic here is the use of the critical ratio (c.r.). Based on the level of $p<0.05$, the c.r. need to be >1.96 before the hypothesis can be rejected. Byrne (2001), although suggesting that non-significant parameters should be deleted from the model, accepts that this could be a sign of sample size that is too small. Theoretical justification can be another reason why a non-significant parameter could be returned (Schumacker and Lomax 2004).

Based on data in tables 6.19-6.22 it is seen that the majority of the estimates are significant (>1.96). Examination of table 6.19 showing factor loadings (presented as regression weights) indicate that all estimates are significant at $p<0.05$, except for quality indicator loading on performance. However this is significant at $p<0.10$. Examination of the Convariances and variances also indicate that the majority of the estimates are significant at $p<0.05$. Based on the analysis of the parameter estimates, it can be concluded that the PMPQ measurement model is acceptable as the feasibility of the estimates, standard errors and statistical significance all point in the right direction. Although some of the estimates have critical ratio (cr) values of <1.96, they were considered theoretically adequate to be included in the model. As noted above, one of the reasons for non significant parameters is the use of small sample size. As the sample size used was small compared to the required minimum, such a result is therefore not unexpected.

Scalar Estimates
Maximum Likelihood Estimates
Regression Weights

			Estimate	S.E.	C.R.	P
Lead3	<---	Leadership	1.13	0.24	4.67	***
Lead2	<---	Leadership	1.14	0.19	6.04	***
Team1	<---	Team	1.00			
Strat3	<---	Strategy	1.00	0.08	11.93	***
Strat2	<---	Strategy	1.03	0.09	11.27	***
Strat1	<---	Strategy	1.00			
Proc3	<---	Process	1.43	0.19	7.43	***
Proc2	<---	Process	1.28	0.18	7.25	***
Team2	<---	Team	1.23	0.11	10.82	***
Cost	<---	Performance	1.00			
Time	<---	Performance	0.26	0.12	2.22	0.03
Quality	<---	Performance	0.47	0.25	1.83	0.07
Team3	<---	Team	1.11	0.12	9.63	***
Lead1	<---	Leadership	1.00			
Com1	<---	Communication	1.00			
Com2	<---	Communication	0.81	0.11	7.72	***
Proc1	<---	Process	1.00			
PM Satisfaction	<---	Performance	1.45	0.63	2.30	0.02
Com3	<---	Communication	1.10	0.11	9.59	***

Table 6. 19: Estimates- Regression Weights

Covariances

			Estimate	S.E.	C.R.	P
Leadership	<-->	Team	0.21	0.07	2.93	0.00
Leadership	<-->	Communication	0.32	0.10	3.37	***
Leadership	<-->	Strategy	0.49	0.13	3.81	***
Leadership	<-->	Process	0.13	0.07	1.75	0.08
Leadership	<-->	Performance	0.12	0.07	1.82	0.07
Team	<-->	Communication	0.26	0.09	2.82	0.00
Team	<-->	Strategy	0.24	0.11	2.15	0.03
Team	<-->	Process	0.29	0.09	3.13	0.00
Team	<-->	Performance	0.09	0.06	1.45	0.15
Strategy	<-->	Communication	0.58	0.16	3.71	***
Process	<-->	Communication	0.18	0.10	1.87	0.06
Performance	<-->	Communication	0.18	0.10	1.92	0.05
Strategy	<-->	Process	0.27	0.13	2.09	0.04
Strategy	<-->	Performance	0.15	0.10	1.56	0.12
Process	<-->	Performance	0.08	0.06	1.29	0.20

Table 6. 20: Estimates- Covariances

Correlations

			Estimate
Leadership	<-->	Team	0.50
Leadership	<-->	Communication	0.62
Leadership	<-->	Strategy	0.73
Leadership	<-->	Process	0.27
Leadership	<-->	Performance	0.47
Team	<-->	Communication	0.43
Team	<-->	Strategy	0.31
Team	<-->	Process	0.52
Team	<-->	Performance	0.29
Strategy	<-->	Communication	0.61
Process	<-->	Communication	0.27
Performance	<-->	Communication	0.50
Strategy	<-->	Process	0.30
Strategy	<-->	Performance	0.32
Process	<-->	Performance	0.24

Table 6. 21: Estimates- Correlations

Variances

	Estimate	S.E.	C.R.	P
Leadership	0.36	0.11	3.27	0
Team	0.49	0.11	4.33	***
Strategy	1.25	0.26	4.84	***
Process	0.61	0.19	3.31	***
Performance	0.19	0.15	1.28	0.2
Communication	0.74	0.17	4.25	***
e3	0.7	0.14	4.94	***
e2	0.21	0.06	3.37	***
e4	0.14	0.03	4.06	***
e12	0.27	0.07	3.87	***
e11	0.36	0.09	4.24	***
e10	0.17	0.06	2.90	0
e15	0.13	0.08	1.60	0.11
e14	0.23	0.07	3.15	0
e17	0.03	0.01	4.56	***
e16	1.16	0.22	5.21	***
e5	0.1	0.04	2.55	0.01
e18	0.28	0.05	5.25	***
e6	0.19	0.04	4.16	***
e1	0.27	0.06	4.23	***
e9	0.17	0.06	2.71	0.01
e7	0.22	0.06	3.61	***
e8	0.29	0.06	4.69	***
e13	0.52	0.1	5.09	***
e19	0.25	0.12	2.13	0.03

Table 6. 22: Estimates- Variances

Assessment of the Measurement Model as a whole

The evaluation of the model as a whole was assessed using goodness of fit statistics. In Chapter Four, Section 4.2.11, the goodness-of-fit statistics were discussed. These include absolute fit indices, incremental fit measures and parsimonious fit indices (Hair *et al* 1998). Although there are no agreed single measures, it is recommended to use a range of indices from each type of measures to gain a better consensus across types of measures as to the acceptability of the proposed model (Hoyle 1995, Schumacher and Lomax 2004 and Hair *et al* 1998). The fit indices used here are the Chi Square statistic (χ^2), Chi square divide by the degrees of freedom (χ^2/df), Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Incremental Fit Index (IFI) and the Tucker Lewis Fit Index also known as the Non normed fit index (TLI/NNFI).

This is consistent with other studies. For example, Pannirselvam and Ferguson (2002) used a similar set of indices and argued that the χ^2 is sensitive to sample size and multivariate normality and therefore the use of other indices that correct for these factors should be used. In addition the Root Mean Square Residue (RMR) and the Root Mean Square Error of Approximation (RMSEA) were also evaluated. Schumacker and Lomax (2004) suggested the use of χ^2, GFI, NFI and RMSEA for a single model.

An examination of the fit indices in Table 6.23 (page 160) shows that the model moderately fits the data. The χ^2 value of 170.69 (p=0.03) suggests that the model is not confirmed. For a well fitting model the χ^2 should have a p-value >0.05 (Hair *et al* 1998). However because of its sensitivity to sample size and multivariate normality other indices were used. The RMR, RMSEA, CFI, TLI and the IFI indices show that the model fits well. However the GFI (0.80) is below the acceptable 0.90 value for a model to be accepted. Overall however these indices indicate a moderate acceptable fit between the model and the data. Some studies have actually accepted this is a marginally acceptable model. For example Grandzol and Gershon (1998) passed values of 0.765 (AGFI), 0.795 (GFI) and 0.754 (NFI) as marginally acceptable. Hair *et al* (1998; p 660) reported values for GFI of 0.865 as marginally accepted. Appendix E presents additional information on the fit indices and other estimates.

Fit Index	Acceptable fit	Indices for data
χ^2		170.69
df		137
p	>0.05	0.03
χ^2/df	≤2 to 5	1.25
RMR	<0.06	0.06
GFI	≥0 .90	0.80
RMSEA	≤0.05 to 0.08	0.06
CFI	≥0.90	0.95
NNFI?TLI	≥0.90	0.94
IFI	≥0.90	0.96

Table 6. 23: Goodness-of-fit Indices

Model Modification

In Section 6.4.3, it was stated that the model development approach is used in this research. This implies that once a model fails to achieve the minimum, then modification to the model is permitted to find a better fitting model. Bryrne (2001) and Schumacker and Lomax (2004) recommend a two stage process. They acknowledge that it will be a strange researcher who would abandon research based on the rejection of the model. They suggest that once results based on the indices suggest a poor fit, the model can be re-specified. AMOS provides some modification indices suggesting possible linkages between parameters. Re-specifying these linkages, it is hoped, would produce a model that would fit the data.

Modification Indices				
Covariances				
			M.I.	Par Change
e16	<-->	e8	5.84	-0.2
e17	<-->	e16	7.29	0.07
e14	<-->	e6	9.88	0.11
e15	<-->	e6	10.11	-0.11
e4	<-->	e13	6.77	-0.11
e2	<-->	e11	6.43	-0.12
Regression Weights				
			M.I.	Par Change
Com2	<---	Quality	5.21	0.3
Team3	<---	Performance	5.61	-0.39
Team3	<---	PC1	6.79	-0.14
Time	<---	PC1	6.04	0.05
Proc2	<---	PC1	5.09	-0.14
Proc3	<---	PC1	6.88	0.16

Table 6. 24: Modification Indices

An examination of modification indices in Table 6.24 (page 160) shows that there is room for improvement of the model. Of interest here is the suggested regression weight for Team3 on Project performance. This suggests that *Team3* potentially cross-loads onto two constructs, project team and project Performance. Further examination of covariances suggest that *e6*, error term for *Team3* should correlate with *e14* and *e15*. These are the two highest modification indices as shown in table 6.24. Based on this it was concluded that *Team 3* is a problem indicator variable and therefore should be deleted. The re-specified model is presented in figure 6.4.

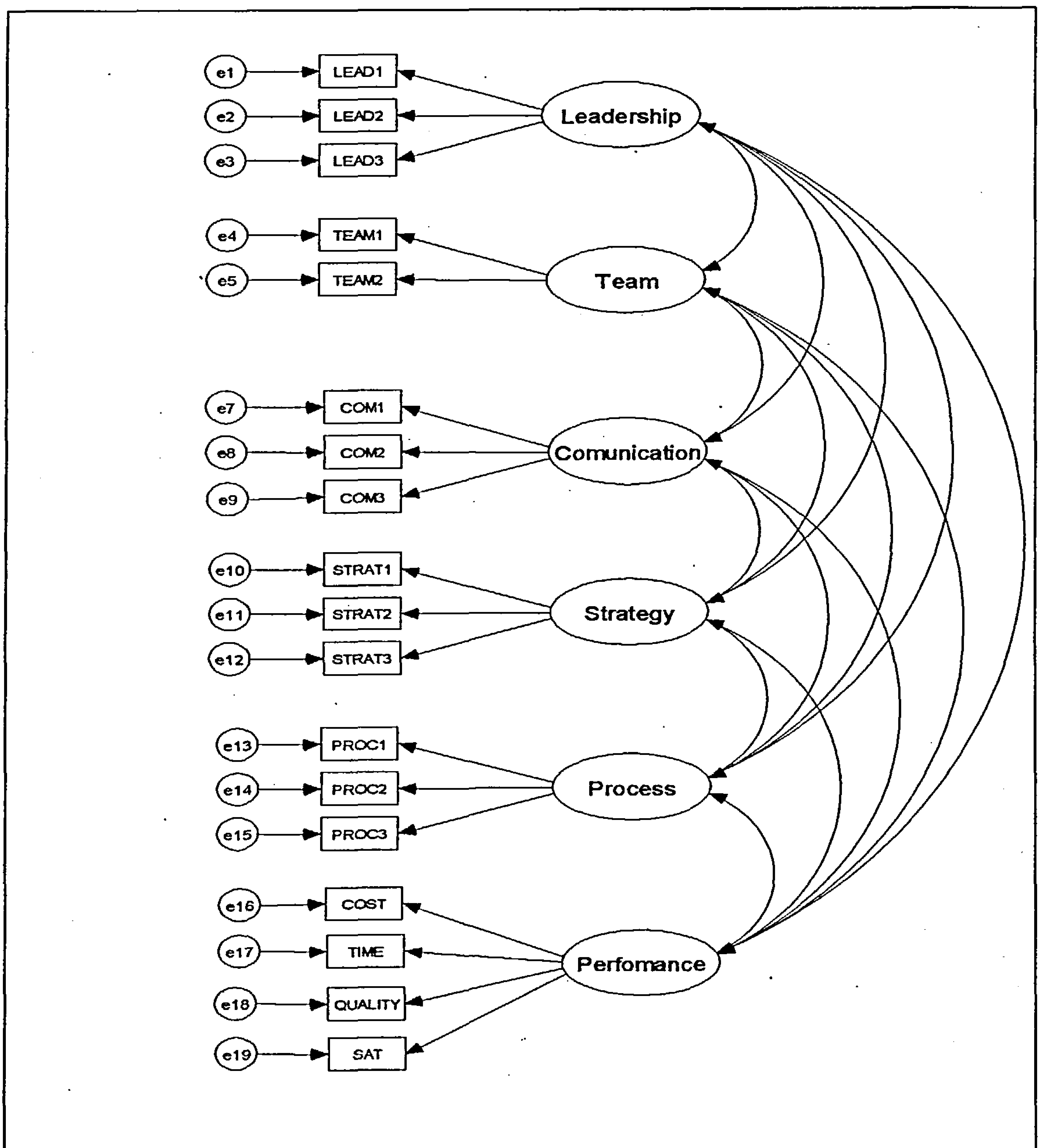

Figure 6.4: Modified Measurement Model

The results show that deleting *Team3* with its associated error term (e6) greatly improved the model as shown in table 6.25. The χ^2 value of 141.19 (p=0.09) suggests that the model is accepted. The RMR (0.05), RMSEA (0.05), GFI (0.82), CFI (0.97), TLI (0.96) and IFI (0.97) show that the model fits moderately well with the data. Further examination of parameter estimates in tables 6.26-6.28, indicate that the model is acceptable. It can therefore be concluded that the PMPQ measurement model as presented in figure 6.4 is valid and therefore can be used in the next stage of analysis. Thus the full structural equation model can now be evaluated based on the findings that the modified measurement model is plausible. More estimates are presented in Appendix F.

Fit Index	**Acceptable fit**	**Indices for data**
χ^2		141.19
df		120
p	>0.05	0.09
χ^2/df	≤ 2 to 5	1.18
RMR	<0.06	0.05
GFI	≥ 0.90	0.82
RMSEA	≤ 0.05 to 0.08	0.05
CFI	≥ 0.90	0.97
NNFI?TLI	≥ 0.90	0.96
IFI	≥ 0.90	0.97

Table 6. 25: Goodness-of-fit Indices for modified measurement model

Regression Weights

			Estimate	S.E.	C.R.	P
Lead3	<---	Leadership	0.98	0.20	4.95	***
Lead2	<---	Leadership	1.00			
Team1	<---	Team	1.00			
Strat3	<---	Strategy	1.00			
Strat2	<---	Strategy	1.03	0.10	10.49	***
Strat1	<---	Strategy	1.01	0.08	11.92	***
Proc3	<---	Process	1.47	0.20	7.35	***
Proc2	<---	Process	1.28	0.18	7.10	***
Team2	<---	Team	1.13	0.14	7.96	***
Cost	<---	Performance	3.85	1.73	2.23	0.03
Time	<---	Performance	1.00			
Quality	<---	Performance	1.80	0.84	2.15	0.03
Lead1	<---	Leadership	0.86	0.14	6.04	***
Com1	<---	Communication	1.00			
Com2	<---	Communication	0.81	0.11	7.70	***
Proc1	<---	Process	1.00			
PM Satisfaction	<---	Performance	5.52	1.85	2.99	0.00
Com3	<---	Communication	1.09	0.11	9.60	***

Table 6. 26: Estimates- Regression Weights

Covariances			Estimate	S.E.	C.R.	P
Leadership	<-->	Team	0.27	0.09	3.20	0
Leadership	<-->	Communication	0.37	0.11	3.51	***
Leadership	<-->	Strategy	0.56	0.14	3.96	***
Leadership	<-->	Process	0.15	0.08	1.80	0.07
Leadership	<-->	Performance	0.04	0.02	2.15	0.03
Team	<-->	Communication	0.27	0.10	2.82	0.00
Team	<-->	Strategy	0.29	0.12	2.39	0.02
Team	<-->	Process	0.32	0.10	3.26	0.00
Team	<-->	Performance	0.03	0.02	1.85	0.06
Strategy	<-->	Communication	0.58	0.16	3.67	***
Process	<-->	Communication	0.19	0.10	1.90	0.06
Performance	<-->	Communication	0.05	0.02	2.29	0.02
Strategy	<-->	Process	0.26	0.13	2.10	0.04
Strategy	<-->	Performance	0.04	0.02	1.73	0.08
Process	<-->	Performance	0.02	0.02	1.46	0.15

Table 6. 27: Estimates-Covariances

Variances	Estimate	S.E.	C.R.	P
Leadership	0.48	0.13	3.73	***
Team	0.53	0.12	4.29	***
Strategy	1.23	0.27	4.54	***
Process	0.60	0.18	3.26	0
Performance	0.01	0.01	1.88	0.06
Communication	0.74	0.17	4.26	***
e3	0.70	0.14	4.94	***
e2	0.21	0.06	3.29	***
e5	0.10	0.05	1.90	0.06
e16	0.28	0.07	3.88	***
e15	0.36	0.09	4.24	***
e14	0.17	0.06	2.87	0
e19	0.10	0.08	1.22	0.22
e18	0.26	0.08	3.42	***
e23	0.03	0.01	4.54	***
e22	1.16	0.22	5.20	***
e6	0.17	0.07	2.37	0.02
e24	0.28	0.05	5.24	***
el	0.27	0.06	4.30	***
e13	0.17	0.06	2.69	0.01
e10	0.22	0.06	3.56	***
e12	0.29	0.06	4.70	***
e17	0.53	0.10	5.13	***
e25	0.25	0.12	2.20	0.03

Table 6. 28: Estimates-Variances

Summary-The Measurement Model Factorial Validity

Preliminary analysis of the measurement model based on CFA indicated that the measurement model is reliable as all constructs used in the analysis had cronbach alpha values exceeding the 0.70 threshold. Initial assessment of the measurement model as a whole based on goodness of fit indices suggests moderately model fit with room for further improvement. An examination of the modification indices suggested a possible misspecification in relation to *Team3* an indicator variable for project management team. The Modification indices showed that *Team3* was cross-loading on Performance construct. Further examination revealed problems with this indicator variable and therefore was deleted from the model. The resulting model shows better values for its goodness of fit indices. Based on these indices it was concluded that the modified model as presented in figure 6.4, achieves an acceptable fit and can therefore be used in the full SEM analysis.

6.4.5 The PMPQ Full Structural Model

Having assessed the measurement model as moderately fitting well the data, the next step was the assessment of the structural model. The interest in this assessment is the evaluation of the validity of the causal structure.

The Hypothesised Model

The Hypothesised structural model based on the modified measurement model is depicted in figure 6.5 (page 165). The theoretical justification of this causal relationship was discussed in Sections 2 and 3 of Chapter Five. The model hypothesises a priori that project performance [performance] is influenced by project leadership [leadership] through project management policies and strategy [strategy], project management team [team], project management communication [communication] and project management processes [process]. Further it is hypothesised that project management processes [process] directly influences project performance [performance], while leadership, strategy, team and communication have an indirect relationship with performance. The significance of these postulated relationships were examines and are presented below.

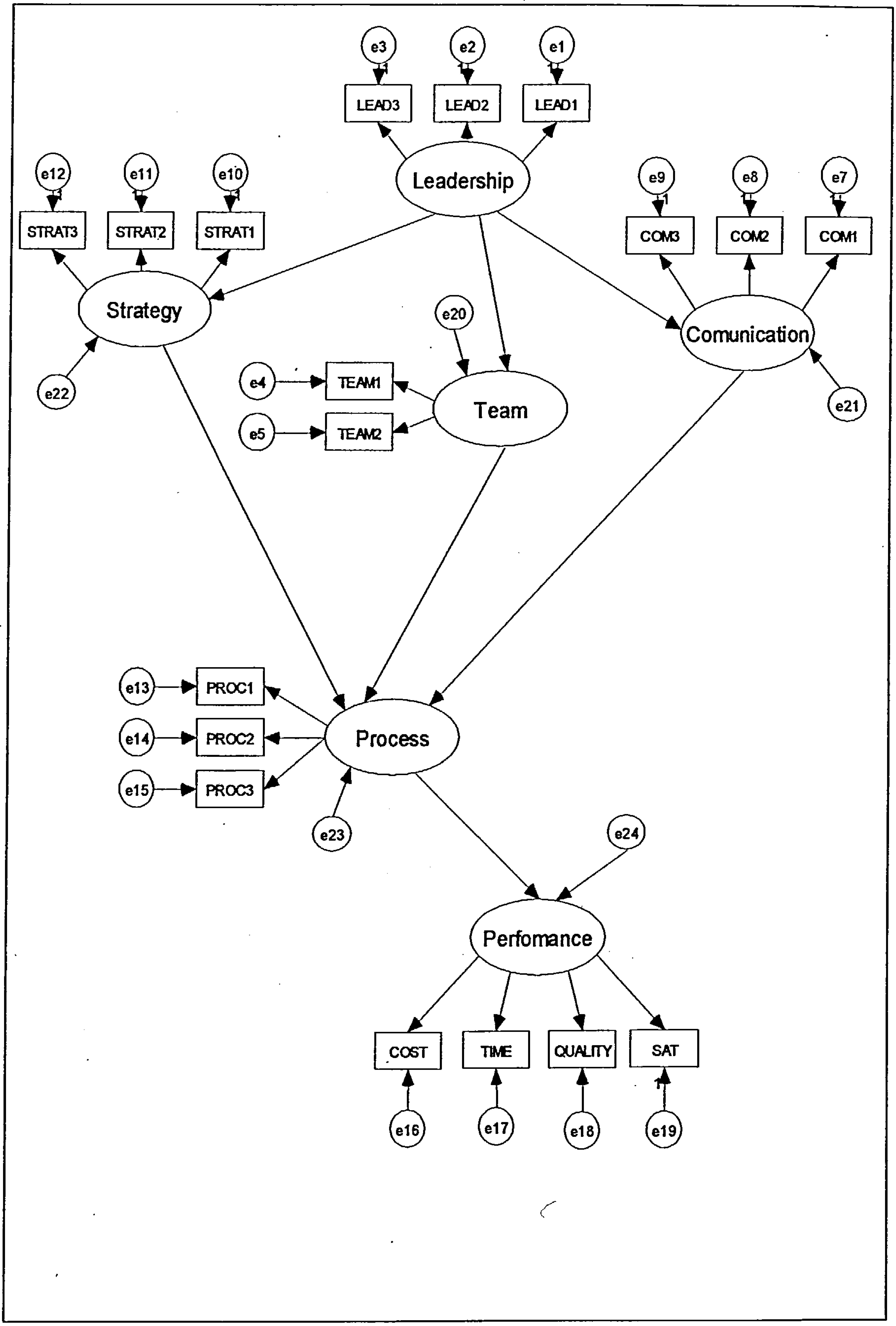

Figure 6.5: Path Diagram of the Full PMPQ Model

Goodness-of-Fit

An examination of the goodness of fit indices in table 6.29 indicates that the model moderately fits well with the data. The χ^2 (p=0.06) indicate that the model is acceptable. The χ^2/df also indicate that the model is acceptable as the value (1.20) is within the acceptable range (χ^2/df< 2-5). The RMR value of 0.08 is above the acceptable limit, however Hair (1998) suggests that 0.08 should be the absolute maximum to accept a model. This, therefore, indicates that the model moderately fits the data. All other indices (RMSEA= 0.06, GFI= 0.81, CFI= 0.96, TLI= 0.95, and IFI= 0.96) are within the acceptable thresholds as discussed in Section 6.4.4 on page 161. Based on this it can be concluded that the model as presented in figure 6.5 is acceptable. (For more indices and estimates see Appendix G)

Fit Index	Acceptable fit	Indices for data
χ^2		153.95
df		128
p	>.05	0.06
χ^2/df	$\leq$2 to 5	1.20
RMR	<0.06	0.08
GFI	$\geq$0.90	0.81
RMSEA	$\leq$0.05 to 0.08	0.06
CFI	$\geq$0.90	0.96
NNFI?TLI	$\geq$0.90	0.95
IFI	$\geq$0.90	0.96

Table 6. 29-Goodness-of-fit Indices

Significance of Estimates

Having concluded that the model is plausible based on goodness of fit indices, the next step was to assess the strength of the relationships as postulated in the causal hypothesis in Section 6.4.2. The path coefficients represented by the regression weights are presented in table 6.30 and figure 6.6 on page 169 and 170 respectively. The critical ratio (c.r.) was used to determine the statistical significance of the coefficient. The direct effects are represented by the arrow joining one construct to another, while the indirect effects are determined by a series of arrows. For example the indirect effect of project management team on performance can be determined by examining the direct effect of team on processes and the direct effect of process on performance. This can be calculated as follows:

Indirect effect of team on performance= direct effect of team on process * direct effect of process on performance

= 0.53*0.22 = 0.12

The same procedure can be used to calculate all the indirect effects. However AMOS provides output for these effects as presented in table 6.31 (page 168). These are used to evaluate the significance of the relationship between constructs.

Based on these estimates it can be concluded that ***H2*** (Project management leadership is positively related to project team management), ***H3*** (Project management leadership is positively related to project communication), ***H4*** (Project management leadership is positively related to project management strategy) and ***H5*** (Project team management is positively related to project management process management) are confirmed as they have significant estimates with critical ratios (C.R.) >1.96 (p>0.05). However Hypotheses ***H6*** (Project communication is positively related to project process management), ***H7*** (Project strategy is positively related to project process management) and ***H8*** (Project process management is positively related to project performance) are rejected as their estimates indicate non-significant results. the c.r. values of 0.05, 0.81 and 1.51 for H6, H7 and H8 respectively are below the required threshold of >1.96.

The rejection of Hypothesis ***H6, H7*** and ***H8*** also implies that ***H1*** (Project performance is directly related to project management processes while it is indirectly related to project management leadership, project management strategy, project management communication and project management team) should be rejected as some of the postulated relationships are not statistically significant. An examination of the indirect relationships also suggests that ***H1*** should be rejected, as all the indirect effects on project performance have very low coefficients. A further examination of the signs of the estimates shows that the relationship between project communication and project process management is not positive. This is in contrast to the postulated relationship. The findings in this case, though surprising indicates that the model of the relationship as depicted in figure 6.5 does not adequately represent the postulated relationships.

Regression Weights						
			Estimate	S.E.	C.R.	P
Team	<---	Leadership	0.71	0.19	3.78	***
Communication	<---	Leadership	1.01	0.22	4.52	***
Strategy	<---	Leadership	1.46	0.28	5.22	***
Process	<---	Communication	-0.01	0.13	-0.05	0.96
Process	<---	Strategy	0.08	0.1	0.81	0.42
Process	<---	Team	0.53	0.16	3.36	***
Performance	<---	Process	0.22	0.14	1.52	0.13

Table 6. 30: Estimates-Regression Weights

Total Effects

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	0.68	0.00	0.00	0.00	0.00	0.00
Strategy	0.76	0.00	0.00	0.00	0.00	0.00
Team	0.54	0.00	0.00	0.00	0.00	0.00
Process	0.36	-0.01	0.12	0.52	0.00	0.00
Performance	0.09	0.00	0.03	0.13	0.26	0.00

Direct Effects

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	0.68	0.00	0.00	0.00	0.00	0.00
Strategy	0.76	0.00	0.00	0.00	0.00	0.00
Team	0.54	0.00	0.00	0.00	0.00	0.00
Process	0.00	-0.01	0.12	0.52	0.00	0.00
Performance	0.00	0.00	0.00	0.00	0.26	0.00

Indirect Effects

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	0.00	0.00	0.00	0.00	0.00	0.00
Strategy	0.00	0.00	0.00	0.00	0.00	0.00
Team	0.00	0.00	0.00	0.00	0.00	0.00
Process	0.36	0.00	0.00	0.00	0.00	0.00
Performance	0.09	0.00	0.03	0.13	0.00	0.00

Table 6. 31: Direct and Indirect Effects

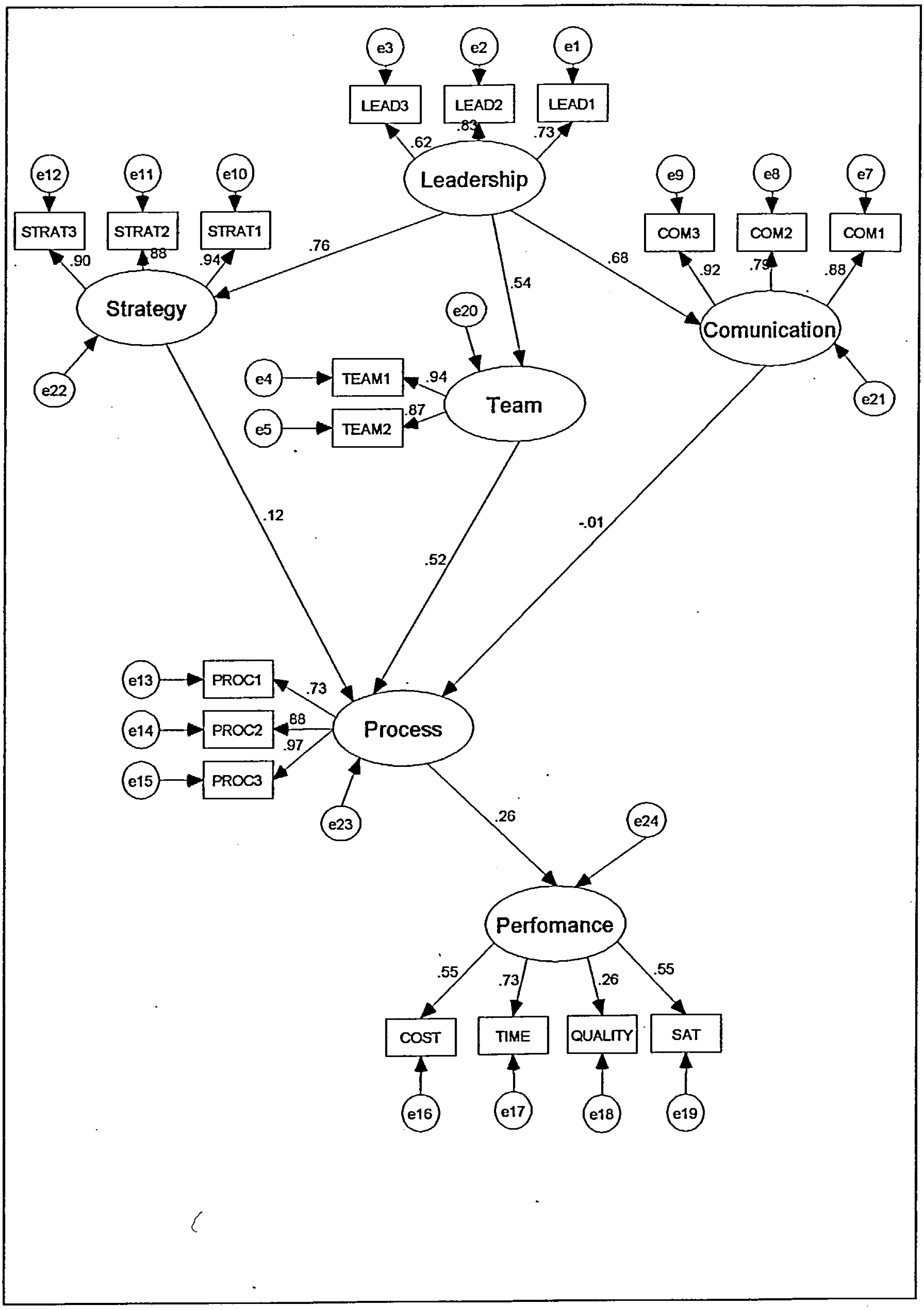

Figure 6. 6: Path Coefficients

Modification indices

Consideration was given to attempting to improve the structural model as suggested by Bryne (2001), that it would be a strange researcher who would abandon the research based on the goodness of fit indices. Tables 6.32 and 6.33 present modification indices for the model. While the modification indices are relatively small it was decided to use them to re-specify the model. Of interest here are the regression weights between constructs, which suggests specifying a model with regression weights between leadership and performance and also between communication and performance as it had the highest modification index. It was decided that the communication-performance relationship be specified. Further, literature suggests deleting non significant factors (Byrne 2001). In this case, the relationships between strategy and processes, communication and process and process and performance, were deleted, while the relationship between communication and performance was specified. The re-specified model is presented in figure 6.7 (page 171). The new postulated relationships between PMPQ constructs and construction project performance are that:

H9. Project performance is positively directly related to project communication.

H10. Project performance is indirectly related to project management leadership through mediating effects of project communication.

Modification Indices				
			M.I.	Par Change
e24	<->	Leadership	3.62	0.12
e19	<->	Leadership	5.32	0.13
e19	<->	e21	3.86	0.13
e13	<->	e20	3.66	-0.13
e18	<->	e19	3.04	0.09
e18	<->	e8	5.82	0.1
e18	<->	e7	3.69	-0.07
e5	<->	e22	3.65	-0.11
e16	<->	e8	6.45	-0.2
e14	<->	e16	4.4	-0.16
e15	<->	e16	4.85	0.16
e10	<->	e8	3.42	0.07
e12	<->	e14	3.58	0.08
e4	<->	e13	8.86	-0.12
e2	<->	e9	3.09	-0.07
e2	<->	e10	4.12	0.08
e2	<->	e11	6.41	-0.12
e3	<->	e23	4.28	-0.15
e3	<->	e11	3.21	0.14

Table 6. 32: Modification Indices

Regression Weights

			M.I.	Par Change
Performance	<---	Leadership	3.62	0.35
Performance	<---	Communication	3.76	0.23
SAT	<---	Leadership	5.32	0.39
SAT	<---	Communication	8.03	0.31

Table 6. 33: Estimates-Regression Weights

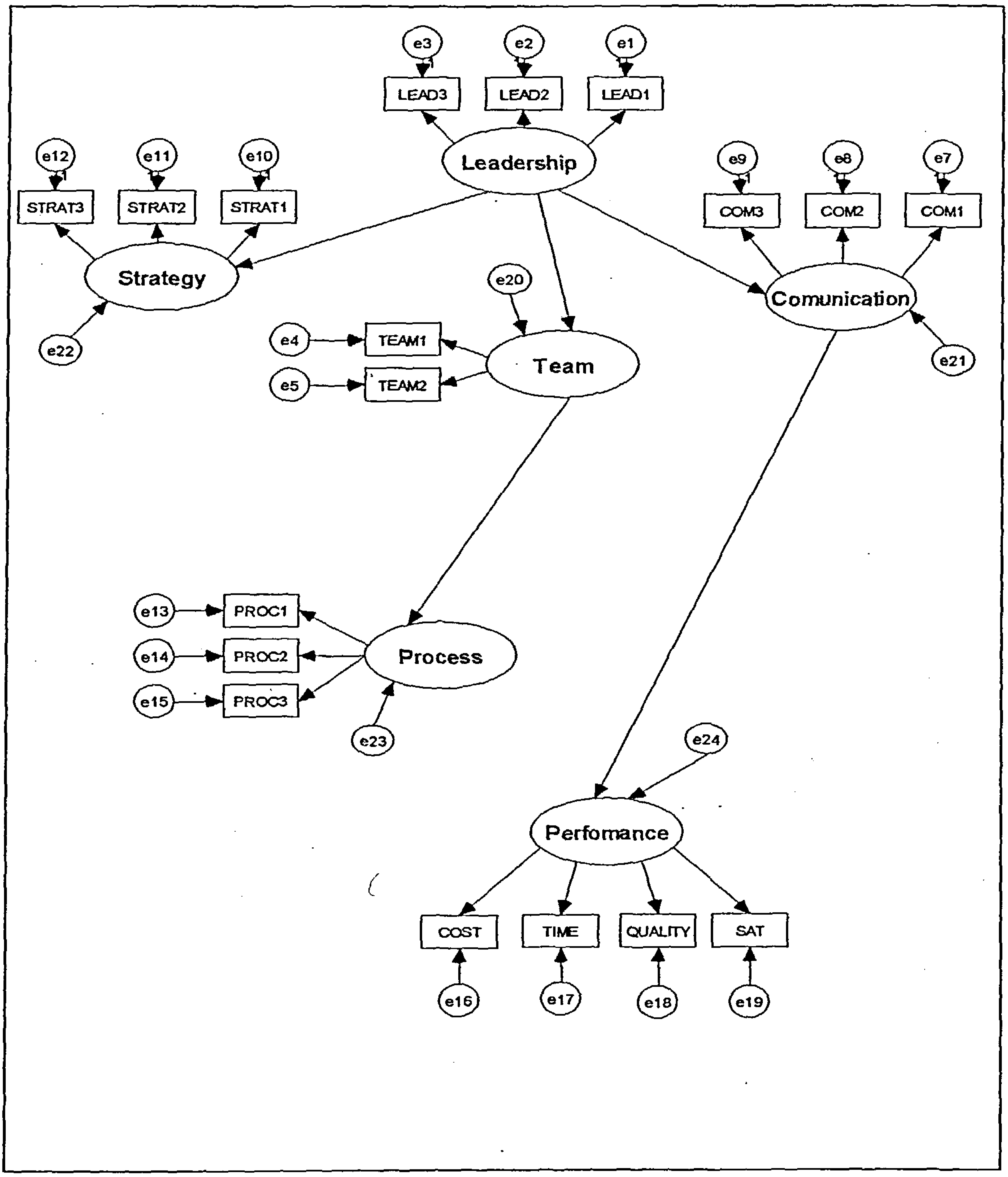

Figure 6. 7: Re-specified PMPQ Model

Goodness of Fit Indices

An examination of the goodness of fit indices show an improvement compared with the original structural model. The results for the goodness of fit indices are presented in table 6.34. The indices indicate that the modified model as presented fits well as all indices are within the acceptable range. For example the chi-square statistic (χ^2 =149.33, p=0.12) and the χ^2/df value of 1.15 indicate an acceptable model. The other indices RMR (0.06), GFI (0.82), RMSEA (0.05), CFI (0.97), TLI (0.96) and IFI (0.97) indicate a reasonable good fitting model. Based on these it was concluded that the modified model is acceptable. (Further information on goodness of fit indices and other estimates for the modified structural model are presented in Appendix H).

Fit Index	**Acceptable fit**	**Indices for Original Structural Model**	**Re-specified Model**
χ^2		153.95	149.33
df		128	130
p	>.05	0.06	0.12
χ^2/df	$\leq$2 to 5	1.20	1.15
RMR	<0.06	0.08	0.06
GFI	$\geq$0.90	0.81	0.82
RMSEA	$\leq$ 0.05 to 0.08	0.06	0.05
CFI	$\geq$0.90	0.96	0.97
NNFI?TLI	$\geq$0.90	0.95	0.96
IFI	$\geq$0.90	0.96	0.97

Table 6. 34 -Goodness of fit indices

Statistical Significance (

Evaluation of the hypotheses as presented in Section 6.4.2 was conducted by examination of structural coefficients and critical ratios. Table 6.35 (page 174) presents the estimates for regression weights. These are also included on the path diagram in figure 6.8. The estimates indicate that they are all statistically significant (p>0.05) with critical ratios (cr) >1.96. Figure 6.8 (173) presents the full model with all associated estimates while table 6.36 presents data on the direct and indirect effects. Because of modifications to the model and the findings that ***H2, H7, H8*** and ***H9*** were non significant, only ***H3, H4, H5*** and ***H6*** were evaluated here. In addition the significance of the direct relationship between communication and performance was evaluated. The indirect relationship between leadership and performance through the mediating effects of communication was also evaluated.

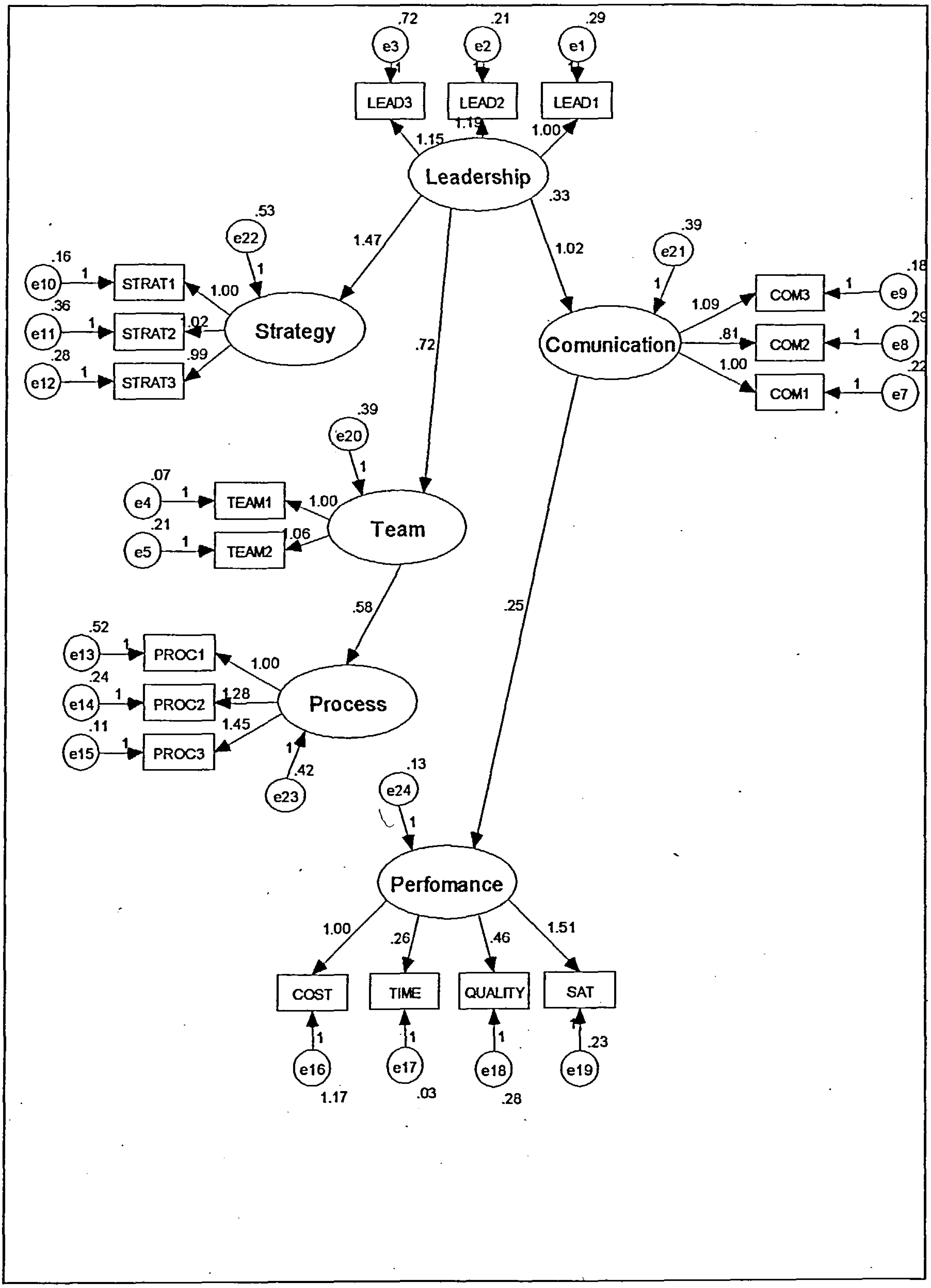

Figure 6.8: PMPQ Model with estimates.

Estimates -Regression Weights

			Estimate	S.E.	C.R.	P
Team	<---	Leadership	0.72	0.19	3.82	***
Commun-ication	<---	Leadership	1.02	0.22	4.58	***
Strategy	<---	Leadership	1.47	0.28	5.24	***
Process	<---	Team	0.58	0.15	3.93	***
Performance	<---	Commun-ication	0.25	0.12	2.03	0.04

Table 6. 35-Estimates: Regression Weights

Hypothesis	**Path**	**Direct**	**Indirect**	**Total**
H2	Leadership-Team	0.55		0.55
H3	Leadership-Strategy	0.76		0.76
H4	Leadership-Communication	0.69		0.69
H5	Leadership-Process		0.31	0.31
	Team-process	0.56		0.56
	Strategy-process			
	Communication-process			
H6	Leadership-performance			0.35
	Team-performance			
	Strategy-performance			
	Communication-performance	0.51		0.51
	Process-performance			

Table 6. 36: Direct, Indirect and Total Effects

Based on the information that (a) cr. values of the path coefficients greater that 1.65 are significant at $p<0.10$; (b) cr-values greater than 1.96 are significant at $p<0.05$; and (c) cr-values greater than 2.58 are significant at $p<0.01$, it can be concluded that the structural coefficients are statistically significant. Thus ***H2*** (Project management leadership is positively related to project team management, ***H3*** (Project management leadership is positively related to project communication), ***H4*** (Project management leadership is positively related to project management strategy) and ***H5*** (Project team management is positively related to project management process management) are not rejected as they have significant estimates with critical ratios (c.r.) >1.96 ($p<0.05$).

In addition the postulated relationship between project communication and project performance ***(H9)*** is also statistically significant (c.r. =2.03, $p<0.05$). Further data is presented in appendix Eight. Examination of the indirect relationships between leadership and performance through mediating effects of project communication ***(H10)*** is also good with an estimate of 0.31 and 0.51 respectively and significant at $p < 0.05$.

6.5 Chapter Summary

This chapter started by presenting the process of acquiring the data used in the analysis. While the use of questionnaire was intended to yield a sample size within the recommended rule of thumbs in SEM, the resultant sample was sixty three. This however was deemed enough to proceed with SEM analysis as evidence shows that valid results have been obtained in some SEM studies with sample size less than 100 (Hair et al (1998). However in order to reduce the effect of sample size on the results, indicator variables were formed into composite variables so as to have only three indicator variables per construct. A two step approach as recommended in literature (Bryne 2001) was used. This required first the assessment of the measurement model. Once this was deemed acceptable, then the structural model was assessed. However the initial assessment of the measurement model indicated that, while it generally had an acceptable fit based on goodness of fit indices and parameter estimates, there was room for improvement of the model. This was subsequently done by re-specifying the model with a deleted indicator item that was deemed problematic. The result of the re-specified model produced an acceptable measurement model. Once this was done, the structural model was assessed. Based on the goodness of fit indices, the model was acceptable as valid. Evaluation of the strength of the direct and indirect relationship between project management process quality variables and construction project performance was based on the significance of the estimates. The findings indicated that hypothesis ***H2***(Project management team is positively directly related to project management leadership), ***H3*** (Project management partnership and resources-communication is positively directly related to project management leadership), ***H4*** (Project management policy and strategy is positively directly related to project management leadership) and ***H5*** (Project management processes is directly positively related to project management team) only were accepted while all other hypotheses were rejected.

Based on the idea that the model development approach was used, the non-significant paths in the original model were deleted and a new path between communication and performance was re-specified. The results based on goodness of fit indices again indicated a good fitting model. Examination of the significance of the estimates also showed that all the estimates were statistically significant. Thus ***H2, H3, H4*** and ***H5*** were confirmed. In addition the postulated relationship between project management communication and project performance ***H9*** (Project performance is positively directly related to project partnerships and resources-communication) was found to be significant. Further examination of the indirect relationship between project management leaderships and project performance ***H10*** (Project performance is positively indirectly related to project management leadership through mediating effects of project partnerships and resources- communication) was found to be statistically significant ($p<0.05$).

CHAPTER SEVEN

Conclusion

7.0 Introduction

The primary aim of this research was to empirically investigate the nature and significance of the relationship between quality in the project management process and construction project performance. In Chapter One the need for a quality perspective in understanding the influence of project management processes on construction project performance was presented. Chapter Two presented a review of literature examination the influence of project management on performance. No past research was identified as having empirically examined project management process quality influences on construction project performance consistent with the aim of this research. Further examination of literature showed that most of the studies had concentrated on evaluation of the direct and individual influences of project management variables on performance. However it was clear that a method such as adopted in this study, that examined both the direct and indirect influences as well as the individual and collective impact of project management variables on performance, was needed in order to provide a better understanding of how project management processes impact on construction project performance. Chapter Three presented a review of literature concerning quality and project management. This was the basis for developing a theoretical project management quality model, which was used to measure project management process quality (PMPQ) in construction project environments.

The interest in this research was to examine the individual and collective causal impact of different project management variables on project performance. In order to achieve this, an appropriate evaluation method was required. Structural Equation Modelling was selected as the appropriate method and was presented in Chapter Four. Structural equation modelling was chosen as the method because of its ability to simultaneously examine a web of causal relationships. The theoretical model in Chapter Five mirrored the SEM concepts. Chapter Six presented the empirical results from the research. This final chapter presents the principle outcomes of the research. In particular it seeks to draw conclusions as to the nature and significance of the relationship between quality in the project management process and construction project performance. The chapter is divided into three sections. Section One presents the findings and conclusions of the research in relation to the aims and objectives as presented in Chapter One. Section Two is concerned with the limitations of the research, while Section Three discusses possibilities of future research in relation to the influence of project management processes and construction project performance.

7.1 Section One: Main Findings

7.1.1 Research aim and Hypotheses

In Section 1.3.1 of Chapter One, the primary aim of the research was stated as an investigation into the nature and significance of the relationship between project management process quality variables and construction project performance. In line with literature on the general relationship between quality and performance, the following theoretical proposition was examined;

There is a significant positive relationship between project management process quality and construction project performance.

In order to examine the above relationship, a project management process quality model was developed. Although there are different ways in which quality of the project management process can be measured, this research used quality management frameworks, and in particular the European Foundation for Quality Management's business excellence model (EFQM) as the basis for the definition of quality constructs in the PMPQ model. The assumptions in the model were that project performance is impacted by project management leadership through project management policy and strategy, project management team, project partnerships and resources (communication) and project management processes. Based on these postulated relationships eight hypotheses were developed and tested. These hypotheses are stated below.

H1: Project performance is positively directly related to project management processes while it is indirectly related to project management leadership, project management strategy, project management communication and project management team.

H2: Project management team is positively directly related to project management leadership

H3: Project management partnership and resources (communication) is *positively directly related to project management leadership.*

H4: Project management policy and strategy is positively directly related to project management leadership

H5: Project management processes is directly positively related to project management team

H6: Project management processes is positively directly related to project partnerships and resources (communication)

H7: Project management processes is positively directly related to Project management policy and strategy

H8: Project performance is positively directly related to project management processes

In addition the following hypotheses were stated in Section 6.4.5 (page 172) that

H9: Project performance is positively directly related to project partnerships and resources (communication)

H10: Project performance is positively indirectly related to project management leadership through mediating effects of project partnerships and resources (communication)

The evaluation of the research hypotheses, using structural equation modelling, provided insight into the nature and significance of the relationship between project management process quality and construction project performance.

7.1.2 The PMPQ Structural Equation Model

The PMPQ model developed in Chapter Five, Section 5.3, reflected the assumed nature of the relationship between project management process quality and construction project performance. This was deemed theoretically sound as its basis was the well known EFQM business excellence model, a quality award framework. This model has been used by many researchers including Bryde (2003), Weserveld (2003) and Claver et al (2003). As discussed in 4.2.1 a full structural equation model has two components. These are the structural model which defines the relationships between constructs and the measurement model which describes the indicators used to measure the constructs.

The findings with respect to these two components of the PMPQ structural equation model are discussed below.

The Measurement Model

The measurement model as defined in Section 5.3.2 of Chapter Five was subjected to statistical analysis in order to determine its validity (See Section 6.4.4). Following the example of Byrne (2001), confirmatory factor analysis was used. However before SEM procedure was conducted, there was a need to reduce the number of indicator variables in order to minimise the effect of sample size on the results as the sample size was less than 100, which was the threshold considered appropriate for structural equation modelling analysis (See Section 4.3.3 and Section 6.2.1). Item parcelling was used to reduce the number of indicator variables per construct. However, before item parcelling was performed, a preliminary reliability analysis was conducted on the original scale to determine the reliability of the measurement scale. The results based on cronbach alpha and inter-item correlation statistics indicated a generally accepted scale for all the constructs except for the leadership and partnership and resources constructs, which were subjected to refinement. The resultant scales as presented in table 6.13 on page 150, were deemed reliable.

Item parcelling procedures were conducted on the resultant measurement scales, using the single factor analysis method. This procedure resulted in quality constructs having only three indicator variables. The measurement model was subsequently subjected to confirmatory factor analysis using structural equation modelling. The preliminary results while indicating that the measurement model was valid based on goodness of fit indices, showed some element of miss-specification. A re-specification of the model yielded a measurement model that was valid. It was concluded therefore that the adjusted measurement model was valid and therefore could be used in the full SEM analysis. The finding that the measurement scale was valid is consistent with the work of Bryde (2002) and Westerveld (2003) who were also partly concerned with the identification of indicator variables for project management constructs. The findings are also consistent with many other studies that have included these variables as critical success factors in project management. These were discussed in Section 2.3.1 and Section 5.3.2.

The Structural Model

Having ascertained that the measurement model was valid, an examination of the full structural equation model was conducted. The interest in assessing the structural model was the evaluation of the validity and significance of the relationships between constructs in the PMPQ model. These postulated relationships are reflected in the hypotheses. The results of the initial SEM analysis of the PMPQ model suggested that the model was valid based on goodness of fit indices. However, an examination of the significance of the relationships, suggest that not all variables have statistical significant effect on project performance when presented in the form of the PMPQ model. The model postulated a direct relationship between project management leadership and project management team *(H2);* project management leadership and project partnership and resources-communication *(H3);* and project management leadership and project management policy and strategy *(H4).* The findings suggest that these relationships are statistically significant, that project management leadership has a profound influence on the effectiveness of project management teams, project management policy and strategy and project partnership and resources-communication.

It was also hypothesised that project management processes was significantly influenced by project management team *(H5),* project management partnership and resources-communication *(H6)* and project management policies and project management policy and strategy *(H7).* However, the results indicate that only project management team has a significant effect on project management processes. Project partnership and resources- communication and project management policy strategy, it is suggested from the results, have no statistically significant influence on project management processes. It was further postulated that project performance is directly influenced by project management processes *(H8).* This relationship, however, was found to be not statistically significant.

Although this result was not expected in project management research, similar results have been found by researchers in the general management field. For example Samson and Terzioski (1999), in analysing the relationship between total quality management practices and operational performance found out that strategic quality planning (policy and strategy), information management and process management were not strongly or positively related to performance. Pannirselvam and Ferguson (2001) also, in evaluating the relationship between constructs in the Balbrige quality award framework, found out that, while human resource management (represented by project management team in the present case) had a significant direct effect on product and process management, the effect of strategic quality planning (policy and strategy) and information management were not significant.

Based on the above findings concerning the statistical significance of the relationships, it was also concluded that ***H1*** which postulated that project performance is positively directly related to project management processes while it is indirectly related to project management leadership, project management policy and strategy, project partnerships and resources (communication) and project management team, should be rejected.

Further the PMPQ model was subjected to model re-specification by deleting paths that were found to be not statistically significant. Thus the paths between project management policy and strategy and project management processes; project partnership and resources- communication and project management processes; and project management processes and project performance were deleted. Based on modification indices suggested in the AMOS output a new path postulating a direct relationship between project partnership and resources- communication and project performance was specified. The results of the analysis indicated an acceptable model with all path coefficients statistically significant. The results of the second analysis still indicated a statistical significant relationship between project management leadership and project partnership and resources- communication , project management team and project management policy strategy and between project management team and project management processes thereby confirming again the hypothesised relationships between these constructs. Of significance also was the postulated new path between project partnership and resources- communication and project performance; that project performance is positively directly related to project partnerships and resources- communication **(H9)**. The results show that there is a significant relationship between project partnership and resources- communication and project performance. An examination also of the indirect relationship between project management leadership and project performance -(***H10***: that Project performance is indirectly related to project management leadership through mediating effects of project management communication) was found to be statistically significant. Generally however, the findings above show that there is a relationship between project management process quality and construction project performance.

7.1.3 Conclusion

The theoretical proposition was that there is a significant relationship between project management process quality and construction project performance. The findings of the research show that such a relationship exists between the different PMPQ constructs and construction project performance. Based on the findings in Chapter Six and summarised in Section 7.1.2 above, it can be concluded that;

(a) The relationship between project management process quality and construction project performance can be presented as a web of relationships as presented in the project management process quality model discussed in Chapter Five and modified in Section 6.4.4. The model presented contains both direct and indirect relationships between project management process quality constructs and construction project performance. This model enabled the empirical evaluation of both the direct and indirect influence and/or the individual and collective impact of project management process quality variables on construction project performance. The findings that the project management process quality model presented as a web of relationships is acceptable, suggests that the common evaluations of the relationship between project management and performance based on direct relationships only may be simplistic as it does not give a full picture of the relationships between project management variables and performance.

(b) The measurement model discussed in Section 5.3.2 and statistically validated in Section 6.4.4 is valid and reliable. The measurement scale presented is also consistent with many studies examining project management critical success factors. One of the issues discussed with respect to many of the studies on critical success factors was the lack of a theoretical model for the organisation of the identified variables. However the use of a project management process quality model, based on a quality award framework, provides a sound theoretical basis for the organisation of the project management critical success factors. This was found to be consistent with the work of Bryde (2003) and Westerveld (2003) who were also concerned with quality (excellence) in project management

(c) Not all project management process quality variables have the same level of influence on construction project performance. It was found that project management leadership and project management partnership and resources-communication had a significant positive impact on construction project performance, while project management team, project management policy and strategy and project management processes did not. The suggestion in Section 7.1.2 was that while the result where unexpected for the non-significant relationships, some studies have found similar results before. No assessment however was made to find out why this was the case. This is presented as an item for future research in Section 7.3.2

(d) Overall it can be concluded that there is a relationship between project management process quality and construction project performance. This is based on the assessment of both the individual and collective impact of project management process quality variables and construction project performance. While not all constructs had a significant impact on construction project performance, it can be generally presented that there is a significant relationship between project management process quality and construction project performance. The nature of the relationship presented in the model shows that the PMPQ model is a web of relationships indicating both direct and indirect influences on construction project performance. For example, the examination of indirect relationships indicates that project performance is significantly indirectly influenced by project management leadership. Thus, although project management leadership is not postulated to affect construction project performance directly, a change in the project management leadership construct will trigger a change in construction project performance.

7.1.4 Implication of Results

The results are significant for construction project management research and application. This research examined the impact of project management process quality on construction project performance using an approach that made it possible to evaluate both the direct and indirect influences as well as the individual and collective impact of project management process quality variables on construction project performance. The implication of the findings are two fold.

Firstly, it was noted in Chapter Two that most of the studies on critical success factors have evaluated single relationships between these variables and project performance without consideration for indirect effects. The model as presented in this research, suggests that the influence on construction project performance can be either direct or indirect. For example some studies have only examined the direct influence of leadership variables on project performance. Indications from the findings in this research suggest that, while there may be direct effects on performance, there is an indirect relationship between project management leadership and construction project performance as indicated in this research. This should be taken into account. This is also seen when the impact of project partnerships and resources (communication) on project performance is considered. Project partnerships and resources (communication), while having a direct impact on construction project performance is also influenced by project management leadership. This suggests that the influence of project partnerships and resources (communication) on project performance can be significantly influenced by project management leadership. It is important therefore that this relationship is accounted for in defining relationships between critical success factors and construction project performance.

Secondly, the findings show that not all constructs have equal importance with respect to their influence on construction project performance. The findings suggest that project management leadership is the most important factor in influencing construction project results. However, its influence as presented in the PMPQ model is not direct but indirect by significantly influencing other project management variables such as project management team factors, project partnerships and resources (communication), project management policy and strategy and project management processes. It was also found that project management team, project management policy and strategy and project management processes had no significant impact on project performance. It should be noted however that project management team, although its impact on project performance was non-significant, its impact on project management processes was found to be significant. While there is need to find out why this is the case, the findings suggest that if more efforts were to be placed on activities that had significant impact, more attention would be given to project management leadership, project partnership and resources-communication. However, the findings do not suggest that project management team, project partnership and resources and project management processes are not important project management practices. The findings only question their significance with respect to their influence on construction project performance

7.1.5 Contribution to Theory and relationship to current thinking

This research contributes to the understanding of the relationship between project management and construction project performance. In Chapters One and Two the question of the value of project management in relationship to the influence of project management on construction project performance was raised. This research contributes to this understanding by using a quality framework in the understanding of this relationship. It was noted that although the issue of project management quality has been addressed in some studies, none were consistent with the aims of this research. Although some of the studies have attempted to evaluate the relationship between project management quality and performance, their deficiencies were noted in Chapter Three. In particular no empirical examination of the relationship in a manner consistent with the approach in this research was conducted. Further the use of Structural Equation Modelling (SEM) to the analysis of the relationship between project management variables and construction project performance allowed the evaluation of both the direct and indirect effects of these variables on project performance. Noted of course was that most studies, that have examined the impact of project management on performance, have used approaches that only considered the direct effects of these variables on project performance. Taking such an approach as in the present research therefore increases the understanding of the relationship between project management and construction project performance. In this respect this research makes a significant contribution to the current debate concerning the influence of project management on construction project performance.

As discussed in Chapter Two, that despite much research in this field there is no agreed consensus in terms of factors that affect project performance. One of the contributing factors to the lack of consensus is the absence of an agreed theoretical framework that can be used to model project management factors influencing construction project performance. This research presents a sound theoretical basis for the definition of factors influencing construction project performance and is consistent with the work of Barad and Raz (2002), Bryde (2002) and Westerveld (2003). The significant of this research in relation to the above studies is that it includes an empirical analysis of the proposed relationships in the construction project management process quality model, an extension of the work of Bryde (2002) and Westerveld (2003)

7.2 Limitations of the Research

7.2.1 Model Design

The development of the project management process quality model only considered internal efficiency of the project management processes and how this influences construction project results. However on a wider scale many other intervening variables can be included. For example the path model in Brown and Adams (1996) includes such intervening variables as project complexity, risk, variations, and procurement. However this research, while recognising the effect of other external factors, intended to examine the internal efficiency of the project management process and how this impacts on construction project performance whether directly or indirectly.

7.2.2 Theoretical Framework and Choice of variables

The choice of variables for the research presented a challenge. The PMPQ measurement model presented was based on literature on critical success factors in project management, similar to that in Westerveld (2003). However the structural model framework used to define the relationship between project management process quality constructs and project performance, was based on a quality management framework. While the approach taken in the definition of variables in the model is similar to Westerveld (2003) and Bryde (2002), one of the criticisms may be that the measurement variables as represented by the critical success factors are not exactly the same as those included in the quality models used. However, care was taken in the selection of variables, which were to an extent similar to those in such quality frameworks. In addition the evaluation of the measurement model based on Cronbach alpha values and goodness of fit indices also showed that the model as presented in this research was valid.

Further, there is much debate concerning the measures of project performance. This research concerned itself only with the traditional criteria of time, cost and quality. In addition the satisfaction of the project management team was used as a surrogate for stakeholder satisfaction with the project. It is not clear, therefore, based on the findings in this research whether project management process quality as presented in this research impacts significantly on other variables in the multi-criteria performance models as presented in Chapter Two.

7.2.3 Sample Limitations

It is acknowledge in this research that the sample size is relatively small compared to the recommendations in most literature. Therefore the interpretation of the results should acknowledge this limitation in this research. In Chapter Four sample size requirements for SEM analysis was discussed. The recommended minimum in some studies was 100 cases. However, an examination of literature showed that studies with less than 100 cases have been used in other studies and provided valid results (See Section 4.3.3 and Section 6.2.2). Further, the use of item parcelling (Section 6.4.4, page 149) to reduce the number of indicator variables, and thereby reducing the complexity of the model, was a step in the right direction aimed at reducing the impact of small sample size. The issue of sample bias due to a significant number of non-respondents was considered. However it was concluded that no sample bias was expected due to the sample frame characteristics (seen Section 6.2.1). Based on this it can be concluded that, while it is acknowledged that the sample size is relatively small compared to the recommended minimum, the sample size was considered adequate and therefore the results presented are valid.

7.2.4 Use of Structural Equation Modelling

SEM is said to use confirmatory factor approach. However because of the modelling strategy used, one can end up using exploratory factor analysis. Consideration was given to modelling strategies. The most common method, model development, was used in this research. This requires that if a model is rejected based on fit indices, the researcher should proceed to modify the model to find a better fitting model. This is recommended in literature. The initial assessment of the measurement model suggested a model that could be improved and therefore a variable was deleted. This provided a better fitting model than the original. The structural equation model was also subject to model re-specification. Such re-specifications have been one of the criticisms of the SEM approach. It is therefore acknowledged in this research that while originally the model basement was confirmatory, subsequent analysis become exploratory as a better fitting model was sort.

7.3 Possibility of Further Research

7.3.1 Improvement to present research-Research Design

The initial findings that some of the hypothesised relationships in the model were not statistically significant did not produce an expected result as the basis of the model was on well developed theoretical framework. Model such as the MBNQA, EFQM and TQM have been shown elsewhere to be valid and that the interrelationships between categories are valid. However, the results in this case suggested that not all postulated relationships in the PMPQ model were significant. Although an examination of general quality management literature found that some studies have found similar results before (See Section 7.1.2), no comparable empirical assessment of such a model in project management research was found in literature One way of comparing results would be to use a different modelling strategy. Three modelling strategies were discussed in Section 4.2.14. These included the strict *confirmatory approach* which involves the specification of only one model with the aim of either rejecting or accepting the specified model. The alternative approach was the *model development strategy*. This was the strategy used in this research and involves the researcher specifying a model with the aim of making further improvement to a specified model if it has been rejected until a good fiting model is found. The third alternative is the *competing models approach*, which involves specification of a number of models based on literature with the aim of choosing one which fits the data well. In view of the results and the lack of comparable empirical studies, the use of the competing models approach would help shed more light into the relationship between project management process quality and construction project performance. This would include the specification of several models, including the project management process quality model used in this study. These models would then be evaluated to find the best fitting models. A number of possible general quality award based models were discussed in Section 5.1. Such an evaluation would provide the basis for comparing the results for the project management process quality model with other models.

7.3.2 Future Related Work

(a) This research used literature on critical success factors to define a measurement model by aligning critical success factors found in literature with the project management process quality constructs. The definition of the constructs and the postulated causal relationships was based on the quality award frameworks. While the measurement model was found to be valid and was consistent with other studies, the selection of the indicator variables differed from the specific indicators variables in the quality awards frameworks. In this respect a definition of a PMPQ measurement model based on the specific areas of interest in the quality frameworks, would provide a different perspective to the analysis of project management process quality factors that are critical to construction project success.

(b) The findings concerning the project management process quality structural model suggested that some of the postulated relationships in the model were not

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APPENDICES

Appendix A-Selecting A Multivariate Technique

(Source Hair et al 1998, p20-21)

Appendix B

Global List of Project Management Process Quality Indicator Variables

Table 1-Indicator variables for project management process quality constructs

Construct	Indicators
Project Management Leadership	• Clarity of Project management roles and responsibilities • Authority given to project manager by client • Capability of the leader • Project manager's level of involvement in project • Commitment to project • Competence of project manager • Project manager's Experience • Project Manager's qualifications • Project Management style • Project management organisation structure • Project managers competencies • Senior management support • Ability to instil a sense of mission • Project administration
Project Management Policy And Strategy	• Use of project management methodology • Definition of project success/failure criteria • Process performance reviews • Formal feedback mechanism • Project brief • Aware of the project's requirements • Development and communication of a vision for the project stakeholders • Implementation strategy • Documentation of organisational responsibility on the project • A suite of project, programme and portfolio matrices • Learning from experience • Project management plan- Specification of the individual action steps for project implementation • Existence of measurable controls
Construct	**Indicators**
Project Management stakeholder Management *[project management stakeholder management practices affecting the quality of the project management process]*	• Integration of stakeholder processes into the overall project management process • Partnering • collaboration between client and project manager • Number of times client has engaged the project management firm for similar services • Experienced clients • Client consultation-communication, consultation and active listening to all impacted parties • Client acceptance-the act of selling the final project to its ultimate intended users • Client support and commitment • Lack of information on client needs • Lack of sustained interest • Conflict within client organisation
Project Management	• Frequency of communication • Communication content

Construct	Indicators
Communication	• Communication media • Accuracy of information • Communication procedures • Communication barriers • understanding of information expectations • Timeliness of communication • Completeness
Construct	**Indicators**
Project Management Teams	• Selection of project team • Project team's skills and knowledge • Cooperation among project team members • Experience of project team members • Number of times the project manager has worked with project team members • Supervision of project team • Project team composition • Project participants' understanding of the functional and technical performance requirements • Project participants understanding of their roles and duties in the project • Project participant's project goals • Degree of trust between project team members • Management of conflicts • Involvement of project team in project planning, early in the project life cycle • Staffing and organising the project team • Availability of reward systems • Project team members' commitment to project and project management process • Team building • Existence of culture of continuous support and improvement • Project management training • Motivation • Frequency of team meetings • Capability of pm staff • Personal friendship between project participants • Teamwork • Project team members' interdependent, interface effectively • Adequate channels of communication among all project participants
Construct	**Indicators**
Project Management Process Management *[project management process management practices that affect the quality of the project management process]*	• Risk management • Implementation of project management methodology • Project Monitoring and control • Documentation of project management processes and procedures • Change management process • Project management tools and techniques • Progress reporting • Project planning / rigid project planning and scheduling routines • Implementation of management processes and procedures, • Requirements definition and development of technical specifications • Design Management • Resource and schedule planning

	• Financial management • Contract management • Procurement management • Quality and reliability management • Configuration management • Decision making management • Reporting and communications • Maturity of an organisation's processes • Monitoring and feedback • Communication • Project management and systems development process • Integration of PM systems, methods and processes
	•
	•
Project Performance	
• Time Performance	• Estimated time performance – actual time performance
• Cost Performance	• Estimated cost performance – actual cost performance
• Quality Performance	• No of defects, no of variations before commitment to construct, no of variations after commitment to construct

Appendix C

Full List of Selected Project Management Process Quality Indicator Variables

Construct	Indicators
Project Management Leadership	• Definition of roles and responsibilities of the project manager • Definition of project management goals • Authority given to project manager by client • Experience of the project manager • Project managers competencies • Project organisation structure • Project managers qualification • Project manager's leadership style • Client support to project manager
Project Management Policy And Strategy	• Project management methodology • Definition of project success/failure criteria • Project management process performance reviews strategy • Formal feedback mechanism • Project manager's involvement in Project brief process • Awareness of the project's requirements by all parties • Quality and detail of project management plan/strategy
Project Management Teams	• Defined roles and responsibilities of all project team members • Skills and knowledge • Cooperation among project team members • Experience of project team members in executing similar projects • Commitment of Project team to project and project management process • Shared understanding of the functional and technical performance required • Capability of project team • Working relationship among project team members • Trust between project participants • Conflict between team members

Construct	Indicators
Project Stakeholders Management	• Partnering arrangements • Collaboration between client and project manager • Number of times client has engaged the project management firm for project management services • Number of times the project manager's firm has worked with project team members' firms on other projects • Suitability of project procurement system used on the project to successfully deliver project goals
Project Management Communication	• The existence, use and effectiveness of formally defined communication procedures • Adequacy of information passing among project team members • Timeliness of communication among project team members during design and construction phases • Suitability of the methods of communication among project team members • Frequency of communication between project team members • Accuracy of information passed among project team members
Project Management Process Management	• Risk management • Implementation of project management methodology on the project • Project management processes were monitoring and control • Implementation of project management processes and procedures as documented in the project management strategy/plan • Change management process • Project management tools and techniques • Control meetings • Project planning • Project management processes and procedures • Frequency of feedback to client about project progress
Project Performance	
• **Time Performance**	• Estimated time performance – actual time performance
• **Cost Performance**	• Estimated cost performance – actual cost performance
• **Quality Performance**	• No of defects, no of variations before commitment to construct, no of variations after commitment to construct

Appendix D

Questionnaire

Letter to Potential Respondents-Questionnaire

Date

Sir/Madam

<u>Questionnaire Survey-Project Management Process Quality</u>

I am currently undertaking PhD research at Heriot-Watt University, investigating the quality management practices in project management process. This questionnaire survey is part of the research process.

Your firm has been identified as one of the companies that undertake construction project management services on behalf of clients. I would like to ask for your help to complete the attached questionnaire to help achieve the objective of the research. The questionnaire is designed to collect project specific data about project management practices that would influence the quality of the project management processes. The questionnaire can be answered by anyone in your firm who has been a project manager on a project. Answering the questionnaire involves reviewing the project management process of most recent project in which you were project managers. This could be a project which has been completed or is currently running. I have included 2 questionnaires in case more people would be willing to answer the questionnaire in relation to the project they managed/are managing, or if more projects could be used to answer the questionnaires.

Please note that your responses will be treated as confidential and subsequent reports will not attribute responses to any particular firm.

Answering the questionnaire accurately and honestly, should take approximately 15 minutes. A business reply envelope has been enclosed to use when sending the completed questionnaire.

Thank you for your cooperation in completing the questionnaire. Should you have any queries please do not hesitate to contact me at the above address

Yours Sincerely

Sambo Zulu

QUESTIONNAIRE SURVEY
QUALITY IN PROJECT MANAGEMENT PROCESSES

This questionnaire survey is prepared as part of a PhD research, investigating quality in project management processes on construction projects. The focus of the research is on consultant project management services. This questionnaire is divided into three parts. Section one gathers general information, section two gathers information about the project to be reviewed and section three focuses on project management practices that would influence the quality of the project management processes. Please answer all questions. Please use the enclosed envelope to send the completed questionnaire. **Be assured that the information collected would be used for academic purposes only and the report will not attribute any responses to any particular organisation**. Should you have any queries concerning any part of the questionnaire, please do not hesitate to contact me at the address provided on the last page of the questionnaire

SECTION ONE: GENERAL INFORMATION

1. **Contact details**

Position held/Designation of Respondent	
Name of Respondent (Optional)	
Phone Number (Optional)	

2. **Category in which organisation falls**

	✓
Quantity Surveyors	☐
Project Managers	☐
Architects	☐
Engineers	☐
Management Contractors	☐
Other (please state)	

3. **Approximate number of years the firm has been involved in providing project management services**

Years of experience	✓
Less than 1 year	☐
1-5 years	☐
5-10 years	☐
>10 years	☐

4. **Approximate number of projects the firm has provided project management services in last two years**

No of Projects	✓
1	☐
2-5	☐
5-10	☐
>10	☐

5. **Approximate annual turnover of the firm (please tick (✓) appropriate answer)**

0-£10M	£10M-£25M	£25M-£50M	£50M-£100M	£100M-£300M	Over £300M

6. **Approximate number of employees in your organisation (please tick (✓) appropriate answer)**

1-25	26-50	51-200	200-500	500-1000	Over 1000

SECTION TWO: PROJECT INFORMATION

Please provide the following project information for a project on which you provided consultant project management services. It is preferred that this project should have been recently completed. However if no such project has been completed in the last two years please provide information for a project currently running.

7. Brief Description of the Project

8. Type Of Project under review

	✓
Civil Engineering	☐
Building Works	☐
Mechanical and Electrical	☐
Other (please state)	

9. Year project started

10. Year project was completed or to be completed

11. Project cost and Time Performance

i.	Project contract sum at tender	
ii.	Actual project cost at completion [if project has been completed]	
iii.	Estimated final project cost at present contract stage [if project is yet to be completed]	
iv.	Contract Period at Tender	
v.	Actual Project Duration at Completion [if project has been completed]	
vi.	Estimated final project duration at present contract stage [if project has been complĕted]	
vii.	Estimated design duration at inception [pre-contract period]	
viii.	Actual design duration [pre-contract stage]	

12. Rate the following on a scale of 1-5 with 1 being minor to 5 being major

		1	2	3	4	5
i.	Number of design variations-pre-contract stage	☐	☐	☐	☐	☐
ii.	Number of design variations-post-contract stage	☐	☐	☐	☐	☐
iii.	Number of defects	☐	☐	☐	☐	☐
iv.	Construction delays	☐	☐	☐	☐	☐

SECTION THREE-QUALITY IN PROJECT MANAGEMENT

This section deals with quality in project management processes. Please note that this research relates to quality of the project management process as opposed to the quality of the product. A number of quality influencing factors, which can affect the quality of the project management process, have been identified from literature. These have been grouped into 6 subgroups including leadership, policy and strategy, project teams, process management, stakeholder management and managing the information system.

In reviewing your project management process for the most recent project identified in section two, how would you rate each of the factors below on a scale of 1-5? Please indicate your rating by ticking [✓] the appropriate box. [1 representing very low and 5 very high]

13. Project Management Leadership

		1	2	3	4	5	6	7
i.	Degree to which the project manager's roles and responsibilities were clearly defined	☐	☐	☐	☐	☐	☐	☐
ii.	Extent of clarity of project management goals	☐	☐	☐	☐	☐	☐	☐
iii.	Level of authority given to project manager by client	☐	☐	☐	☐	☐	☐	☐
iv.	Level of experience of the project manager in executing similar projects	☐	☐	☐	☐	☐	☐	☐
v.	Adequacy of project managers competencies in executing project management duties	☐	☐	☐	☐	☐	☐	☐
vi.	Suitability of the project organisation structure in achieving project results	☐	☐	☐	☐	☐	☐	☐
vii.	Degree to which a formal project management quality system was used on the project	☐	☐	☐	☐	☐	☐	☐

14. Project Management Strategy

		1	2	3	4	5	6	7
i.	Degree to which a standard project management methodology exists in your firm	☐	☐	☐	☐	☐	☐	☐
ii.	Degree to which project success/failure criteria were clearly defined	☐	☐	☐	☐	☐	☐	☐
iii.	Degree to which Project management process performance reviews were performed	☐	☐	☐	☐	☐	☐	☐
iv.	Existence of a formal feedback mechanism	☐	☐	☐	☐	☐	☐	☐
v.	Extent of contribution of the project manager in the project brief	☐	☐	☐	☐	☐	☐	☐
vi.	Degree to which all parties to the project were fully aware of the project's requirements	☐	☐	☐	☐	☐	☐	☐

15. Management of the Project Team

		1	2	3	4	5	6	7
i.	Degree to which the selection of project team (eg consultancy firms with their associated personnel) was based on a defined objective criteria	☐	☐	☐	☐	☐	☐	☐
ii.	Adequacy of project team's skills and knowledge in executing project activities	☐	☐	☐	☐	☐	☐	☐
iii.	Degree of cooperation among project team members	☐	☐	☐	☐	☐	☐	☐
iv.	Level of experience of project team members in executing similar projects	☐	☐	☐	☐	☐	☐	☐
v.	Number of times the project manager has worked with project team members on other projects	☐	☐	☐	☐	☐	☐	☐
vi.	Level of supervision of project team	☐	☐	☐	☐	☐	☐	☐
vii.	Level of conflict in the project team	☐	☐	☐	☐	☐	☐	☐

16. Management of the Project Management Process

		1	2	3	4	5	6	7
i.	Degree to which a formal risk management strategy existed	☐	☐	☐	☐	☐	☐	☐
ii.	Extent to which a formal project management methodology was used on the project	☐	☐	☐	☐	☐	☐	☐
iii.	Degree to which the project management processes were monitored and controlled	☐	☐	☐	☐	☐	☐	☐
iv.	Degree of documentation of project management processes and procedures	☐	☐	☐	☐	☐	☐	☐
v.	Degree to which project processes where integrated	☐	☐	☐	☐	☐	☐	☐
vi.	Degree to which formal change management process existed	☐	☐	☐	☐	☐	☐	☐
vii.	Degree to which project management tools and techniques (such as the use of work breakdown structures, earned value analysis, use of project management software etc) were used.	☐	☐	☐	☐	☐	☐	☐
viii.	Frequency of progress reporting to client	☐	☐	☐	☐	☐	☐	☐

17. Managing the Project Stakeholders

		1	2	3	4	5	6	7
i.	Degree to which stakeholder processes were integrated into the overall project management process	☐	☐	☐	☐	☐	☐	☐
ii.	Degree to which partnering arrangements existed	☐	☐	☐	☐	☐	☐	☐
iii.	Degree of collaboration between client and project manager	☐	☐	☐	☐	☐	☐	☐
iv.	Number of times client has engaged the project management firm for similar services	☐	☐	☐	☐	☐	☐	☐

18. Managing the project Information System

		1	2	3	4	5	6	7
i.	Degree to which a formal project communication strategy existed	☐	☐	☐	☐	☐	☐	☐
ii.	Adequacy of information passing through the project team	☐	☐	☐	☐	☐	☐	☐
iii.	Timeliness of communication	☐	☐	☐	☐	☐	☐	☐
iv.	Suitability of the methods of communication	☐	☐	☐	☐	☐	☐	☐
v.	Frequency of project meetings	☐	☐	☐	☐	☐	☐	☐

	Yes	No
Would you be willing to be contacted in future as a follow up to your responses (Please indicate by ticking appropriate response (✓)		

Thank you for your assistance in answering the questionnaire. Please use the enclosed envelope to send the completed questionnaire.

__Contact Address__
S Zulu
School of the Built Environment
Heriot Watt University
Riccarton, Edinburgh
EH14 4AS

Tel: 0131 451 4664
Email: s.zulu@hw.ac.uk

Appendix E

Estimates for Original Measurement Model-AMOS Output

Table 6.14: Summary of Variables in the Model

Observed, endogenous variables	Unobserved, exogenous variables
Lead3	Leadership
Lead2	e3
Team1	e2
Strat3	Team
Strat2	e4
Strat1	Strategy
Proc3	e12
Proc2	e11
Time	e10
Cost	Process
Team2	e15
Quality	e14
Team3	e17
Lead1	e16
Com3	e5
Com1	Performance
Com2	e18
Proc1	e6
PM Satisfaction	e1
	e9
	Communication
	e7
	e8
	e13
	e19

Table 6.15 Parameter summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	25	0	0	0	0	25
Labelled	0	0	0	0	0	0
Unlabeled	13	15	25	0	0	53
Total	38	15	25	0	0	78

Computation of degrees of freedom (Default model)

Number of distinct sample moments:	190
Number of distinct parameters to be estimated:	53
Degrees of freedom (190 - 53):	137

Result (Default model)
Minimum was achieved Chi-square = 170.69 Degrees of freedom = 137 Probability level = .03

Scalar Estimates

Maximum Likelihood Estimates
Regression Weights

			Estimate	S.E.	C.R.	P
Lead3	<---	Leadership	1.13	0.24	4.67	***
Lead2	<---	Leadership	1.14	0.19	6.04	***
Team1	<---	Team	1.00			
Strat3	<---	Strategy	1.00	0.08	11.93	***
Strat2	<---	Strategy	1.03	0.09	11.27	***
Strat1	<---	Strategy	1.00			
Proc3	<---	Process	1.43	0.19	7.43	***
Proc2	<---	Process	1.28	0.18	7.25	***
Team2	<---	Team	1.23	0.11	10.82	***
Cost	<---	Performance	1.00			
Time	<---	Performance	0.26	0.12	2.22	0.03
Quality	<---	Performance	0.47	0.25	1.83	0.07
Team3	<---	Team	1.11	0.12	9.63	***
Lead1	<---	Leadership	1.00			
Com1	<---	Communication	1.00			
Com2	<---	Communication	0.81	0.11	7.72	***
Proc1	<---	Process	1.00			
PM Satisfaction	<---	Performance	1.45	0.63	2.30	0.02
Com3	<---	Communication	1.10	0.11	9.59	***

Standardized Regression Weights

			Estimate
Lead3	<---	Leadership	0.63
Lead2	<---	Leadership	0.83
Team1	<---	Team	0.88
Strat3	<---	Strategy	0.90
Strat2	<---	Strategy	0.88
Strat1	<---	Strategy	0.94
Proc3	<---	Process	0.95
Proc2	<---	Process	0.90
Team2	<---	Team	0.94
Cost	<---	Performance	0.37
Time	<---	Performance	0.54
Quality	<---	Performance	0.36
Team3	<---	Team	0.87
Lead1	<---	Leadership	0.76
Com1	<---	Communication	0.88
Com2	<---	Communication	0.79
Proc1	<---	Process	0.74
PM Satisfaction	<---	Performance	0.78
Com3	<---	Communication	0.92

Covariances

			Estimate	S.E.	C.R.	P
Leadership	<-->	Team	0.21	0.07	2.93	0.00
Leadership	<-->	Communication	0.32	0.10	3.37	***
Leadership	<-->	Strategy	0.49	0.13	3.81	***
Leadership	<-->	Process	0.13	0.07	1.75	0.08
Leadership	<-->	Performance	0.12	0.07	1.82	0.07
Team	<-->	Communication	0.26	0.09	2.82	0.00
Team	<-->	Strategy	0.24	0.11	2.15	0.03
Team	<-->	Process	0.29	0.09	3.13	0.00
Team	<-->	Performance	0.09	0.06	1.45	0.15
Strategy	<-->	Communication	0.58	0.16	3.71	***
Process	<-->	Communication	0.18	0.10	1.87	0.06
Performance	<-->	Communication	0.18	0.10	1.92	0.05
Strategy	<-->	Process	0.27	0.13	2.09	0.04
Strategy	<-->	Performance	0.15	0.10	1.56	0.12
Process	<-->	Performance	0.08	0.06	1.29	0.20

Correlations

			Estimate
Leadership	<-->	Team	0.50
Leadership	<-->	Communication	0.62
Leadership	<-->	Strategy	0.73
Leadership	<-->	Process	0.27
Leadership	<-->	Performance	0.47
Team	<-->	Communication	0.43
Team	<-->	Strategy	0.31
Team	<-->	Process	0.52
Team	<-->	Performance	0.29
Strategy	<-->	Communication	0.61
Process	<-->	Communication	0.27
Performance	<-->	Communication	0.50
Strategy	<-->	Process	0.30
Strategy	<-->	Performance	0.32
Process	<-->	Performance	0.24

Variances

	Estimate	S.E.	C.R.	P
Leadership	0.36	0.11	3.27	0
Team	0.49	0.11	4.33	***
Strategy	1.25	0.26	4.84	***
Process	0.61	0.19	3.31	***
Performance	0.19	0.15	1.28	0.2
Communication	0.74	0.17	4.25	***
e3	0.7	0.14	4.94	***
e2	0.21	0.06	3.37	***
e4	0.14	0.03	4.06	***
e12	0.27	0.07	3.87	***
e11	0.36	0.09	4.24	***
e10	0.17	0.06	2.90	0
e15	0.13	0.08	1.60	0.11
e14	0.23	0.07	3.15	0
e17	0.03	0.01	4.56	***
e16	1.16	0.22	5.21	***
e5	0.1	0.04	2.55	0.01
e18	0.28	0.05	5.25	***
e6	0.19	0.04	4.16	***
e1	0.27	0.06	4.23	***
e9	0.17	0.06	2.71	0.01
e7	0.22	0.06	3.61	***
e8	0.29	0.06	4.69	***
e13	0.52	0.1	5.09	***
e19	0.25	0.12	2.13	0.03

Modification Indices

Covariances

			M.I.	Par Change
e16	<-->	e8	5.84	-0.2
e17	<-->	e16	7.29	0.07
e14	<-->	e6	9.88	0.11
e15	<-->	e6	10.11	-0.11
e4	<-->	e13	6.77	-0.11
e2	<-->	e11	6.43	-0.12

Variances

	M.I.	Par Change

Regression Weights

			M.I.	Par Change
Com2	<---	Quality	5.21	0.3
Team3	<---	Performance	5.61	-0.39
Team3	<---	PC1	6.79	-0.14
Time	<---	PC1	6.04	0.05
Proc2	<---	PC1	5.09	-0.14
Proc3	<---	PC1	6.88	0.16

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	53.00	170.69	137.00	0.03	1.25
Saturated model	190.00	0.00	0.00		
Independence model	19.00	903.73	171.00	0.00	5.28

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	0.06	0.80	0.72	0.58
Saturated model	0.00	1.00		
Independence model	0.35	0.30	0.22	0.27

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	0.81	0.76	0.96	0.94	0.95
Saturated model	1.00		1.00		1.00
Independence model	0.00	0.00	0.00	0.00	0.00

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	0.80	0.65	0.76
Saturated model	0.00	0.00	0.00
Independence model	1.00	0.00	0.00

NCP

Model	NCP	LO 90	HI 90
Default model	33.69	4.47	71.08
Saturated model	0.00	0.00	0.00
Independence model	732.73	642.35	830.62

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.75	0.54	0.07	1.15
Saturated model	0.00	0.00	0.00	0.00
Independence model	14.58	11.82	10.36	13.40

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.06	0.02	0.09	0.25
Independence model	0.26	0.25	0.28	0.00

AIC

Model	AIC	BCC	BIC	CAIC
Default model	276.69	327.17	390.28	443.28
Saturated model	380.00	560.95	787.20	977.20
Independence model	941.73	959.83	982.45	1001.45

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	4.46	3.99	5.07	5.28
Saturated model	6.13	6.13	6.13	9.05
Independence model	15.19	13.73	16.77	15.48

HOELTER

Model	HOELTER 0.05	HOELTER 0.01
Default model	61.00	65.00
Independence model	14.00	15.00

Execution time summary

Minimization:	0.07
Miscellaneous:	0.98
Bootstrap:	0.00
Total:	1.05

Appendix F

Estimates for Adjusted Measurement Model- AMOS Output

Estimates

Regression Weights

			Estimate	S.E.	C.R.	P
Lead3	<---	Leadership	0.98	0.20	4.95	***
Lead2	<---	Leadership	1.00			
Team1	<---	Team	1.00			
Strat3	<---	Strategy	1.00			
Strat2	<---	Strategy	1.03	0.10	10.49	***
Strat1	<---	Strategy	1.01	0.08	11.92	***
Proc3	<---	Process	1.47	0.20	7.35	***
Proc2	<---	Process	1.28	0.18	7.10	***
Team2	<---	Team	1.13	0.14	7.96	***
Cost	<---	Performance	3.85	1.73	2.23	0.03
Time	<---	Performance	1.00			
Quality	<---	Performance	1.80	0.84	2.15	0.03
Lead1	<-	Leadership	0.86	0.14	6.04	***
Com1	<-	Communication	1.00			
Com2	<-	Communication	0.81	0.11	7.70	***
Proc1	<-	Process	1.00			
PM Satisfaction	<-	Performance	5.52	1.85	2.99	0.00
Com3	<-	Communication	1.09	0.11	9.60	***

Standardized Regression Weights:

			Estimate
Lead3	<---	Leadership	0.63
Lead2	<---	Leadership	0.83
Team1	<---	Team	0.91
Strat3	<---	Strategy	0.9
Strat2	<---	Strategy	0.88
Strat1	<---	Strategy	0.94
Proc3	<---	Process	0.96
Proc2	<---	Process	0.89
Team2	<---	Team	0.89
Cost	<---	Performance	0.37
Time	<---	Performance	0.54
Quality	<---	Performance	0.36
Lead1	<---	Leadership	0.75
Com1	<---	*Communication*	0.88
Com2	<---	Communication	0.79
Proc1	<---	Process	0.73
PM Satisfaction	<---	Performance	0.78
Com3	<---	Communication	0.92

Covariances

			Estimate	S.E.	C.R.	P
Leadership	<-->	Team	0.27	0.09	3.20	0
Leadership	<-->	Communication	0.37	0.11	3.51	***
Leadership	<-->	Strategy	0.56	0.14	3.96	***
Leadership	<-->	Process	0.15	0.08	1.80	0.07
Leadership	<-->	Performance	0.04	0.02	2.15	0.03
Team	<-->	Communication	0.27	0.10	2.82	0.00
Team	<-->	Strategy	0.29	0.12	2.39	0.02
Team	<-->	Process	0.32	0.10	3.26	0.00
Team	<->	Performance	0.03	0.02	1.85	0.06
Strategy	<->	Communication	0.58	0.16	3.67	***
Process	<->	Communication	0.19	0.10	1.90	0.06
Performance	<->	Communication	0.05	0.02	2.29	0.02
Strategy	<->	Process	0.26	0.13	2.10	0.04
Strategy	<->	Performance	0.04	0.02	1.73	0.08
Process	<->	Performance	0.02	0.02	1.46	0.15

Correlations

			Estimate
Leadership	<-->	Team	0.55
Leadership	<-->	Communication	0.62
Leadership	<-->	Strategy	0.73
Leadership	<-->	Process	0.28
Leadership	<-->	Performance	0.47
Team	<-->	Communication	0.44
Team	<-->	Strategy	0.35
Team	<-->	Process	0.56
Team	<-->	Performance	0.35
Strategy	<-->	Communication	0.61
Process	<-->	Communication	0.28
Performance	<-->	Communication	0.49
Strategy	<-->	Process	0.31
Strategy	<-->	Performance	0.32
Process	<-->	Performance	0.26

Variances				
	Estimate	S.E.	C.R.	P
Leadership	0.48	0.13	3.73	***
Team	0.53	0.12	4.29	***
Strategy	1.23	0.27	4.54	***
Process	0.60	0.18	3.26	0
Performance	0.01	0.01	1.88	0.06
Communication	0.74	0.17	4.26	***
e3	0.70	0.14	4.94	***
e2	0.21	0.06	3.29	***
e5	0.10	0.05	1.90	0.06
e16	0.28	0.07	3.88	***
e15	0.36	0.09	4.24	***
e14	0.17	0.06	2.87	0
e19	0.10	0.08	1.22	0.22
e18	0.26	0.08	3.42	***
e23	0.03	0.01	4.54	***
e22	1.16	0.22	5.20	***
e6	0.17	0.07	2.37	0.02
e24	0.28	0.05	5.24	***
e1	0.27	0.06	4.30	***
e13	0.17	0.06	2.69	0.01
e10	0.22	0.06	3.56	***
e12	0.29	0.06	4.70	***
e17	0.53	0.10	5.13	***
e25	0.25	0.12	2.20	0.03

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	51	141.19	120	0.09	1.18
Saturated model	171	0	0		
Independence model	18	799.86	153	0	5.23

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	0.05	0.82	0.75	0.58
Saturated model	0	1		
Independence model	0.36	0.32	0.23	0.28

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	0.82	0.77	0.97	0.96	0.97
Saturated model	1		1		1
Independence model	0	0	0	0	0

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	0.78	0.65	0.76
Saturated model	0	0	0
Independence model	1	0	0

NCP

Model	NCP	LO 90	HI 90
Default model	21.19	0	55
Saturated model	0	0	0
Independence model	646.86	562.1	739.13

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.28	0.34	0	0.89
Saturated model	0	0	0	0
Independence model	12.9	10.43	9.07	11.92

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.05	0	0.09	0.43
Independence model	0.26	0.24	0.28	0

AIC

Model	AIC	BCC	BIC	CAIC
Default model	243.19	288.26	352.49	403.49
Saturated model	342	493.12	708.48	879.48
Independence model	835.86	851.77	874.44	892.44

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	3.92	3.58	4.47	4.65
Saturated model	5.52	5.52	5.52	7.95
Independence model	13.48	12.11	14.97	13.74

HOELTER

Model	HOELTER 0.05	HOELTER 0.01
Default model	65	70
Independence model	15	16

Appendix G

Estimates for the full structural model: Original Structural Model

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	43.00	153.95	128.00	0.06	1.20
Saturated model	171.00	0.00	0.00		
Independence model	18.00	799.86	153.00	0.00	5.23

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	0.08	0.81	0.75	0.61
Saturated model	0.00	1.00		
Independence model	0.36	0.32	0.23	0.28

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	0.81	0.77	0.96	0.95	0.96
Saturated model	1.00		1.00		1.00
Independence model	0.00	0.00	0.00	0.00	0.00

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	0.84	0.68	0.80
Saturated model	0.00	0.00	0.00
Independence model	1.00	0.00	0.00

NCP

Model	NCP	LO 90	HI 90
Default model	25.95	0.00	61.31
Saturated model	0.00	0.00	0.00
Independence model	646.86	562.10	739.13

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.48	0.42	0.00	0.99
Saturated model	0.00	0.00	0.00	0.00
Independence model	12.90	10.43	9.07	11.92

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.06	0.00	0.09	0.36
Independence model	0.26	0.24	0.28	0.00

AIC

Model	AIC	BCC	BIC	CAIC
Default model	239.95	277.95	332.11	375.11
Saturated model	342.00	493.12	708.48	879.48
Independence model	835.86	851.77	874.44	892.44

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	3.87	3.45	4.44	4.48
Saturated model	5.52	5.52	5.52	7.95
Independence model	13.48	12.11	14.97	13.74

HOELTER

Model	HOELTER 0.05	HOELTER 0.01
Default model	63.00	68.00
Independence model	15.00	16.00

Estimates
Regression Weights

			Estimate	S.E.	C.R.	P
Team	<---	Leadership	0.71	0.19	3.78	***
Communication	<---	Leadership	1.01	0.22	4.52	***
Strategy	<---	Leadership	1.46	0.28	5.22	***
Process	<---	Communication	-0.01	0.13	-0.05	0.96
Process	<---	Strategy	0.08	0.1	0.81	0.42
Process	<---	Team	0.53	0.16	3.36	***
Performance	<---	Process	0.22	0.14	1.52	0.13
SFA3LE_B	<---	Leadership	1.15	0.26	4.51	***
SFA3LE_A	<---	Leadership	1.19	0.2	5.92	***
SFA3TEAM	<---	Team	1			
SFASTR_B	<---	Strategy	0.99	0.08	11.86	***
SFASTR_A	<---	Strategy	1.02	0.09	11.3	***
SFASTRAT	<---	Strategy	1			
SFA3PR_B	<---	Process	1.48	0.2	7.32	***
SFA3PR_A	<---	Process	1.28	0.18	7.04	***
SFA3TE_A	<---	Team	1.06	0.14	7.54	***
PC1	<---	Performance	1			
TP	<---	Performance	0.24	0.09	2.74	0.01
QLTYAG	<---	Performance	0.23	0.14	1.61	0.11
SFA3LEAD	<---	Leadership	1			
SFACOM1	<---	Communication	1			
SFACOM2	<---	Communication	0.8	0.1	7.65	***
SFA3PROC	<---	Process	1			
SATAGREG	<---	Performance	0.69	0.25	2.77	0.01
SFACOM3	<---	Communication	1.09	0.11	9.49	***

Standardized Regression Weights

			Estimate
Team	<--	Leadership	0.54
Communication	<--	Leadership	0.68
Strategy	<--	Leadership	0.76
Process	<--	Communication	-0.01
Process	<--	Strategy	0.12
Process	<--	Team	0.52
Performance	<--	Process	0.26
Lead3	<--	Leadership	0.62
Lead2	<--	Leadership	0.83
Team1	<--	Team	0.94
Strat3	<--	Strategy	0.9
Strat2	<--	Strategy	0.88
Strat1	<--	Strategy	0.94
Proc3	<--	Process	0.97
Proc2	<--	Process	0.88
Team1	<--	Team	0.87
Cost	<--	Performance	0.55
Time	<--	Performance	0.73
Quality	<--	Performance	0.26
Lead1	<--	Leadership	0.73
Com1	<--	Communication	0.88
Com2	<--	Communication	0.79
Proc1	<--	Process	0.73
PM satisfaction	<--	Performance	0.55
Com3	<--	Communication	0.92

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.
Leadership	0.33	0.11	3.13
e20	0.4	0.1	3.95
e21	0.4	0.11	3.68
e22	0.54	0.14	3.72
e23	0.4	0.13	3.19
e24	0.39	0.21	1.83
e3	0.71	0.14	5.01
e2	0.21	0.06	3.49
e4	0.07	0.06	1.15
e12	0.28	0.07	3.89
e11	0.36	0.09	4.22
e10	0.17	0.06	2.8
e15	0.08	0.08	1.01
e14	0.27	0.08	3.57
e17	0.02	0.01	2.43
e16	0.94	0.22	4.24
e5	0.21	0.08	2.75
e18	0.3	0.06	5.37
e1	0.29	0.07	4.52
e9	0.17	0.06	2.62
e7	0.21	0.06	3.42
e8	0.3	0.06	4.69
e13	0.54	0.1	5.16
e19	0.45	0.11	4.26

Modification Indices (Group number 1 - Default model)
Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e24	<-->	Leadership	3.62	0.12
e19	<-->	Leadership	5.32	0.13
e19	<-->	e21	3.86	0.13
e13	<-->	e20	3.66	-0.13
e18	<-->	e19	3.04	0.09
e18	<-->	e8	5.82	0.1
e18	<-->	e7	3.69	-0.07
e5	<-->	e22	3.65	-0.11
e16	<-->	e8	6.45	-0.2
e14	<-->	e16	4.4	-0.16
e15	<-->	e16	4.85	0.16
e10	<-->	e8	3.42	0.07
e12	<-->	e14	3.58	0.08
e4	<-->	e13	8.86	-0.12
e2	<-->	e9	3.09	-0.07
e2	<-->	e10	4.12	0.08
e2	<-->	e11	6.41	-0.12
e3	<-->	e23	4.28	-0.15
e3	<-->	e11	3.21	0.14

Variances: (Group number 1 - Default model)

	M.I.	Par Change

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
Performance	<---	Leadership	3.62	0.35
Performance	<---	Communication	3.76	0.23
PM satisfaction	<---	Leadership	5.32	0.39
PM satisfaction	<---	Communication	8.03	0.31
PM satisfaction	<---	Com2	9.2	0.32
PM satisfaction	<---	Com1	6.37	0.24
PM satisfaction	<---	Com3	6.14	0.22
PM satisfaction	<---	Lead1	6.72	0.3
Proc1	<---	Team1	3.71	-0.23
Com2	<---	Quality	5.89	0.32
Com1	<---	Quality	3.41	-0.23
Lead1	<---	PM satisfaction	3.54	0.18
Quality	<---	Com2	3.54	0.15
Cost	<---	Com2	3.93	-0.3
Proc2	<---	PM satisfaction	3.37	-0.17
Proc2	<---	Cost	5.61	-0.15
Proc3	<---	Cost	5.2	0.13
Strat1	<---	Com2	3.31	0.14
Team1	<---	Proc1	4.11	-0.11

Total Effects

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	1.01	0.00	0.00	0.00	0.00	0.00
Strategy	1.46	0.00	0.00	0.00	0.00	0.00
Team	0.71	0.00	0.00	0.00	0.00	0.00
Process	0.49	-0.01	0.08	0.53	0.00	0.00
Perfomance	0.11	0.00	0.02	0.12	0.22	0.00
PM Satisfaction	0.07	0.00	0.01	0.08	0.15	0.69
Proc1	0.49	-0.01	0.08	0.53	1.00	0.00
Com2	0.81	0.80	0.00	0.00	0.00	0.00
Com1	1.01	1.00	0.00	0.00	0.00	0.00
Com3	1.11	1.09	0.00	0.00	0.00	0.00
Lead	1.00	0.00	0.00	0.00	0.00	0.00
Quality	0.02	0.00	0.00	0.03	0.05	0.23
Team2	0.76	0.00	0.00	1.06	0.00	0.00
Cost	0.11	0.00	0.02	0.12	0.22	1.00
Time	0.02	0.00	0.00	0.03	0.05	0.24
Proc2	0.62	-0.01	0.10	0.68	1.28	0.00
Proc3	0.72	-0.01	0.12	0.79	1.48	0.00
Strat1	1.46	0.00	1.00	0.00	0.00	0.00
Strat2	1.50	0.00	1.02	0.00	0.00	0.00
Strat3	1.45	0.00	0.99	0.00	0.00	0.00
Team1	0.71	0.00	0.00	1.00	0.00	0.00
Lead2	1.19	0.00	0.00	0.00	0.00	0.00
Lead3	1.15	0.00	0.00	0.00	0.00	0.00

Standardized Total Effects (Group number 1 – Default model)

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	0.68	0.00	0.00	0.00	0.00	0.00
Strategy	0.76	0.00	0.00	0.00	0.00	0.00
Team	0.54	0.00	0.00	0.00	0.00	0.00
Process	0.36	-0.01	0.12	0.52	0.00	0.00
Perfomance	0.09	0.00	0.03	0.13	0.26	0.00
PM Satisfaction	0.05	0.00	0.02	0.07	0.14	0.55
Proc1	0.26	0.00	0.08	0.37	0.73	0.00
Com2	0.53	0.79	0.00	0.00	0.00	0.00
Com1	0.60	0.88	0.00	0.00	0.00	0.00
Com3	0.62	0.92	0.00	0.00	0.00	0.00
Lead	0.73	0.00	0.00	0.00	0.00	0.00
Quality	0.02	0.00	0.01	0.04	0.07	0.26
Team2	0.47	0.00	0.00	0.87	0.00	0.00
Cost	0.05	0.00	0.02	0.07	0.14	0.55
Time	0.07	0.00	0.02	0.10	0.19	0.73
Proc2	0.32	-0.01	0.10	0.46	0.88	0.00
Proc3	0.35	-0.01	0.11	0.50	0.97	0.00
Strat1	0.71	0.00	0.94	0.00	0.00	0.00
Strat2	0.67	0.00	0.88	0.00	0.00	0.00
Strat3	0.68	0.00	0.90	0.00	0.00	0.00
Team1	0.51	0.00	0.00	0.94	0.00	0.00
Lead2	0.83	0.00	0.00	0.00	0.00	0.00
Lead3	0.62	0.00	0.00	0.00	0.00	0.00

Direct Effects (Group number 1 - Default model)

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	1.01	0.00	0.00	0.00	0.00	0.00
Strategy	1.46	0.00	0.00	0.00	0.00	0.00
Team	0.71	0.00	0.00	0.00	0.00	0.00
Process	0.00	-0.01	0.08	0.53	0.00	0.00
Performance	0.00	0.00	0.00	0.00	0.22	0.00
PM Satisfaction	0.00	0.00	0.00	0.00	0.00	0.69
Proc1	0.00	0.00	0.00	0.00	1.00	0.00
Com2	0.00	0.80	0.00	0.00	0.00	0.00
Com1	0.00	1.00	0.00	0.00	0.00	0.00
Com3	0.00	1.09	0.00	0.00	0.00	0.00
Lead	1.00	0.00	0.00	0.00	0.00	0.00
Quality	0.00	0.00	0.00	0.00	0.00	0.23
Team2	0.00	0.00	0.00	1.06	0.00	0.00
Cost	0.00	0.00	0.00	0.00	0.00	1.00
Time	0.00	0.00	0.00	0.00	0.00	0.24
Proc2	0.00	0.00	0.00	0.00	1.28	0.00
Proc3	0.00	0.00	0.00	0.00	1.48	0.00
Strat1	0.00	0.00	1.00	0.00	0.00	0.00
Strat2	0.00	0.00	1.02	0.00	0.00	0.00
Strat3	0.00	0.00	0.99	0.00	0.00	0.00
Team1	0.00	0.00	0.00	1.00	0.00	0.00
Lead2	1.19	0.00	0.00	0.00	0.00	0.00
Lead3	1.15	0.00	0.00	0.00	0.00	0.00

Standardized Direct Effects (Group number 1 – Default model)

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	0.68	0.00	0.00	0.00	0.00	0.00
Strategy	0.76	0.00	0.00	0.00	0.00	0.00
Team	0.54	0.00	0.00	0.00	0.00	0.00
Process	0.00	-0.01	0.12	0.52	0.00	0.00
Performance	0.00	0.00	0.00	0.00	0.26	0.00
PM Satisfaction	0.00	0.00	0.00	0.00	0.00	0.55
Proc1	0.00	0.00	0.00	0.00	0.73	0.00
Com2	0.00	0.79	0.00	0.00	0.00	0.00
Com1	0.00	0.88	0.00	0.00	0.00	0.00
Com3	0.00	0.92	0.00	0.00	0.00	0.00
Lead	0.73	0.00	0.00	0.00	0.00	0.00
Quality	0.00	0.00	0.00	0.00	0.00	0.26
Team2	0.00	0.00	0.00	0.87	0.00	0.00
Cost	0.00	0.00	0.00	0.00	0.00	0.55
Time	0.00	0.00	0.00	0.00	0.00	0.73
Proc2	0.00	0.00	0.00	0.00	0.88	0.00
Proc3	0.00	0.00	0.00	0.00	0.97	0.00
Strat1	0.00	0.00	0.94	0.00	0.00	0.00
Strat2	0.00	0.00	0.88	0.00	0.00	0.00
Strat3	0.00	0.00	0.90	0.00	0.00	0.00
Team1	0.00	0.00	0.00	0.94	0.00	0.00
Lead2	0.83	0.00	0.00	0.00	0.00	0.00
Lead3	0.62	0.00	0.00	0.00	0.00	0.00

Indirect Effects (Group number 1 - Default model)

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	0.00	0.00	0.00	0.00	0.00	0.00
Strategy	0.00	0.00	0.00	0.00	0.00	0.00
Team	0.00	0.00	0.00	0.00	0.00	0.00
Process	0.49	0.00	0.00	0.00	0.00	0.00
Performance	0.11	0.00	0.02	0.12	0.00	0.00
PM Satisfaction	0.07	0.00	0.01	0.08	0.15	0.00
Proc1	0.49	-0.01	0.08	0.53	0.00	0.00
Com2	0.81	0.00	0.00	0.00	0.00	0.00
Com1	1.01	0.00	0.00	0.00	0.00	0.00
Com3	1.11	0.00	0.00	0.00	0.00	0.00
Lead	0.00	0.00	0.00	0.00	0.00	0.00
Quality	0.02	0.00	0.00	0.03	0.05	0.00
Team2	0.76	0.00	0.00	0.00	0.00	0.00
Cost	0.11	0.00	0.02	0.12	0.22	0.00
Time	0.02	0.00	0.00	0.03	0.05	0.00
Proc2	0.62	-0.01	0.10	0.68	0.00	0.00
Proc3	0.72	-0.01	0.12	0.79	0.00	0.00
Strat1	1.46	0.00	0.00	0.00	0.00	0.00
Strat2	1.50	0.00	0.00	0.00	0.00	0.00
Strat3	1.45	0.00	0.00	0.00	0.00	0.00
Team1	0.71	0.00	0.00	0.00	0.00	0.00
Lead2	0.00	0.00	0.00	0.00	0.00	0.00
Lead3	0.00	0.00	0.00	0.00	0.00	0.00

Standardized Indirect Effects (Group number 1 – Default model)

	Leadership	Communication	Strategy	Team	Process	Performance
Communication	0.00	0.00	0.00	0.00	0.00	0.00
Strategy	0.00	0.00	0.00	0.00	0.00	0.00
Team	0.00	0.00	0.00	0.00	0.00	0.00
Process	0.36	0.00	0.00	0.00	0.00	0.00
Performance	0.09	0.00	0.03	0.13	0.00	0.00
PM Satisfaction	0.05	0.00	0.02	0.07	0.14	0.00
Proc1	0.26	0.00	0.08	0.37	0.00	0.00
Com2	0.53	0.00	0.00	0.00	0.00	0.00
Com1	0.60	0.00	0.00	0.00	0.00	0.00
Com3	0.62	0.00	0.00	0.00	0.00	0.00
Lead	0.00	0.00	0.00	0.00	0.00	0.00
Quality	0.02	0.00	0.01	0.04	0.07	0.00
Team2	0.47	0.00	0.00	0.00	0.00	0.00
Cost	0.05	0.00	0.02	0.07	0.14	0.00
Time	0.07	0.00	0.02	0.10	0.19	0.00
Proc2	0.32	-0.01	0.10	0.46	0.00	0.00
Proc3	0.35	-0.01	0.11	0.50	0.00	0.00
Strat1	0.71	0.00	0.00	0.00	0.00	0.00
Strat2	0.67	0.00	0.00	0.00	0.00	0.00
Strat3	0.68	0.00	0.00	0.00	0.00	0.00
Team1	0.51	0.00	0.00	0.00	0.00	0.00
Lead2	0.00	0.00	0.00	0.00	0.00	0.00
Lead3	0.00	0.00	0.00	0.00	0.00	0.00

Appendix H

Estimates for the Adjusted Full Structural Model- AMOS Output

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	41	149.33	130	0.12	1.15
Saturated model	171	0	0		
Independence model	18	799.86	153	0	5.23

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	0.06	0.82	0.76	0.62
Saturated model	0	1		
Independence model	0.36	0.32	0.23	0.28

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	0.81	0.78	0.97	0.96	0.97
Saturated model	1		1		1
Independence model	0	0	0	0	0

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	0.85	0.69	0.82
Saturated model	0	0	0
Independence model	1	0	0

NCP

Model	NCP	LO 90	HI 90
Default model	19.33	0	53.73
Saturated model	0	0	0
Independence model	646.86	562.1	739.13

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	2.41	0.31	0	0.87
Saturated model	0	0	0	0
Independence model	12.9	10.43	9.07	11.92

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.05	0	0.08	0.5
Independence model	0.26	0.24	0.28	0

AIC

Model	AIC	BCC	BIC	CAIC
Default model	231.33	267.56	319.2	360.2
Saturated model	342	493.12	708.48	879.48
Independence model	835.86	851.77	874.44	892.44

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	3.73	3.42	4.29	4.32
Saturated model	5.52	5.52	5.52	7.95
Independence model	13.48	12.11	14.97	13.74

HOELTER

Model	HOELTER 0.05	HOELTER 0.01
Default model	66	71
Independence model	15	16

Estimates

Regression Weights

			Estimate	S.E.	C.R.	P
Team	<---	Leadership	0.72	0.19	3.82	***
Communication	<---	Leadership	1.02	0.22	4.58	***
Strategy	<---	Leadership	1.47	0.28	5.24	***
Process	<---	Team	0.58	0.15	3.93	***
Performance	<---	Communication	0.25	0.12	2.03	0.04
Lead3	<---	Leadership	1.15	0.25	4.51	***
Lead2	<---	Leadership	1.19	0.2	5.93	***
Team1	<---	Team	1			
Strat3	<---	Strategy	0.99	0.08	11.83	***
Strat2	<---	Strategy	1.02	0.09	11.32	***
Strat1	<---	Strategy	1			
Proc3	<---	Process	1.45	0.2	7.38	***
Proc2	<---	Process	1.28	0.18	7.18	***
Team2	<---	Team	1.06	0.14	7.69	***
Cost	<---	Performance	1			
Time	<---	Performance	0.26	0.12	2.19	0.03
Quality	<---	Performance	0.46	0.26	1.78	0.07
Lead1	<---	Leadership	1			
Com1	<---	Communication	1			
Com2	<---	Communication	0.81	0.11	7.73	***
Proc1	<---	Process	1			
SAT	<---	Performance	1.51	0.68	2.23	0.03
Com3	<---	Communication	1.09	0.11	9.5	***

Standardized Regression Weights

			Estimate
Team	<---	Leadership	0.55
Communication	<---	Leadership	0.69
Strategy	<---	Leadership	0.76
Process	<---	Team	0.56
Perfomance	<---	Communication	0.51
Lead3	<---	Leadership	0.62
Lead2	<---	Leadership	0.83
Team1	<---	Team	0.94
Strat3	<---	Strategy	0.9
Strat2	<---	Strategy	0.89
Strat1	<---	Strategy	0.94
Proc3	<---	Process	0.96
Proc2	<---	Process	0.9
Team2	<---	Team	0.87
Cost	<---	Perfomance	0.37
Time	<---	Perfomance	0.52
Quality	<---	Perfomance	0.34
Lead1	<---	Leadership	0.73
Com1	<---	Communication	0.88
Com2	<---	Communication	0.79
Proc1	<---	Process	0.73
SAT	<---	Perfomance	0.8
Com3	<---	Communication	0.91

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P
Leadership	0.33	0.11	3.13	0
e20	0.39	0.1	3.99	***
e21	0.39	0.11	3.64	***
e22	0.53	0.14	3.72	***
e23	0.42	0.13	3.21	0
e24	0.13	0.11	1.26	0.21
e3	0.72	0.14	5.01	***
e2	0.21	0.06	3.52	***
e4	0.07	0.06	1.2	0.23
e12	0.28	0.07	3.91	***
e11	0.36	0.09	4.21	***
e10	0.16	0.06	2.78	0.01
e15	0.11	0.08	1.42	0.16
e14	0.24	0.08	3.25	0
e17	0.03	0.01	4.6	***
e16	1.17	0.22	5.22	***
e5	0.21	0.08	2.83	0
e18	0.28	0.05	5.28	***
e1	0.29	0.06	4.52	***
e9	0.18	0.06	2.8	0.01
e7	0.22	0.06	3.55	***
e8	0.29	0.06	4.66	***
e13	0.52	0.1	5.11	***
e19	0.23	0.13	1.79	0.07

Total Effects (Group number 1 – Default model)

	Leadership	Communication	Team	Performance	Process	Strategy
Communication	1.02	0	0	0	0	0
Team	0.72	0	0	0	0	0
Performance	0.26	0.25	0	0	0	0
Process	0.41	0	0.58	0	0	0
Strategy	1.47	0	0	0	0	0
PM Satisfaction	0.39	0.38	0	1.51	0	0
Proc1	0.41	0	0.58	0	1	0
Com2	0.83	0.81	0	0	0	0
Com1	1.02	1	0	0	0	0
Com3	1.11	1.09	0	0	0	0
Lead1	1	0	0	0	0	0
Quality	0.12	0.12	0	0.46	0	0
Team2	0.76	0	1.06	0	0	0
Cost	0.26	0.25	0	1	0	0
Time	0.07	0.06	0	0.26	0	0
Proc2	0.53	0	0.74	0	1.28	0
Proc3	0.6	0	0.84	0	1.45	0
Strat1	1.47	0	0	0	0	1
Strat2	1.5	0	0	0	0	1.02
Strat3	1.45	0	0	0	0	0.99
Team1	0.72	0	1	0	0	0
Lead2	1.19	0	0	0	0	0
Lead3	1.15	0	0	0	0	0

Standardized Total Effects (Group number 1 - Default model)

	Leadership	Communication	Team	Performance	Process	Strategy
Communication	0.69	0.00	0.00	0.00	0.00	0.00
Team	0.55	0.00	0.00	0.00	0.00	0.00
Performance	0.35	0.51	0.00	0.00	0.00	0.00
Process	0.31	0.00	0.56	0.00	0.00	0.00
Strategy	0.76	0.00	0.00	0.00	0.00	0.00
PM Satisfaction	0.28	0.41	0.00	0.80	0.00	0.00
Proc1	0.22	0.00	0.41	0.00	0.73	0.00
Com2	0.54	0.79	0.00	0.00	0.00	0.00
Com1	0.60	0.88	0.00	0.00	0.00	0.00
Com3	0.63	0.91	0.00	0.00	0.00	0.00
Lead1	0.73	0.00	0.00	0.00	0.00	0.00
Quality	0.12	0.17	0.00	0.34	0.00	0.00
Team2	0.48	0.00	0.87	0.00	0.00	0.00
Cost	0.13	0.19	0.00	0.37	0.00	0.00
Time	0.18	0.27	0.00	0.52	0.00	0.00
Proc2	0.27	0.00	0.50	0.00	0.90	0.00
Proc3	0.29	0.00	0.53	0.00	0.96	0.00
Strat1	0.71	0.00	0.00	0.00	0.00	0.94
Strat2	0.67	0.00	0.00	0.00	0.00	0.89
Strat3	0.68	0.00	0.00	0.00	0.00	0.90
Team1	0.52	0.00	0.94	0.00	0.00	0.00
Lead2	0.83	0.00	0.00	0.00	0.00	0.00
Lead3	0.62	0.00	0.00	0.00	0.00	0.00

Direct Effects (Group number 1 – Default model)

	Leadership	Communication	Team	Performance	Process	Strategy
Communication	1.02	0.00	0.00	0.00	0.00	0.00
Team	0.72	0.00	0.00	0.00	0.00	0.00
Performance	0.00	0.25	0.00	0.00	0.00	0.00
Process	0.00	0.00	0.58	0.00	0.00	0.00
Strategy	1.47	0.00	0.00	0.00	0.00	0.00
PM Satisfaction	0.00	0.00	0.00	1.51	0.00	0.00
Proc1	0.00	0.00	0.00	0.00	1.00	0.00
Com2	0.00	0.81	0.00	0.00	0.00	0.00
Com1	0.00	1.00	0.00	0.00	0.00	0.00
Com3	0.00	1.09	0.00	0.00	0.00	0.00
Lead1	1.00	0.00	0.00	0.00	0.00	0.00
Quality	0.00	0.00	0.00	0.46	0.00	0.00
Team2	0.00	0.00	1.06	0.00	0.00	0.00
Cost	0.00	0.00	0.00	1.00	0.00	0.00
Time	0.00	0.00	0.00	0.26	0.00	0.00
Proc2	0.00	0.00	0.00	0.00	1.28	0.00
Proc3	0.00	0.00	0.00	0.00	1.45	0.00
Strat1	0.00	0.00	0.00	0.00	0.00	1.00
Strat2	0.00	0.00	0.00	0.00	0.00	1.02
Strat3	0.00	0.00	0.00	0.00	0.00	0.99
Team1	0.00	0.00	1.00	0.00	0.00	0.00
Lead2	1.19	0.00	0.00	0.00	0.00	0.00
Lead3	1.15	0.00	0.00	0.00	0.00	0.00

Standardized Direct Effects (Group number 1 - Default model)

	Leadership	Communication	Team	Performance	Process	Strategy
Communication	0.69	0.00	0.00	0.00	0.00	0.00
Team	0.55	0.00	0.00	0.00	0.00	0.00
Performance	0.00	0.51	0.00	0.00	0.00	0.00
Process	0.00	0.00	0.56	0.00	0.00	0.00
Strategy	0.76	0.00	0.00	0.00	0.00	0.00
PM Satisfaction	0.00	0.00	0.00	0.80	0.00	0.00
Proc1	0.00	0.00	0.00	0.00	0.73	0.00
Com2	0.00	0.79	0.00	0.00	0.00	0.00
Com1	0.00	0.88	0.00	0.00	0.00	0.00
Com3	0.00	0.91	0.00	0.00	0.00	0.00
Lead1	0.73	0.00	0.00	0.00	0.00	0.00
Quality	0.00	0.00	0.00	0.34	0.00	0.00
Team2	0.00	0.00	0.87	0.00	0.00	0.00
Cost	0.00	0.00	0.00	0.37	0.00	0.00
Time	0.00	0.00	0.00	0.52	0.00	0.00
Proc2	0.00	0.00	0.00	0.00	0.90	0.00
Proc3	0.00	0.00	0.00	0.00	0.96	0.00
Strat1	0.00	0.00	0.00	0.00	0.00	0.94
Strat2	0.00	0.00	0.00	0.00	0.00	0.89
Strat3	0.00	0.00	0.00	0.00	0.00	0.90
Team1	0.00	0.00	0.94	0.00	0.00	0.00
Lead2	0.83	0.00	0.00	0.00	0.00	0.00
Lead3	0.62	0.00	0.00	0.00	0.00	0.00

Indirect Effects (Group number 1 – Default model)

	Leadership	Communication	Team	Performance	Process	Strategy
Communication	0.00	0.00	0.00	0.00	0.00	0.00
Team	0.00	0.00	0.00	0.00	0.00	0.00
Perfomance	0.26	0.00	0.00	0.00	0.00	0.00
Process	0.41	0.00	0.00	0.00	0.00	0.00
Strategy	0.00	0.00	0.00	0.00	0.00	0.00
PM Satisfaction	0.39	0.38	0.00	0.00	0.00	0.00
Proc1	0.41	0.00	0.58	0.00	0.00	0.00
Com2	0.83	0.00	0.00	0.00	0.00	0.00
Com1	1.02	0.00	0.00	0.00	0.00	0.00
Com3	1.11	0.00	0.00	0.00	0.00	0.00
Lead1	0.00	0.00	0.00	0.00	0.00	0.00
Quality	0.12	0.12	0.00	0.00	0.00	0.00
Team2	0.76	0.00	0.00	0.00	0.00	0.00
Cost	0.26	0.25	0.00	0.00	0.00	0.00
Time	0.07	0.06	0.00	0.00	0.00	0.00
Proc2	0.53	0.00	0.74	0.00	0.00	0.00
Proc3	0.60	0.00	0.84	0.00	0.00	0.00
Strat1	1.47	0.00	0.00	0.00	0.00	0.00
Strat2	1.50	0.00	0.00	0.00	0.00	0.00
Strat3	1.45	0.00	0.00	0.00	0.00	0.00
Team1	0.72	0.00	0.00	0.00	0.00	0.00
Lead2	0.00	0.00	0.00	0.00	0.00	0.00
Lead3	0.00	0.00	0.00	0.00	0.00	0.00

Standardized Indirect Effects (Group number 1 - Default model)

	Leadership	Communication	Team	Perfomance	Process	Strategy
Communication	0.00	0.00	0.00	0.00	0.00	0.00
Team	0.00	0.00	0.00	0.00	0.00	0.00
Perfomance	0.35	0.00	0.00	0.00	0.00	0.00
Process	0.31	0.00	0.00	0.00	0.00	0.00
Strategy	0.00	0.00	0.00	0.00	0.00	0.00
PM Satisfaction	0.28	0.41	0.00	0.00	0.00	0.00
Proc1	0.22	0.00	0.41	0.00	0.00	0.00
Com2	0.54	0.00	0.00	0.00	0.00	0.00
Com1	0.60	0.00	0.00	0.00	0.00	0.00
Com3	0.63	0.00	0.00	0.00	0.00	0.00
Lead1	0.00	0.00	0.00	0.00	0.00	0.00
Quality	0.12	0.17	0.00	0.00	0.00	0.00
Team2	0.48	0.00	0.00	0.00	0.00	0.00
Cost	0.13	0.19	0.00	0.00	0.00	0.00
Time	0.18	0.27	0.00	0.00	0.00	0.00
Proc2	0.27	0.00	0.50	0.00	0.00	0.00
Proc3	0.29	0.00	0.53	0.00	0.00	0.00
Strat1	0.71	0.00	0.00	0.00	0.00	0.00
Strat2	0.67	0.00	0.00	0.00	0.00	0.00
Strat3	0.68	0.00	0.00	0.00	0.00	0.00
Team1	0.52	0.00	0.00	0.00	0.00	0.00
Lead2	0.00	0.00	0.00	0.00	0.00	0.00
Lead3	0.00	0.00	0.00	0.00	0.00	0.00

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Chapter Seven

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