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DEVELOPING A PERFORMANCE MEASUREMENT FRAMEWORK FOR MUNICIPAL CONSTRUCTION PROJECTS IN SAUDI ARABIA

By

SALEH ALSULAMY

A thesis submitted in partial fulfilment of the requirements of Edinburgh Napier University, for the award of Doctor of Philosophy

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DECLARATION

This is to certify that I am responsible for the work submitted in this thesis, that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning

Signature: …………………………………………….

Date: ………………………………………………….

DEDICATION

This thesis is dedicated to:

My spirit (My Father) may Allah have mercy on him

My head crown (My mother)

My love (My Wife)

My heart (My Children):

Ammar, Marwan, Iyah, and Hisham

My Brothers and Sisters:

Saleha, Jameelah, Nouf, Naif, Aisha, Fatimah, Majid, Anwar, Munira, Nihal, Anwaar, Tamadhor and Faisal

My Close friend:

Abdullah Alhawati

ABSTRACT

Performance measurement has the main aim of helping organizations to realize how decision-making processes can be harnessed to improve success rate in past activities and how the understanding from the current and past can lead to future improvements. Specifically, a comprehensive performance measurement practise must enhance the achievement of the key aim of the project stakeholders, the objectives of the project itself, and the needs of the users all of which should be capable of being represented in raw data to be manipulated and measured by a performance measurement tool. The performance of a project is directly related to its potential for success, and on the other hand, the CSFs of a project have a direct bearing on the project's performance. In essence, the efficiency and effectiveness measures of a project are essential yardsticks for assessing project performance and success.

The stakeholders in a project have needs and expectations which the project is being conceived to satisfy, therefore, these needs and expectations must be held paramount during the conceptual design, development execution, and operation stages of a project. This is applicable to the general construction industry and in particular, in construction projects implemented by municipal organisations. However, municipal construction project have been fraught with delays, cost overruns and failure in operational performance. Hence, the overall aim of this research is to develop a framework within which municipal construction project performance can be measured in the SA at any stage of the project, and specifically to increase its effectiveness and efficiency of the project in order to improve the project's performance to the satisfaction of stakeholders.

This study was implemented through the administration of a questionnaire survey based on a hypothesis that requires the identification of the challenges and obstacles that are facing the implementation of municipal construction project in SA. The collected data is based on responses from three major organisations; government, contractors and consultants that are involved in the delivery of municipal construction projects in SA. Mean and analysis of variance (ANOVA statistic) was used to manipulate the data from the questionnaire within the SPSS v.20 software environment. The resulting framework was subjected to a validation procedure which involved a structured interview process based on a focus group consisting of experts that were specially selected for the purpose establishing the extent to which the framework is practical, clear, applicable and comprehensive. Also, the focus group was used to determine the significance of the CSFs, PMs, and success (efficiency and effectiveness) measures.

Overall, this study found that a total absence of performance measurement concept process permeates the management of construction projects in SA and in the municipality construction projects in particular. To close this gap, this study was embarked upon to investigate and identify the various performance measurement approaches and frameworks that are used to support the guidance of project performance toward success. Notably, this study emphasises the importance of stakeholder needs and expectation forming the bases of municipality construction projects in SA. Specifically, this study suggests that the measurement of project performance in municipality construction projects in SA should be integrated in a holistic framework containing several elements that will help to guide construction projects toward success.

PUBLICATIONS ARISING

09/2012	Alsulamy, S., Wamuziri, S., & Taylor, M. (2012). A Conceptual Evaluation of Benchmarking for Performance Measurement in Construction Projects Saudi Arabia. *IFME 2012 Exhibition.* Helsinki.
06/2012	Alsulamy, S; Wamuziri, S and Taylor, M (2012) Evaluation of key metrics for measurement of project performance *In*: Smith, S.D (Ed) *Procs 28th Annual ARCOM Conference*, 3-5 September 2012, Edinburgh, UK, Association of Researchers in Construction Management, 1101-1110.
01/2014	Alsulamy S; Gupta N K; Sloan B. (2014) Factors influencing municipal construction project performance. *Proceedings of the ICE - Municipal Engineer*, Volume 167, Issue 2, pp 108-117, January 2014/
03/2014	Alsulamy S; Gupta N K; Sloan B and Wamuziri S. (2014). Identification of Performance Measures for Municipal Construction Projects in Saudi Arabia. *Int. J. of Civil and Environmental Engineering*, Volume 36, Issue 1, pp 1192-120, March 2014.
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LIST OF ABBREVIATIONS

% of VA for	of variance accounted for
Agr	Agronomist
ANOVA	Analysis of Variance
Arch	Architect
BSC	The Balanced Scorecard
CEng	Civil Engineer
Cons	Consultant
Cont	Contractor
CPV	Cumulative percentage variance
CSFs	Critical Success Factors
EEng	Electrical Engineer
EFQM	The European Foundation for Quality Management
Eig	Eigenvalue
Eng	Engineer
FL	Factor loading
Gov	Government
KMO	Kaiser-Meyer-Olkin
KPIs	Key Performance Indicators
SA	Saudi Arabia
MBNQA	Malcolm Baldrige National Quality Award
MEng	Mechanical Engineer
MM	Municipality Mayor
PD	Projects Director
PM	Performance Measurement
KPIs	Key Performance Indicators
PM	Project Manager
PMF	Performance Measurement Framework
MPMP	Municipal Performance Measurement Program
PMS	Performance Measurement System
PoVE	Percentage of variance explained
PMs	Project Performance Measures
PSMs	Project Success Measures
PWC	Public Work Contract
QS	Quantity Surveyor
SEng	Site Engineer
SPSS	Statistical Package for Social Sciences

"To measure is to know." *Lord Kelvin*

"You cannot measure what you do not define." *(Fink, 2006)*

"If you cannot measure it, you cannot manage it." *Peter Drucker*

"If you cannot measure it, you cannot improve it." *Lord Kelvin*

"If you don't measure results, you cannot tell success from failure" (evaluate); "If you cannot see success, you cannot reward it" (motivate); "If you cannot see success, you cannot learn from it" (lean best practise); "If you can demonstrate results, you can win public support" (promote) *(Behn, 2003)*

1. CHAPTER ONE: BACKGROUND TO THE RESEARCH

1.1 Introduction

The construction industry plays a key role in the performance of all economic sectors. The Saudi Government has supported construction projects through substantial investment in infrastructure projects including roads, parks, buildings, road lighting, road slope protection, bridges, and irrigation (Abbas, 1998). The municipal ministry is charged with this responsibility and is a major stakeholder in the implementation and management of these projects. In response to significant pressure from high level authorities to deliver such projects to citizens, hundreds of these projects commence annually. However, a lack of experience, insufficiently skilled staff, routinely poor execution processes, and poor project management practices, such as monitoring, control, and performance measurement, have been major weaknesses within Saudi construction projects (Assaf, & Al-Hejji, 2006; Al-Sedairy, 2001; Al-Sedairy, 1999; Al-Khalil & Al-Ghafly, 1999a; Al-Khalil & Al-Ghafly, 1999; Al-Hammad, 1995). In recent years, some studies have been conducted regarding this within the Saudi construction industry. However, research into municipal projects still remains a problem area with a dearth of research studies. Likely reasons for this lack of research may be due to insufficient specialists in municipal agencies. This is apparent through weak project performance and failure to achieve goals with respect to the basic success criteria which are; time, quality and target (Al-Nagadi, 2010; Al-Sedairy S. T., 2001).

So far, in SA, there has been little consideration given to applying PMSs in the construction sector (Ankrah & Proverbs, 2005). Despite the lack of interest in the application of PMSs in construction sector, the three basic criteria of time, cost, and quality can still be applied to determine the success of the project (Haponava & Al-Jibouri, 2010). However, ambiguity and weaknesses in the relationship between the owner and contractor of construction projects are still present and have not been investigated adequately (Löfgren & Eriksson, 2009). With regard to the practice of performance measurement in the government sector, it is apparent from previous research that the understanding of the concept of performance measurement is limited and not applied efficiently and properly (Bracegirdle, 2003). Bracegirdle suggested areas for further discussion, such as the actual returns that can be achieved for investing in performance measurement. Latiffi et al (2009) recommended the examination of the relationship between organisations' strategic development and performance measurement, as well as investigating criteria of measures selection.

Despite the limited number of studies conducted in the construction sector in SA (Alsuliman, Graeme & Chen, 2012), the research to date has tended to focus on the causes of various problems that face construction projects rather than implementing and assessing new methods to improve performance (Assaf, & Al-Hejji, 2006; Al-Sedairy S. T., 2001; Al-Sedairy S. t., 1999; Al-Khalil & Al-Ghafly, 1999a). Several reasons were being responsible for the poor performance of construction projects during their lifecycles (planning stage, execution stage, and operation stage). The most important factor was found to be the lack of a comprehensive performance framework for all phases of the project, as well as the absence of a strategic agenda for the construction sector in general. Thus, it is obvious from the above that there is an urgent need to develop a system through which to determine current performance, resolve problems and benchmark them against best practice in order to meet the expectations of stakeholders, municipalities, contractors and consultant. According to Kaplan & Norton (1996, p. 100), *"if you can't measure it, you can't manage it",* as well as, "*You cannot manage what you do not measure"* (Fink, 2006, p. 85)*;* consequently, you cannot measure what you do not define*"* (Fink, 2006), therefore, it will be necessary to include CSFs, PMs and PSMs, as well as a benchmarking system.

This study intends to investigate issues relating to the difficulties of project performance measurement and project performance improvement in SA and the benefits derived from best practices (as applied in developed countries) and their potential application in SA.

1.2 Statement of the problem

One of the most significant problems facing construction projects in developing countries is the lack of consideration and planning in the pre-implementation stage, as well as the failure of projects during their execution. As a result, the desired goals are neither achieved nor integrated with the general developmental or economic strategy of the country (Al-Hammad, 1995). Whilst there is also a lack of methods and mechanisms to monitor and control projects, as can be the case in developed countries, some research has been undertaken in developed countries regarding how to control and measure the performance of construction projects in the public and private sectors (Haponava & Al-Jibouri, 2009; Ankrah & Proverbs, 2005; Beatham et al. 2004). It is essential, therefore, that these are investigated to select suitable methods and appropriate mechanisms that can be applied to address the poor performance of construction projects in SA. However, a new PMS is anticipated to address and remedy these issues involving institutional aims, plans, goals and strategies. Figure 1-1 shows the background of problem.

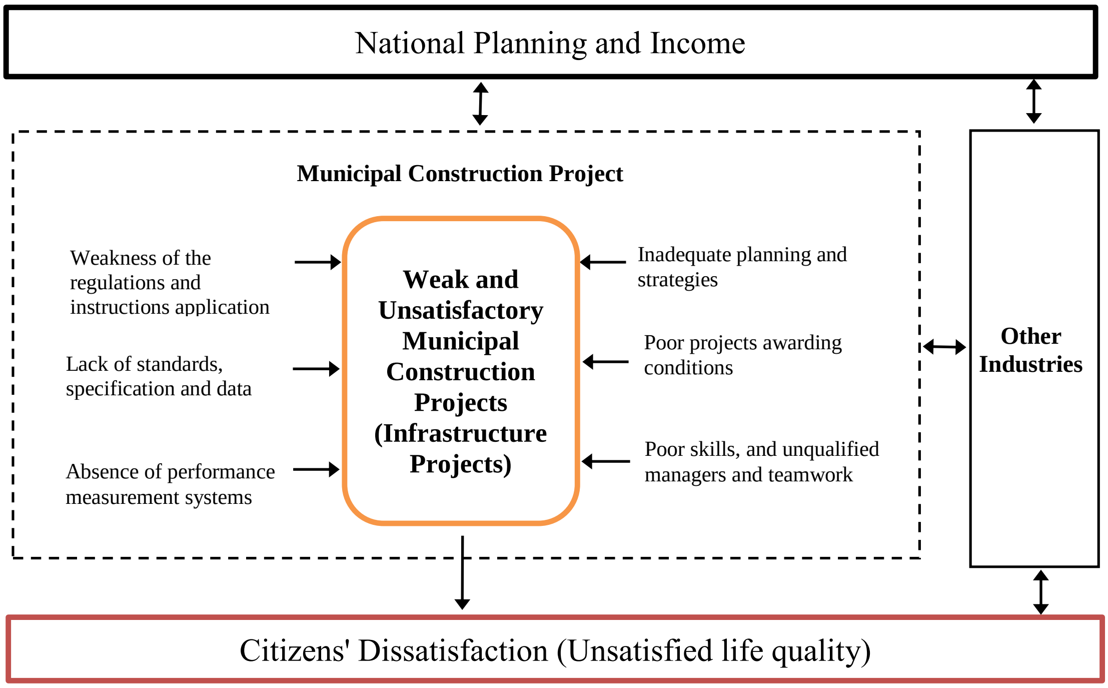

Figure 1-1: Problem background

1.3 Research Aims and Objectives.

1.3.1 Aim

The main aim of this research is the development of a framework to measure municipal construction project performance in Saudi Arabia at any stage of the project and, thus, enable its performance to be improved. In general, the study will concentrate on issues relevant to raising efficiency and effectiveness in project outcomes in municipalities in SA. To achieve this aim, there are several objectives that must be considered and investigated.

1.3.2 Objectives

In order to achieve the research aim, the following objectives were set:-

- Review existing performance measurement framework being used in the construction industries and public authorities of the developed countries including the performance measurement process, project stages, project stakeholders, CSFs, and PMs and PSMs.
- Identify project stages, key participants and stakeholders involved in the delivery of municipal construction project and the relationship among them,
- Identify the procurement and execution procedures of construction projects in municipalities in SA;
- Examine the current process and approach to managing and measuring construction projects in municipalities in SA and problematic areas;
- Explore and determine the performance measurement process, CSFs, and PMs and PSMs in the implementation of municipal construction projects;
- Develop a practical and effective framework for evaluating municipal construction projects performance in SA;
- Evaluate and validate the proposed performance measurement framework through experts' opinion and perceptions; and
- Conclude result of study and recommend further investigation in the field of construction projects performance measurement and other in relation.

1.4 Focus of the Research

The research scope of this study is limited to construction projects in municipalities in SA. However, this research will divide project performance into two key areas. The first area will focus on PMSs knowledge around the World, where the current models that are in use will be investigated to ascertain the extent to which they achieve their goals. In addition, relevant research studies in this area will be reviewed and analysed to explore the possibility of creating an improved method to measure municipal projects.

The second area concentrate on the current practise in municipalities in SA. Here, the current project execution approaches at all project stages will be identified. This will be with a view to explain the problem areas, project stages and key performers such as owners (municipal team), contractors, consultants. The research has a quantitative and qualitative aspect, which means that the focus is on descriptive and factual information as well as theoretical. To achieve reliable results, a large amount of data will have to be collected.

1.5 Research Questions

The research questions to be investigated to achieve the objectives are: -

- What are the PMSs used to assess construction project performance around the world?
- What are the processes of performance measurement for construction projects around the world?
- What are the strengths and weaknesses in current performance measurement practices?
- What are the key stakeholders and stages in municipal construction projects in SA?
- What are the obstacles and challenges facing municipal construction projects in SA?
- What is the process of execution of construction projects in municipalities in SA?
- What methods and techniques are being used to measure construction projects performance in municipalities in SA?
- What are the processes of performance measurement for construction projects in municipalities in SA?

1.6 Research Design

The method is a fundamental prerequisite for successful research. The most essential research methods and the most commonly used in scientific research are the theoretical and practical approaches; although, there are many other scientific methods (Remenyi, 1996). The principal step for the success of research is to choose the appropriate methodology, which in turn depends on the aims of the research and questions that are to be answered. It is a guide to the researcher to design a suitable approach to gather data and to help analyse this data. Thus, the research is based on qualitative and quantitative techniques.

This research has been undertaken on the basis of measuring the performance of the construction projects in municipalities in SA through all stages of project execution. In addition, theoretical approaches are included to review previous research further to practical approaches that are concerned with field work to collect information and data through questionnaires and interviews. The research programme can be classified into five basic phases as seen in Figure 1-2.

Phase One: The literature review stage is considered an essential part of research as it is intended to develop an understanding of the nature of the problem and establish the study aim and objectives and identify research theories and hypotheses seeking to construct the theoretical framework for the research questions. This exploratory phase is particularly concerned with literature that investigates success of construction project performance in various countries of the developed world. The objective of investigating previous studies and research is to establish knowledge regarding concepts of PMSs in terms of their processes in government and the private sector, and to identify the PMSs, CSFs, PMs, stakeholders, and key project stages and stakeholders in the construction projects. The existing PMSs were used to formulate an initial questionnaire used for the pilot study in the second phase, and formulation of a conceptual framework.

Phase Two: The interview and pilot study stage took place to design the questionnaire. The interview is conducted to identify project stages and key participants involved in the delivering of construction projects in municipalities in SA and the relationships between construction project performers, and citizens, also, current procurement system practiced in construction projects in municipalities in SA. Moreover, six key practitioners in municipalities exclusively were interviewed to answer the above questions. The pilot study is conducted to test the accuracy of questions being asked and to establish appropriate questions to obtain the required information. A sample size of ten respondents was considered adequate enough to develop the final questionnaire.

Phase Three: This phase deals with the task of data collection to answer the questions and discover the stakeholders' perceptions about CSFs, PMs, and PSMs. The questionnaire was directed to all participants in the project; the public sector (mayors and officials) and the private sector (contractors and consultants). Also, the following will be explored:

- Problematic Areas ,
- Performance Measurement Process,
- Critical Success Factors,
- Performance Measures, and
- Performance Success Measures.

Phase Four: The first objective of this stage is to test research hypotheses, also, to determine the CSFs, the PMs and PSMs in the implementation of municipality construction projects. The data will be described by means of various statistical analyses as the data is mostly ordinal in nature. These will include descriptive statistics to analyse the trends in perceptions/opinions, e.g., frequency distribution, measurement of dispersion; and, inferential statistics to analyze ratings/rankings, analysis of variance (ANOVA), chi-square, and discover the CSFs, PMs and PSMs through factor analysis. The data will also be tested for reliability and validity using appropriate statistic, e.g., Cronbach’s alpha which is the most commonly used for ordinal data. All the data will be analysed using Statistical Product and Service Solutions (SPSS v20) software. Output trends will be studied respondents’ perceptions, satisfaction levels, formulation of PMS. The second objective is to interpret and discuss the analysis results that obtained from chapter 7.

Phase Five: The final stage was structured into two tasks. The first task is developing a practical framework for evaluating construction project performance including validation of the performance measurement framework that will be finalised after this phase. The validation process will be conducted within a construction project in municipalities. The experts will be chosen from government officials, contractors and consultants. The second task is conclusion and recommendations. A set of recommendations will be constructed based on pooled recommendations from the stakeholders’ surveys, experts’ interviews, and the researcher’s observations in the field. Figure 1-2 shows research methodology diagram.

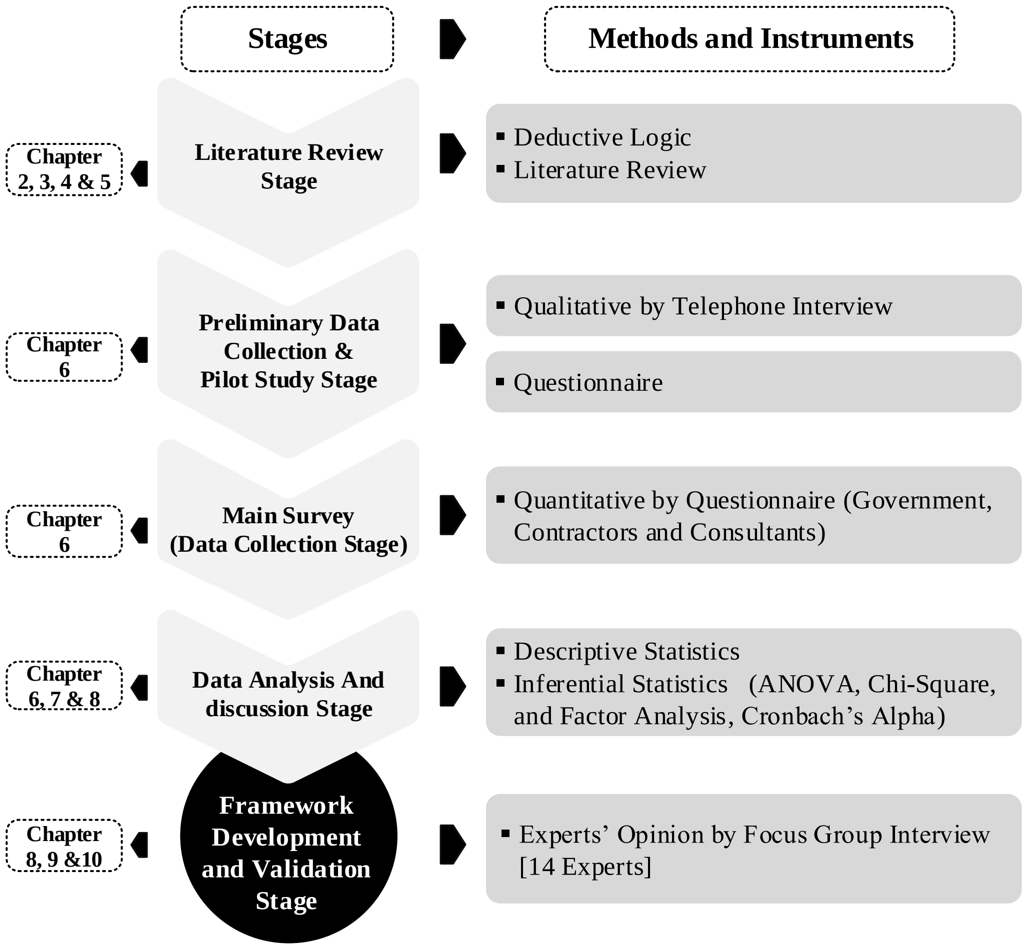

Figure 1-2: Research methodology diagram

1.7 Outline of the research

The purpose of this research is to review the literature that has been written regarding performance measurement in general, and in the construction industry and government sector in particular, as well as investigating and researching the current conditions of the Saudi construction market. Therefore, it is constructed in ten chapters.

Chapter 1 is concerned with background research, which highlights the problem statement to draw out the research aims, objectives and questions, in addition to considering the theory and hypotheses of the study.

Chapter 2 investigates, reviews, and presents the historical background of performance measurement including aims of performance measurement, the definition of performance measurement, and the challenges and processes of its implementation, in addition to identifying the commonly used measurement models such as the Balanced Scorecard, the Malcolm Baldridge National Quality Award, the European Foundation Quality

Management, and Key Performance Indicators, as well as other approaches such as Benchmarking. In addition, given the objectives of the research, which focus on measuring the performance of construction projects in the municipal sector in SA, the application of performance measurement will be investigated in greater depth in this section of report. The subsequent contents of the review are concentrated on the practice of measurement in the construction industry, obstacles facing its implementation, and the most important requirements and processes in addition to defining success including CSFs and PMs. Furthermore, in this chapter, the literature review regarding the practice of performance measurement in the public sector will be discussed. The experience of municipalities in the utilisation of performance measurement will be investigated, in addition to demonstrating the current situation in the municipalities' authority and construction market and their weaknesses and challenges.

Chapter 3 discusses the findings of the research in performance measurement in private and public organisation in developed countries such as the UK, USA, Canada, and Australia, in addition to the Saudi construction industry. The gaps in knowledge is identified and presented.

Chapter 4 assesses the construction industry in the economy and the role of PMSs in improving of construction projects. There are numerous different approaches and each is assessed and its key features discussed.

Chapter 5 explores the Saudi Arabia construction industry, also the current practise and process of delivering municipal construction project.

Chapter 6 outlines research design and methods, including identifying appropriate approaches, tools and instruments, and analysis techniques which should be employed. Also, it deals with study sample size, telephone interview and questionnaire design and their administration, reliability of collected data. As well as, it presents pilot study result, validation method including experts' samples and interview questions.

Chapter 7 presents statistical quantitative data analysis of the questionnaire survey conducted to collect data from participants who involved in municipal construction projects in SA. It explores result of hypothesis test, also documents variables of CSFs, PMs and PSMs based on three stakeholders namely: municipality, contractor and consultant across the three stages of construction project life cycle (conceptual, planning and tendering stage and production stage and operation stages). It examines the significant differences in the perception of respondents by employment of analysis of variance (ANOVA), as well as, factor analysis techniques were used to reduce these variables, and then extract most important variables by companied means and factor analysis approaches.

Chapter 8 discusses research findings in the light of the literature review, it also discusses the key principal to build performance measurement framework.

Chapter 9 explores creation of proposed framework and its components based on results obtained from discussion chapter derived from survey and literature review and framework validation.

Chapter 10 illustrates a summering of the research achievements and presents the contribution for both knowledge and municipal construction project. It also shows the limitations of the research, as well as, recommendations that can be taken in consideration in measuring performance of municipal construction project in SA and future suggestions.

2. CHAPTER TWO: PERFORMANCE MEASUREMENT SYSTEM KNOWLEDGE

2.1 Introduction

PMSs have become fundamental tools in the successful management of organisations in order to ensure they achieve their goals. Performance measurement is referred to as the process to determine to what extent the (general) aim and (specific) objectives of a project have been achieved (Sinclair & Zairi, 1995). It can be undertaken in order to enhance an organisation's ability to draw up superior plans, to better implement innovation and learning, and to permit incremental organisational development.

Therefore, the concept, definition, purpose, problems, and processes of performance measurement shall be investigated. Three specific models of performance measurement shall be discussed (the BSC, the EFQM Excellence model, and the Baldrige Criteria), as well as two generic methods of performance measurement (KPIs and benchmarking), which shall be discussed in greater detail. The three specific models of performance measurement are branded PMSs with prescribed processes; whereas, the two generic methodologies are performance measurement tools that can be applied in any PMS.

2.2 Historical Context of Performance Measurement Systems

Performance measurement has improved over the past decade with the appearance of many new methods that can measure financial and non-financial aspects (Neely et al. 2003). There has also been the appearance of new organisations promoting specific PMSs. These frameworks vary according to place of application, and whether they are for organisations, projects, or stakeholder performance (Yang et al. 2010).

According to Greiling (2005), the concept of performance measurement as a discrete process was first proposed in the 1940s by the New York Bureau of Municipal Research as a budgetary system. Successive expansions and developments of the concept took place in the 1960s and 1970s. In the 1980s, zero-based budgeting systems were developed, which became a key topic in the public sector into the 1990s (Nudurupati et al. 2007). Performance measurement was adopted by the accounting sector in the 1970s, where financial indicators (lagging indicators) were applied. Since then, many systems and frameworks have emerged and developed to include non-financial indicators and subjective indicators such as quality, customer satisfaction, and innovation, eg, the BSC and KPIs.

The concept of performance measurement has evolved over three distinct generations: the first generation of PMSs was designed to measure financial information, but was criticised for not integrating actual PMs; the second generation was created to address the weaknesses of the first by taking into consideration strategies and success factors and to deploy them in the process; and, the third generation was developed to link financial and non-financial information to the concept of cash flow (Neely et al. 2003).

Performance measurement, as a management tool that determines success or failure of performance, whether organisationally or functionally, can be thought of as a means to provide answers to three key questions: "*How well an organization performing? Is the organization achieving its objectives? How much has the organization improved from the last period?*" (Phusavat et al. 2009 p. 647). Beatham et al. (2004, p. 95) mentioned that performance measurement has been conducted by managers who "*want to know where they are and what they have to do to improve*". Thus, PMSs are widely applied in the business sector (Edwards & Thomas, 2005). Ghobadian & Ashworth (1994) suggest that PMSs have three levels: the individual PMs, the group of PMs, and the relationship between the PMs and internal environment.

2.3 Definition of Performance Measurement

Performance measurement is often extensively discussed; however, it is not often defined (Ghobadian & Ashworth, 1994). Before starting to review and investigate the previous research regarding performance measurement, it is necessary to define some terms that are applicable to PMSs: -

- Ahmad, Gibb, & McCaffer (1998, p. 187) defining **performance measurement** as *"a process that involves the assignment of numerals to objects or events according to rules or to represent properties"*.
- **Performance measurement** is *"the process of determining how successful organizations or individuals have been in attaining their objectives"* (Sinclair & Zairi, 1995, p. 50).

- **Performance measurement** is defined as a *"process of assessing progress toward achieving predetermined goals, including information on the efficiency with which resources are transformed into goods and services (outputs), the quality of those outputs (how well they are delivered to clients and the extent to which clients are satisfied) and outcomes (the results of a programme of activity compared to its intended purpose)"* (Kulatunga, Amaratunga, & Haigh, 2007, p. 679).
- **Performance measures** are the numerical or quantitative indicators that show how well each objective is being met (Sapri & Pitt, 2005). Moreover, they area *"vital sign of the organisation and how well the activities within a process or the outputs of a process achieve a specific goal"* (Sapri & Pitt, 2005, p. 432).
- **Performance measurement systems are** *"a systematic way of evaluating the inputs, outputs, transformation and productivity in a manufacturing or non-manufacturing operation"* (Neely et al. 2005 p. 1242).

2.4 Purpose of Performance Measurement

The behavioural dynamics of an organisation are major factors in the performance, and, as stated by Crowther (1996), *"It is of direct and immediate importance to the business community, as the very survival of a business depends on its ability to evaluate performance"*. The availability of reliable and consistent evaluation of previous achievement is a pivotal requirement for future planning and progress, and allows for cross-sectional comparison with other competing businesses as well as longitudinal comparison within the organization.

As cited by Beathem et al (2004), seven reasons are identified by Neely (2000) stating why performance measurement is now a management priority: the dynamic nature of work, increasing competition, specific improvement initiatives, national and global quality awards, changing organizational roles, more enlightened consumers, as well as information technology. These reasons can equally be applied to the construction industry. Therefore, it is the main function of such a system to help find explanations for any problems, to command and measure definite actions, and to forecast for future occasions.

Nevertheless, good performance measurement relies on the efficiency of human resource management. An inability to provide appropriate financial data or ensure smooth, consistent running of performance management systems limit many local authorities to the extent to which they can be utilised for budgetary decision making. In 1973, the traditional understanding of performance measurement was stated by Teague & Eilon (1973) in terms of three purposes: to achieve goals; to assess, improve and control processes; and to benchmark the performance (Sapri & Pitt, 2005). However, in the 1990s, there was a change in the purpose of measuring performance towards meeting customer satisfaction and quality (Neely et al. 2003). Consequently, according to Bracegirdle (2003), PMSs now have the following three purposes: to provide accountability; to improve performance; and to determine expenditure.

According to Phusavat et al. (2009) performance measurement provides quantitative and qualitative data to improve performance by decision making as seen in Figure *2-1*2-1.

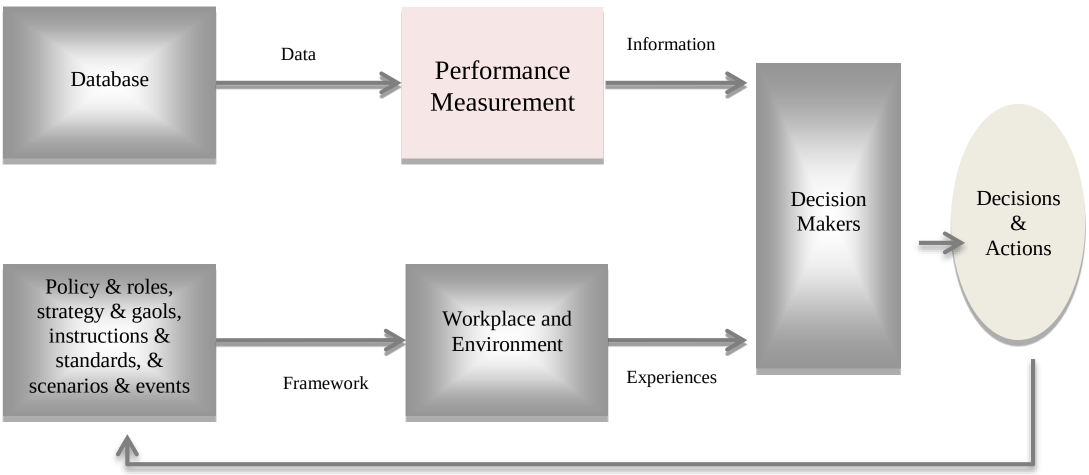

Figure 2-1: Performance measurement and manager roles (Phusavat et al. 2009)

Public managers have been applying this data for managerial purposes – these being to evaluate, control, budget, motivate, promote, celebrate, learn, and improve (Behn, 2003). In addition, Ghobadian & Ashworth (1994) mention that performance measurement has been applied to increase effectiveness and efficiency of provided services – “effectiveness” referring to meeting customers’ expectations, and “efficiency” meaning the use of resources in an economical way to provide the required service.

Beatham et al (2004) surmise that performance measurement in organisations is being included as part of their strategic control plans for the following reasons: -

- Position checking: to continually monitor progress and define current position.

- Position communicating: to inform employees and customers on at least an annual basis through performance reports in order to increase transparency and encourage participation.
- Priorities confirmation: to identify the priorities of activities, performance information, and data to be provided.
- Progress compulsion: to enable the organisation to discover potential improvement areas in order to improve performance.

2.5 Barriers of Performance Measurement

The traditional measures that have been used to monitor financial performance, such as "profit" and "turnover", are most appropriate to businesses. However, despite their importance in monitoring financial aspects, they do not, in themselves, raise the level of competitive performance or technology. Moreover, they have been criticized for encouraging short-term goals and focusing on minimisation of conflict.

The challenges of execution and improvement of PMSs can be seen clearly in some key areas such as consumption of time and resources, difficulties in data gathering, public access to performance measurement data, and, moreover, the creation inside governmental authorities of a culture positively disposed to performance measurement (Bracegirdle, 2003).

PMSs are widely applied in the business sector; however, numerous problems prevent municipalities from utilising performance measurement as a method of benchmarking. There are several key aspects to these problems. Firstly, there is a lack of financial indicators for the private sector to utilise due to the fact that services in government are invariably by definition "unprofitable". Secondly, local government deals with constantly variable duties and to focus on any key service area in order to assess its performance is a very difficult task. Choosing a suitable measurement for municipal performance is complex as well. Thirdly, publicity of performance data to citizens has priority in municipalities, although this aspect of external scrutiny is less of an issue for the business sector (Edwards & Thomas, 2005).

Neglect of comprehensive strategic priorities and focus on functional thinking are deemed common hindrance in public sector (De Waal & Gerritsen, 2006). Similarly, a lack of a corporate approach means that departments within a municipality are not concerned with organisational interests and objectives. As a consequence of this, a weakness of strategic thinking is reflected in the PMS. Enhancement of citizens' participation in performance measurement in governance is still weak, thereby requiring further consideration.

Pollanen (2005) states that performance measurement in the government sector are not being broadly applied due to four types of obstacles that inhibit performance measurement acceptance and execution, which are: -

1. Institutional, eg, resistance to transparency;
2. Technical, eg, lack of specifications and standards;
3. Financial, eg, significant investment of resources and time; and,
4. Pragmatic, eg, poor convenience and reliability.

A potential reason for this is that it is very hard for local government to measure a particular service because some have imperceivable and unknown outcomes that are difficult to measure (Swindell & Kelly, 2002). There are also problems related to developing common definitions for indicators and key concepts within the public sector. Obviously, this prohibits effective comparisons between different public sector organisations. However, common databases have been developed, such as one by World Bank Governance, which is noted as being one of the best with other databases having conceptual problems (Walle, 2008). Consequently, there are growing requests for common indicators to enable comparison between the public sectors of different countries (Walle, 2008).

2.6 Process of Performance Measurement

In general, Ghobadian & Ashworth (1994) state that any PMS has four phases: -

1. Determine requirements and identify PMs;
2. Identify desired goals;
3. Monitor achievements; and,
4. Have on-going reviews of areas of failure.

Any such system will consist of processes, criteria and mechanisms to which it is necessary to align an organisation's desired goals (Phusavat et al. 2009). To specify and develop good performance measurement, several criteria should be taken into account.

The measures should be valid, reliable, understandable, resistant to deviation, comprehensive, non-redundant and focused on controlling performance (Ammons, 1995). Furthermore, it is possible to divide the components that contribute towards performance into three types (Ahmad, et al. 1998): -

1. Hardware, which involves plant, equipment and so on;
2. Software, which involves processes, people and structures; and,
3. Behaviours.

Therefore, any measurement system should attempt to be aware of all components that contribute towards performance.

A more complex division of the PMS was devised by Sinclair & Zairi (1995), which divided the process into main phases of strategy development and goal deployment, and then process management and measurement.

The first phase was then further divided into thirteen steps: -

1. Identify the mission and aims based on the stakeholders' (society, clients and practitioners) requirements and expectations.
2. Create CSFs to achieve goals and needs.
3. Design PMs such as KPIs for each CSF.
4. Determine targets for KPIs.
5. Assign directors and managers responsibilities.
6. Improve short and long terms plans to meet desirable and outstanding performance.
7. Deploy the goals, missions, plans, KPIs, targets, CSFs, and responsibility to specific actions process.
8. Manage process.
9. Measure performance through comparison of KPIs with desired planned performance.
10. Discover potential areas of improvement and determine an action plan.
11. Link actions with performance.
12. Identify the organisation's capability and compare it to KPIs.
13. Reward outstanding performance.

The second level is further divided into eleven steps (Sinclair & Zairi, 1995): -

1. Set and structure a process map.
2. Design process PMs (input, in-process, and output) based on missions, plans, goals and users' needs including data gathering methods, measurement definitions, and measurement frequencies.
3. Set performance targets.
4. Allocate responsibilities.
5. Develop plans to achieve process performance targets.
6. Create sub-processes to plans, goals, measures, and responsibilities.
7. Execute processes.
8. Measure performance and compare the results to KPIs and targets.
9. Utilise performance data.
10. Annually, compare process capability against measures.
11. Reward outstanding process.

Although more complex than the four phases of the Ghobadian & Ashworth (1994) analysis, the basic principles of deciding the goals, defining measures, monitoring achievements, and reviewing progress still feature.

2.7 Models of Performance Measurement

2.7.1 The Balanced Scorecard

The BSC model was designed in 1992 by Kaplan & Norton as a new method to measure the performance of the four business "dimensions": -

1. Financial;
2. Customers;
3. Business processes; and,
4. Learning and innovation.

Learning and innovation are considered to be "leading indicators"; whereas, the focus of the BSC is towards financial measures, which are considered "lagging indicators". This represents one of the weaknesses of BSC models, as well as causing many problems in its performance. Letza (1996) states that this method must be integrated with the participants' goals and general strategies, so that the BSC can translate the strategies into goals to measure them. It measures previous activities, known as lagging indicators, as used in many organisations. The BSC model also has the potential to use leading measures when an organisation translates its strategies and visions into a comprehensive framework as in Figure 2-2.

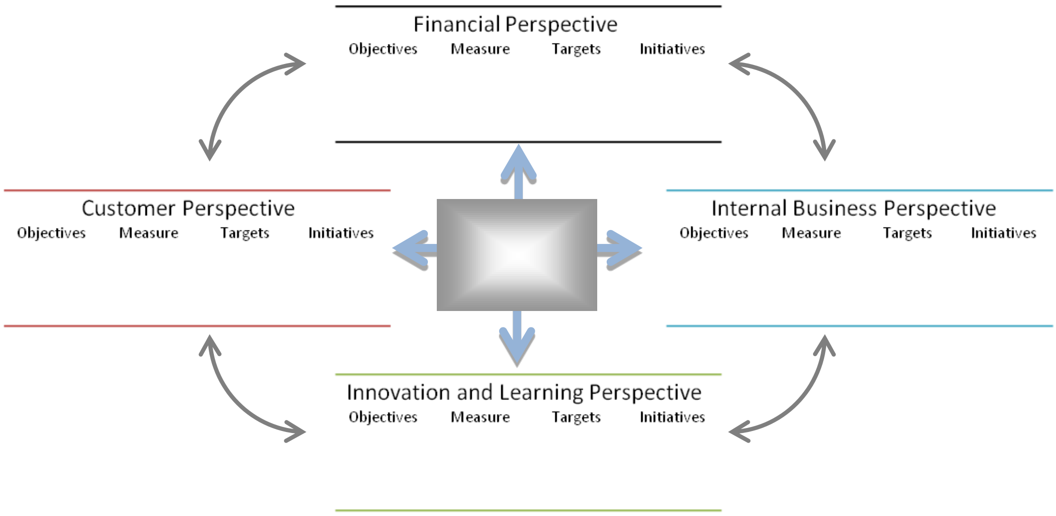

Figure 2-2: Translating vision and strategy (Kaplan & Norton, 2005)

The BSC model is described by Kaplan & Norton as a method that aims to "move beyond a PMS to become the organizing framework for a strategic management system" (Banker et al. 2004). The BSC model presents a framework for understanding the relationship between aims, activities and outcomes; moreover, it can link strategy, plans, and budgets in order to create process systems to monitor and manage the performance. It has been designed as a PMS for monitoring and innovation rather than to provide accountability (Ho & Chan, 2002).

Kaplan (2001) mentions that the BSC is being used in the public sector to enhance its ability to connect its responsibilities, objectives, strategic goals, and operational processes with measures. In addition, it is utilised as a method of integrating communication methods in order to achieve desired outcomes. The focus of the public sector is not only on performance management, but it is also concerned with providing performance reports through defined performance indicators (Wisniewski et al. 2004). As such, the BSC is seen as an appropriate means to offer a selective framework for the government sector to give performance indicators, reports, accounting statements, and to enable comparison.

The purpose of the development of the BSC is to address the weaknesses in traditional PMSs, which include the inability to link overall strategy with organisational goals, an excessive focus on lagging indicators, and short-termism (Atkinson, 2006). One of the advantages of the BSC is that it provides a coordinated manner in which to link strategies and priorities clearly and coherently with economic and service plans in order to ensure on-going performance development (Wisniewski et al. 2004).

Beatham et al (2004) noted in their evaluation of the model that the positive features of the BSC include that it is commonly accepted, and known to be effective where non-financial measures need to be linked to financial goals; however, it is highly dependent on the involvement of senior management (Beatham et al. 2004).

Nevertheless, since the BSC model started in 1992, it has been criticised for having weaknesses in its implementation such as it does not focus on the major factors that play key roles in performance (Kagioglou et al. 2001). It has also been suggested that BSC has shortcomings in compiling and implementation. It does not take into consideration interactions between prospective partners, for example, customer or suppliers, and their effect on each other. Consequently, the BSC method was criticised for not being an appropriate method to offer effective solutions to problems that relate to suppliers, employees, and the community (Kennerley & Neely, 2002b).

Whilst it emphasises the measurement of profit-related factors, there is increased attention on utilising the BSC in government organisations such as municipalities. However, according to Haponava & Al-Jibouri (2012) and Yang et al (2010), the BSC model is criticised as a performance measurement tool in that it is only really applicable for enabling organisations to identify strategies to achieve targets by taking appropriate actions and measurement and not applicable to measure project performance. Despite these weaknesses, it has been seen that in those municipalities which have implemented the BSC model, there was an effective integration with strategies, while municipalities that have not used it, it highlighted weaknesses in the compatibility between the measurement of performance and implementation of strategies.

Neely, et al (2003) suggested that to overcome the weaknesses of the BSC model, it has to be enabled to answer the following questions: -

1. Who are our key stakeholders and what do they want and need?

2. What strategies do we have to put in place to satisfy these needs?
3. What processes do we need to have in place to execute our strategy?
4. Which capabilities do we need to perform our processes?
5. What do we expect from our stakeholders in return?

The answers to these questions are to encourage and enable an organisation to design a comprehensive and integrated success framework.

2.7.2 European Foundation for Quality Management

In 1989, the EFQM Excellence Model was shaped by European Foundation for Quality Management for quality management purposes. Its focus was to improve overall organisational quality, and it is unique in that it distinguishes between results (PMs) and organisations' enablers (Westerveld, 2003). The EFQM model uses nine fundamental concepts of excellence to enhance the continuous improvement of an organisation. These are results orientation, people development and involvement, customer focus, continuous learning, innovation and improvement, leadership and constancy of purpose, partnership development, management by process and facts, and public responsibility (Beatham et al. 2004).

The EFQM Excellence Model has been utilised by companies in the construction industry and others such as manufacturing, finance, insurance, and as part of management through Total Quality Management. It is suggested for use as a means of self-assessment in order to benchmark with other organisations, as a guide for improvement, an approach to thinking, and a structure for the organisation's management system (EFQM, 2010). Beatham et al. (2004) added that the purpose is to conduct a regular review of an organisation's activities. The main aim for implementation of the EFQM model is to identify the performance improvement areas (Beatham et al. 2004).

The key distinction between EFQM Excellence Model and the BSC is that the EFQM model is designed to deal with best practice; whereas, the BSC model is focused on communication and performance measurement. However, the EFQM model is criticised as being less comprehensive and less clear than the BSC model despite the shortcomings mentioned previously. There are also other aspects mentioned as criticisms, such as resistance to change, documentation difficulties, insufficient time and funds allocation, and ambiguities in terms of defining areas of improvement (Yang et al. 2010). A schematic of the EFQM model can be seen in Figure 2-3.

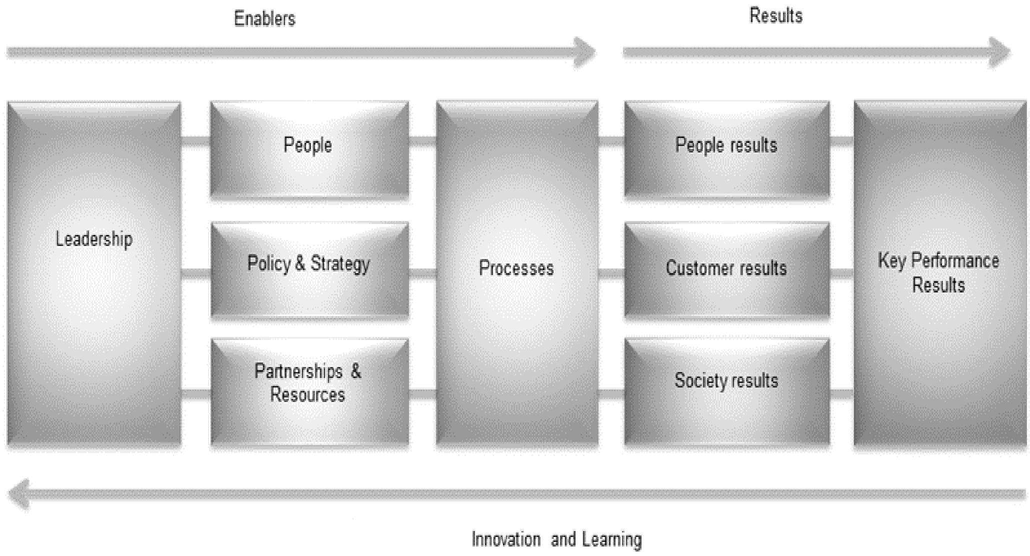

Figure 2-3: The EFQM model (Beatham et al. 2004)

2.7.3 Baldrige Criteria for Performance Excellence

The MBNQA was established by the Malcolm Baldrige National Quality Improvement Act of 1987 to improve organisational competitiveness by focussing on the outcomes of customer satisfaction and organisational performance (Jacob, et al. 2004). The Baldridge Award, via the Baldrige Criteria for Performance Excellence, is considered a driver for quality and customer satisfaction, which measures outstanding features in several dimensions: leadership (how leaders manage their organisations), strategic planning (how to set strategic orientations and plans implementation), customer and market (requirements and expectations), information and analysis (manage and analyse data in order to support performance management), human resources (training and skills improvement), process management, and business results. The Baldridge Criteria is the equivalent of the EFQM model in European countries. According to Bassioni et al. (2004)

both are utilised as performance measurement frameworks. Despite the range of these categories, there are key aspects that are considered to be fundamental to all: leaderships, system, aims, and measures

The basic idea of the Baldridge Criteria was to focus on leadership and customer satisfaction with less emphasis on the outcomes; although, there has been a recent shift towards quality and operational results (Hodgetts et al. 1999). The main objectives of MBNQA are not only to enhance management quality, but also to provide a comprehensive framework to assess an organisation's development and progress towards excellence through employee and customer satisfaction. However, critics have noted some weaknesses in the Baldridge Criteria: the application itself consumes time and money, and the financial measures are also deemed to be poor (Jacob et al. 2004). A schematic of the Malcolm Baldridge Criteria can be seen in Figure 2-4.

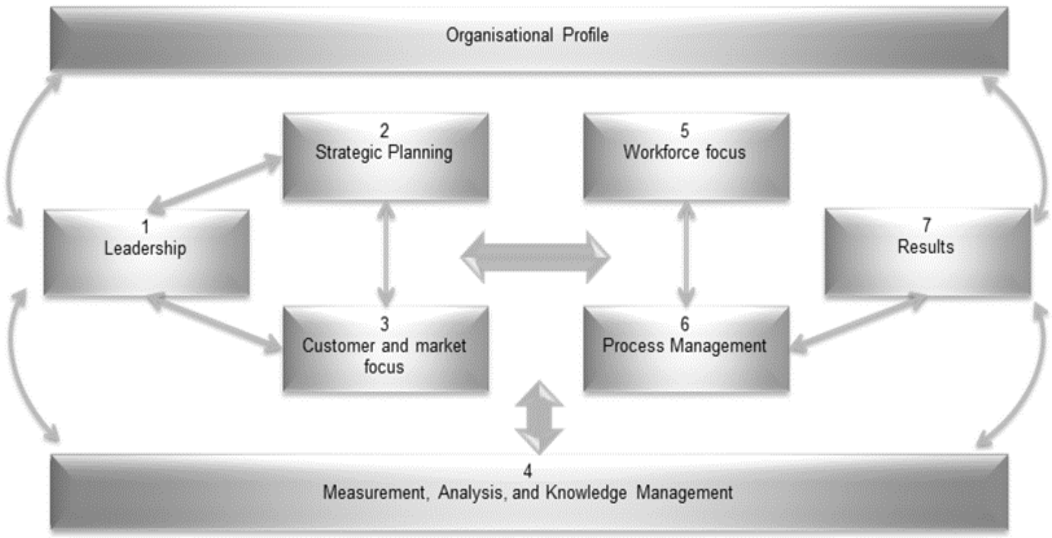

Figure 2-4: Malcolm Baldridge Criteria (Vokurka, 2001)

2.8 Methodologies of Performance Measurement

2.8.1 Key Performance Indicators

2.8.1.1 Concept of Key Performance Indicators

According to previous research, KPIs have been designed and used in the UK construction industry to measure client satisfaction, defects, construction time and cost, productivity, profitability, impact of environment, etc. The first usage of the KPI concept was in 1961 in the companies of D Ronald Daniel to refine business strategy. The performance measurement indicators theory is driven by the concept of benchmarking (Haponava & Al-Jibouri, 2009). According to the Egan Report (1998), KPIs were improved by the Government's Movement for Innovation and the Construction Best Practice Programme (CBPP). Many other KPI models exist, including the CBPP method, which is used in the construction industry as a benchmark against other companies. There are currently 38 KPIs and a business solution has been launched whereby trained advisors help organizations select KPIs that meet their business needs as can be seen in Table 2-1.

Table 2-1: Founder and years designing KPIs (adapted) *(Beatham et al. 2004)*

Organisations	Key Performance Indicators	Objectives
The CBPP, 1998	Client satisfaction (product, service), profitability, productivity, defects, safety, predictability (time, cost), construction time and construction cost.	Measure different stages of a construction project and to support of benchmarking
The ACE with DETR, ICE, RIBA, RICS, and CIC, 2001	Client satisfaction (overall performance, value for money, quality, time delivery, health and safety awareness), training, productivity, and profitability.	measure construction project performance and support benchmarking
Respect for People (RFP), 2002	Employee satisfaction, staff turnover, sickness absence, safety, investors in people, working hours, pay, training, diversity, and travelling time.	Assess construction project performance and to support of benchmarking
The Construction Industry Research and Information Association (CIRIA), 2000	Clients' needs, design process, integration of design with supply chain, internal cost/time management, risk, re-use of design, experience, innovation, and client/user satisfaction	Used for self-assessment
Design Quality Indicator (DQI)	Build quality, functionality, and impact.	Measure design quality, assessing and managing value of the product
Satisfaction of Service KPIs (SoS KPIs)	Cost management and reporting, programme management and reporting, planning, flexibility, communication, team working, innovation, managing the environment, managing safety and after care service.	Costumer focused

KPIs are considered critical components for the improvement of all aspects of construction projects, from effectiveness and efficiency to supporting decision-making (Ibrahim et al. 2010). The public sector is increasingly dependent on using KPIs to determine best practice and achieve continuous development of financial and non-financial benefits; whereas, in the private sector, KPIs are utilised to attain profitability and competitive benefits. KPIs are measures used to assess the performance of activities to achieve an organisation's desired goals. As such, this process starts with taking measures and then benchmarking these to gain the information required to enable decisions to be made for improvement (Enoma & Allen, 2007). A schematic of this process can be seen in Figure 2-5.

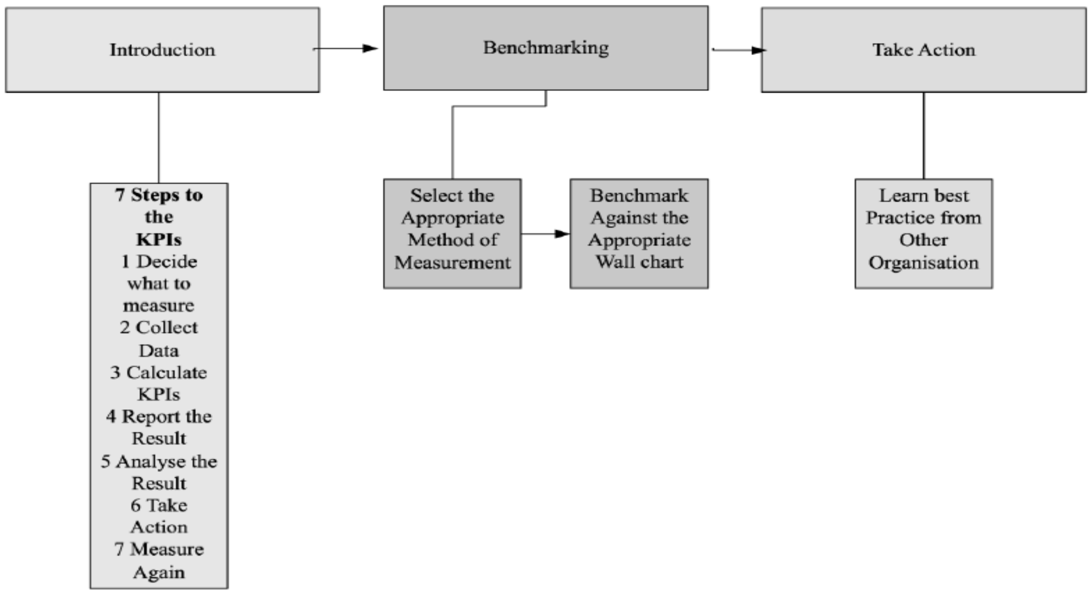

Figure 2-5: KPI development and implementation (Enoma & Allen, 2007)

Beatham et al (2004) notes that the initial concept of KPIs and performance measurement has shifted in the construction sector and that KPIs are now used mainly as a comparison method for benchmarking. The KPI model can measure performance of the project at organisational and stakeholder levels. The successful implementation of KPIs features seven steps as can be seen in Figure 2-6.

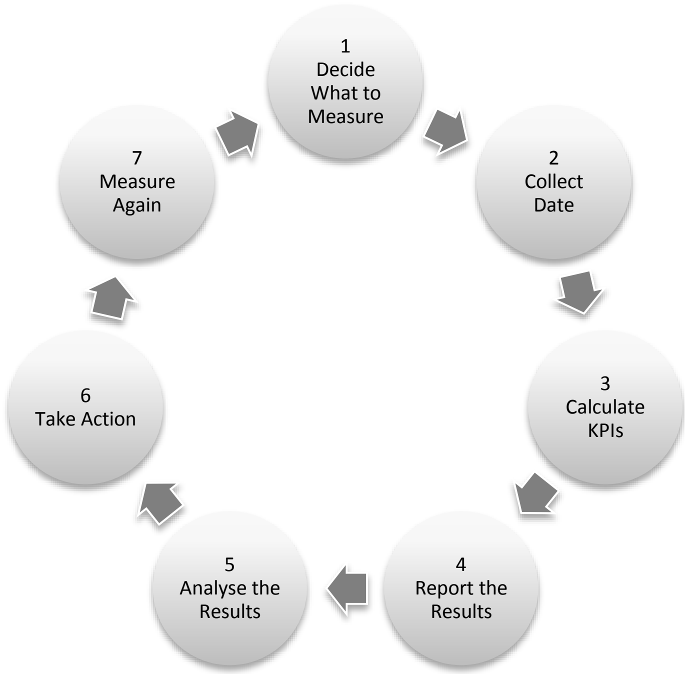

Figure 2-6: Seven steps to implementation of KPIs (Ibrahim et al. 2010)

Beatham et al (2004) stated that the KPIs system takes into consideration measuring performance across different project stages to achieve stakeholder needs and expectations. It covers a wide range of aspects such as cost, time, satisfaction, risk, environment, financial, managerial, and others aspects when compared to the BSC model, the EFQM model, and the MBNQA criteria. Through research of the most common performance measurement frameworks in order to identify the most important indicators for measuring construction projects during various stages, the KPI framework is the only one that defined measures that were based on stakeholders needs (Beatham et al. 2004; Chan & Chan, 2004).

2.8.1.2 Types of Key Performance Indicators

KPIs can be categorised as objective and subjective measures. The objective (quantitative) measures are calculated mathematically by formulae and give numerical values; whereas, the subjective (qualitative) measures are stakeholders' opinions and perceptions (Chan & Chan, 2004).

Objective measures include construction time, speed of construction, time variation, unit cost, percentage net variation over final cost, net present value, and accident rate. Subjective measures include quality, functionality, end-users' satisfaction, client's satisfaction, design team's satisfaction, and the construction team's satisfaction (Toor & Ogunlana, 2009) as can be seen in Figure *2-7*2-7.

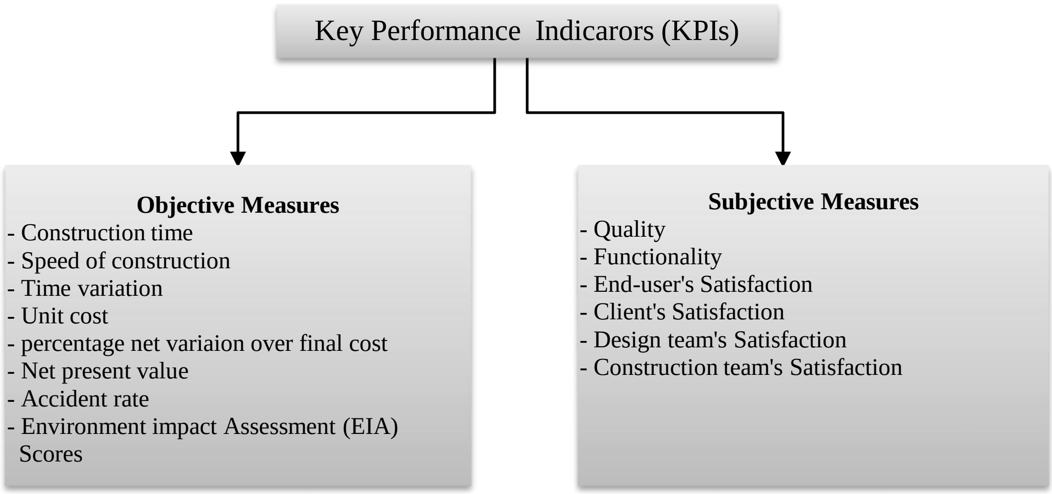

Figure 2-7: KPIs (Toor & Ogunlana, 2009)

KPIs are applicable to the construction industry (Chan & Chan, 2004). Moreover, KPIs have had a major impact on improvements in the construction industry – they provide both the public and private sector with a simple manner to measure their performance effectively including benchmarking. This benchmarking can be either external (against another industry) or internal (within the same industry). According to the Egan Report on "Rethinking Construction" (Egan 1998), the construction industry has been using KPIs to ensure that their targets in improvement are achieved.

However, there are actually three types of measures within the field KPIs: the KPIs themselves, Key Performance Outputs, and Perception Measures: -

- **KPIs** are focused on the process of performance through linking causes and effects. However, the KPIs rely on benchmarking, which is a basic tool of any measurement.
- **KPOs** are the final outputs of terminated events and are deemed as lagging measures that have no effect on future. Despite this, they are useful in rethinking similar actions in future.
- **Perception Measures** are utilised at any level, whether during execution or in the final results. As such, they can be conducted by means of questionnaires or survey.

However, all three types of measurement are considered as KPIs in construction industry.

The traditional indicators, which are cost, quality and time (the "Iron Triangle") have long been used by the construction industry to measure its performance; however, they are insufficient to measure project success (Haponava & Al-Jibouri, 2009). The need for measuring performance in construction projects has led to the evolution and implementation of KPIs within various aspects of a typical construction project. Although different types of KPIs have been developed, each one of them has their shortcomings, especially those based on time, cost and quality. However, they can be greatly enhanced by other factors such as the quality of relationship between project participants, and this can positively affect achievement of project objectives (Haponava & Al-Jibouri, 2009).

Haponava & Al-Jibouri found that very few KPIs were process oriented, which, therefore, necessitated their further study and their attempts at developing process-based KPIs. They recommended measuring the process of execution and the outcomes as well. Using a framework in which the construction process has been divided into various stages, they defined process-based KPIs – defining the initiative, feasibility and project definition phases. Despite this, the Iron Triangle largely remains the key preference indicator to determine project successes (Toor & Ogunlana, 2009).

Despite the fact that KPIs have been extensively investigated in research, there are some obstacles, such as reservations in providing financial data, weaknesses in the accuracy of recording accidents, and differences in the calculation of what constitutes "profit"; for example, government projects are primarily focussed on the supply of services (Chan and Chan, 2004).

Similarly, according to Beatham, etal. (2004), construction KPIs suffer due to several failings. Firstly, KPIs are associated with post results, and do not monitor the performance during execution through which deviations could be discovered and addressed. Secondly, KPIs are not consistent with whole-organisation planning and interests; consequently, they do not fulfil the strategic need for comprehensive measures. Thirdly, there is often inaccurate information. Fourthly, KPIs do not have specific dedicated criteria that cover all areas that need to be measured, but, instead, it depends on selecting key criteria in areas. In addition, they concentrate on the results instead of the process, also it does not deal with success factor. They should take into consideration the alignment between measures and strategies, and vision and mission of an organisation at different levels as seen in the Figure *2-8*2-8.

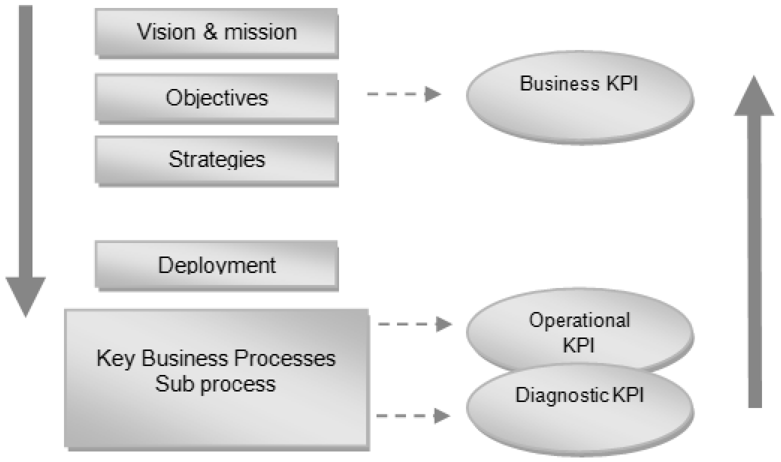

Figure 2-8: Alignment of KPIs (Beatham et al. 2004)

Characteristics of Good Key Performance Measures

There are fundamental principles that should be taken into consideration before using KPIs. These include (Ibrahim, Jing, & Wenge, 2010): -

- Consider why they are being used;
- Measure what is critical to success;
- Keep it simple;
- Set up a system to use the KPIs and to benchmark them; and,
- Limit the number of indicators to about 8-12.

Also they should be (Toor & Ogunlana, 2009): -

- Acceptable and understood by the organisation;
- Updated periodically; and,
- Displayed in a simple format.

Similarly, Beatham et al (2004) suggest that good measures have similar characteristics, which are: -

1. In order to be successful in the in the use of KPIs, it should be recognised that there are differences between KPIs (leading), KPOs (lagging), and perception measures (individuals' judgements).
2. Good measures have a comprehensive overview and they rely on leading and lagging indicators.
3. They support the decision maker with updated information.
4. They have to be balanced between the organisation's strategy and interests.
5. They must be involved as a fundamental component of the system and the process of execution.
6. There must be staff participation in the improvement of the measures.
7. The results must be up to date and valid to be useful to the organisation for benchmarking their performance (internal and external).
8. The processes and stages of design and construction have to be recognised and clear.
9. The measurement systems have to be improved and take into consideration processes and sub-processes.

Finally, it is important to note that the identification of KPIs is not in itself sufficient for the success of a PMS, but it should be considered carefully in the process of measurement and its application (Enoma & Allen, 2007). The major issue in using KPIs is that they are concerned with past events (lagging indicators). As a result, these measures offer little chance to change the future (Beatham, et al. 2004).

2.8.2 Benchmarking

2.8.2.1 Concept of Benchmarking

Benchmarking is a tool principally used to establish weaknesses and gaps within an organisation compared to other similar organisations and identify different strategies according to an organisation's objectives and aims (Kouzmin et al. 1999) – it can discover opportunities and areas for improvement, and monitor competitors' abilities and performances (Neely et al. 2005). Benchmarking systems have appeared as a result of increasing pressure to compete in the global market, to such an extent that it has become inherent to the success of the performance of business organisations (Lam et al. 2007). Therefore, benchmarking, as key part of a PMS, enhances decision making, and explains the importance accorded to it in the construction industry (Beatham et al., 2004).

In terms of definition, benchmarking is *"the continuous process of measuring products, services and practices against the company's toughest competitors of those companies renowned as industry leaders"* (Gleich et al. 2008). Whereas, according to Büyüközkan et al (1998), the benchmark is *"a point of reference from which measures and comparisons of any sort may be made"*. They explained further that benchmarking is defined as an on-going search to attain best practise through measuring and comparing products, processes, services, and procedures, and to apply them to improve performance to achieve desirable outcomes. In other words, benchmarking is a measurement and improvement performance process (Büyüközkan & Maire, 1998).

The UK Construction Best Practice Programme (CBPP) defined benchmarking as *"a systematic process of comparing and measuring the performance of the companies (business activities) against others, and using lessons learned from the best to make targeted improvements"* (Takim & Akintoye, 2002). Also, it has been defined as a methodical process applied to compare and measure an organisation's performance and translate best practices that are used by others to make improvement (Hinton et al. 2000).

Folz (2004) stated that benchmarking has the potential to enhance a local authority's service delivery performance and that there is a need to draw to the attention of managers in the public sector the benefits of measuring service delivery quality by using of performance data in the benchmarking process.

2.8.2.2 Types of Benchmarking

Bowerman et al (2002) presented four kinds of benchmarking in governmental organisations (process, data, functional, and strategic), utilised according to the desirable goals: if the goal is to achieve a balance between cost and efficiency, data can be compared, while if the concern is regarding the quality of deliverable service, it is possible to investigate the process. According to Takim & Akintoye (2002), benchmarking in the construction project has been categorised into three types: -

- **Internal benchmarking** is aimed to compare particular areas within an organisational structure such as operational processes with others to see how they have been performing relatively in their business. Internal benchmarking is an investigation that deals with utilised processes and practises. Fundamentally, internal benchmarking represents the main base for the establishment and design of measurement systems and also to identify appropriate measures as can be seen in Figure 2-9.

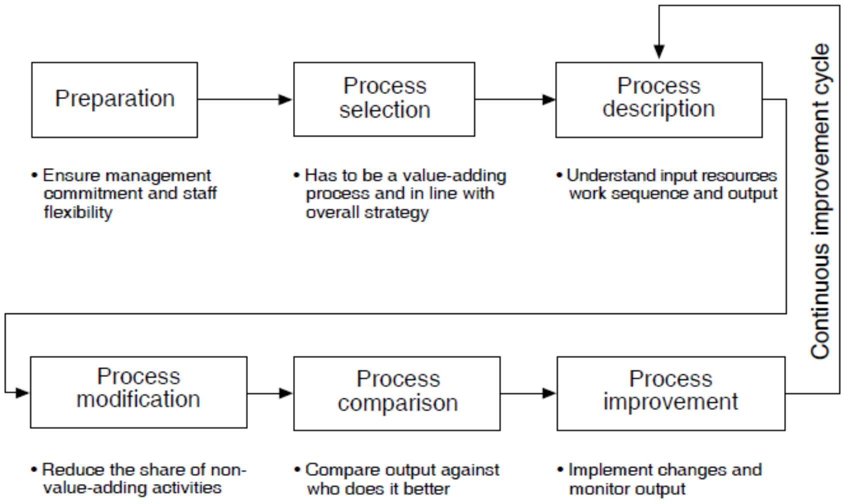

Figure 2-9: Main elements of internal benchmarking (Mohamed, 1996)

- **Project benchmarking** is concerned with measuring and comparing project performance, which involves project productivity, customer expectations and databases (Mohamed, 1996). The second level of the benchmarking focuses on project performance measurement by measuring KPIs such as performance time, performance of teamwork, as well as the effectiveness of communication. Benchmarking of project performance is a key support to the organisational internal benchmarking.
- **External benchmarking**: This emphasises and covers the whole industry such as construction industry in order to raise productivity, competition, and develop techniques and methods to meet aims and objectives. The external benchmarking level is designed to select and implement best practices that are applied in other industries in order to improve construction projects, and thus, this level does not generate direct and immediate benefits (Mohamed, 1996).

2.8.2.3 Benchmarking Applications in the Public Sector

The original purpose of establishing the benchmarking system during the 1980s was to enhance the ability of the private sector to develop its performance and raise competition; however, it has expanded into both public and private sectors to improve their management, actions, processes and procedures (Kyro & Finland, 2003). In municipal organisations, it is being utilised as a comparison approach concentrated on delivering service performance to obtain best practices (Folz, 2004). The tendency of the public sector to use benchmarking is more for defensive purposes rather than for development and improvement (Jones & Kaluarachchi, 2008).

Therefore, there is a need to encourage the public sector to utilise benchmarking as a method of developing its performance. The nature and culture of the public sector and specialised nature of its operational processes affect the design and effectiveness of benchmarking. Although the utilisation of benchmarking in companies increases cooperation and enhances motivation, it creates competition in governmental departments that may be difficult to ascertain due to the varying nature of municipal services and lack of similar criteria for comparison (Kouzmin et al. 1999). An examples of where benchmarking is being practiced found in the Ontario Centre for Municipal Best Practices, the Tennessee Valley Authority (TVA), and USA Armed forces (Amaratunga & Baldry, 2002).

According to Takim et al (2002) it is clear that benchmarking is used as a key component of PMSs such as KPIs, the BSC model, and the European Foundation Quality Management model to find areas for improvement and identify causes and effects so as to develop performance in order to achieve required goals. Integrated approaches combining methods such as benchmarking and the BSC model are also being applied by some municipalities (Bracegirdle, 2003). However, the challenges and obstacles to the implementation of benchmarking in the public sector are that the use of benchmarking relies on performance indicators; therefore, choosing suitable indicators is a significant matter, and, in addition to the difficulty of finding “the best of the class” for appropriate comparison, there is also often a lack of experience, and a shortage of the information required (Kouzmin et al. 1999).

2.8.2.4 Benchmarking Applications in the Construction Industry

According to Egan (1998), benchmarking has been applied in UK construction industry by representatives of the KPI Working Group. In other countries, there is the National Benchmarking System for the Chilean construction industry, and the Construction Industry Institute (CII) benchmarking and metrics system for the Brazilian construction industry (SISIND) (Dorsch & Yasin, 1998).

However, benchmarking does not cover all construction project phases, such as the project selection stage. Thus, it is necessary to identify performance indicators (parameters) in terms of all project phases (Takim & Akintoye, 2002). The purpose behind comparison of construction companies is on two goals: firstly, to determine the status of the organisation among the competitors; and secondly, to find the best practices that are utilised by other organisations (Takim & Akintoye, 2002). Ramabadron et al (2005) distinguish between two categories of benchmarking that are being implemented in construction projects: competitive benchmarking focused on comparing particular data regarding competitors including products, functions, services, plans, processes, strategies, and outcomes; whilst the second type is co-operative benchmarking that is applied to find best practises between organisations.

Therefore, an integrated improvement framework that involves a benchmarking system and PMS needs be utilised to overcome obstacles and challenges that are facing construction performance to meet requirements and desirable planned goals (Augusto et al. 2008).

2.8.2.5 Process of Benchmarking

Although there are differences in the structure and phases of the steps applied to various types of benchmarking, they require four basic steps: prepare, determine goals, select factors, and determine the framework to benchmark the project (Phusavat et al. 2009). According to Gleich et al. (2008), the process itself consists of: -

1. Analysis: group and evaluate data.
2. Comparison: comparing the data, identify performance gaps, investigation resources and best practices and illustrate potential improvement areas.
3. Improvement: exchange and adapt the best practices to improve the performance.

Furthermore, according to Büyüközkan et al (1998), the benchmarking implementation process has to have on-going cyclical actions and, therefore, in order to meet this concept it is divided into five main stages:-

1. Self-analysis: consists of three steps concerned with measuring and analyzing the internal performance of the organisation.

2. Pre-benchmarking: is designed in four steps to determine key objectives, partners, measures and preparation date.
3. Benchmarking: is to benchmark and compare the current performance.
4. Post-benchmarking: corresponds to the execution of development activities that were determined previously, and it relies on best practices.
5. Observation and adjustment: assesses the progress.

According to Neely et al (2005), four steps are identified in the implementation of the benchmarking process: planning, analysis, integration and taking action. However, other scholars have designed a nine step benchmarking process as can be seen in Figure *2-10*2-10.

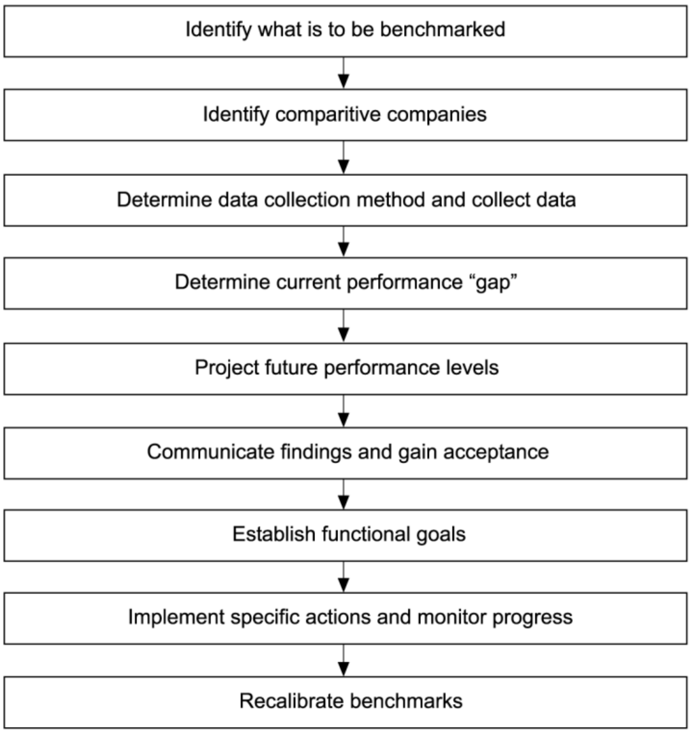

Figure 2-10: The nine-step benchmarking process (Neely et al. 2005)

2.8.2.6 Challenges and Obstacles in the Implementation of Benchmarking

Despite the significance of benchmarking in the private sector, benchmarking has not been given adequate attention in terms of research and study in the public sector (Bowerman et al. 2002). Also, there is intense resistance from public organisations to engage in benchmarking systems due to rigid regulations and rules that encourage bureaucracy (Cheung, Suen, & Cheung, 2004).

Benchmarking has not been implemented widely in construction sector, due to several reasons, the most important of which are: -

- The absence of an appropriate understanding of the benchmarking by practitioners;
- Ambiguity surrounding what must be done to complete the process of benchmarking; and,
- Lack of information and data through the historical absence of data collection and documentation in the construction sector.

Additional obstacles include fluctuations in productivity, including attributes inherent to the nature of construction projects, which depend on the budget and size of the project (Mohamed, 1996) and the complexity of construction process, changeable environments, short execution periods, speed of sequence of events and activities, uniqueness of construction, and extreme competition (Palaneeswaran & Kumaraswamy, 2000).

2.9 Conclusion

The concept of performance measurement as a discrete process has been present since the 1940s, and although variously defined, it is the process of collecting, analysing and presenting data on the performance of a project or organisation. Historically, the initial focus of measurement was on lagging quantitative indicators; however, they have evolved to incorporate virtually all available aspects of an organisational process, including qualitative and leading indicators, in order to measure progress and improve outcomes.

PMSs are now considered a fundamental tool to control and monitor organisational and project performance to ensure that processes achieve overall goals. Performance measurement is being applied as a key management method to determine success or failure of performance whether in the private or public sector; however, the adoption of these systems is not as common in the public sector or in the construction sector. There is clearly reluctance within these sectors to adopt PMSs either through a lack of understanding or senior leadership, or due to cultural resistance to change.

The success of a PMS relies fundamentally on including benchmarking as part of its process. This research has shown that the objective of measuring performance in public and private sectors is to improve productivity, effectiveness, efficiency, and the quality of the delivered service in the three levels of “organisation”, “project” and “stakeholders”, in addition to determining expenditure and increasing accountability. Benchmarking as part of a PMS is considered as a means to determine areas of strength and weakness, as well as to monitor competitors’ abilities. Despite this, the importance of performance measurement and benchmarking are not widely applied.

To further research for performance measurement concept, the following chapter is aimed to investigate performance measurement in municipal context.

3. CHAPTER THREE: MUNICIPAL PERFORMANCE MEASUREMENT

3.1 Introduction

Performance measurement was an obscure concept until the 1940s when it became an available tool for local government management. However, Ghobadian & Ashworth (1994) mentioned that performance measurement was more widely introduced into local government in the early 1980s due to demands placed on the public sector to introduce such systems. The broad thrust of the demands placed on the public sector was to *"improve the efficiency and effectiveness of managers and the organization"* (Ghobadian & Ashworth, 1994, p. 36).

Increasingly, demands have emerged for governments to improve their performance in service-delivery and to raise accountability and transparency for stakeholders and citizens alike (Wisniewski, Olafsson, & Iceland, 2004). This demand is not centred on the traditional measures of cost, time, and quality, but now includes efficiency and effectiveness of services. Therefore, it is becoming increasingly difficult to ignore the significance of performance measurement in both the public and private sectors, including municipal governments and the construction industry. This is because PMSs have become a fundamental factor in the successful management of an organisation in order to ensure it achieves its goals. PMSs are now commonly utilised to enhance an organisation's ability to draw up superior plans, to promote innovation and learning, improve on-going development, and to monitor and control performance. Phusavat et al (2009) stated that in the past, performance measurement was a critical management instrument that enhanced responsibility and quality; whereas, in the future, it will be a driver to increase government capability, transparency, and accountability.

3.2 Application of Performance Measurement in Government

It has been found that there is a strong link between citizen-satisfaction and the outcomes of benchmarking (Swindell & Kelly, 2002); consequently, in the government sector, the trend is for performance management systems to be increasingly utilised. The commonly stated purposes for performance measurement have been noted as *"evaluation, control,* *budgeting, motivation, promotion, celebration, learning and improving"* (Padovani et al. 2010).

During the 1980s, the focus of performance management was primarily on hard measures with little attention to customer satisfaction (Swindell & Kelly, 2002). However, there was a shift in thinking in the 1990s, where governments that were previously disinterested in performance measures began to consider their implimentation (Swindell & Kelly, 2002).

According to Bracegridle (2003), PMSs have been applied for three main objectives: -

1. To provide accountability;
2. To improve performance; and,
3. To determine expenditure.

In local government, the effectiveness of PMSs lie in the three "factors of validity", which means the strength of the PMS, its legitimacy, which indicates the extent to which PMs correspond based on strategic goals, also it facilitates problem that facing local authorities that stated by Higham & Fortune (2010) how to move policy objectives into reality. Finally, its functionality, which is how focused it is on the purposes that are behind performance measurement implementation (Padovani et al. 2010).

3.3 Types of Performance Measurement System in Government

There are many measures used in the public sector that assess quality of the service that are widely accepted as proven indicators (Swindell & Kelly, 2002). Accountability is a concept commonly used in the public sector; it can be measured in both aspects of PMs: financial and non-financial (Kloot, 1999). In local government, there are four types of PMs that are currently being used (Ammons, 1995). The first are workload measures that are focused on quantitative aspects of work performed or services delivered. The second are efficiency measures that are designed to assess the extent to which work is maximized and resource use is minimized. The third is effectiveness measures that measure how far planned goals and requirements have been achieved and the satisfaction levels of customers as well. The fourth type are productivity measures that are combined efficiency and effectiveness measures.

According Swindell & Kelly (2002), performance can be divided into internal and external performance measures. Internal performance measures attend to the objectives of the organisation and are often carried out through well-defined indicators, the definitions of which have been evaluated by administrators. External measures, such as citizen satisfaction, can be derived from the results of customer satisfaction surveys.

Some researchers also classify two kinds of local government performance measurement: hard and soft indicators, and have called for further research into the link between those indicators; whereas, others defined performance measures as either being objective data and or subjective, eg (Swindell & Kelly, 2002).

3.4 Public Project Success Criteria

Ghobadian & Ashworth (1994) mentioned that actual performance in local authorities derived from two main components: service efficiency and service effectiveness. Efficiency refers to the achievement of an output (the result) with the minimum of inputs (expense or effort), and effectiveness refers to the degree to which the output (the result) achieved the objectives. They proposed that efficiency means the use of resources in an economical way to achieve the required service and defined it as *"provision of specified volume and quality of service with the lowest level of resources capable of meeting that specification"* (Ghobadian & Ashworth, 1994, p. 39), and that effectiveness refers to meeting customers' expectations to their satisfaction and defined it as *"providing the right services to enable the local authority to implement its policies and objectives"* (Ghobadian & Ashworth, 1994, p. 40). It is mentioned that the important performance measures identified in addition to effectiveness and efficiency are productivity and quality. Figure *3-1* illustrates the relation between input, output and outcomes, as well as their relation with efficiency and effectiveness.

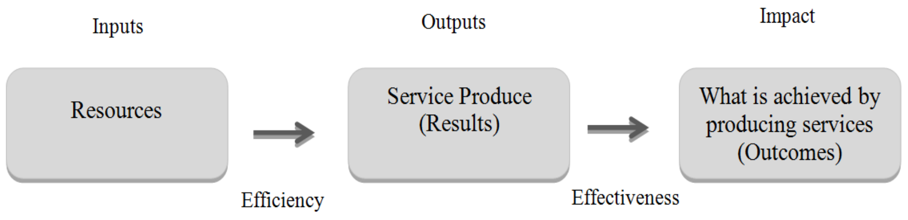

Figure 3-1: Efficiency and Effectiveness (Ghobadian & Ashworth, 1994)

Cooke-Davies (2002) identifies different definitions of the project success components, where efficiency refers to process and organisational structure and effectiveness refers to time, budget and specification. Accordingly, in order for efficiency to be achieved, appropriate methods, approaches, and standards need to be applied. Effectiveness is defined by the extent to which customer satisfaction is achieved (Cooke-Davies, 2002).

Although there are differences between the public and private sectors in terms of internal environment, operating and even strategies, there are some similarities between the two sectors in their goals and objectives. They both seek to reduce operating and production costs, ie, increase efficiency, and raise the level of effectiveness of the services provided (Dorsch & Yasin, 1998). The economic aspect has focused on the consumption and the allocation of resources in an appropriate and effective manner, where efficiency is deemed as maximising result and minimising resource used (Kloot, 1999). Both economy and efficiency are measurable indicators, whilst effectiveness is defined as the extent to which the outcome is satisfied and has a positive impact.

3.5 Experience of Municipalities in Performance Measurement

3.5.1 The Atlanta Dashboard

The Atlanta Dashboard method focuses on final results as opposed to operation processes (Edwards & Thomas, 2005). Furthermore, the method does not reflect any specific values or philosophy. According to Edwards et al., (2005), the new mayor of Atlanta, USA, faced significant issues regarding the delivery of public services, which were caused by a shortage of performance information. There were significant omissions in evaluation of employee performance and financial accounting. The concept of the dashboard was to synthesise and consolidate performance information and to utilise user satisfaction, ie, the citizens, as a control. This method also enables any data omission to be highlighted. The method allowed the mayor to focus on city management and achieve goals irrespective of the operational process that is chosen by managers and workers. As a result, there is no need for senior management to assess the operations of the individual internal departments.

3.5.2 Performance Management Analysis for Dutch Municipality

Lelystad, Performance-Driven is a performance management program launched by the Lelystad municipality in the Netherlands. Historically, there was limited accountability of civil servants and the existing structure suffered from a lack of long-term planning based on retrospective analysis. In order to raise the sense of responsibility within the municipality, a programme was initiated called *"Leadership with Guts"* that intended to *"improve policy making and execution, make tasks and responsibilities more clear, increase accountability, improve customer orientation, increase the quality of management and employees, and improve communication across the organisation"* (De Waal & Gerritsen, 2006, p. 6). The method creates performance measurement indicators that enhance financial accountability via an objectives-led programme budget. The indicators that are utilised by the municipality of Lelystad focused on financial indicators with respect to outcomes, impacts and issues as a result of current operational systems. Lelystad municipality introduced a set of CSFs and PMSs such as KPIs to translate the whole organisation's aims into departmental aims thereby raising quality through performance alignment (De Waal & Gerritsen, 2006) as can be seen in Figure *3-2*.

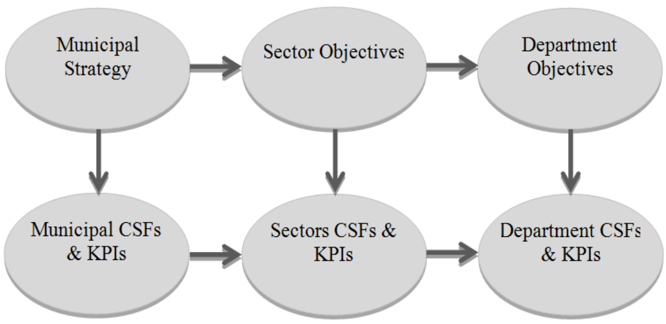

Figure 3-2: Lelystad municipality Strategy (De Waal & Gerritsen, 2006)

3.5.3 Municipal Performance Measurement Program

Municipal Performance Measurement Program (MPMP) is a performance measurement method launched in 2000 by the Ontario provincial government for its municipalities. It considers two factors in its measures: *efficiency*, including the use of current resources compared with its outcomes of services according to the costs; and *effectiveness*, which points out the outcomes of the services in relation to its targets (Burke, 2005).

A fundamental consideration for the implementation of MPMP is the selection of the appropriate method to collect the data and how the results are to be recorded. This data is to be shared among the other municipalities in order to enable the discovery of the best practices whilst taking into consideration some attributes, for example, conditions, location, environment, and topography. Additionally, the strategic approach of providing services and management strategies are deemed key factors in achieving efficiency and effectiveness in the public services. MPMP has three steps (Housing, 2007): -

1. Define organisational goals and missions;
2. Set the target results; and,
3. Determine the appropriate measures for requires outcomes.

MPMP provides citizens and elected officials within municipalities with information regarding factors such as costs, standard values, and other municipal services by collecting and sharing data (Burke, 2005). It also aims to improve such services through creativity, productivity, and accountability by creating regulated service performance data for core sectors and by obtaining feedback from citizens. As such, the MPMP has stimulated improvements in the performance of Ontario municipalities and generated a culture of multi-stakeholder reviewing of performance (Burke, 2005).

3.5.4 Aims of Performance Measurement System for Municipalities

It is stated by Ammons (1995) that performance measurement and monitoring systems were being practiced for the key purposes of increasing accountability, facilitating planning/budgeting, improving operations, assessing programming, reallocating resources, and directing operations/contract monitoring. Over the years, performance measurement has been subjected to various attempts to encourage its improvement, increase its ability to provide accountability and transparency, and enhance its role in supporting decision making and improving management practices (Hadad, Keren, & Laslo, 2013).

The US Government Accounting Standards Board aims to measure the performance of each municipality and then to compare them with each another to enable the improvement of service provision (Swindell & Kelly, 2002). A range of measurement tools are used by municipalities to assess their organisational performance, such as the BSC model, the

Malcolm Baldridge Model, the EFQM Excellence Model, and KPIs as discussed in more detail in previous chapters. Performance measurement is applied in government to attain four fundamental benefits: to enhance accountability, to improve performance, to motivate productivity and innovation, and to improve government expenditure process (Housing, 2007). This is illustrated in Figure 3-3.

Figure 3-3: Benefits of performance measurement (Housing, 2007).

Behn (2003), however, suggests that in the public sector there are different purposes for the application of performance measurement compared to other sectors. These can be identified as: -

- To reflect end-users' (citizens') requirements as evidence of deliverable services effectiveness.
- To monitor allocation of governmental expenditure in budgets and resources, as well as employee motivation, performance contracting, improving public services, accountability, and to increase transparency between government agencies and citizens.
- To set goals, objectives, and strategic plans, to allocate resources in order to execute programs, and to monitor and measure outcomes to determine to what extent these meet desirable goals and objectives.

- To identify best practice and define potential areas for improvement, to utilize the indicators as improvement targets to enhance performance, to benchmark performance against those which are outstanding, to report the results to stakeholders (such as citizens, practitioners), and to raise the possibility of cooperation in developing potential outcomes.
- To enable transparency and accountability by officials, to enable customers to assess value of government services, and to allow performance improvement by providing necessary data for change
- To facilitate planning, evaluation, organizational learning, driving improvement efforts, decision making, resource allocation, control, facilitating the devolution of authority to lower levels of the hierarchy, and helping to promote accountability.

Performance measurement has a very important role in the improvement of coordination and communication processes among different municipalities and in decision-making (Melkers & Willoughby, 2005). This is clarified in a report conducted by the US Government Accounting Standards Board, where 80% of city and county governments using PMSs benefitted, stating that they enabled a more concentrated approach to their objectives and improved their awareness regarding the key factors that impact the achievement of objectives, and increased the quality and communication among partners. In summary, Bracegirdle (2003) states that: -

- The fundamental feature of a high-performing public sector is the use of an integral PMS that enables and activates citizens' participation.
- PMS are utilised by municipalities to assess the results of their service delivery in terms of quality, efficiency and volume.
- Performance measurement is an essential tool to achieve perpetual learning in the institution; nevertheless, this is not to be isolated from a suitable framework.
- Enhancement of citizens' participation in performance measurement in governance is still weak, thereby requiring further consideration.
- Implementation and development of PMS in the government sector is facing more significant problems from process and institutional aspects rather than methodological or technological aspects.

Other research (Behn, 2003) states that the objectives for using performance measurement can be grouped into the following three categories, which are not usually mutually exclusive: providing accountability, improving performance, and helping determine expenditures. Also, performance measurement has been linked to the strength of the organisation’s human resource system, capacity for innovation, ability to reflect and learn. Public sector managers have been applying performance measurement for managerial purposes such as to evaluate, control, budget, motivate, promote, celebrate, learn and improve.

3.6 Critical Aspect for Structuring Performance Measurement System

A desire and suitable environment for change are essential conditions for achieving success in the implementation of any new initiative (Melkers & Willoughby, 2005). Further to this, resources should be available for achieving such success. Support from different government authorities, whether executive or legislative, should exist and leaders within municipal services should be enthusiastic and be able to have faith in the performance measurement information avaiable in order to achieve their goals. Those in leadership roles should use new methods, be willing to use the performance measurement information more seriously, and show flexibility in the execution.

It is important to make a comparison between the assessment of service quality and citizen satisfaction of delivered services; however, there are questions regarding how appropriately to do this and whether there can be any agreement in the findings (Swindell & Kelly, 2002). Kloot (1999) suggests that performance measurement of public service provision and delivery should be concentrated in six areas (with consideration for economy, efficiency, and effectiveness throughout): -

1. Competitiveness;
2. Financial performance;
3. Service quality;
4. Flexibility;
5. Resource allocation; and,
6. Learning and innovation.

Undertaking the establishment of a PMS requires valid and relevant data, the creation of strategic goals and a methodology to accomplish them, and the use of transparency in order to gain citizens' trust (Edwards & Thomas, 2005). Furthermore, good performance measurement relies on the efficiency of human resource management.

Given the lessons learned in the application of performance measurement in public service, it has been argued that the practice is in its infancy, and can only develop with time; although, it satisfies the objective of public accountability, highlighting areas in need of attention, and supporting good governance in the municipal context. For municipalities that adopt PMSs, Bracegirdle (2003) recommends the following: -

- Choose suitable measurement methods derived from actual practises.
- Use established external criteria relying on professionals, experts, and specialists including advanced tools to develop measurement methods.
- Put emphases on the key factors that have a significant impact on performance.
- Assess actual outcomes and link them with sources in the light of organisational capacity.
- Enhance their ability to control and monitor the performance and results.

For a successful PMS, participation of citizens is considered fundamental component. In order to meet the needs and desires of citizens' in their different involvements with municipalities, it is necessary to provide various levels of services whether such activities are productive or financial (Folz, 2004). In addition, service providers should take into consideration the level of quality that meets these needs and preferences. For the performance measurement and the measured performance to be effective, they must be accepted by all of the employees who have an effect on performance. Furthermore, for the purposes of legitimacy, any such program needs to include citizen in the PMS (Poister et al. 2010).

3.7 Participation of Citizens in Performance Measurement System

Satisfaction results are very important in PMSs. Swindell et al (2002) take the view that citizen satisfaction and quality is considered a more desirable measurement for municipal services than some of the qualitative measures. For this concept to be incorporated effectively, the citizen-municipality relationship needs to be understood as well.

Morewve, measurement of citizens' satisfaction has a very important role in the evaluation of services beyond organisational performance.

Further to this, Swindell et al (2002) suggest that in using citizens' opinions to determine the assessment of a municipal services that some other factors might affect their assessment of the quality of the services. The measurement methods used to calculate service performance are based on accumulation of objective data, whereas citizen satisfaction is independent to each citizen and dependent on many factors at the neighborhood level. Where citizen satisfaction is considered a necessary part of performance accountability, citizens can share in the decision-making process of municipalities through their feedback of information and communication between them and municipal representatives (Burke, 2005). In the US and other governments, few citizens have the opportunity to influence performance measurement, with limited numbers taking part in municipal surveys (Bracegirdle, 2003). Furthermore, stakeholders have only a partial understanding of the citizens' role in performance management thus providing few opportunities for citizens to participate in decision making.

3.8 Conclusions

Increasing demands have emerged for governments to improve their performance in service delivery and raise accountability and transparency both for stakeholders and citizens in terms of both traditional measures, and efficiency and effectiveness (Wisniewski et al. 2004). To this end, there is a need for the greater adoption of PMSs. These systems are applied in government to attain four fundamental benefits: to enhance accountability, to improve performance, to motivate productivity and innovation, and to improve government expenditure process.

Pollanen (2005) states that resistance to transparency, lack of specifications and standards, the significant investment of resources and time, and the poor convenience and are considered to be the likely reasons that prevent the more widespread utilisation of performance measurement in local government. Therefore, in order to achieve success in the implementation of PMSs in municipal government services, it is essential that the correct conditions should be established and their requirements and concerns met. The following chapter covers other aspect for performance measurement concept that is concerned with assessing construction project performance.

4. CHAPTER FOUR: ASSESSING CONSTRUCTION PROJECT PERFORMANCE

4.1 Introduction

It is becoming increasingly difficult to ignore the significance of performance measurement in public and private sector construction organisations given the rapid changes in the construction industry in terms of developments in technology, financial instruments, and complex project execution. The lack of application of performance measurement in the construction sector, despite its importance, is due to several reasons but mainly the lack of information and insufficient training on how to use it (Costa et al. 2004).

The construction industry is an important contributor to the economy of a country; however, it has quite an unstable nature (Toor & Ogunlana, 2009). As a result of rapid change and increasing uncertainty in terms of technology, budgets and operational processes, the construction industry has become more complicated and dynamic (Albert, 2001). Consequently, the need for improving the performance of the construction sector is wholly apparent. To achieve performance improvement, measurable objectives must be set and then used to determine critical success factors and performance measures.

The traditional indicators of cost, quality and time (the Iron Triangle) are still being utilised by the construction industry as primary measures of performance despite their deficiency in measuring project successes (Haponava & Al-Jibouri, 2009). Recently, however, measuring success has shifted from these traditional measures to include a wider comprehensive set of metrics of project lifecycle, starting from the initial feasibility phase to the final closedown phase (Lehtiranta et al. 2012).

4.2 Performance Measurement in Construction Industry

Performance measurement has not become widely used in construction industry. Therefore, performance measurement is needed to assess how well they have been working, how well they are presently working, and, more significantly, how well they will work in the future so that the aspects in which they are failing can be recognized and corrected (Ankrah & Proverbs, 2005). Jones et al (2008) also argued that the construction industry should change to be more focused on main drivers such as customer satisfaction, leadership, quality agenda and team and process integration.

In the construction industry, two aspects of performance can be measured: either the success of the organisation's performance, or the success of the project (Ankrah & Proverbs, 2005). Ankrah et al. (2005), in an attempt to clarify further, suggested performance measurement has been characterised as the organisational task of designating statistics to entities and the registration of actions in order to offer motivation that provides on-going development. In the construction industry, performance measurement is considered to be an organized technique to evaluate performance by evaluating the inputs, outputs and final project outcomes.

In construction projects, the aim of performance measurement is to evaluate and improve quality and efficiency of the project execution process, in addition to identifying potential areas for future improvement (Lehtonen, 2001). Performance measures can be divided in one of three ways: -

1. Financial or non-financial measures;
2. Soft or hard measures; and
3. Process or output parameters measures.

Alternatively, they can be divided into two categories. The first category is focused on *use of measures* that is sub-divided into *improvement measures*, which are used to discover areas of weakness in current performance, and *monitoring measures*, which are deemed to be controlling and monitoring tools to provide managers with data and information regarding operational process. The second category is the *focus of measures*, which are applied to demonstrate the organisation level where measures are used (Lehtonen, 2001).

There are broader "soft" measures such as "customer satisfaction" which have become increasingly important, besides the traditional measures of expenditure, duration and quality. Much focus is also being directed to the impact on the environment, safety, investment and training, in addition to on-going productivity and profitability (Ankrah & Proverbs, 2005). Traditionally, the majority of construction projects' performance was measured through financial indicators. Despite their usefulness, they are considered lagging indicators focused on past events. Also, further weaknesses include poor strategy development potential, lack of information on environment, and poor analysis of the relationship between partners and quality. To overcome weaknesses in measuring the performance of construction projects, two distinct attempts were launched in Australia and the United Kingdom (Cheung, et al. 2004).

4.3 Construction Performance Measurement Approaches

Whilst there is an increasing understanding of the significance of PMSs among construction companies for monitoring and controlling performance, regrettably, this awareness has not been transferred into action in the construction industry (Takim & Akintoye, 2002). Despite this, there are a large number of existing PMSs, whether currently practised or merely developed and used in academia. These can be categorized across four aspects: construction project performance; construction productivity, project viability, and project quality.

Given the project-based nature of the construction industry, the current measurement systems that are driven by the market and, consequently based on measures of profitability, are not appropriate for measuring and improving performance of construction projects (Ankrah & Proverbs, 2005). In the construction industry, any project performance measuring concepts can basically be divided into a macro level (assessed at the end of project) and a micro level (assessed during project stages). Analysis of performance on the macro level is considered useful for determining future business strategies; whereas, analysis of performance on the micro level is useful for determining a project's progress and completion (Cha & Kim, 2011).

A literature review conducted by Ugwu & Haupt (2007) of the South African construction industry to determine KPIs for sustainability of infrastructure projects found that at the national, sub-regional and continental levels the focus was on the macro level. In other study conducted by Haponava & Al-Jibouri, (2012) proposed KPIs where identified based on three construction project stages: pre-project stage, design stage, and construction stage. An integrated performance index was established by Pillai et al (2002) based on different aspects such as merit, risk, project status, cost effectiveness, and production preparedness of the projects (Yang et al. 2010). Kaare & Koppel (2012) clarify that in

Highways Agency in Great Britain seven KPIs are reliability, major project, safety, maintenance, customer satisfaction, efficiency, and carbon emissions.

However, Yang, et al (2010) considered construction project analysis across three levels: project level, organisational level, and stakeholder level. The first application of performance measurement can be found at the project level. Given that construction projects are complicated, invariably unique, and have many stakeholders, performance measurement will involve different processes, aspects, environments, and participants. At the stakeholder level in the construction industry, the relationship among different participants is complicated due to different projects involving different types of project stakeholders. Thus, measuring various project stakeholders' performance is an important component whether at the project level or organizational level.

In the US, the most common project performance management models are Benchmarking Metrics by the Construction Industry Institute, and in the UK are KPIs from Constructing Excellence (Cha & Kim, 2011). They are used to achieve continuous performance improvement and maximise cost effectiveness and productivity. The stated purpose of the Construction Industry Institute's PMS is to discover best practice and improve project outcomes. In other words, it is aimed to promote the performance of the industry through a consistent PMS. Benchmarking Metrics consist of six categories: budgeted and actual project costs, planned and actual project schedule, facility capacity, project outcomes, work hours, accident data, and project impact factors.

Similarly, in the UK, KPIs have the stated purpose of increasing competency at both the domestic and global level. They are considered to be applicable to measure construction performance at both the project and organization level (Cha & Kim, 2011). Generally, KPIs are divided into five categories: project-related, procurement-related, participants-related, project management-related, and external factors. The KPIs have been designed by the UK Construction Industry Best Practice Programme as measurement instruments, implemented in three main steps: -

1. Identifying what should be measured;
2. Data gathering and calculation; and,
3. Analysis of KPIs result.

KPIs are focused on time, cost, quality, client satisfaction, change orders, business performance, and health and safety. In addition to the previous framework, Project Performance Monitoring Systems were built on the basis of KPIs and PPE measures consisting of eight groups of PMs, these being people, communication, time, cost, quality, environment, client satisfaction and health and safety (Cheung, et al. 2004).

Kagioglou et al (2001) suggested a Performance Measurement Process Framework (PMPF) based on the BSC model with additional to "project" and "supplier" perspectives. Samson & Lema (2002) proposed a performance measurement framework with effective indicators. Costa et al (2004) presented a system and guidelines to recognise and implement best practices in the performance measurement framework. Salminen (2005) suggested a construction PMS for site to establish CSFs. It was noted that there are different applications of KPIs in construction. Other varied applications of KPIs in recent years have included "design KPIs" by Chan & Chan (2004) to measure construction projects success, and Beatham et al (2004) proposed a framework for a project measurement system that included KPI and aligned them to the organisation's aims and objectives.

In Australia, the Project Performance Evaluation (PPE) framework was introduced by New South Wales Public Works Department. The framework is designed to cover soft parameters such as communication and dispute resolution in addition to other PMs including time, cost, quality, safety, contractual, and environment (Cheung et al.2004). However, it was proposed to also cover new subjective parameters of communication and dispute resolution.

In Taiwan, an evaluation approach was proposed by Yang & Peng (2008), Construction Project Management (CPM). It was introduced to monitor ongoing and completed public construction projects. This approach consisted of two stages: in-service and post-service. The in-service stage PMs consisted of cost, quality, time, communication and technique/tool; whereas for the post-service stage they were cost, quality, time and scope. The main considerations during the in-service stage are cost, quality, time, communication, and techniques; whereas, during the post-service stage they are cost, quality, time, and scope (Yang & Peng, 2008).

Takim et al (2002) proposed a new conceptual model based on stakeholders' satisfaction during the three stages of project life cycle needs: planning, execution, and termination stage. It incorporated and integrated some key success factors of construction projects, which were: the relationship between success factors, project performance, efficiency, effectiveness, stakeholders' performances, needs and expectations, and stakeholders' continual participation. These factors have performance indicators that are measured in the three phases of project life cycle: the procurement, the process and the termination.

However, the previously mentioned PMSs do not focus on measuring project performance during all project phases of a construction project regarding financial and non-financial factors except KPIs (Pillai et al. 2002). Most of frameworks that have been proposed have been developed theoretically rather than empirically (Pillai et al. 2002).

4.4 Measuring Municipal Construction Project Performance

The construction sector is one of the most significant contributors of growth to the national economy (Wibowo, 2009), and is employed by governments as a tool to achieve the modernisation of society and to improve the quality of life (Eriksson, 2013). The construction industry operates in both the public and private sectors; however, often the most significant projects are developed and owned by the government in the form of infrastructure, and public facilities, such as hospitals, schools, and airports (Othman et al. 2006).

The construction industry can be distinguished from other industries, such as manufacturing and services, by being described as project-based (Brian & Thomas, 2007); however, this increases the difficulties in the sector given that each project is invariably unique (Barrett & Sexton, 2006). In addition, such projects are often operated under multi-firm project organisations and include the owner, contractor, consultant, suppliers, stakeholders, the community, and designer (Yang et al. 2010).

According to Edwards & Thomas (2005), citizens have two areas of concerns in terms of municipal services delivery, which are efficiency and effectiveness. In the same context, user satisfaction can be achieved by considering their expectations, needs, and desires (Folz, 2004). Swindell & Kelly (2002) found that the perception of citizens towards success of public project is as subjective as project data is objective. The authors concentrated on the reliability of data collected through surveys to investigate to what extent citizens were satisfied regarding government projects. They noted that citizens' evaluations of municipal projects were based on their experiences and their attitudes, both of which may be influenced by factors not relevant to the project. In a municipal project that is provided to the public as a non-profit service (Moulton & Eckerd, 2012), citizen satisfaction regarding the quality of that service is a significant component and should be taken into consideration (Swindell & Kelly, 2002).

Previous research conducted in South Africa found that success for a public construction project can be measured across six dimensions for infrastructure project success which include: economy, environment, society, resource utilisation and project management (Ugwu & Haupt, 2007). In Malaysia, public construction project success metrics include four perspectives, which are a financial perspective, a customer perspective, an internal perspective, and a learning and growth perspective (Chan T. K., 2009).

In Thailand, public facility and infrastructure projects are deemed successful if they achieve operational flexibility, maintainability, energy efficiency, sustainability, and the intended function to ends-users, in addition to satisfying stakeholders' demands and expectations, and regulations with project success being achieved in several aspects, including human, project, management, and environmental (Toor & Ogunlana, 2009).

In Great Britain, successful road infrastructure projects must be achieved according to reliability, delivery on time, budget, safety, maintenance, environment, customer satisfaction and value added to national development, ie, efficiency (Kaare & Koppel, 2012). In Guyana, the aspects of cost predictability of construction, cost per unit, and time predictability of construction, time per unit, and cost for change are utilised. Furthermore, in Hong Kong, USA, UK, Canada, Australia, Germany, and Korea, three dimensions of predictability, process, and outcomes are identified as well as 18 KPIs in order to determine to what extend projects are delivered successfully (Lin, Sun, & Kelly, 2011).

Bracegirdle (2003) suggests that performance measurement is applicable in both the private and public sector and found that municipal performance measurement takes many different forms. There are various types of measures can be used to feed information to decision makers, and that PMs often include cost, quality, efficiency, and outcomes of providing these goods and services.

4.5 Key Processes and Requirements for Performance Measurement

To encourage effective performance measurement, a performance matrix needs to be developed appropriately and effectively to include all phases of the project from the selection, study, implementation, delivery, and, the usage phase (Haponava & Al-Jibouri, 2012). In order to propose performance measures, they should be based on identified project stages and sub-processes. Stakeholders' performances and project performance should be measured in each stage separately in order to determine the success of a project and involve the proposed PMS (Takim & Akintoye, 2002).

Performance measurement is an on-going process, the purpose of which is to enhance the improvement, and achievement of aims and objectives. It can be summarised in five steps (Kim et al. 2007): -

1. Measuring performance phase, which includes establishing basic attributes of performance management, performance objectives, success factors and targets.
2. Store phase, which is the recording of data and information, as well as defining the way which they are demonstrated.
3. Analysis phase.
4. Reporting performance phases.
5. Using data phase.

Creating a PMS depends on identifying project stages across their lifecycle that are associated with various variable such as performance indicators or success factors (Takim et al. 2003). The author identifies three stages: selection, execution, and eventually the implementation phase. Therefore, when designing and using an effective performance measurement framework, in order to link its measures with project aims, appropriate data has to be taken, along with measuring the financial and non-financial aspects (Ankrah & Proverbs, 2005).

The major issue in using KPIs is that they are concerned with analysing past events (lagging indicators). Conversely, leading measures deal with current activities that are being performed. As a result, lagging measures offer little chance to change the future

(Beatham et al. 2004). According to Haponava & Al-Jibouri (2012) it is argued that successful PMSs for construction project should align to the stakeholders' organisations goals. As well as, Performance indicators should be weighted depending upon the particular condition of a project (Cha & Kim, 2011).

To achieve the purpose of a PMS, which is to check project position, communicate this position, identify priorities and enhance progress, certain features are commonly included: -

- Should be focused on financial and non-financial aspects (Bititci, Turner, & Begemann, 2000);
- Must be understandable and acceptable to the majority of participants and shareholders (Amaratunga & Baldry, 2002b);
- Should offer updated data and information frequently (Ankrah & Proverbs, 2005);
- Should be key composed of indicators (Ankrah & Proverbs, 2005);
- Must offer clarification (Amaratunga & Baldry, 2002b);
- Should focus on the main processes of an organisations' strategies (Ankrah & Proverbs, 2005);
- Should illustrate the relationships between cause and effect in performance (Amaratunga & Baldry, 2002b);
- Must be established to gather information (Amaratunga & Baldry, 2002b);
- Should be active (Bititci et al. 2000);
- Should be comparable against others (Amaratunga & Baldry, 2002b); and,
- Measures should be clear and in alignment with the aims and objectives (Ankrah & Proverbs, 2005).

Alternatively, Beatham et al. (2004) have suggested that good performance measures have the following characteristics: -

- A comprehensive overview of the industry should be used to select leading and lagging indicators.
- Differences between KPIs (leading), KPOs (lagging), and perception measures (individuals' judgements) must be understood and applied.
- Indicators need to be balanced between the organisations' strategy and interests.
- The stages of design and execution have to be recognised and clear.

- They must be used as a fundamental component of the system and the process of execution.
- The measures should take consideration of processes and sub-processes.
- There should be active staff participation in the improvement of the measures.
- The measures can be updated and used by organisation to benchmark their performance internally and externally.
- The selected measures should support the decision makers with updated information.

According to Chan & Chan (2004), the essential purpose of performance measurement is to facilitate project performance throughout the construction industry; thus, the process of developing performance measures should involve consideration of the following factors: -

- Measures should be focused on critical aspects of outputs or outcomes.
- Measures should be limited and manageable in number and be maintainable for regular use.
- Measures need to be consistent and used systematicly.
- Data must be collected as simply as possible.
- Measures should be designed to be used on every project.
- Measures must be accepted, understood and owned across project stakeholders.
- Measures need to be flexible and improvable.

Love and Holt (2000) suggested that developing a comprehensive stakeholder perspective approach to performance measurement is required to attain successful strategies in order to achieve optimal business performance.

Chan and Sundaraj (2009) asserted that good performance measures should have some characteristics such as: -

- Non-financial measures;
- Be frequently measured;
- Limited to measures;
- Understood by stakeholders; and.
- Have significant and positive impact.

Takim and Akintoye (2002) recommend that the needs and expectations of stakeholders to be included by PMSs need to be measured during the project stages. Additionally, they state that one should distinguish between project success, which refers to efficiency and effectiveness, and project performance. The integrated PMS by Takimi et al (2003) is based on three stages: -

1. The construction project should be divided into key phases;
2. Identify key factors in each stage; and,
3. Integrate these factors with PMs.

Fundamentally, for performance measurement frameworks for construction projects to be effective, success factors and performance indicators across project stages have to be identified (Willis & Rankin, 2011). The project performance data that is used to determine project success is derived during the various stages. Kulatunga (2011) mentioned that PMSs for construction projects are based on the identification of the CSFs and performance measures during its lifecycle.

According to Sinclair & Zairi (1995) effective process management for outstanding performance measurement should be conducted through five levels as followed: -

1. **Strategy development and goal deployment** is considered as the starting point for any PMS. It is concerned with development and deployment of organisation strategies and project goals. This level is achieved through steps which are: develop mission/vision statement (stakeholders needs and expectations); identify CSFs; define PMs for each CSF; set targets measures; assign responsibility; develop action plans; deploy mission, CSFs, KPIs, targets, responsibility and plans to macro processes; manage organizational processes; measure performance, benchmark performance results; identify improvement areas; and take action.
2. **Process management and measurement** consists of the sub-process to identify and map processes; translate organisational and project goals, stakeholders' requirements and action plans into process PMs; define desired performance targets; assign responsibility; develop plans to attain performance targets; deploy measures, targets, plans and responsibility to all sub-processes; operate

processes; measure performance and compare with performance targets; and identify improvement areas to gain on-going improvement.

3. **Performance appraisal and management** level is where performance appraisal is defined as *"the process by which organizations establish measures and evaluate individual employees"* (Sinclair & Zairi, 1995, p. 51).
4. **Break-point performance assessment** is the fourth level and conducted in followed steps: identify measurement need that comes from poor performance and desire for improvement; identify measurement approaches, measurement execution, and results feedback for the planning process.
5. **Reward and recognition** is given where superior performance is achieved whether objectively or subjectively.

Depending on variations in the purposes for performance measurement, there are different PMSs with different gaols, process and components and no system fits for all. Consequently, in order to measure project performance, it necessary to develop an appropriate framework for measuring construction project performance that takes into consideration its circumstance and uniqueness (Yang et al. 2010).

Pillai et al (2002) stated that measuring the construction project in each stage is a fundamental component to judging performance success; however, it is not enough to determine the outcome success. Harponava & Al-Jibouri (2012) proposed measures which were based on key construction project stages, rather than on whole project, in order to provide a real picture of the state of the various stages and sub-stages separately. Therefore, any performance measurement framework should be proposed to measure each stage's performance as well as the overall project success.

4.6 Barriers in Construction Industry Performance Measurement

The construction industry is deemed to be one of the most complex and risky sectors, especially as it is a "multi-actor business" (Löfgren & Eriksson, 2009). As a consequence of its dynamic and ambiguous environment, several issues have surfaced such as poor relationships and a lack of collaboration among those actors, ineffective communication, poor trust, and a lack of customer focus. Löfgren et al (2009) stated that in construction projects that were outstanding in satisfying costumers, they derived their higher productivity and performance in terms of quality, time, and cost from superior partnering and collaboration between stakeholders.

According to Nudurupati et al (2007), the key issues in the construction industry are resource allocation, recording, and storage of data and information, and logistics. However, other significant potential sources of problems that hinder construction projects is a lack of consensus in defining the concept of project success among stakeholders before beginning the project; thus, success factors and PMs must be determined at the pre-project phase (Lim & Mohamed, 1999).

4.7 Construction Project Performance Success and Project Success

Success is an undeniably vital issue, achievement of which is sought in all sectors. In the construction sector success is still broadly measured by the degree of achieving the project objectives and expectations of stakeholders in terms of the traditional norms of the iron triangle of time, cost, and quality (Arslan & Kivrak, 2009). However, it is variable depending on the situation and observer (owner, planner, consultant, engineer, contractor, operator, supplier), and is defined by each depending on individual goals and expectations.

Construction project success is influenced by a set of factors, for instance project attributes such as size, cost, environment, contract and specifications, the relationship, and cooperation between stakeholders, qualification of engineers, and teamwork (Cheung et al. 2004).

According to Müller & Turner (2007), stakeholders judge project success from different perspectives based on their personal perceptions. Generally, there is no agreement among scholars on the definition of success. Proposed definitions aspects relating to technical attainment, profitability, learning and social outcomes, and to what extent they have been achieved in project closedown stage (Nguyen et al. 2004).

Nguyen et al (2004) stated that determining project success or failure is still ambiguous due to the fact that measuring project success it is not clear, success factors vary between project stakeholders and the project stakeholders' objectives vary during the project stages. However, it is acknowledged that success of construction projects is achieved when the projects is accomplished within time, budget, specifications, satisfies the client, is profitable for the contractors, had no claims made, and achieved the planned purpose. In addition, they remarked that success means achievement of certain stakeholders' expectations. Construction projects success is defined as attaining project goals and desires including *"technical, financial, educational, social, and professional aspects"*.

Toor & Ogunlana (2009) argued that success in construction projects can also be seen across the micro and macro level. The micro level is concerned with the success of project stages and sub-stages; whereas, the macro level is related to what extend the original project aims and objectives were achieved. This is in line with Othman et al (2006), where they consider it is essential for public construction projects to be completed on time and on budget; however, its success is judged in macro level.

Therefore, the success of construction projects can be measured under two distinct definitions during project lifecycle. The first definition is *project outcomes success* that deals with project outcomes at delivery stage compared to stakeholders' objectives and expectations (Lehtiranta, Kärnä, Junnonen, & Julin, 2012). This is the "macro view" of success (Toor & Ogunlana, 2010). The second definition is *project performance success* that focuses on PMs such as cost, time, quality, and satisfaction (Jugdev & Muller, 2005). This is the "micro view" of success (Toor & Ogunlana, 2010). It is noted that the distinction between these two definitions is that project success is measured at the end; whereas, project management success is measured throughout project execution. Despite this differentiation, in order to determine the overall project success both definitions must be taken into consideration (Lehtiranta, Kärnä, Junnonen, & Julin, 2012).

Similarly, Nguyen *et al* (2004) also stated that in order to determine success, it is required to distinguish between *project success* and *project performance success*. Cooke-Davies (2002) claims that *project success* is related to the initial intended purpose of the project, which can be measured after close out of project; whereas, *project performance success* is associated with measuring cost, time and quality/performance and also others during project stages. They also mention that overall project success can be obtained when having an outcome better than planned in terms cost, time, quality, safety, and higher than expected levels of stakeholder satisfaction.

Takim et al (2003) state that overall project success has two aspects: tangible and non-tangible. The tangible aspect is cost and time; whereas, the non-tangible aspect focuses on stakeholders' satisfaction, that is associated with the extent project outcomes satisfy the end-users' expectations and needs. In a non-profit construction project, success is determined by efficiency and effectiveness. The efficiency of such construction projects relates to utilising resources economically, and, consequently, is a measure of the "processes" resulting in the project outputs; whereas, the effectiveness component is concerned with achieving the project objectives, and, consequently is a measures of the "results" and relates those to the project outcomes (Edwards & Thomas, 2005). Therefore, in order to judge construction project success, it is necessary to take into consideration both the outputs of the project that focus on efficiency and outcomes that deal with effectiveness (Takim et al. 2004).

Chan & Chan (2009) proposed that the success of a project can be divided into four time periods. The first period is success of the project at execution. The second period is success of the project at the defect liability period. The third period is success of the project after one-to-two years. The fourth period is success of the project after three-to-five years. The authors added that success can be defined for each stage as *"The first stage is the delivery process: doing it right; the second stage is the post delivery system: getting it right; and the last stage is the post-delivery benefits: getting them right"*. For Chan & Chan (2009) it is divided into four aspects: accomplish the planned goals, produce benefits for the end-user, add value to the organisation, and improve the infrastructure. The overall project success is the result from all four aspects mentioned.

4.8 Construction Project Performance Success Components

4.8.1 Role of Drivers Success and Success Measures

CSFs are measured against standards that are defined as success criteria (Nguyen et al. 2004), whilst Cooke-Davies (2002) suggests success criteria are measures for determining to what extent the project has succeeded or failed in achieving the aims of the project. Chan et al (2004) suggests that for a successful framework, the relationship between CSFs and KPIs should be identified. Westerveld (2003) stated that in several studies conducted previously that project success relies on developing a comprehensive framework to link success factors and success criteria. Combining these elements not merely results in project success but leads to on-going improvement.

Müller & Turne (2007) state that the project sponsor and manager should identify project targets to determine relevant success factors and appropriate PMs to achieve project success. They found in their study a positive relationship among success factors, success criteria, and projects success. Nguyen et al (2004) consider that distinction between CSFs and success criteria is essential to produce project success. CSFs are defined as inputs that enhance and direct the project to be achieved successfully; whereas, PMs are used to judge project success or failure. According to Westerveld (2003), several studies suggest that for a successful performance management framework, CSFs, and PMs should be linked.

4.8.2 Critical Success Factors

Nguyen et al (2004) state that CSFs are defined as any engine or influential element such as knowledge, skill, behaviour, methods and attributes that have an impact resulting in performance success and project success. They are limited in number, can be objective or subjective, and have significant impact on project results (Nguyen, et al. 2004). CSFs can not only contribute to a project's success, but even its failure (Lim & Mohamed, 1999). In another definition, CSFs are key areas of activity that are necessary to achieve project purpose successfully.

Chan et al (2004) identified in their study the most important success factors and classified them into five groups which are project attributes, procedures, project management, human resources and environmental factors. From an international perspective, in the USA, quality workmanship, honesty, having good subcontractors, customer communications, reputation, having good employees, and completing projects on time, respectively, were deemed significant success factors by construction companies; whereas, in Germany, employee development, effective risk management, innovation, partnerships with customers, and lean organisational structure, were considered success factors.

Five factors were classified as the most significant factors out of 20 CSFs investigated. These were: -

1. Competent project manager;
2. Adequate funding until project completion;

3. Multidisciplinary/competent project team;
4. Commitment to project; and,
5. Availability of resources.

Critical success factors are utilised as directors to organisational strategy to optimise and meet outstanding performance levels. Despite the significance of these factors, they cannot fulfil the desired goals if they are not linked properly to each other. Establishing relevant and reliable CSFs is deemed fundamental to evaluate project success regarding both objective and subjective measures – these factors are assessed to increase the productivity of construction project performance.; therefore, the frameworks that have been designed rely on effective communication, dispute resolution, sufficient resources, management, mutual trust and cooperation between all stakeholders, commitment, coordination, and inventiveness (Jacobson & Choi, 2008).

Lim & Mohamed (1999) purposed an assessment model for project progress starting from the conceptual phase to the operational phase. A set of factors identified for the model were based on two definitions of success, macro and micro. The factors were determined to cover some key areas such as feasibility studies, marketing research, experience, site conditions, weather, flooding, shortages, wastage, mistakes, workmanship, damages, thefts, approvals, changes, supervision, logistics, and interfacing. The macro definition is affected by decisions taken in the conceptual stage and can be tested at the operational stage where stakeholders' satisfaction can be assessed. Whereas, the micro definition is associated with the construction stage where project time, cost, performance, quality and safety factors are established for project performance success. It has been observed that construction stage components are the most deeply studied and that time, cost, and quality are considered the most important success factors.

Muller & Turner (2007) assert that choosing appropriate CSFs enhances the likelihood of project success, whether in its construction or operational stage. In their study to identify CSFs for construction project in Taiwan, CSFs were divided into four groups, the most important of which was collaborative team culture, then long-term quality focus, followed by consistent objectives, and resource sharing.

Takim & Akintoye (2002) designed a PMS which proposed that the first step towards project success started with success factors. The results of a study conducted by

Lehtiranta et al (2012) show that there is correlation between CSFs, project success, and stakeholder satisfaction. As stated by Cooke-Davies (2002) that to determine CSFs three questions should be asked: -

- What factors lead to project management success?
- What factors lead to a successful project?
- What factors lead to consistently successful projects?

A summary of various CSFs from the authors cited is noted in Appendix 1.

4.8.3 Project Performance Measures

In the construction industry, many attempts have been made to introduce measures for construction project performance in order to meet improvement targets. The objective of using such indicators is to measure the performance of one or more aspects of the project (Haponava & Al-Jibouri, 2009).

The three traditional criteria which are cost, time and quality are deemed as fundamental standards with which to measure construction project success and are used by majority of practitioners and professionals in construction field (Eriksson & Westerberg, 2011). However, the authors criticised them as being focuses on short term aims. Chan & Chan (2004) noted that threre are four aspects to measure project success: project efficiency, impact on customer, impact on business, and preparing for the future. Kumaraswamy & Thorpe (1999) also noted that there are also other aspects to determine project success such as meeting budget, schedule, the quality of workmanship, stakeholder’s satisfaction, transfer of technology, health and safety, and functionality (Ali, 2010).

The majority of project performance measurement frameworks in use are based on financial aspects, even though they are lagging indicators which have been criticised as having a lack of strategic focus, and not providing data on quality, relationships, and the environment (Cheung et al. 2004).

Lagging measures are focussed on results and do not offer the opportunity to change current performance - they are just used for historical review (Haponava & Al-Jibouri, 2012). Leading measures are used to predict future performance activity and give the opportunity to change current performance (Beatham et al. 2004). Therefore, on the basis of dividing performance measures into leading and lagging measures, project success and project outcomes success can be distinguished. Leading measures are used to measure the project process performance, while lagging measures are used to measure the project outcome. Process performance is related to efficiency of the process, and outcome performance is conserened with effectiveness of outcomes. Thus, leading indicators should be linked to relevant CSFs that will enhance project success. A comprehensive PMS can be improved by integrating both process performance and outcome performance. Furthermore, the measurement results of overall performance can be used as a database for new projects (Lin et al. 2011). Haponava & Al-Jibouri (2009) suggested measureing the construction processes rather than just the outcomes of the project.

Chan & Chan (2004) set out measures including objective and subjective indicators to measure construction project performance. The data calculation method of the developed measures is divided into two groups. The first group consists of mathematical formulae for monitoring construction time, construction speed, time variation, unit cost, percentage net variation over final cost, net present value, accident rate, environmental performance, etc. The second group is formed by the opinions and personal judgement of the stakeholders of quality, functionality, and satisfaction. The suggestion for objective and subjective measures was supported later by Haponava & Al-Jibouri (2009) to include more comprehensive of dimensions. The differing perspectives of these measures are summarised in Appendix 2.

4.8.4 Project Success Measures

Performance measurement has been seen differently in public sector. In the 1990s, the focus shifted to customer satisfaction instead of the “three Es” of economy, efficiency and effectiveness of the 1980s (Kouzmin, et al. 1999). Project success measures are defined as a set of metrics used to quantify the efficiency and the effectiveness of actions. Effectiveness is focused on achievement of the objectives; whereas, efficiency is expressed as best utilisation of the resources to achieve results (Marques et al. 2010). The common goal of PMSs is to enhance the productivity and cost effectiveness of the construction industry and to eliminate its inefficiency (Cha & Kim, 2011). Thus, stakeholders should to try to improve the success of their projects by using a PMS to measure their efficiency and effectiveness in terms of both financial and non-financial aspects (Takim et al. 2003). They can also judge public sector services with respect to their quality, impact, productivity and effectiveness. In this regard, it is essential to conduct citizen, customer, or client surveys (Kouzmin et al.1999). Similarly, government performance needs to include measures of efficiency and effectiveness (Kloot, 1999).

In public organisations such as municipalities, three types of measures are considered as significant: non-financial process measurement, output measures, and outcomes measures. Process of measurement reflect the relationships between inputs and outputs where input is the quantity of resources consumed to provide the service required. Output measures are concerned with the achieved work, which, in other words, is the efficiency in resource utilisation. Outcome measures indicate the influence and impact of delivered services on the quality of end-users' lives, ie, its effectiveness. The definition of efficiency is the percentage of outputs comparing to inputs and the definition of effectiveness is the relationship between outcomes and its objectives. Both efficiency and effectiveness measures are considered as the ultimate aim of comprehensive PMSs. Despite the significance of both efficiency and effectiveness measures, it is noted by Pollanen (2005) that effectiveness measures were implemented more frequently than efficiency measures and that this was to be expected given that measuring outcomes is ambiguous and more complex than measuring outputs.

Takim et al (2003) stated that efficiency and effectiveness are considered as two elements for measurement of a project's success. The "processes" (efficiency in the strategic planning, management and utilisation of resources) are measured under efficiency elements which are related to project outputs. These measures could be calculated if methodology, system of measurement, and standards are given for benchmarking. Whereas the "results" are measured under the effectiveness element and these relate to the outcomes of a project including satisfaction of users, objectives of the project and core business, and use of the project. According to the authors, achievement of the predetermined goals as an output is usually termed as project success. In the same context, Maloney (1990) state that the resource utilisation is a part of construction project efficiency; on the other hand, construction project effectiveness is obtained when ultimate requirements are achieved.

For Takim & Akintoye (2002) efficiency can only be achieved by ensuring standard systems and methodology, internal organisational measures (abide by schedule, budget and specification), and strong management. The effectiveness of a project is determined by the efficiency of the result; this means that if end-users are satisfied, then the project is a success. In the same context, for effectiveness measures, consultants and the Government focus on operational programs and project functionality while contractors and private clients focus on large profit margins and pre-defined goals (Takim et al. 2004).

A PMS was introduced in the Atlanta, USA, municipality where it found that citizens are concerned about public service delivery in two regards, efficiency as owners and effectiveness as consumers of government services. Thus, it is suggested that outcomes are needed to reflect both efficiency and effectiveness. To address the problems related to these dimensions that resulted in users satisfactions, PMSs should be able to evaluate the success continuously (Edwards & Thomas, 2005).

According to Takim (2005) there are indicators by which efficiency and effectiveness are suggested to determine the success or failure of a construction project: -

4.8.4.1 Project Efficiency Measures

Project time governs every other aspect in the efficiency of a project if not followed strictly a project should be completed on schedule.

Project cost (budget) refers to the completion of a project as per the estimated costs; the project cost is also measured variably by the stakeholders.

Project quality is directly related to material availability, and how the quality for each procured item was checked; therefore a construction project quality is concerned with the application of established requirements of the materials.

Project safety is a pre-requisite while starting a construction project in any environment. The workers/employees should be briefed by the project managers about the health and safety requirements. It is common to understand that accidents on construction site take place, due to many reasons that are absence of health and safety rules, and carelessness of the workforces.

Productivity is commonly understood to be directly affected by the labour force. In this, worker time-keeping is significant.

The **External project environment** can represent a significant threat to construction projects. The project managers should be very careful in estimating external factors, eg, political stability; economic indicators; the social, technical, legal and fiscal framework; the business environment; and, industrial relations.

Degree of interaction refers to the extent of interaction among those who are related to a construction project. They are designers, builders, and project managers. In addition, a project's planning; designing, procurement, and the initial starting up phases are part of these interactions. If the interaction among the project partners lacks coordination, a project would likely fail. Hence, it is maintained that a project's performance can be enhanced if interaction happens as and when required.

The **Quality of the working environment** can help achieve set objectives within time. However, where the management and employees have oppositional problems, this can again cause a project to fail.

Environmental effects are the damages that a project inflict on the surrounding environment.

Social obligation is the duty a project has towards making a positive contribution to society. This eventually contributes towards nation-building and improvements in quality of life.

4.8.4.2 Project Effectiveness Measures

Client and user satisfactions reveals the realities of a project's effectiveness. A client will be satisfied when a project is delivered on time, is of high quality, and to the budget agreed. It is regarded that client satisfaction is an attribute of project success.

The **level of effectiveness (achievement of outcomes)** operates over two layered objectives: corporate objectives and project's own objectives. A construction project has to go through lengthy procedures to gain permission from a local authority.

Project functionality and fitness for purpose is a reflection that a construction company's reputation is at stake if the delivered project does not live up to the end-users' expectations and standards. This is the success of a project after construction. A completed construction project must show conformance with the latest technologies used during the construction processes or phases, and the technical aspects of a project must be judged against the money invested during the project activities.

Freedom from Defects is an expectation that the clients need the finished product to be free of flaws and errors. Defects can arise due to non-standard work performed by builders, inefficient project management, materials not being checked, or low quality materials.

Value for Money relates to every aspect in a construction project. It starts from planning, designing, and awarding of contracts, and continues through to every subsequent phase.

Profitability is judged differently; it is the increment where revenues exceed costs.

The **absence of any legal claims and proceedings** is a major concern. In any situation where there is a breach contracts, it gives rise to options such as arbitration, or even litigation. There can be a number of situations where either the client or contractor ask for changes during the project. This invariably has a financial obligation for one party against the other.

Learning and exploration are linked with knowledge, improvement, and feedback. Highlighting the importance of learning and knowledge management, it is indicated that while focusing on internal capabilities of a company, skills must be seen as a priority, and employees skills should be strengthened through provision of training.

Generating a positive reputation will occur where the construction companies do not make spurious claims against from the clients. It is noted that these companies can survive even in difficult economic times due to the trust engendered by them.

Further efficiency and effectiveness measures can be seen in Appendix 3.

4.9 Main Construction Project Stages

A typical construction project is unique; however, processes are generally similar, and have been named in various ways by researchers who have approached the subject at different levels of depth, using names such as feasibility, pre-project stage, pre-design stage, project initiation stage and pre-project planning stage (Haponava & Al-Jibouri, 2009). According to Higham & Fortune (2010) the first stage has vital impact on success of construction project. Despite this variance in naming, there is agreement that in order to achieve project stakeholders' expectations, monitoring, and PMSs are essential for each stage (Haponava & Al-Jibouri, 2009).

According to literature reviews of the construction project lifecycle conducted by Haponava et al (2012), Kaare & Koppel (2012), Willis & Rankin (2011), Haponava et al (2001), Popov et al (2010), and Fleming (2009), the construction project progress is divided into various stages and thereby sub-stages. Fleming (2009) stated that usually the construction project begins with the planning and design stage including environmental investigation, funding acquisition, and conceptual design. Then the construction, tendering/bidding, and award sub-stages. The commissioning stage is at the end of the construction phase and is followed by final stage of operation.

According to Lim & Mohamed (1999) construction projects are undertaken in seven complex phases: initiating, planning, financing, designing, approving, implementing and completion. Each stage has success factors and PMs known as the life cycle. For Delgado-Hernandeza & Aspinwalla (2005), there are five stages in a construction project: briefing, designing, tendering, construction, and commissioning. However, they may vary depending on attributes and proposed activities for each project. A performance measurement framework was developed that consisted of three stages, then these stages have sub stages according to objectives and the desired work to carried out during each of them (Haponava & Al-Jibouri, 2012).

Haponava et al (2012) defined a project lifecycle that is classified and divided into stages and sub-stages according to several factors and parameters. These take into consideration objectives and sequences of activities and work needed to deliver each stage, as well as PMs, CSFs, PMs, and stakeholders' perspectives dependent on relationships (Takim & Akintoye, 2002). Haponava et al (2001) stated the concept of dividing construction projects into stages is deemed a cornerstone in the design of performance metrics. According to Haponava (2009) achieving construction project activities rely on identifying project stages and sub-stages. During these stages, it is essential to evolve the processes and sub-processes in order to determine KPIs (Willis & Rankin, 2011). Construction project performance data collected from the lifecycle stages is utilised by performance measurement metrics.

Assundani & Klooenborg (2008) divided construction projects into several stages in the project lifetime, starting with project initiation and ending with project close down. Lim & Mohamed (1999) noted that construction projects are practiced in seven complex phases: initiating, planning, financing, designing, approving, implementing, and completing a project. This is known as the project life cycle. Project construction has two essential phases which are the preparation stage including project plans and design, and the execution stage which includes the implementation process (Haponava & Al-Jibouri, 2009). Yang & Peng (2008) indicate that construction projects consist of a main stage and as well sub-stages. The first stage includes financial analysis, formulation of the preliminary budget, scheduling, feasibility study report, etc. The second stage is design featuring management and coordination of the progress of the design, tendering strategy, etc. The third stage is tendering featuring tender documentation preparation, evaluation of tenders, etc. The fourth stage is construction featuring interface of various work items, schedule and quality control, change orders, etc. The last stage is implementation, which includes maintenance or operational manuals, acceptance and transfer of the project, etc.

According to the KPIs Report for the UK Minister for Construction (2000), five stages were identified to define the KPIs across the project lifecycle. The five stages start with the commitment to invest as the point determining the launch of the planning and design process, and then the commitment to construct as the start of the construction project. The next stage follows the construction stage, and is where project is ready for use. The end of the defect liability period is the penultimate stage, and the last stage is the end of the project lifetime.

Identifying and characterising construction project stages is necessary to developed CSFs and PMs that are based on objectives and desired outputs and outcomes of each project stages (Kulatunga et al. 2011). Accordingly, critical successes and measures are derived during earlier stages as early planning in a construction project is crucial to achieve its success (Kulatunga et al. 2011). Significant decisions undertaken during the construction or operation period often cannot be made without significant impact on the process, project time and project cost. Thus, it is necessary to undertake performance control and monitoring processes in the early stages of a project. Experts consider that decisions taken in the early stages of a project have a greater impact on project success than on the project in later stages (Haponava & Al-Jibouri, 2009).

According to Haponava & Al-Jibouri (2009), the first stage is divided into to three basic phases of planning, design and, tendering and award phases. Each of these phases is divided to sub-phases. Takim & Akintoye (2002) presented a framework to measure construction projects across three stages of procurement, process, and close out. It is provides data to judge performance at each stage and as well as overall success. Later, Takim et al., (2003) proposed PMSs to measure public construction projects in different stages such as strategy formulation stage, procurement stage, implementation stage, and project completion stage, where success factors and measures variables could be taken throughout these stages. To identify construction project stages, scholars conducted several studies which are summarised and classified in Appendix 4. Each phase is given different names according to its aim, works and attributes.

4.10 Conclusion

Researchers unanimous agree and have a consensus regarding the significance of the construction sector and its influence on the economies of countries despite its unstable and uncertain nature (Toor & Ogunlana, 2009). Research undertaken in the construction sector have concluded that poor performance is as a consequence of concentrating on desired goals instead of processes that lead to achieve these goals successfully. PMSs are applied in the construction industry as a method for measuring the success of a construction project (Edwards & Thomas, 2005) with the main intentions being the provision of accountability, optimisation performance, and determining expenditures (Bracegirdle, 2003). However, Many previous studies that focused on performance in the construction sector concluded that there is poor performance with regards to achieving goals and the expectations of stakeholders. In recent years, the concept has shifted from merely product-oriented to process-based (Haponava & Al-Jibouri, 2010).

The need for measuring performance in construction projects has led to the evolution various aspects of a typical construction project. Within different types of KPIs, shortcomings have persisted related to time, cost. and quality; however, by following a process approach and focussing on multiple project stakeholders, their usage and promotion in the industry needs to be continued (Edwards & Thomas, 2005). Indeed, from the review of the literature, it can be found that very few performance indicators are process-oriented, which therefore necessitated their further study and attempts at developing process-based PMS. Therefore, it is recommended to measure the process of execution and the outcomes as well (Edwards & Thomas, 2005).

5. CHAPTER FIVE: CURRENT CONSTRUCTION PRACTICE IN SAUDI ARABIA

5.1 Introduction

Saudi Arabia was founded in the west of the Asian continent in 1932, and has an area of 2,149,690 km^2. According to the 2010 census the Kingdom's population was estimated to be approximately 28.7 million. The Saudi Kingdom consists of 13 regions each with an allocated municipality (Amana); each of them is divided into provinces, which have small municipalities. In SA, despite the importance of construction industry and its impact on the growth of other industries and national income, it has not been studied adequately and there is an obvious lack of research (Abd Elshakour, et al. 2012). The government of SA is heavily committed to expanding the volume of infrastructure within the country mainly to diversify the economy away from its heavy reliance on oil. Therefore, it is important that the infrastructure put in place by the government are able to achieve their aim of satisfying the needs of specific stakeholder's needs of the government of SA and the citizenry, especially regarding raising the quality of life in the country (Eriksson, 2013).

It is already established that the construction industry is a vital component of the national economy (Othman, et al. 2006). Saudi Arabia is a developing country and like other developing economies experiences weaknesses in the provision of services to citizens in terms of effectiveness and efficiency. This weakness is also experienced in the government and construction sectors. However, construction projects by the government, municipalities, and the private sector in SA face enormous problems that result from the absence of PMSs and benchmarking (Al-Otaibi & Price, 2009). As construction projects are the main driver behind national development, their performance needs improvement. It is on this basis that this research is being undertaken with specific reference to SA.

Public construction projects in SA represent the core of the construction sector with projects such as public buildings, roads, bridges, water engineering infrastructure, domestic and recreational facilities (Al Shaikh & Chahine, 2010). However, the Saudi construction sector is experiencing high growth and development in comparison to developed countries. As a result of a lack of understanding of participants in the work environment in terms of society, culture, climate, government legislation and roles, as well as the weakness in the understanding of the project conditions in various stages including study, design, implementation or operating phase, the construction sector has been negatively affected and weaknesses have appeared in the performance with delays in the delivery of projects, overruns in cost and in poor quality (Assaf, & Al-Hejji, 2006).

5.2 Saudi Arabian Economy

The Saudi economy is heavily dependent on oil revenue, which represent approximately 80% of the state budget (Al Shaikh & Chahine, 2010). As a consequence of the economic boom resulting from the increase in oil prices, there has been a steady increase in city population which in turn has led to increased demand for construction projects, especially infrastructure which delivered by the Ministry of Municipal and Rural Affairs. The Saudi government has created its Five Year Plan for national development, which in turn has been divided into an annual allocation of development projects (Al-Khalil & Al-Ghafly, 1999b).

The Saudi economy is deemed one of the most significant in the developing countries of the world (Mitra & Tan, 2013). The construction industry in SA is still under development and growth compared to developed countries, and this growth in the Saudi economy is a result of the increase in global demand for oil, which has caused prices to increase rapidly and, thus, increase the annual revenue of the state. The construction sector has also been impacted by this economic growth (Mitra & Tan, 2013). Thus, it is deemed to be the backbone and main driver of the other economic sectors in many countries, whether developed or developing (Aibinu & Jagboro, 2002). In SA, it represents 6-10% of GDP in one estimate (Wibowo, 2009), or 6.4% of GDP in another estimate (Al Shaikh & Chahine, 2010).

5.3 Saudi Construction Industry

SA has experienced a large construction boom since oil was discovered in the 1970s (Al-Sedairy, 2001). This boom in the construction market and the acceleration in the demand for construction projects both in the public or private sector, must be accompanied by a parallel development in technical and logistical support including the development of regulations and legislation, training, design, strategic plans, performance management systems, performance measurement frameworks, and benchmarking, as well as identifying the success criteria and CSFs (Ahcom, 2004). However, the construction industry is suffering from the absence of a system or a framework for measuring and evaluating the performance of projects in the public and private sector (Al-Otaibi & Price, 2009).

5.3.1 Saudi Construction Projects Value

Sugiharto et al. (2002) emphasised that construction projects play a crucial role in the development of a country's economy and their national plans; in addition, the government sector represents the largest client for the construction projects. ,In addition, the fact that there is sharply increase in the number of the population which leads to increases the demand for infrastructure across country have led to a significant expansion in the construction sector (Al-Otaibi & Price, 2009).

Consequently, public construction projects in SA represent the core of the construction sector due to the severe shortage of infrastructure, and the majority of these projects are owned by the government sector such as buildings, roads, infrastructure, bridges, dams, utilities, and residential and sports facilities. This boom in the number of projects has attracted architectural, construction, and consultant companies to the construction market in SA. The majority of these companies are multinational and totally based on foreign teamwork and labour (Al-Shaikh and Chahine, 2010).

The total expenditure in the Saudi construction sector in 2008, measured by the level of gross fixed capital formation (GFCF) was estimated by 5.8% to US$40 billion. In 2010, the Saudi construction industry grew to US$50 billion. The value of government expenditures on infrastructure projects which had been implemented between 2005 and 2010 was US$220 billion. However, this growth will maintain and continue averaging around 4% until 2015. Hence it is expected that the construction industry will continue its growth to reach US$420 billion between 2011 till 2015 (Al Shaikh & Chahine, 2010).

The Saudi construction sector contributes approximately 34% of the non-oil national income (Al Shaikh & Chahine, 2010). Research and Markets (2011) noted that it is expected that there will be an annual growth rate of 4% from 2011-2015 as can be seen in Table 5-1. Thus, the Ninth Five Year Plan was started in 2010, increasing demand on infrastructure and construction projects and creating a rapid and significant expansion in the construction industry (Al-Otaibi & Price, 2009).

Table 5-1: Construction industry growth in SA (Research and Markets, 2011)

	2011	2012	2013f	2014f	2015f	2016f	2017f	2018f
Construction industry value, US$bn	23.12	25.45	27.93	30.34	32.45	34.67	37.07	39.66
Construction industry, real growth, % y-o-y	4.14	4.07	4.22	4.13	3.46	3.85	3.92	3.98
Construction industry % of GDP	4.87	4.92	4.93	5.03	5.08	5.14	5.22	5.28
Total capital investment US$bn	127	142.9	160.1	170.3	180.2	190.2	200.8	211.9

f = *BMI forecasts*

5.3.2 Procurement System for Municipal Construction Project

In Saudi Arabia, public projects have been delivered as part of national development plans to develop basic infrastructure in the municipalities (Al-Khalil & Al-Ghafly, 1999b). Open competition procurement method is a common way to deliver new public projects; however, the lowest construction cost criterion is applied to appointed contractors in municipalities (Al-Sedairy, 2001). Public project accreditation in SA is implemented according to plans in place and compliant with strategic plans. However, approval of these public projects by the Ministry of Finance depends on the rationale and need to deliver these projects. It is added that the success or failure of the region to get their projects backed it is required to convince that the Ministry of Finance. Procedures for requesting any new public construction project is initiated at the request of the national government. This request includes estimated cost, justification for the need, and a project brief (Alsapan et al. 2012).

According to Alsapan et al (2012) the current practise of procurement in SA is divided into two types. The first is “design and construct” and second is simply “construct”. A project’s design is introduced as a separate contract; however, the construction project stage is started as a new contract. Both are conducted in the same structure; however, the first type includes design step as part of contractors’ responsibility in construction stage; whereas, the second type is applicable for already designed projects. The Saudi construction procurement approach used to deliver municipal construction projects can be seen in Figure 5-1.

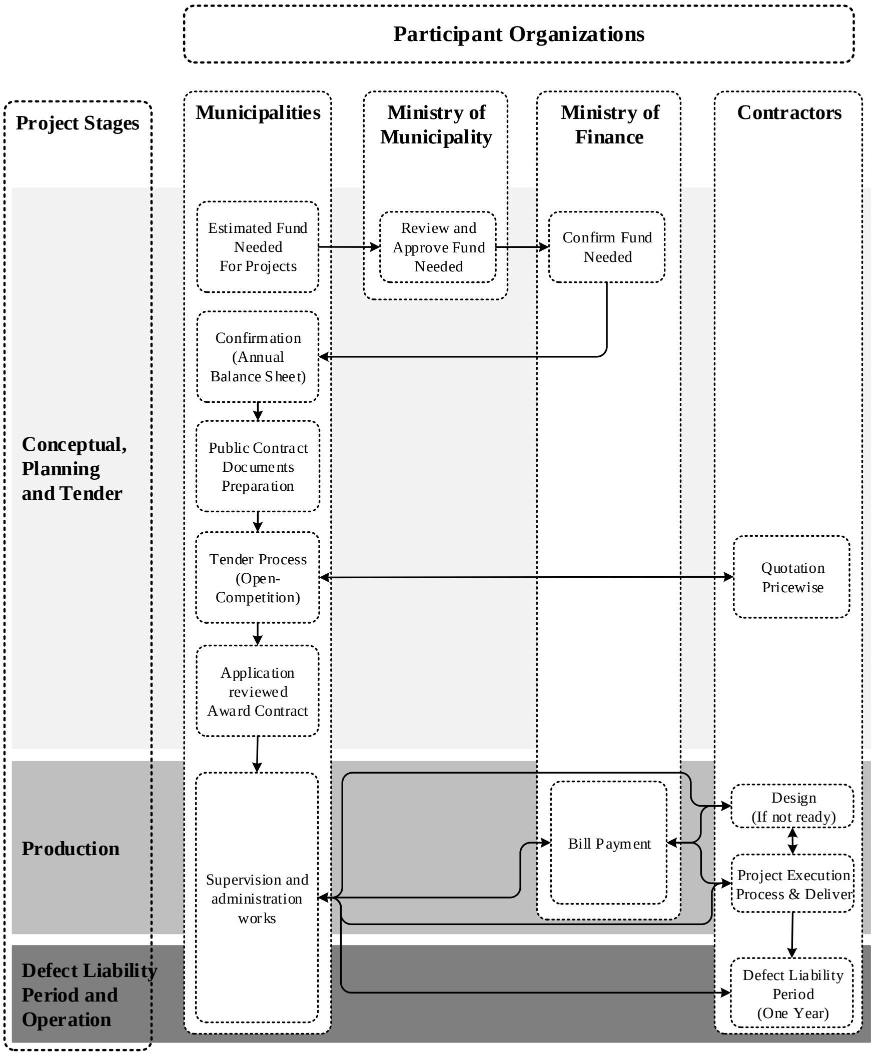

Figure 5-1: Municipal construction procurement approach (Alsapan et al. 2012)

Delivering public construction projects consists of thirteen steps across three project stages, eleven in conceptual, planning and tender stage, two in the construction stage, and one in the operation stage. The first stage involves identifying needs by integrating the municipal council's plan with national development plans; identifying the projects' site; developing a project brief; estimating the funds needed for the proposed project; reviewing and approving the estimated funds needed by Ministry of Municipalities; confirming the funds needed by Ministry of Finance; having the confirmation (Annual Balance Sheet) provided to the municipality; preparing proper public contract documents and bills of quantities, specifications, and technical conditions; starting the tendering process (open competition); and then reviewing the tenders and awarding the contract.

The second stage consists of three steps: design if not already done, project execution, and hand over of the project. Operation is last stage.

The practise of a systemic and comprehensive procurement approach is an essential factor in the success of public construction projects (Eriksson & Westerberg, 2011). Therefore, Alsapan et al (2012) states there is an urgent need to restructure the tendering requirements including tendering periods of time, contractors pre-qualifications, tendering documents, and the criteria of contractor selection.

The problems of traditional public projects have serious effects that could cause financial problems, delays, and reduced quality in the execution of such projects (Jacobson & Choi, 2008). One of the biggest problems in public works is that they are invariably won by the lowest bidder. In tendering projects for governments, the lowest bidding contractor is often selected prior to the completion of the design documents. As a consequence, there is often no coordination or cooperation between the contractors, the party of execution, and the architect of the design. Further to this, most public works have no significant integration between these levels, so the original vision is often lost in execution (Jacobson & Choi, 2008).

The common practice of governments awarding the tender to the lowest price without taking into account the qualifications and capabilities of the contractors has resulted in selecting unqualified contractors, which increases the likelihood of poor performance of the project (Wamuziri & Seywright, 2005). There are many negative aspects of the practice of accepting the lowest offer, such as delays, absence of trust and effective communication, each party having his own targets, and the negative effect of taking actions.

5.3.3 Weakness Aspects in Saudi Construction Market

The Saudi construction sector is suffering from the absence of a framework for measuring and evaluating the performance of projects in the public and private sector (Al-Otaibi & Price, 2009). In this respect, it is concluded by Mitra & Tan (2013) that weaknesses of construction projects in SA are due to a lack of skills, manpower productivity, lack of control by project managers, shortage of labour, poor planning and approval control, changes in design, poor control and owner payment delays, and cash flow problems.

Failure in the construction industry vary in cause from project to project and dependent upon the attributes of the projects (Al-Barrak, 2004). An alternative view of the causes of failures in the Saudi construction industry suggests the factors leading to poor performance are grouped in four main categories, which are: financial factors, managerial factors, expansion factors and environmental factors. According to Sugiharto et al (2002) the World Bank report stated that construction projects in developing countries suffer for several issues, including “equipment shortages, inefficiencies in using materials, imbalances in organisational structure, unfair competition, limited funds, planning uncertainties and a lack of human resource development”.

One of the most significant problems facing the progress of construction projects in developing countries is the lack of consideration and planning of projects in the pre-implementation stage, as well as failure of projects during their execution. As a result, the desired goals are neither achieved nor integrated with the general developmental or economic strategy in the country (Al-Hammad, 1995). Whilst there is also a lack of methods and mechanisms to monitor and control projects, as is the case in developed countries, some research has been done in developed countries regarding how to control and measure the performance of construction projects in the public and private sectors (Haponava & Al-Jibouri, 2009).

Majority of public construction projects that failed to be delivered on time represented 30% of the total projects (Sambasivan & Soon, 2006). These failures were as a consequence of 56 causes which have been identified, amongst which include: design problems, delay in execution, change orders and designs, payment issues, cash flows to the contractor, the relationship between stakeholders, and delays in the decision-making. The significant factors for the poor performance and delays are cash flow, relationships between parties, delays in decision-making, inadequate execution of plans and schedules, design issues, bureaucracy, and unqualified teamwork (Assaf, & Al-Hejji, 2006). According to Alsuliman, Graeme, and Chen, (2012) showed that the construction industry in SA suffered from poor performance.

Construction project management in SA is experiencing problems inherent in the projects’ environment, thus project delivery is often in the absence of basic success criteria, which are time, cost and quality (Assaf, & Al-Hejji, 2006). This failure in the lack of project success criteria is largely due to several factors, including such as financial obstacles, late decisions, difficulties and delay in receiving permeation to work and poor communication and coordination between parties. The regulations and roles of tendering in public authorities in SA have not included qualitative and per-quantitative criteria (Al-Khalil & Al-Ghafly, 1999b).

Al-Barrak, (2004) showed that poor and insufficient planning is responsible for construction delays in the SA, such practice often causes more obstacles in planning and management, more cost, obstructions in execution of the project and an absence of coordination (Jacobson & Choi, 2008). According to Al-Hammad, (1995) the construction industry in the KSA have revealed that there are problems in the performance of construction projects and this is due to several reasons, which are divided in four main groups and subcategories namely: insufficient contract standardisation and specification, financial issues, lack of site management and supervision, and unqualified teamwork. This can be seen in Table 5-2.

Table 5-2: Construction performance problems (Al-Hammad, 1995)

Group	Factors
Insufficient contract, standardization and specification	Lack of accuracy in specification and standards, Inappropriate criteria and processes for pre-selection contractors, Unspecified labour skills in contract, Lack of penalty clause in contract, Slowness of contractor performance and owner approval.
Financial issues	Inappropriate schedule of payment, Owners' low budget for building, Performance of external work by labourers, Insufficient labourer food support by contractor, Lack of cost indexes used by owners for cost estimation, Inaccurate estimation of costs by contractors, loading unnecessarily on the contractor, Lack of proper information between owners' building and financial departments.
Lack of site management and supervision	Lack of direct supervision by contractor, Lack of direct supervision by owner, Underestimation of leadership and supervision, Insufficient communication between contractor and supervision
Unqualified teamwork	Inappropriate selection of teamwork and labourer by contractors, Familiarity of teamwork with modern technology, Lack of communication between contractor, owner and teamwork, Labourers' illiteracy, Contractors overestimation of teamwork's capabilities, Contractors' lack of knowledge of local climatic and environmental factors, Lack of training program for team, Lack of team incentive, Insufficient team loyalty, Contractor unawareness of owner complaints about team abilities, Long distance from worksite to team accommodation.

Failure in the construction industry varies in cause from project to project dependent upon the attributes of the projects. An alternative view of the causes of failures in the Saudi construction industry suggests the factors leading to poor performance were grouped in four main categories these are: financial factors, managerial factors, expansion factors and environmental factors (Jadid, 2013). These can be seen in Table *5-3*.

Table 5-3: Causes of failures in Saudi construction industry (Jadid, 2013)

Main factor	Causes
Managerial Causes	Lack of Experience in the line of Work, Replace Key Personnel, Assigning Project Leader in the Site, Labour Productivity and Improvement, Bad Decisions in Regulating Company Policy, Use of Project Management Techniques, Company Organization, Procurement practices, Claims, Internal company problems, Recruitment from one country, Recruiting multi-nationality, Owner's absence from the company, Using computer applications, Frauds, and Neglect.
Financial Causes	National slump in the economy, Construction industry regulation in SA, Owner involvement in construction phase, and Bad weather.
Expansion Causes	Expanding into new geographic locations, Opening a regional office, Increased number of projects, Increased size of projects, Change the type of the work, Lack of managerial maturity, and Change from private to public or vice versa.
Environmental Causes	Low margin profit due to competition, Cash flow management, Bill and collecting effectively, Poor estimation practices, Evaluate project profit in one fiscal year, Employee benefits and compensations, and Controlling equipment cost and usage.

5.4 Conclusion

Despite the continued large investment and growth in the Saudi construction sector, it is being hampered by a lack of functional PMSs. If such were implemented on a wide scale, then many of the causes of failures in the Saudi construction industry could be eliminated or significantly reduced. The study by Abd Elshakour et al (2012) showed that business efficiency and effectiveness measures are considered as significant in PMSs. Further, public construction projects are facing real problems regarding performance, and where earlier studies have also shown that more than a third of government projects in SA were delayed (Al-Khalil & Al-Ghafly, 1999a). However, in introducing such a system, there will be significant cultural and historical obstacles to overcome for such a system to be accepted. Chapter six will describe the research methods which are applied to achieve aim and objectives of this research.

6. CHAPTER SIX: RESEARCH METHODS FOR STUDY

6.1 Introduction

Humanity has acquired scientific knowledge through different modes of study. Empirical research, often through trial and error, has historically been the most fundamental and effective approach to the formation of new learning. However, the cost of error can be high and the number of trials required can be prohibitive. As intelligent beings, humans have developed inference and reasoning that has evolved over time to become an essential part of the process for acquiring new knowledge. Theoretical logic, abstract thinking, and reflection are relevant techniques for opening future avenues of practice and success. Research has become the universal approach to investigate, plan, experiment, implement, monitor and evaluate the different realms of human understanding. Developments in research are ever advancing and have become ever more complex and organised in methodological fashions that ensure the success of the proposed programs. This chapter will outlines and highlight research philosophy, logic, approaches, data, collection methods, and data analysis procedure.

6.2 Research philosophy

In layman's terms, research means the search for knowledge. According to Williams (2007), research is sometimes erroneously regarded as the gathering information, documenting of facts, and rummaging through previously collected data for information. Contrary to this opinion, research is the process of collecting, analyzing, and interpreting data in order to understand a phenomenon (Leedy & Omrod, 2005). The research process is scientific in nature due to the fact that it follows a predetermined procedure, and is also systematic since it involves the definition of the research objective, evaluation of data collected, and writing-up the findings, all of which takes place within established frameworks and in accordance with existing guidelines (Saunders, Lewis, & Thornhill, 2009; Fellows & Liu, 2008).

These frameworks and guidelines help researchers to have an idea of what the research should contain and what is to be left out, including the type of inferences to be drawn from the evaluation of the data collected. The research process starts with asking at least one question about a specific phenomenon of interest, the research question will help a researcher to direct attention, thoughts, efforts, in deciding on the most suitable approach to answer the question and then make sense of the phenomenon of interest. To ensure that the results of the research are appreciated by others, a researcher needs to explain the philosophical approach that has been used in answering the research question which in essence helps to validate the research outcome. According to Crossan (2003), it is the nature of philosophical questions that best demonstrates the value of understanding philosophy, he concurred with Smith, (1998) that the uncomplicated style and innocent manner of questioning produces confusion and instability in humans' assumptions and ideas about the world, but that this is exactly what makes the study of philosophy of special benefit.

Crossan (2003) emphasised that the circular nature of philosophical questioning is valuable in itself since it encourages in-depth thinking, and engenders the asking of further questions in relation to the topic under question. In essence, research philosophy refers to a researcher's vision of the world and represents the foundation on which the research procedure is built. According to Saunders, et al., (2009), all research studies are underpinned by two main assumptions and undertakings, namely: ontology, and epistemology which are markedly different regarding the procedure for a research study. According to Pathirage, Amaratunga, & Haigh, (2008), epistemological undertakings, ontological assumptions and axiological purposes about the nature of the world enhances the harmonization and the formulation of research philosophy, thus influencing the choice of suitable research approach and methods.

6.2.1 Ontology

Ontology is concerned with the nature of reality, it explains 'what' knowledge is and the assumptions about reality, it basically questions the assumptions of a researcher regarding the way the world operates and the researcher's commitment to specific views (Pathirage, Amaratunga, & Haigh, 2008). Saunders, et al., (2009) identified two aspects of ontology which are objectivism and subjectivism, they explained that while objectivism portrays the position that in reality, social entities exist external to social actors that are concerned with their existence, subjectivism on the other hand posits that social phenomena are created from the perceptions and consequent actions of the social actions that are concerned with their existence. Therefore, the ontology for this research study is subjectivism since the primary data for the research is based on the perceptions and opinions of the research respondents.

6.2.2 Epistemology

Epistemology is about knowledge and its contents, Saunders, et al., (2009) referred to epistemology as concerning what constitutes acceptable knowledge in a field of study. Basically, epistemology explains the theory of knowledge and basically refers to how we know what we do, what justifies us in believing what we do, and what standards of evidence we should use in seeking truths about the world and human experience (Audi, 2005). In essence, epistemology describes 'how' the researcher knows about the reality and assumptions about how knowledge should be acquired and accepted (Pathirage, Amaratunga, & Haigh, 2008). Easterby-Smith, Thorpe, & Jackson, (2008) cautioned that not thinking through on philosophical issues that guide a research study, may not necessarily be critical, but it can gravely affect the quality of outcome of a research study, which is the main idea of research design.

Epistemological presuppositions help researchers to control the approach of their research, increases validity of the results and ensure that knowledge produced from the research process is cumulative (Girod-Seville & Perret, 2001). In order to understand the nature, value and status of scientific knowledge that can be generated through a research study, researchers can draw inspiration from the major paradigms within epistemological streams, and these are discussed below:

6.3 Research Paradigms

6.3.1 Positivism

Positivism is rationally connected to pure scientific rules and based on facts in order to satisfy the four requirements of falsifiability, logical consistency, relative explanatory power, and survival (Lundberg & Young, 2005). According to Lundberg & Young, (2005), positivism theories must conform to empirical observations but should be falsifiable, and theoretical propositions in the research must be directly connected to one another, and the theory must explicitly explain or predict competing theory, thus, a falsifiable, consistent, and explanatory theory should be able to withstand empirical tests. Positivism also aims at measuring the variables of a social phenomenon through quantification, and it strongly maintains that methodological procedures of natural sciences are adaptable to social sciences (Bell, 1993). Girod-Seville & Perret (2001) supported this argument and posited that the positivist paradigm portrays humans and physical matter as amply similar which lends them to similar measurement techniques. This may therefore explain why the positivist paradigm finds it rather convenient to approach research problems by following the three-step procedure of diagnosis, design, and change (Jonker & Pennink, 2010).

Further, Scandura & Williams (2000) explained that the positivist researcher always tries to achieve research objectives by testing theory, with the purpose of increasing the predictive understanding of specific phenomena. Saunders et al., (2009) agreed with this explanation and highlighted that only observable facts that have been developed based on a hypothesis that was drawn relying on the principles of a current theory will lead to credible research results. Based on these explanations, the positivist paradigm can be regarded as an ideology that regards only research outcomes that rely on plausible and identifiable scientific procedures. In spite of its popularity, Kura & Sulaimon, (2012) highlighted that positivism has some weaknesses which weaken its relevance in the field of social science. The most notable weakness they identified is that it over simplifies the real world into experimental situations that is difficult to apply in reality.

6.3.2 Interpretivism

The paradigm of interpretivism lays emphasis on the examination of text to determine entrenched meanings, especially regarding how people use language and symbols to define and construct social practices in order to understand people's actions and behaviours (Balarabe Kura, 2012). Hussey & Hussey (1997) explained that interpretivism draws upon concepts that positivists ignore such as self "consciousness," "freedom of choice," and meanings. From the interpretivism perspective, world is interpreted through trends and through the logic of situations, and not the laws of social reality, since it is easier to understand people's perceptions which can be used to explain their behaviours by conducting a detailed, qualitative study in pursuit of knowledge (Kaplan & Maxwell, 1994). This means that intepretivists try to appreciate knowledge based on social reality from the perspective of detailed understanding and interpretation of meaning of events and specific life experiences (Balarabe Kura, 2012). Anderson et al., (1994) also highlighted that interpretivist research focuses on the full complexity of human sense making as the situation emerges, and does not predefine dependent and independent variables.

According to Kura & Sulaimon, (2012), interpretivism uses research methods such as participant and non-participant observation to understand facts of interaction within their context. They also believe that social reality is based on subjective interpretation of actions, and positivists have failed in this area of representing the relationship between the researcher and the phenomenon being researched, since they deal with objects that are external to the researcher. Interpretivist paradigm has been criticised in terms of difficulties arising in establishing validity, reliability, and generalisations in social research, and there are also concerns about the researcher's intrusion in the lives of the participants as the interpretation, which rests within the researcher, could be biased (Weber, 2004). However, intepretivists have argued that interpretations are part of scientific knowledge in their own right, although interpretation of reality depends upon the researcher (Balarabe Kura, 2012). Although they emphasise meaning and interpretation of reality through understanding of behaviours and experiences of people, they tend to overlook the influence of natural environment on their subjects and research (Kaplan & Maxwell, 1994).

6.3.3 Epistemological Orientation of the Current Research

Construction management research is situated at the intersection of natural and social science, and while natural science studies events consisting of a sequence of facts that are independent of human perception, social science on the other hand depends on human perception (Love, Holt, & Li, 2002). This study is a mixture of both natural science and social science in that while it studies performance measurement within the Saudi Arabian construction industry from a social science perspective based on the perceptions and opinions of the research respondents, the analysis of the data collected for the study is based on natural science studies. A review of the field of construction management reveals that two main methodologies dominate research studies, and these are the positivist and interpretivist paradigms (Dainty, 2008; Love, Holt, & Li, 2002). This current research also follows the industry trend, while the data collection and analysis takes on a positivist perspective, the research data explication takes on an explanatory research approach.

This can be seen from Figure 6-1 which highlights the research philosophy, strategy and process which underpins the research. The study follows a well-defined structure influenced by the positivist approach to research studies; the researcher has followed the set laws and rules that are underpinned by this approach. The research study started with the definition of research objectives that are based on the research questions, and from this the research hypothesis were drawn. The study then applied a phased approach towards conducting the study starting with a review of relevant literature, development of the conceptual framework, design of questionnaires, and pilot administration of the questionnaires all of which fall within the first phase.

The second phase consists of the data collection, while the analysis of data collected and the results were presented in third phase. In the fourth phase the resulting model from the data analysis is presented as well as the conclusions and recommendations. From the foregoing, the overriding paradigm of this research study is the positivist paradigm since it involved the testing of hypothesis that was developed from existing theory and it involved the measurement of observable social realities which exists objectively and externally to the researcher (Easterby-Smith, Thorpe, & Jackson, 2008). A theoretical model was also developed which can be used to explain cause and effect relationships, and can also be used to predict outcomes.

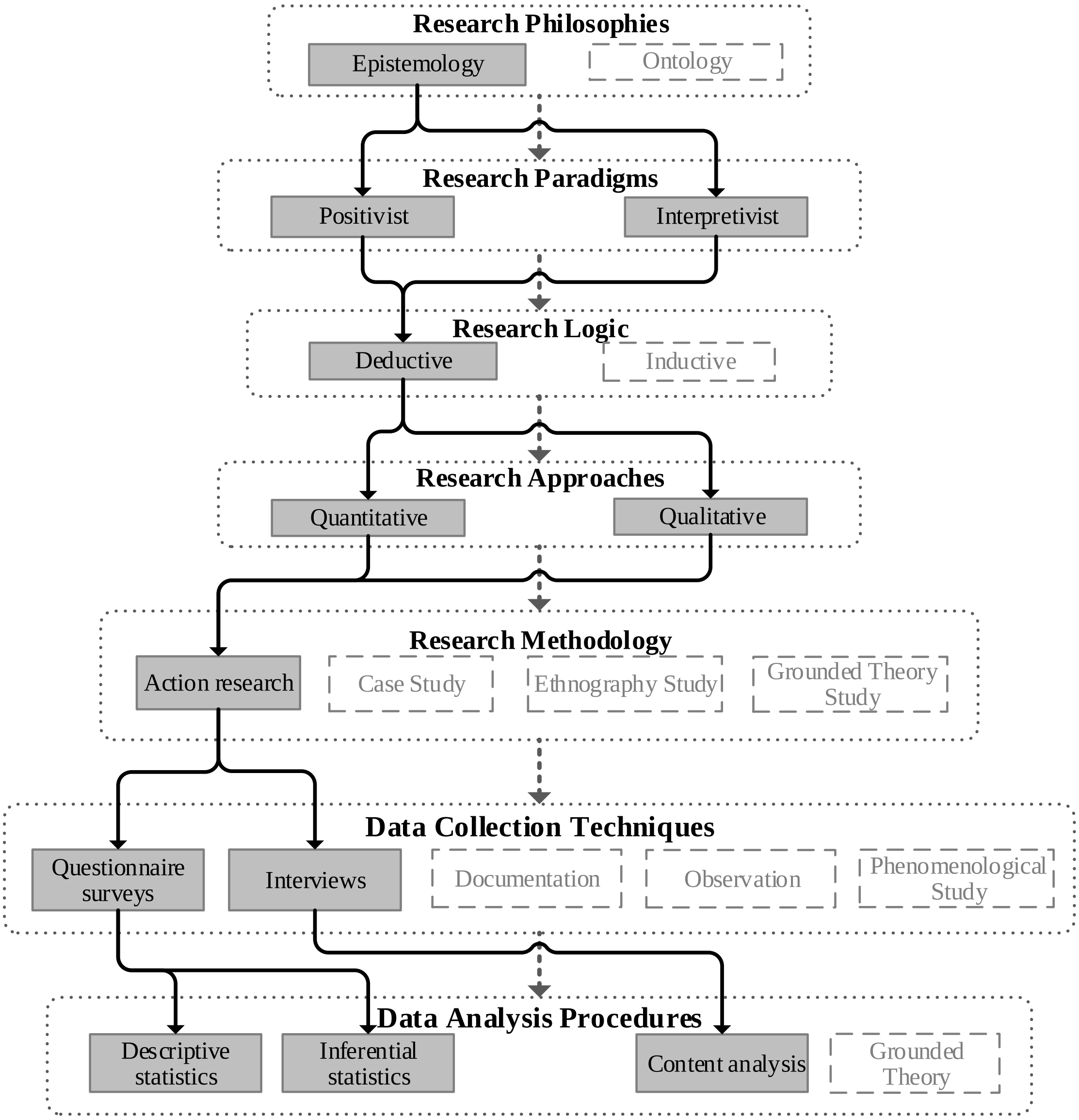

Figure 6-1: Research strategy philosophies and process (Alkraiji, 2011)

6.4 Research Logic

Research logic refers to the two broad methods of reasoning in research, and these are the deductive and inductive approaches (Dainty, 2008; Love, Holt, & Li, 2002). They are two separate methods of reasoning which have very different conceptual approaches to them when conducting research, and are discussed in turn based on the conceptual framework in Figure 6-2.

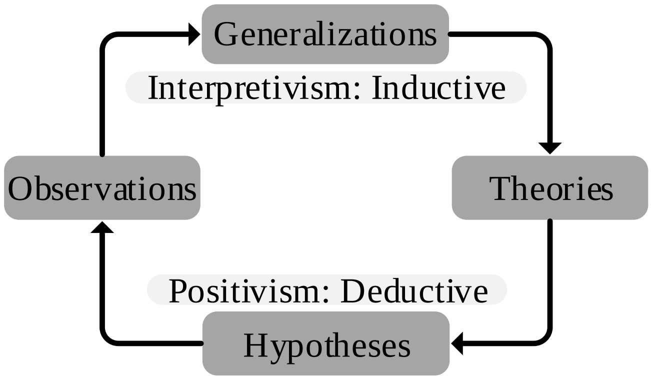

Figure 6-2: Deductive vs. Inductive Logic

6.4.1 Deductive Approach

Deductive research approach works from the more general to the specific, it tends to proceed from theory to data (theory, method, data, findings), usually referred to as top-down approach (Balarabe Kura, 2012). Specifically, it involves the formulation of hypothesis based on existing theory, and then designing a research strategy to test the hypothesis (Wilson & Chaddha, 2010). Monette et al., (2005) explained that deductive research approach works by means of hypotheses which can be derived from the suggestion of theory, which means that it involves deducing conclusions from propositions. According to Collis and Hussey (2003), the deductive research approach is the dominant approach in the natural sciences in which laws remain the basis of explanation, permits the anticipation of phenomena, predicts their occurrence and therefore permits them to be controlled. Accordingly, Robson (2011) introduces the procedure through which deductive research can be implemented:

- Deducing a hypothesis from the theory
- Expressing the hypothesis in operational terms
- Testing the operational hypothesis
- Examining the specific outcome of the inquiry
- If necessary, modifying the theory

6.4.2 Inductive Approach

The inductive approach refers to the procedure in which theory would follow the data (in sequence from theory to method, to data and finally to findings) rather than vice versa as with deduction. According to Collis & Hussey (2009), the inductive research approach builds theory by collecting qualitative data from personal interviews with the aim of understanding what is happening within a particular circumstance. They explained further that the researcher relies on the data that has been collected such as personal interviews to build theory with the aim of understanding what is happening within a particular circumstance. Basically, the inductive approach involces sense making from a research data, and the result of thi process would be the formulation of a theory Saunders et al., (2009)

The approach followed in this research study is consistent with the deductive research approach; this is because the research approach aligns with the positivist paradigm which supports a scientific approach to managing a research study, this paradigm aligns with the deductive approach. Following Gill & Johnson's (2002) explanation that learning involves reflecting upon specific past 0experiences and through the development of conceptual and theoretical concepts, this research was implemented based on the theoretical study started with the theoretical concept that ***"You cannot measure what you do not define"*** (Fink, 2006, p. 85), ***"If you cannot measure it, you cannot manage it"*** Peter Drucker as cited by (Behn, 2005, p. 1), consequently, ***"If you cannot measure it, you cannot improve it***" this is a quote from Lord Kelvin (Kelvin, 2013). These concept are advances with an underpinning research design which follow the process of from literature review, preliminary data collection, the main survey, data analysis, and the development of a framework for measuring the performance of construction projects in SA at any stage according to stakeholders' needs.

The research started with problem definition and theory that there is a lack of methods and mechanisms for monitoring and controlling construction projects in the SA and this is one of the factors responsible for construction project management failure in the country. This was followed by the development of hypotheses which are aimed at developing a framework within which the performance of municipal construction projects in SA can be measured at any stage of the project. Data was then collected to test the hypothesis, and the results were analysed using the Analysis of Variance (ANOVA), the t-test, and the Chi-square test with the aid of the SPSS statistical software V20. The result was used to develop a performance measurement framework, which was validated using the interview approach. This process is necessary in order to improve performance and increase effectiveness and efficiency of construction projects to the satisfaction of citizens and all other stakeholders. The specific procedure followed in conducting this study is shown in Figure 6-3.

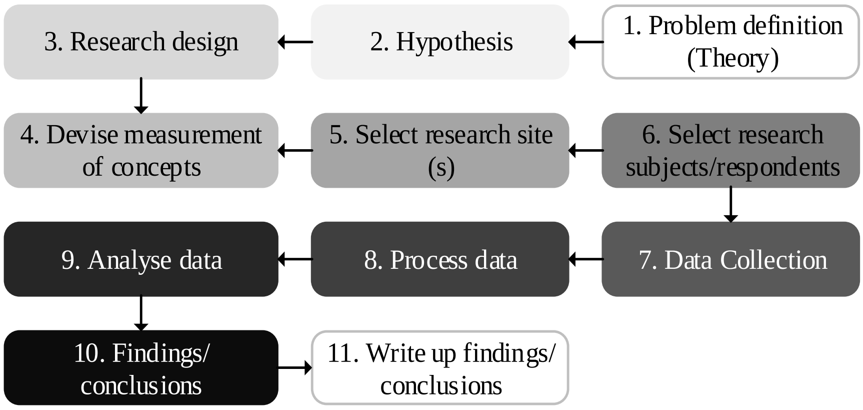

Figure 6-3: Deductive approach procedure

6.4.3 Research theory

The depth of the theoretical base which underpins a research discipline underscores the maturity level achieved by scholars within the area of research. According to Betts & Lansley (1993), one of the characteristics of a mature discipline is the presence of a sound theoretical base. Previous researchers have made several efforts to define theory, and this has resulted in its description in several diverse ways which is based on different philosophical stances. From a general perspective, according to Sutherland (1975) theory can be described as "an ordered set of assertions about a generic behaviour or structure assumed to hold throughout a significantly broad range of specific instances". Also Gill and Johnson (2002) define theory as a network of suppositions advanced to enhance the conceptualisation and explanation of a specific social or natural phenomenon. From this perspective, it can be inferred that the hypotheses are drawn to highlight a contention regarding the connections existing between two or more concepts using an explanatory method. Concepts represent the structuring of theories and hypotheses presented in the form of theoretical ideas used to organize items with one or more common properties. , often theory is described as a model, framework, and collection of propositions or hypotheses for explanation and understanding a phenomenon (Pathirage, Amaratunga, & Haigh, 2008).

This research study has been implemented based on the theoretical perspective of the maxim ***"You cannot measure what you do not define"*** (Fink, 2006, p. 85), ***"If you cannot measure it, you cannot manage it"*** attributed to Peter Drucker whose work influenced the organisation of humans in business environment as well as early business thinking as cited by (Behn, 2005, p. 1), consequently, ***"If you cannot measure it, you cannot improve it***" as quoted from Lord Kelvin as cited by (Stattina & Loeb, 2014, p. 703). In more details, ***"If you don't measure results, you can't tell success from failure" (evaluate); "If you can't see success, you can't reward it" (motivate); "If you can't see success, you can't learn from it" (lean); "If you can demonstrate results, you can win public support" (promote)*** (Behn, 2003, p. 600).

According to Drucker (2007), a manager must be able to correct his own performance and to achieve this objective; the manager must have an understanding that goes beyond what his own goals are, basically, a manager must be able to measure his performance and results against the present goal. Drucker (2007) explained further that to be effective, goals must be clear, simple and rational, they must also be relevant, and direct attention and efforts to the most important parts of the task to be performed. Hence the task to be performed must be defined and although not in strictly quantitative terms, but must contain enough information to specify desired results, this will enhance the measurement of expected results against the specified desired results.

6.4.4 Research Hypotheses

As stated previously that this research is conducted by applying deductive approach that included research theory as shown in Figure 6-2 and 6-3. Thus, the formation of hypotheses is a useful tool to define and direct study (Fellows & Liu, 2008). Establishing hypotheses that are suspected to be causes behind poor construction projects is deemed to be a fundamental approach in order to determine appropriate data collection methods and analysis. Guided by the research aims and objectives and relevant literature, hypotheses were proposed. These hypotheses were assumptions on the causes of unsatisfactory results: -

H1: Weakness of regulation and poor instructions in their application to construction projects has a negative effect on performance and outcomes.

H2: The lack of standards, specification, and data results in unsatisfactory performance and results in construction projects.

H3: Poor conditions for awarding contracts, and poor criteria for contractor selection leads to poor performance and outcomes.

H4: Inadequate planning and strategies is associated with poor performance and outcomes.

H5: Poor management skills, poor people management skills, as well as unqualified managers lead to poor performance and outcomes.

H6: The absence of a PMS (in Saudi municipal projects) leads to poor project performance and outcomes.

6.5 Research Approaches

Research approach refers to the three popular approaches to conducting research, and these are the quantitative, qualitative and the mixed method research approaches. While the qualitative method is philosophically rooted in the naturalistic paradigm, the quantitative method is rooted in positivistic paradigm, and the mixed method is a combination of both the qualitative and the quantitative methods (Newman, 1998). The three methods are discussed and their application to the researcher highlighted in the following paragraphs

6.5.1 Quantitative Approaches

Quantitative research uses statistical analysis techniques to produce numerical results from which inferences are drawn. Thomas (2003) distinguished between the two methods, but while explaining quantitative approach, he argues that measures or amounts are the parameters, and inferences are presented after having conducted statistical analysis. These methods tend to use numerical (parametric) data as a source to generate information using a definite set of statistical formulas. Such data can usually be interpreted and utilised in a clear mathematical fashion with the application of standard statistical formulae or techniques in order to describe or understand the data in question. These can include experimental studies, surveys, cohort studies and case control studies. It is worth noting that some studies, such as surveys, are capable of handling both numerical and non-numerical data depending on the statistical formula used (Knight & Ruddock, 2008).

6.5.2 Qualitative Approaches

Qualitative methods on the other hand, set out to investigate quality (non-parametric) data such as opinions, attitudes, and levels of satisfaction in order to conclude behaviour-modifying knowledge or acquire a better understanding of multi-faceted dynamics that cannot be transformed into specific numbers and figures. However, the development of investigating tools like the Likert scale provide an interface that can make certain types of qualitative data lend themselves to numerical rendering and manipulation (Woods, 2006).

Quantitative and qualitative approaches can be utilised in any research attempt, as both are effective at underpinning the issues of the research. However, the majority of researchers stress for the selection of only one. Time and cost considerations are the main problem when it comes to choosing one or the other (Thomas, 2003).

6.6 Research Strategy

There are various research stratgies with their different distinctive characteristics Saunders et al., (2009) emphasised the importance of adopting a lucid research strategy when conducting a research, and they defined research strategy as the general plan of how a researcher will go about answering the research questions. Also, Bryman (2008) referred to research strategy as a general orientation to the conduct of research. According to Saunders et al., (2009), the research strategy suitable to a research study must be chosen based on the research questions and objectives, including the extent of knowledge existing on the subject area being studied, the amount of time and resources available, as well as the philosophical underpinnings of the researcher. However, Yin (2003) adopted a different approach and suggested that a specific research strategy must be selected based on three conditions: the type of research question, the extent of control which the researcher has over actual behavioural events and the degree of focus on contemporary or historical events.

There are various different types of research strategies with distinguishing features from which a researcher may select, based on the identified criteria above. The most common research strategies in construction management research are:

- Surveys;

- Case studies;
- Action research;
- Experiments;
- Grounded theory;
- Archival research;
- Ethnographic research; and,
- Case control studies and cohort studies (Easterby-Smith, Thorpe, & Jackson, 2008; Saunders, Lewis, & Thornhill, 2009).

A research study can only apply one or more of these strategies based on the identified criteria to achieve previously established research objectives. The current research adopted a combination of the survey strategy and the action research strategy. Surveys are commonly used construction management research, and are either cross-sectional studies (obtaining data from a specific point in time) or longitudinal studies (data is generated over a period of time), looking at the available descriptors of a particular phenomenon at a particular point or period of time. Data is generated using questionnaires or interviews with a large population sample to allow a degree of confidence to generalise the results to that population (Creswell, 2009). Naoum (2007) identifies two types of surveys: descriptive and analytical. The descriptive survey is a mere summation of the numbers of respondents who share a certain attitude, opinion, or behaviour towards a particular issue. An analytical survey, on the other hand, seeks to associate a phenomenon to other independent factors, which may lead to further research to establish causal relationships between variables.

Surveys have the advantage of enabling the collection of a large body of data that can be analysed statistically to test a hypothesis, personal influence of the researcher is minimised, and large sample that represents the population allows for generalising the results (Robson, 2011). Although the survey strategy has some limitations such as Cognitive bias of the respondents, Reactivity bias, and the potential for a low response (Robson, 2011), the strategy has been adopted for this research because of its suitability for collecting large body of data that can be analysed statistically and the potential for the research result to be based on real-world situations (Kelley, Clark, Brown, & Sitzia, 2003).

This study also adopted the action research strategy. Also known as participatory research or collaborative enquiry, it is succinctly referred to as “learning by doing”, a process in which a problem is identified and individuals attempt to resolve the problem through a continuous reflective process (O'Brien, 1998). The action research strategy is an approach that is commonly used to bring about change within specific contexts (Parkin, 2009), the strategy involves systematic observations and data collection which can be used by a researcher in reflection, decision making and the development of more effective organisational strategies (Koshy, Koshy, & Waterman, 2011). On major criticism of action research is that it time-consuming and its results are not generalizable, however, since the current research study is being conducted in Saudi Arabia with the aim of developing a performance measurement framework for construction projects, this was not an issue for the researcher. (Hamilton, 1981).

6.7 Data Collection Methods

There are two major sources for collecting data for a research study; they are the primary and secondary source of data collection (Saunders, Lewis, & Thornhill, 2009).

- **Secondary research** involves collating, summarising and reviewing existing data from more than one study to formulate collective evidence from previous experience and research (Bryman A. , 2008). This type of data includes systematic reviews and meta-analysis studies. For this research, the literature review was conducted for searching the existing research and studies on concept of performance measurement systems for construction projects. Also, the current practise of this concept in Saudi Arabia in general and in municipal construction projects in particular. Literature review was targeted to identify key variables that contributed to success of research aim. As well as, investigate the relevant research work conducted and established research theories, objectives and questions, also, to determine research methods that applied in similar studies by scholars previously (Fellows and Liu 2008).
- **Primary research** is concerned with data that are yet to be collected and generates novel information about a particular problem (Bryman A. , 2008). In this current research, a semi-structured questionnaire was designed and formatted included to both open-ended and closed questions to help the respondents to express their opinion and perception regarding freely. The questionnaire was distributed to key three providers who involved in municipal construction project delivering to citizens. The

questionnaires were compressed a set of questions regarding the main factors for evaluating and measuring contractor performance.

6.7.1 Questionnaires Survey

Bulmer (2004) emphasised that questionnaires must be reliable, especially over time, and that they should give the same results if they are tested upon the same respondents at least two-thirds of the time. Czaja and Blair (2005) reported that in face-to-face surveys for a questionnaire that both the respondent and researcher need to meet at one point where the questions can be asked for the questionnaire to be completed. Respondents can receive clarifications from the researchers, and such findings might be considered more credible. It should be noted that face-to-face surveys are expensive, and can involve much coordination, travelling, and time. However, the response rates are often higher than other survey methods due to the presence of a human interviewer (although such a presence may also skew the responses, as noted previously). Furthermore, face-to-face surveys also permit more complex and open-ended questions to be asked.

Brace (2013) discussed how to design a questionnaire and noted the factors and issues related to obtaining data through market research. Gillham (2013) suggested that market research is a reliable way to start further research. Regarding questions, he maintained that open and closed questions during survey could assist the researcher to get appropriate responses. The questionnaire in this research will be designed by focusing on all the issues noted during the literature review about the issues faced by project managers, contractors, consultants, and government officials. While designing the questionnaire in this research, consideration will be given to the respondent’s understanding of: -

In order to achieve the research aims, the following objectives were set: -

- Review existing performance measurement framework being used in the construction industries and public authorities of the developed countries including the performance measurement process, project stages, project stakeholders, CSFs, and PMs and PSMs.
- Identify project stages, key participants and stakeholders involved in the delivering of municipal construction project and the relationship among them,
- Identify the procurement and execution procedures of construction projects in municipalities in SA;

- Examine the current process and approach to managing and measuring construction projects in municipalities in SA and problematic areas;
- Explore and determine the performance measurement process, CSFs, and PMs and PSMs in the implementation of municipal construction projects;
- Develop a practical and affective framework for evaluating municipal construction projects performance in SA;
- Evaluate and validate the proposed performance measurement framework through experts' opinion and perceptions; and
- Conclude result of study and recommend further investigation in the field of construction projects performance measurement and other in relation.

In order to, achieve above objectives there are some questions should be asked and answered these are;

- What are the PMSs used to assess construction project performance around the world?
- What are the processes of performance measurement for construction projects around the world?
- What are the strengths and weaknesses in current performance measurement practices?
- What are the key performers and stages in municipal construction projects in SA?
- What are the obstacles and challenges facing municipal construction projects in SA?
- What is the process of execution of construction projects in municipalities in SA?
- What methods and techniques are being used to measure construction projects performance in municipalities in SA?
- What are the processes of performance measurement for construction projects in municipalities in SA?

6.7.2 Interviews Survey

An interview technique was used for data collection for this research. Researchers can choose from a wide range of methods of collecting information from sample members. The most commonly-used techniques of data collection include face-to-face interviewing, telephone interviewing and questionnaires (Roberts, 2007). There are different formats of interviews 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.

Gubrium and Holstein (2003) proposed that interviews are widely used techniques and undoubtedly provide reliable results for research. They indicated that interviews provide empirical data by asking people questions regarding their personal profile. However they indicated that the interviewer should ask proper questions and respondents will be obliged to provide the required information. Blaxter, Hughes and Tighte (2006) described unstructured interviews as naturalistic. The interviewer can become more adept at interviewing; the researcher applies those strategies which enable interviewers to talk about the issues to a deeper level.

Creswell basically highlighted the importance of qualitative research and supported interviews to obtain quality data. Berg (2009) indicated that qualitative methodologists prefer to obtain data through interviews, and this technique dominates in social sciences. This type of research takes time to undertake and time to analyse the data. Quality interview research focuses on what, where, and when. The qualitative methodology also stresses about concepts, description of issues, and detailed explanations. (Silverman, 2010) argued that research methodology is a way which addresses the issues in social sciences.

In addition to above, Berg (2009) argued about the importance of interviews, and linked experience of interviewing in being key to getting required data. He also suggested that interview questions should be written prior to starting interviews. In this research, two interviews technique were applied semi-structured telephone interviews and semi-structured focus group interviews were mainly conducted in order to determine the level of acceptance and applicability of the framework.

6.7.2.1 Telephone interview

According to Carr & Worth (2011) stated that the first conduction to telephone interviews was for quantitative surveys, than recently it is applied to collect qualitative data. The use of this technique is determined by the practical advantages such as reduces costs and time, as well as, interviewees would answer short answers comparing with face-to-face interviews. Telephone interview is administrated by some researchers such as (Abdulghaffar, 2009; Narimah, 2008; Haimon, 1998).

It is claimed that telephone interview is considered as an appropriate data collection method for researcher. A comparing study conducted to telephone and face to face interviewing tend to conclude that telephone interviewing produces data which are at least comparable in quality to that attained by face to face data collection. The telephone interviewing has many advantages including a high response rate, the opportunity for interviewers to correct obvious misunderstanding and the possible use of prober (Carr & Worth, 2011).

The telephone interview has some advantages for both researchers and participants, it offers chance to cover wide geographical areas comparing with other methods. It offers also flexibility to the researchers in terms of time and locations. According to Musselwhite, et al. (2007) there are some of these advantages as a follow;

- Using the telephone could reduce data collection costs by 50–75%.
- Use of the telephone allows interviewers to cover a greater geographic area
- Interviews conducted by telephone may also be completed at a faster pace than those undertaken in-person.
- Safety has also been cited as an advantage of using telephone interviews to collect data

In this research there are some reasons to apply telephone interview. Frist, to collect required data must travel from UK to SA than back to UK to complete framework design seeking to introduce study questionnaire. Thus this travel certainly will consume time and money and also physical effort. Second reason, for face to face interviews in Saudi municipalities it was fundamentally travel between Saudi cities, this will therefore consumes physical effort, financial and time, due to that Saudi Arabia is a large country and divergent parties. Thus, telephone interview technique was chosen to avoid this issues to investigate some required data and ambiguities existing in the framework which would need to be clarified. The semi-structured telephone interview was used with expert managers who had long experience in municipalities such as Head of Construction Project Administration Departments, Vice Mayor of Sub-Municipalities, Deputy Mayor of Construction Projects Agency and Senior Engineer.

6.7.2.2 Focus group interview

The focus group technique of data collection has become an integral part of the qualitative research community (Barbour & Kitzinger, 1998), There are several different definitions of the focus group technique of data collection, but the most broadly used definition is that which refers to the technique as a "small gathering of individuals who have a common interest or characteristics, assembled by a moderator, who uses the group and its interactions as a way to gain information about a particular issue" (Williams & Katz, 2001, p. 2). Patton (2002) explained that unlike a series of one-on-one interviews, the participants in a focus group get to hear one another's responses and to make additional comments beyond their own original responses as they hear what other people have to say about the subject being discussed.

He explained further that the participants need not agree with one another or reach any kinds of consensus, nor is it necessary for them to disagree, since the objective is to get high quality data in a social context where people can consider their own view within the perspective of others' views. One main advantage of the focus group technique is that is makes use of a large group of people within the same group allowing for the collection of a wide range of opinions or attitudes in the form of data within a very short period, and are very effective when used in combination with other data collection methods, thus providing in-depth insights into the research study (Wall, 2001; Barrows, 2000). This is the main reason why the technique was applied and its use contributed immensely to the research study.

6.8 Data Analysis Procedure

Data analysis is an ongoing activity that helps to answer research questions and gives direction to future data collection. The analysis of data collected for this study was implemented in two main stages: analysis of the questionnaire data and analysis of the interview data. The findings of the questionnaire and interview data revealed the key outcomes regarding the key procurement process related to construction project in municipality in SA. The key process used in analysing the data emanating from the findings of the questionnaire and interviews are discussed below.

6.8.1 Descriptive Statistics

Descriptive statistics was used to analyse the questionnaire, the data analysed include the biographic data collected through the questionnaire, this data is needed to explain the characteristic of the research respondents mainly regarding their age, qualification, years of experience and position within the organisation. The main research questions were also analysed with descriptive statistical tools to help understand the pattern of the respondents' perceptions of the research questions.

6.8.2 Inferential Statistics

Inferential statistics refers to the attempt to used statistical techniques to draw inferences from the data that was collected for a research study. According to Trochim & Donnelly (2008), inferential statistics is used to infer from data what the collective population sample might think about a phenomenon under study, and it is also used to make judgements about the probability that an observed difference between identified groups is dependable one or that it is one that might have occurred only by chance. The statistical tools used on this study include the Chi Square, Regression Analysis, and the Analysis of Variance (ANOVA) statistic.

6.9 Research Design and Process

The research process is started with identifying the research aim and theories that based on articulating of the research problem, followed by research objectives and questions, key aspects of this study shown in Figure 6-4.

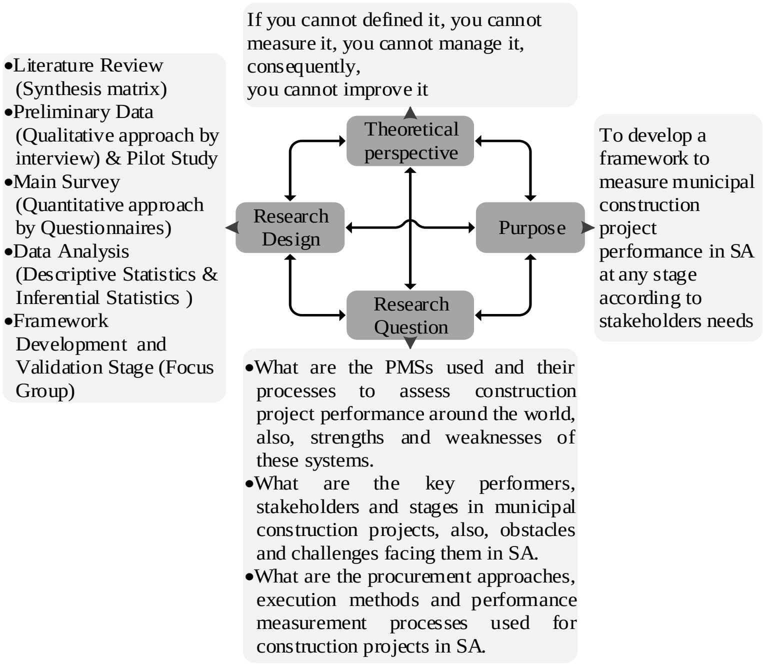

Figure 6-4: Key Aspects of the Study

However, to achieve these elements, it was necessary to identify related subjects to concept of performance measurement systems. Thus, this step also is considered as fundamental corner stone to identify research gaps, scope and themes. The themes considered to be as a study manifest that allows researchers to understand the study requirement in scientific manner. This research relayed on three diminutions where represented research themes shown in Figure 6-5.

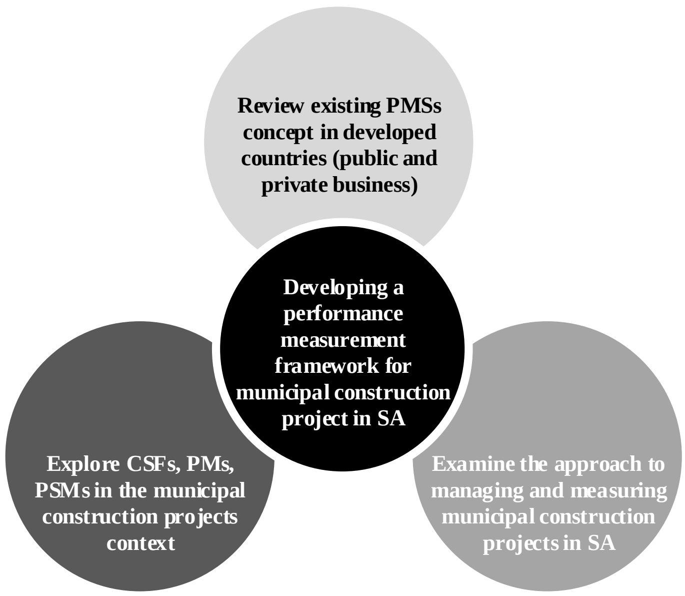

Figure 6-5: Study themes

To achieve the research aims, the research approaches adopted included investigate previous studies and research, preliminary investigations by interview tool and main survey conducted by questionnaire. The research was conducted in five steps as shown in Figure 6-6. Data and information required to be collected were divided into two step based on the purpose sought of these data and information, from the organisation that involved on delivering of municipal construction projects representing in three organisations named (municipalities, contractors and consultants). The first step is Qualitative data that was collected by phone interview from key qualified professional and specialist in municipal team in SA. The second step is and quantitative data gathered by questionnaire (municipalities, contractors and consultants).

The approaches employed in this research to collect required data are both qualitative and quantitative data, as it provides different data sources that increase argument in the participants' responses. Also, it supports the researcher to form a complete picture of research aspects. Both qualitative and quantitative approaches were used in this research included interviews, questionnaires and focus groups.

The preliminary investigations was conducted by using phone semi-structured interviews were designed to gain information regarding project stages, stakeholders and relationship among them, procurement system to provide municipal projects, and number of organisations involved in municipal project delivering across of SA. These interviews were conducted with municipal organisation team such as heads of construction project departments and senior engineers.

The main survey was conducted through semi-structured questionnaire, it was utilised to obtain data from performers and practitioners in the municipal construction projects. These data and information were collected for developing performance measurement framework. The questionnaire was developed and derived based on in-depth literature review and interviews.

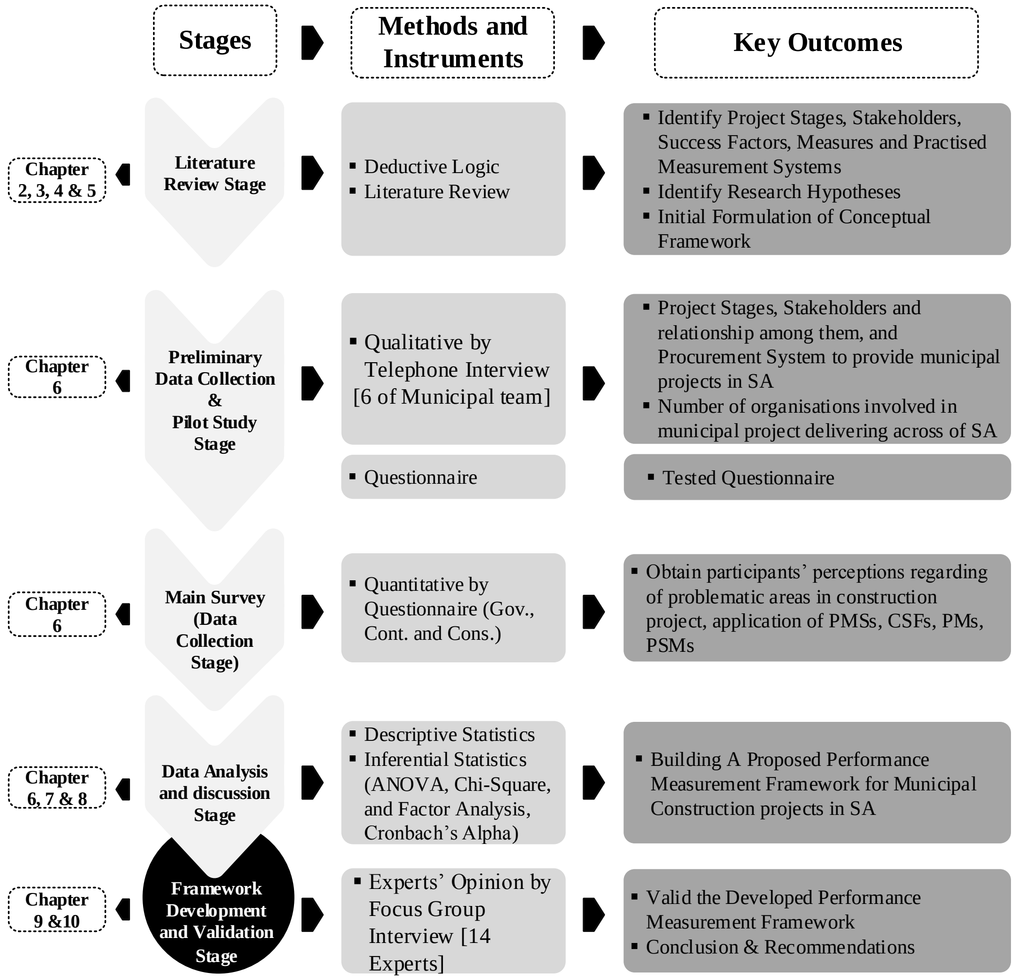

Figure 6-6: Research process

6.10 Research Procedure

6.10.1 Research Stage I: Review of Literature

Objective 1: Review existing performance measurement framework being used in the construction industries and public authorities of the developed countries including the performance measurement process, project stages, project stakeholders, CSFs, and PMs and PSMs.

***Procedure*:** A detailed review of literature from multiple sources (text books, journal articles, conference papers, websites, institutional reports, etc) helped to identify the performance measurement systems, construction project stage, stakeholders and performer, success factors, performance measures and project success measures.

Output: Formulation of an initial conceptual framework including framework components which are; construction project stage, stakeholders and performer, success factors, performance measures, project success measures.

6.10.2 Research Stage II: Preliminary Data Collection and Pilot Study

6.10.2.1 Preliminary Data Collection by Interview

Objective 2: Identify project stages, key participants and stakeholders involved in the delivering of municipal construction project and the relationship among them,

Objective 3: Identify the procurement and execution procedures of construction projects in municipalities in SA;

In this research, semi-structured telephone interviews were conducted in order to determine the project stages, key participants and stakeholders involved in the delivering of municipal construction project and the relationship among them, as well as, to identify the procurement system applied to deliver construction projects in municipalities. This technique was conducted in order to avoid the expenditure requirements that would be incurred in face to face interview.

Procedure: Developed interview questions based on the review of literature cited in the research stage I. The interviewees were from municipal team random selected, six officials who were in high position in SA were interviewed to identify the current procurement system, process and approach practised to manage and deliver construction projects in municipalities in SA. As well as, identify project stages, key participants involved in the delivering of municipal construction project and stakeholders, also, the relationship among them, spatially how and when the citizens' needs and expectations identified and who should represent them. The interview research was conducted in May 2012 by telephone Interview. The process and results of interview are summarised as a follow;

The interview questions:

- What are the current procurement system, process and approach practised to manage and deliver construction projects in municipalities in SA?

- How many stages are there in municipal construction project?
- How many stakeholders are involved in the delivering of municipal construction project?
- When do stakeholders communicate with each other?
- How are the citizens' needs and expectations identified? If Yes in which stage?

The interview result:

The interview questions were formulated to provide information about municipal construction project in terms of procurement, stages and stakeholders. The result sought to form the basis for structuring conceptual performance measurement. Generally, there was obvious agreement and correspondence among the interviewees responses where it was indicated that the public construction project are being provided based on Public Works Contract for construction project, therefore managing and delivering all construction project apply same approaches and process. The result of telephone interviews were coded. Table 6-1 illustrations the result summery of interviewees' responses and for more details Appendix 5.

Table 6-1: Telephone interview response result

	Question	*Interview Result Summary*
Question 1:	*What are the current procurement system, process and approach practised to manage and deliver construction projects in municipalities in SA?*	Open competition based on Public Work Contract (one stage contract)
Question 2:	*How many stages are there in municipal construction projects?*	Three Stages (Planning and tendering stage, construction stage and operation stage include one year defect liability)
Question 3:	*How many key participants are involved in the delivering of municipal construction project and stakeholders?*	Four Stakeholders (Three practitioners include Municipal team, Contractor and Consultant) and Citizens as Users).
Question 4:	*When stakeholders are communicating with each other?*	Municipal team as owner (all project stages) Contractor (in tendering sub-stage and construction stage) Consultant (in tendering sub-stage and construction stage)
Question 5:	*How are the citizens' needs and expectations identified?*	Frequent meeting to identify and discover citizens needs conducted by City Council (Citizens' Representative)
Question 6:	*If Yes in which stage?*	Users (Citizens) (identify needs sub-stage and operation stage)

Output: Identified current procurement system, process and approach practised to manage and deliver construction projects in municipalities in SA. As well as, identified project stages, key participants involved in the delivering of municipal construction project and stakeholders, in order to complete initial conceptual framework design that was structured in first stage that shown in Appendix 6, thus, the questionnaires will be completed. Figure 6-7 shows the municipal construction procurement approach including stages and sub-stages for frist stage, stakeholders and the relashonship among them.

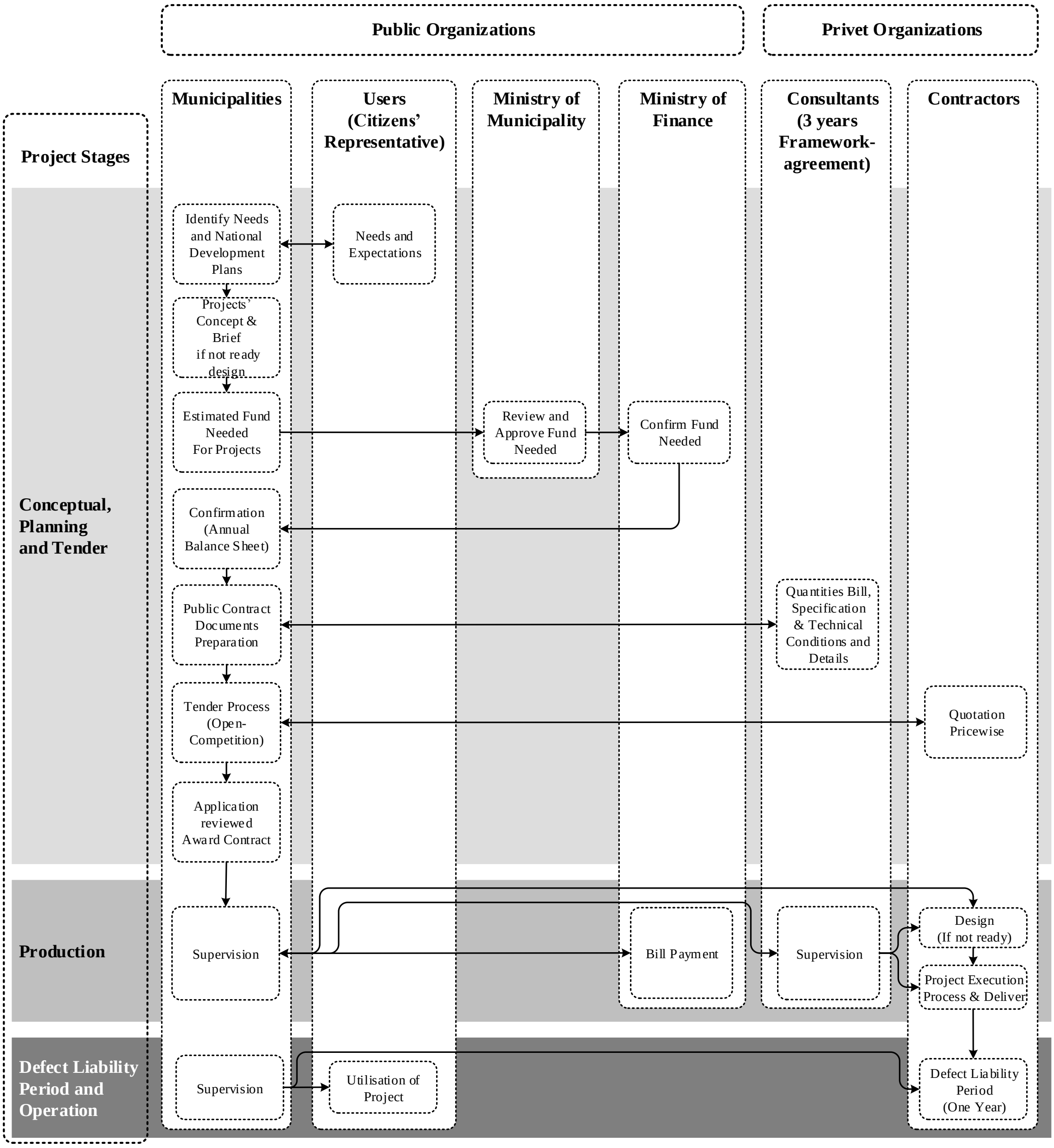

Figure 6-7: Municipal construction procurement approach (Interview Result)

6.10.2.2 Pilot Study

Brace (1999a) discussed piloting questionnaire questions prior to launching the full survey. Pilot studies are not a new idea as they have been in practice in the social sciences for some period of time. Blaxter et al. (2006) suggested pilot research can be used for a researcher to determine future problems and obstacles in the use of a questionnaire. Ritchie & Lewis (2003) argued the role of pilot study, and stressed that pilot research helps the researchers in many ways and allows questions to be re-framed, and for time and resources to be saved.

Sub-Objective of this stage is: To examine the clarity, readability and understanding of questionnaire, also, to identify if there is any problems such as the wording and the length.

Procedure: Develop an initial questionnaire based on the review of literature cited in the research first stage and structured framework in second stage. Random samples of ten key stakeholders relevant to construction projects in municipalities in SA were chosen. A sample size of ten respondents was considered adequate enough to develop the final questionnaire. The ten distributed questionnaires were collected, without any noteworthy changes required. The pilot study was conducted in June 2012 and permitted the questions to be checked afterward.

Output: Final tested questionnaire (Appendix 7)

6.10.3 Research Stage III: Data Collection (Questionnaires)

Bulmer (2004) emphasised that questionnaires must be reliable, especially over time, and that they should give the same results if they are tested upon the same respondents at least two-thirds of the time. Czaja & Blair (2005) reported that in face-to-face surveys for a questionnaire that both the respondent and researcher need to meet at a location where the questions can be asked for the questionnaire to be completed. Respondents can receive clarifications from the researchers, and such findings might be considered more credible. It should be noted that face-to-face surveys are expensive, and can involve much coordination, travelling, and time. However, the response rates are often higher than other survey methods due to the presence of a human interviewer (although such a presence may also skew the responses, as noted previously). Furthermore, face-to-face surveys also permit more complex and open-ended questions to be asked.

***Objective 4*:** Examine the current process and approach to managing and measuring construction projects in municipalities in SA and problematic areas;

Objective 5: Explore and determine the performance measurement process, CSFs, and PMs and PSMs in the implementation of municipal construction projects;

***Procedure**:* Collect information from three key stakeholders regarding their roles and responsibilities in the supply chain and execution of construction projects. The questionnaire included the perspectives on the roles and responsibilities of each player at each respective stage as well as the interaction between various team members and its effect on the overall performance and success of the projects.

A variable number of stakeholders were used in the survey subject to the variations in the presence and availability in municipalities; for example, it is known from the beginning that the number of consultants would be lower as compared to the government officials or contractors.

Output: Problematic areas, CSFs, PMs and PSMs for municipal construction projects.

6.10.4 Research Stage IV: Data Analysis

Objective 6: Determine the performance measurement process, CSFs, and PMs and PSMs in the implementation of municipal construction projects, and problematic areas;

Procedure: Describe the data by means of various statistical analyses as the data is mostly ordinal in nature. These included descriptive statistics to analyse the trends in perceptions/opinions, eg, frequency distribution, measures of central tendencies, measures of dispersion; and, inferential statistics to analyze ratings/rankings, eg, t-test, analysis of variance (ANOVA), chi-square, and discover the most CSFs through factor analysis. The data was also tested for reliability and validity using appropriate statistic, eg, Cronbach's alpha which is the most commonly used for ordinal data. Further analyses were performed to uncover sample characteristics such as group differences, including differences between the groups. These techniques reduced a large number of overlapping measured variables to a much smaller set of factors (Pallant, 2010).

Process: All data was tabulated and initially analyzed in MS Excel and analyzed in MS Excel and SPSS v20.

***Output*:** Trends in respondents' perceptions, satisfaction levels, formulation of performance measurement framework.

6.10.5 Research Stage V: Development, Validation and Recommendations

Objective 7: Develop a practical and affective framework for evaluating municipal construction projects performance in SA;

Objective 8: Evaluate and validate the proposed performance measurement framework through experts' opinion and perceptions; and

Objective 9: Conclude result of study and recommend further investigation in the field of construction projects performance measurement and other in relation.

***Procedure*:** Based on most CSFs, PMs and PSMs a practical framework for measuring the construction projects were formulated. This framework were subjected to validation through fourteen experts' opinion from three organisations as a key stakeholders (government officials, contractor and consultant). Based on the fact that each municipality in SA consists of five administrative levels, the interviews were conducted from the top managers (called Mayor in SA) in the hierarchy and the top engineer (who is called Head of construction Projects administration department).

***Output*:** Besides validating the framework, the interviews consolidate the information about key problems in the present state of affairs and hence serve to triangulate the data collected through questionnaires. A set of recommendations were construction based on pooled recommendations from the stakeholders' surveys, experts' interviews, and the researcher's observations in the field. The research process are presented in Figure 6-8.

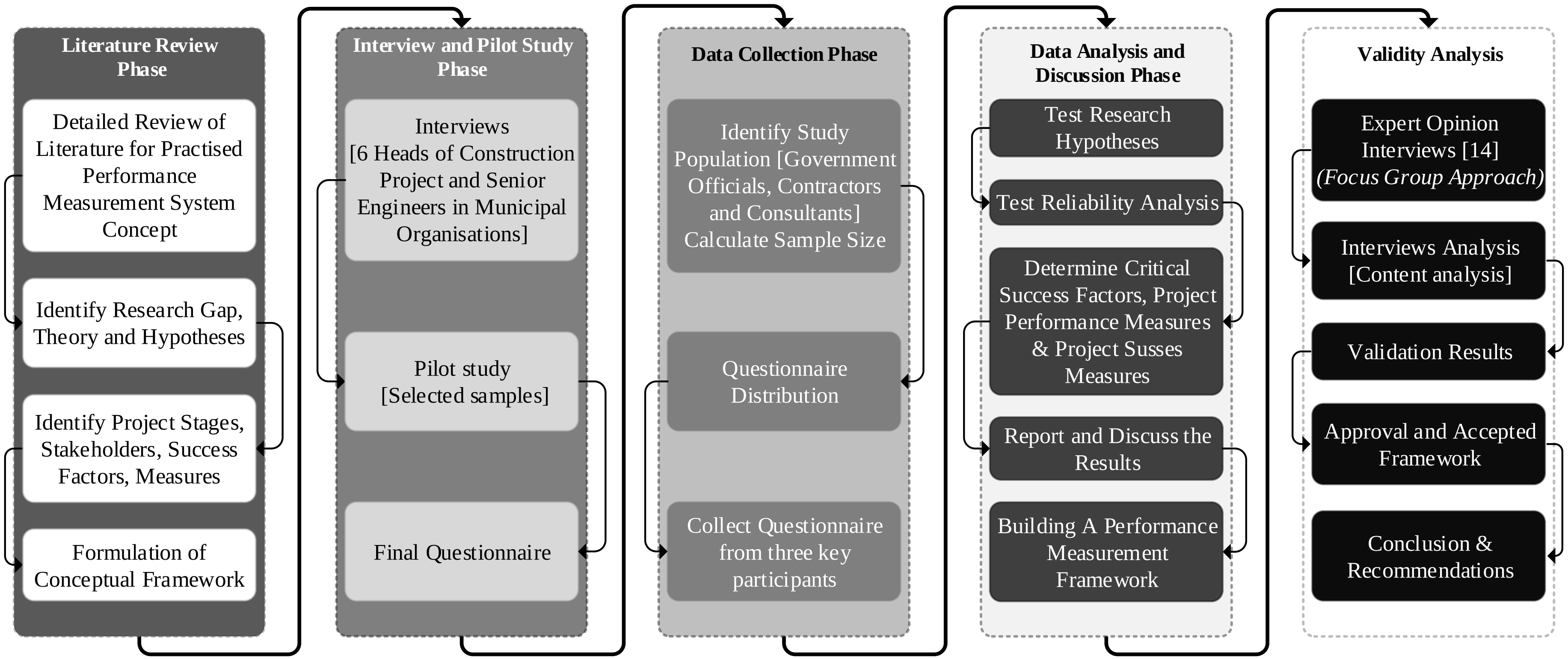

Figure 6-8: Research procedure (inputs, research methods, and outputs)

6.11 Data Collection Techniques

6.11.1 Sample Size

The main purpose of sampling is to enable the researcher to collect data that reflects the population. Sampling is a fundamental factor and should be considered before distributing the study questionnaire to achieve an effective collection of data (Fellows & Liu, 2008). Thus, the correct sample size must be determined in order that it accurately represents the whole population. In every research study the most significant question regarding sampling is (What size sample is needed?). The answer is affected by the purpose of the study, population size, the risk of selecting a bad or irrelevant sample, and sampling error. In addition to these, there are other factors needed to be specified in order to determine the appropriate sample size, which are the precision level, the confidence level, and the degree of variability (Israel, 1992).

Municipal construction projects in SA are administered and delivered by the Ministry of Municipalities and Rural Affairs through municipalities and sub-municipalities. However, the responsibility of carrying out and implemented these infrastructure project is in cooperation and participation with private consultants and contractors. Consequently, the target population of this research was divided into three different types of organisations (government, contractor, and consultant) who are delivering municipal construction projects to provide public services. They were suggested and determined based on results of pilot study.

However, municipal organisations were municipalities (limited to large municipalities called Amanh) and the top three level out of five levels for municipalities of province (graded A to C), contractors (limited to contractors registered and classified by MMRA in SA as graded Level 1 to 5), and consultants who have contracts with municipalities. An organisation of this can be seen in Figure 6-9.

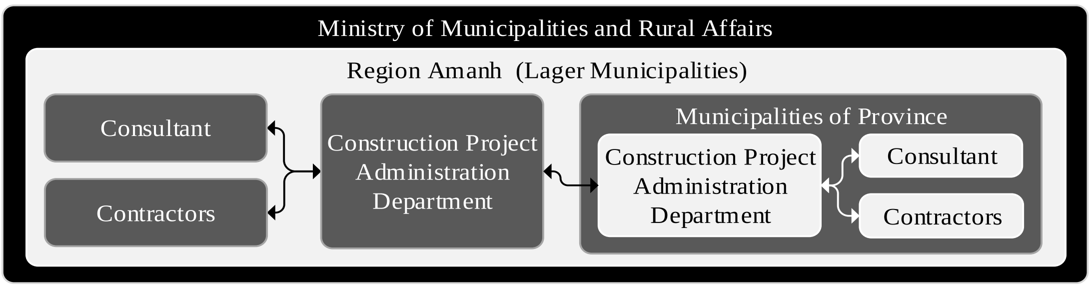

Figure 6-9: Organisation of Saudi municipalities

The total of population was restricted to professional who hold minmam of university degree level qualifications, such as civil engineers, architects, quantity surveyors, electrical and mechanical engineers, mayors, and project directors.

To determine a suitable sample size, the following formulas from Baartt et al. (2001) and Cochran (1977) were used to calculate the necessary sample. The following formula was used to calculate the sample size which represented the population: -

$$n_s = \frac{t^2 \times s^2}{e^2}$$

Where: -

n_s= required return sample size

t = alpha level value (0.05 = 1.96 for sample size of 120 or more)

s = estimated standard deviation in population for 7 point scale (1.167)

e = acceptable level of error for the mean being estimated (0.03 × 7 scale)

Therefore,

$$n_s = \frac{1.96^2 \times 1.167^2}{(0.03 \times 7)^2} = 118$$

However, according to Baartt et al. (2001) n_f is required because the initial result n_s of sample size for all population samples which is 118 > 5% of the individual populations; therefore, in order to find a suitable sample size a new formula should be used that is: -

$$n_f = \frac{\mathrm{n}_s}{\left(1 + \frac{\mathrm{n}_s}{\text{population}}\right)}$$

Consequently, the determined samples size is presented in Table 6-2 as follows: -

Table 6-2: Samples size

Organisations	**Sample size (n_f)**
Municipalities	56
Contractor	72
Consultants	46
Total	174

6.11.2 Parameters

A number of variables have been discussed in the previous chapters, such as PMSs, CSFs, PMs, construction projects stages and process, as well as the reasons for failure, and needs and expectations of stakeholders. Therefore, these issues have been included in the considerations in the development of the survey questionnaire.

The questionnaire contained unique variables, covering aspects such as general information and the participants' views on time, cost, quality, stakeholders' satisfaction, health and safety, environment, innovation and learning, business performance, strategies and management, and project production.

Field (2009) pointed out that since there are many methods which might cause problems; therefore, a method that could address the research issues and parameters should be applied. However, levels of measurement must correspond to the statistical explanations of data. Therefore, the majority of questions in the questionnaire were closed or Likert-type scale ratings measuring the relative importance of performance measures and success factors. The last part of questionnaire invited suggestions/recommendations to improve the effectiveness and efficiency of the delivered service. All of these were developed to gather information from experts (government officials, contractors, and consultants) to identify CSFs, PM and PSM for municipal construction projects' performance. This questionnaire was developed in such a way that all necessary information could be collected in an effective manner.

6.11.3 Questionnaires Distribution Procedure

In the process of the questionnaire distribution, key practitioners were targeted, which included architects, civil engineers, project directors, site engineers, project managers, municipality mayors, quantity surveyors, agronomists, mechanical engineers, and electrical engineers. Information about these persons was obtained from databases provided by the municipalities. Selection in this category was based on the experience and capability and the likelihood to participate in the study by filling out the questionnaire in order to put forward their views regarding construction projects performance. The questionnaires were distributed via post to contractors, consultants, and by personal delivery to mayors of several municipalities for an increases response rate. The distribution was at the beginning of July 2012; however, during the subsequent three months, many follow-up calls and personal contacts were used to accelerate and encourage return of completed questionnaires.

6.12 Result of Pilot Study

It is recommended to conduct a pilot study of a questionnaire prior to its full deployment (Naoum, 2007). A pilot questionnaire is considered the most beneficial tool to ensure that a questionnaire is clear and understood by all respondents, as well as to identify ambiguities in the meaning of questions, how long recipients take to complete it, and to eliminate any questions that do not yield usable data (Rattray & Jones, 2007). Therefore, during development of the questionnaire, it was essential that the questionnaire be tested by sample of respondents. The participation of respondents provided an opportunity to evaluate the reliability and validity of the questionnaire format. The initial version of questionnaire was 9-pages long.

The pilot study was carried out in June 2012 amongst Saudi construction professionals involved in municipal construction. The pilot questionnaire study was sent to ten respondents: one architect, three project managers, three project directors, two municipal mayors, one electrical engineer; of which four were from municipalities, four were from contractors' organisations, and two were consultants. All participants had experience in construction project management and had been involved in roles delivering municipal construction projects.

Table 6-3 details the results of the characteristics of participants who were requested to participate in the pilot study. The approaches were used in the pilot study were open-ended and face to face interviews combined with informal discussions. Despite the questionnaire being lengthy, it was considered manageable to be answered within 10 minutes – a duration which is considered an acceptable period of time. Since the questionnaires were required to be collected, it was important to select practitioners who had good experience in managing construction projects to ensure that the questionnaires would be subjected to sufficient rigour.

Table 6-3: Pilot study respondents

Organization	Designation	No. Year's Experience	Data Collection Approach
Government	Mayor	24	Face to Face Questions
	Mayor	27	Face to Face Questions
	Projects Director	22	Questionnaires
	Architect	19	Questionnaires
Contractors	Projects Director	30	Questionnaires
	Project Manager	32	Questionnaires
	Projects Director	20	Face to Face Questions
	Electrical Engineer	18	Questionnaires
Consultants	Project Manager	26	Questionnaires
	Projects Director	31	Questionnaires

Ten participants from three organisations responded with their comments and suggestions on how improve the questionnaire. The results of the analysis of the data collected from the pilot study indicated that there was not sufficient variability between respondents score. It has also been suggested that a 7-point Likert scale increases variability of responses (Kim, 2010) and provides more research validity and reliability than a 5-point scale. Consequently, the 5-point Likert scale for these questions was increased to a 7-point Likert scale.

Based on the suggestions, the questionnaire was reconsidered and corrected to produce a new and improved version. A copy of the final version of the survey questionnaire is included as Appendix 7.

6.13 Analysis Methods and Instruments

6.13.1 Approaches to Analysis

The primary data was taken from the returned questionnaire responses and inputted into and analysed by SPSS v20 in order to check and determine whether various groups of participants have different viewpoints about CSFs on comprehensive construction projects.

6.13.2 Validation of Research Hypothesis

Testing hypotheses is considered a fundamental component of statistical inference. In order to carry out such a test, some hypotheses have been proposed: the null hypothesis and the alternative hypothesis. The null hypothesis assumes that there is no experimental relationship or effect and the alternative hypothesis assumes that there is. The null hypothesis needs to be rejected in order to accept the alternative hypothesis. It can be used to determine the probability that a population parameter is true. Hypothesis testing is a verification process of to what extent that a proposed hypothesis can be accepted (Gravetter & Wallnau, 2008).

Four steps are followed to conduct hypothesis testing. Firstly, state the hypotheses. Then, identify statistics to assess the acceptance of the null hypothesis. The statistical analyses are conducted using two approaches, which would include the mean, ANOVA's mean, and the *t*-test. The third step is to find the P-value by using computing statistic test. The last step is a comparison of the P-value to a determined significance value.

A comparison was made between the principal variables of perceptions and opinions regarding construction project obstacles, training received, experience and practice of PMSs, PMSs known and used, and PMs used to evaluate project performance.

The mean values of responses of the three participants' samples (government, contractors, and consultants) were ranked based on importance level. The ANOVA test was used to examine the significant differences of their opinions and perceptions. The result of the analysis indicated that the null hypotheses were rejected; therefore, the alternative hypotheses applied. For the responses to the 7-point Likert scale questions, a simple *t*-test was used to assess if the response is significantly different from the middle position of 4. The *t*-test was conducted at a 5% level of confidence. Consequently, H_1 is true if: -

$$t = \frac{\bar{x} - \mu_{H_0}}{\hat{\sigma}_{\bar{X}}}$$

To compare groups such as government, contractors, and consultant, analysis of variance is used to test if at least one of the means is significantly different that 5%. To assess difference in sequences a binomial test of significant was used (Field, 2009). The formula of the test: -

$$P_{value} = (p_t - \overline{p}) \pm 1.96 \sqrt{\frac{\overline{p}(1-\overline{p})}{n}}$$

6.13.3 Comparison of Mean

The mean, which is the statistical term for average, is a component of descriptive statistics used to summarise properties of a single variable (Koop, 2006) or as Donnelly (2013) puts it, it is the centre point of a data set. It is calculated by adding all the values from a data set and then dividing the result by the number of observations, ie, the number of values. The common mathematical representation of an average is (Donnelly, 2013): -

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Where,

$\bar{x} =$ sample mean

$x_i =$ values in the sample

$n =$ number of data values in the sample

In statistical terms, as Donnelly (2013) puts it, these are the "population mean". Here, the word "population" indicates that estimates are obtained from an actual "population" of data. According to Donnelly, "population mean" is calculated in the same way as the sample mean. The only difference here is in its notation. As Koop (2006) suggests, population is data collected over time. The formula for population mean is as follows: -

$$\mu = \frac{\sum_{i=1}^{n} x_i}{N}$$

Where,

$\mu =$ population mean

$N =$ number of data values in the population

Both mean and population mean estimate the central tendency by giving each value the same weight. However, there might be a situation when certain values are greater in importance than others. In that case, it is recommended to use a weighted mean, which allows assigning more weight to certain values and less weight to others (Donnelly, 2013). The weighted mean is calculated from a following equation: -

$$\bar{x} = \frac{\sum_{i=1}^{n}(w_i x_i)}{\sum_{i=1}^{n} w_i}$$

Where,

$w_i =$ weight for each data value x_i

The mean, as Donnelly (2013) commented, is a conventional statistical measure. It is used to summarise a data set with a single value. It is easy to compute and understand. However, there are some limitations attached to it. Firstly, when the mean is used to summarise many data values, one can lose information about the original data, which in some cases can be critical. Secondly, issues can arise due to "outliers". As Donnelly (2013) defines, outliers are extreme values above or below the mean that require special consideration. Outliers can appear due to data entry errors or measurement errors. If outliers are present in the data set, it is recommended to eliminate them from a sample in order to avoid distorting the analysis. However, as Donnelly comments, outliers can be genuine values that happened to be very large or small and should remain in the analysis. Therefore, all data within this research project shall be considered with caution.

6.13.4 Analysis of Variance

The technique known as the analysis of variance is a common tool in social and physical sciences (Koop, 2006). According to Donnelly (2013), an ANOVA test can describe the cause of variation in the data. In other words, the purpose of an ANOVA test is to assess whether the variation in the data is due to a type of variable or simply as a result of randomness. As such, this test has many useful business applications.

In order to perform an ANOVA test, there is a need to estimate the "factor" and "levels" in the analysis. A "factor" in ANOVA assesses the cause of variation and a "level" describes a category within the factor of interest in the data. According to Donnelly (2013), ANOVA comes in a few forms. Each form of the test organises the data according to the objectives of the test.

ANOVA is a basic procedure; however, it is very reliable. Here, it compares the means of different levels of one factor. Generally, it is used to assess the influence of one factor on the data values. A good feature of this procedure is that it allows testing unequal sample sizes. The *F*-test is normally used for one-way ANOVA (Donnelly, 2013).

A Two-Way ANOVA, as Donnelly (2013) indicates, examines the simultaneous effect that two main factors have on observed data. Here, these two factors have a potential to contribute to the estimates. Whereas this procedure examines the simultaneous effect of Factor A and Factor B, there is also a need to consider any interaction between Factor A and Factor B that could be affecting variation in the data. Following Donnelly (2013), the Total Sum of Squares (SST) for a Two-Way ANOVA is estimated by computing the Sum of Squares Factor A (SSFA), Sum of Squares Factor B (SSFB), Sum of Squares Interaction (SSFAB), and Sum of Squares Error (SSE). The SSFA measures the variation between Factor A means and the grand mean for all the data set. SSFB estimates the same variation but for Factor B. SSAB assesses the variation as of the effect between Factor A and Factor B.

6.13.5 Factor Analysis

According to Williams et al (2012), factor analysis is a multivariate statistical methodology with three key functions. The first function allows for the reduction of a large number of variables into a smaller more manageable set of variables also known as factors. The second function is that it establishes underlying dimensions between measured variables and latent constructs, and the third is that it provides construct validity evidence of self-reporting scales. As Tryfos (1998) argues, factor analysis is a statistical method for investigating whether a certain number of variables of interest, $x_1, x_2 \dots x_i$, have a direct relationship to a smaller number of unobservable factors, $f_1, f_2 \dots f_i$. Tucker & MacCallum (1997) highlighted that in general terms; it is achieved by making use of the implications of factor analysis theory. They also suggested that the influence of common factors on the number of variables gives rise to correlations among variables of interest.

Regarding construction research management, Pallant (2010) suggested the use of factor analysis technique, helps to identify a small set of factors that represent the underlying relationships amongst a group of variables. Previous studies by Cheung & Yeung (1998), Pongpeng & Liston (2003), and Li (2003) also successfully applied this method in research within the construction management sector. The assessment of the suitability of the data for factor analysis is regarded as an important aspect of this procedure. According to Tabachnick & Fidell (1996), two main issues need to be examined in order to determine whether a particular data set is suitable for factor analysis. The first is the sample size. The second is the strength of relationship among variables.

Factor analysis is a popular multivariate analytical technique for identifying strong relationship among variables (Albogamy, Scott, Dawood, & Bekr, 2013). Giving that many variables are selected as significant variables according to mean method result of the analysis conducted to determine which variables are the most significant for municipal construction project at three stages of its life cycle. Factor analysis is required to explore whether or not the variables can be tested to group them under key components for the variables (obstacles and barriers and CSFs, PMs, efficiency measures and effectiveness measures) so that the main factors could be identified.

Thus, the factor analysis technique is carried out to derive a cluster of any multivariate interrelationships existing among CSFs at construction project stages. In this study, various tests of factor analysis were conducted to determine the appropriateness of the factor analysis for factor extraction using SPSS v20 software. This includes the KMO and Barlett test of Sphericity, also, the Principal Component Factor Analysis was used to identify a relatively small number of interrelated CSFs (Hair et al. 1998, p. 112).

The recommended value of KMO should be greater than 0.5 for acceptable factor analysis (Lin, Sun, & Kelly, 2011). According to (Lin, Sun, & Kelly, 2011) to extract common factors, principal components are considered as components when having an Eigen value of 1 and more to meet the criterion to be extracted. The scree plot test is also used to identify the optimum number of factors to be retained by looking for a relatively large interval between eigenvalues. The rationale for the Scree test is that since the principal component solution extracts factors in successive order of magnitude, the substantive factors appear before the numerous trivial factors which have small eigenvalues that account for a small proportion of the total variance (Fellows & Liu, 2008). The Scree test is derived by plotting the latent roots against the number of factors in their order of extraction, and the shape of the resulting curve is used to evaluate the cut-off point as recommended by Hair et al., (1998, p. 112).

The varimax orthogonal rotation of principle component analysis was further applied to interpret these factors. The variables which are consisted in order under these grouping are based on their factor loadings. The values in the columns of factor name are the correlation between original variables and common factors. A factor loading indicates the degree of association of a variable with the component and the percentage variance of the component that is explained by the variable. For each factor, all items with a load equal to or greater than 0.50 were assigned to the corresponding factor (Quesada-Pineda & Madrigal, 2013). As recommended in Hair et al. (1998, p. 112) that factor loading should be equal or greater than 0.5 with sample size of this research (120 samples).

6.13.6 Content analysis of Interview Analysis

Content analysis is conducted as a good tool to evaluate and compare positions (Guthrie et al. 2004). According to Kondracki et al. (2002) the Content analysis is used to infer latent meanings of perception about a subject of research. It described as the main tool for analysing and categorising data collected from interviews to extract required result for. It is used as a research instrument to conclude ideas and perception mentioned within such as interview and report. Zhang & Wildemuth (2009) mentioned that content analysis is preceded through some steps which are relied on determining study goals and flexibility of content analysis, however generally these steps are divided into eight steps: first is organize the data; several categories of information data could be analyse by content analysis, however, it is needed to be converted into written text to start analysis. Second is define the unit of analysis; *‘‘the unit of analysis refers to the basic unit of text to be classified during content analysis’’*. Third is develop categories and a coding scheme; fourth is test your coding scheme on a sample of text. Fifth is code all the text; application of coding rules to entire of text is dependent on sufficient consistency. In order to avoid *“drifting into an idiosyncratic* sense of what the codes mean” during processing coding, the coding should be checked repeatedly. Sixth is assessing your coding consistency. Seventh is drawing conclusions from the coded data. Eighth is reporting methods and findings. Content analysis method is carry out by computer programs, such as SPSS.

According to Kondracki et al. (2002) in order to gain successful content analysis three elements should be achieved; clarify and define categories coding, determined study objectives clearly, quantified data and information and a consistent coding. Zhang & Wildemuth (2009) mentioned that in seeking to acquire reliable and correct inferences of interview data, it is necessary that systematic and transparent procedures to be involved. Due to the simplicity of content analysis, it is conducted in this study by analysing interview texts to classify and coding selected words and terms (Fellows & Liu, 2008).

The interview text was sorted into four contents areas: about the participants' background, participants' perception about performance measurement process, CSFs, PMs and PSMs (effectiveness and efficiency). To obtain a sense and concepts or perception of interviewees, the interviews were read through many times and then analysed in five steps. Firstly, recording and transcript data and information to presence key and specific themes, terms and words. Secondly, categorising and coding keywords and terms to extract concepts. Systematic coding on content analysis technique was made in five areas of investigation: CSFs, PMs and effectiveness and efficiency measures. Thirdly, coding the main concepts and fourthly is organising and processing of information. Finally, describe and present results analyse. In this study, the results are analysed by means of Statistical Package for Social Sciences (SPSS) software.

6.14 Analysis of Respondents' Characteristics

6.14.1 Analysis of Response Rate

Table 6-4 shows the data collection results from the 368 questionnaires that were distributed to various target groups amongst municipalities and construction organisations that involve in delivering of municipal construction projects. Over a three month period, and after many follow-up calls and use of personal contacts, 120 questionnaires were returned. The majority of the questionnaires had been completed in a satisfactory manner. Most of the respondents held senior level positions in their organisations and had an average experience of approximately 15 years. The respondents included 38 government organisations (municipalities), 44 contractors, and 38 consultants (out of 108, 186, and 74 distributed questionnaires respectively). Overall, the questionnaire had a 40.6% response rate. However, an average of 36.6% were completed fully.

Table 6-4: Response rate

Organisations	Distributed Questionnaires	Response Rate	Completed Response No.	Completed Response Rate
Government	108	41 %	38	35 %
Contractors	186	28 %	44	24 %
Consultants	74	53 %	38	51 %
Total	**368**	**40.6 %**	**120**	**36.6 %**

While the 9-page questionnaire was considered necessary for covering all of the issues that come with making a municipal construction project successful in SA, it is reasonable to assume that this extensive scope may have been the reason behind the somewhat low response rate. Such response rates have been experienced in similar studies of the construction industry in SA. Nevertheless, there were a sufficient number of different project stakeholders who successfully completed the questionnaire and returned it. This provides a reasonable level of confidence that their response can be taken as representative of the target population.

As the response rate suggests, the most active were consultants, followed by government officials, and then contractors, with response rates being 53%, 41% and 28% respectively. Overall, the response rate was 40.6%, which can be considered to be significant according to Akintoye (2000), and Dulami et al (2003) where they considered that in the construction industry a 20% to 30% response rate for a postal questionnaire is common and acceptable. In addition, some other studies were conducted with similar responses such as Takim, (2005) in his research had a response rate of 21%; Ofori & Chan (2001) in their study had a response rate of 26%; Vidogaha & Ndekugri (1998) had a response rate of 27%; and, Shash (1993) had a response rate of 28.3%. This gives us a certain level of confidence that their response can be taken as representatives of the target population.

Question 1 asked participants to indicate their job title. The results obtained, as can be seen in Table 6-5, that shows that the largest number of government identified themselves as Projects Director (11 out of 38), followed by Municipality Mayor (9 out of 38), Civil Engineers and Architects (each 7 out of 38). In the case of contractors, the majority of respondents identified themselves as Project Director (9 out of 44), followed by Site Engineers (8 out of 44), Civil Engineers (6 out of 44), and Engineers (5 out of 44). The majority of consultants identified themselves as Project Director (12 out of 38), and civil engineers and architects (each 7 out of 38). As a group, the biggest proportion of respondents were Projects Director (32 out of 120), followed by Civil Engineers (20 out of 120) and Architects (18 out of 120).

Table 6-5: Analysis of job title

Position	Organisation's Activities			Total
	Government	Contractor	Consultant	
Agronomist	0	0	1	1
Architect	7	4	7	18
Civil Engineer	7	6	7	20
Electrical Engineer	1	3	5	9
Engineer	1	5	1	7
Mechanical Engineer	0	4	4	8
Municipality Mayor	9	0	0	9
Project Manager	2	4	1	7
Projects Director	11	9	12	32
Quantity Surveyor	0	1	0	1
Site Engineer	0	8	0	8
Total	38	44	38	120

These results suggest that in case of government officials, those who responded are mostly projects director, Mayor, civil engineer and architects. This does suggest that municipalities in SA employ people with a technical and managerial expertise such as civil engineer and architects or those with a significant project management experience, ie, project directors, or one that needs to have technical knowledge and experience to become an employee of a municipality. In case of contractors and consultants, the majority of respondents came from an engineering background. This suggests that in case of construction project management, engineering and civil and architectural experience in particular is preferable in SA. Surprisingly, occupations such as agronomist were indicated only by consultants. Although a number of respondents with this area of expertise were very few, it nevertheless indicates that consultants employ the broadest spectrum of professionals.

In case of business activities, the largest group in the study were contractors, following government (municipalities), and then consultants. As can be interpreted from the data in Table 6-6, there is no significant association between an organisation’s activities and size of company. Although the results obtained from the questionnaire suggest that majority of contractors and consultants operate more than SR100 million in turnover. It therefore suggested that these two groups of respondents are either involved in large-scale projects or are occupied with many smaller-scale projects which in aggregate generate significant turnover for the companies. It also indicates the dynamics of the construction sector in SA, which is, as these numbers suggest, very strong.

Table 6-6: Analysis of company size

Size of Company SR Million	**No. of Organisation**		**Total**
	Contractor	**Consultant**	
Less than 10	3	0	3
Between 10 and 20	2	0	2
Between 20 and 50	7	11	18
Between 50 and 100	13	10	23
Over 100	19	17	36
Total	**44**	**38**	**82**

The results obtained from the questionnaire analysis for number of professional and qualified employees involved in the delivery of construction projects and working for municipalities (construction project administration), contractor organisations and consultant organisations such as Engineers, Mayor and Managers are presented in Table 6-7 that shows number of employees in government, contractor and consultants, which are 13, 47 and 28 respectively. This suggests that contractors are large employers in the Saudi construction sector. The number of employees in Construction Company is more than the number of consultants because that the tasks assigned by the contractor include many professions such as Engineers, Managers, whereas government and consultants are limited largely to engineers only.

Table 6-7: The mean of professional employees' number

	Government	**Contractor**	**Consultant**
Mean of Professional Employees Number	13	47	28

As can be seen in Table 6-8, the mean number of years of experience for government is 20.3, contractors is 21.4, and for consultants it is 25.9. This difference is not significant where P=0.095. The table indicates that the majority of respondents who are government employees, contractors and consultants have more than 15 years working experience.

Table 6-8: Number of work experience in construction years

Organisation's Activities		Number of Years of Work Experience in Construction					
		No Exp.	**<5**	**5 to 10**	**10 to 15**	**> 15**	**Total**
Government	Architect			1	2	4	7
	Civil Engineer		1		1	5	7
	Electrical Engineer					1	1
	Engineer					1	1
	Municipality Mayor			1	2	6	9
	Project Manager				1	1	2
	Projects Director				3	8	11
	Total	0	1	2	9	26	38
Contractor	Architect			1	1	2	4
	Civil Engineer				1	5	6
	Engineer			1		4	5
	Electrical Engineer				1	2	3
	Mechanical Engineer				1	3	4
	Project Manager				1	3	4
	Projects Director				1	8	9
	Quantity Surveyor				1		1
	Site Engineer			1	2	5	8
	Total	0	0	3	9	32	44
Consultant	Agronomist					1	1
	Architect			1	1	5	7
	Civil Engineer					7	7
	Electrical Engineer				1	4	5
	Engineer				1		1
	Mechanical Engineer					4	4
	Project Manager					1	1
	Projects Director				2	10	12
	Total	**0**	**0**	**1**	**5**	**32**	**38**

The next question assessed the kind of projects each category of respondents involved with. Unsurprisingly, as can be seen in Table 6-9, government officials are involved in every project type, including buildings, roads, electrical works, civil engineering projects, e.g., dams, flood control structures, bridges and tunnels, as well as landscaping. As it is known, the Saudi government is the major contractor in the country and, therefore, is involved in key project types. In terms of contractors, the largest numbers of respondents indicated electrical works as the main organisational activity, followed by roads, civil engineering projects, landscaping, and buildings. Similarly, consultants indicated that they were mostly involved in building and electrical works projects, followed by other organisational activities. Although levels of response differ depending on the organisation, it nevertheless can be suggested that based on the results presented in the table above, building, electrical works and civil engineering projects are dominant activities within the Saudi construction sector.

Table 6-9: Analysis of project types

Project Types	Organisation's Activities		
	Government	Contractor	Consultant
Buildings	100 %	63.6 %	94.7 %
Roads	100 %	81.8 %	89.5 %
Electrical Works	100 %	95.5 %	94.7 %
Dams, Flood Control Structures, Bridges and Channels	100 %	77.3 %	84.2 %
Landscaping	100 %	72.7 %	84.2 %
Planting Parks and Irrigation Networks	100 %	59.1 %	84.2 %

6.15 Interview Approaches (Focus Group) for Framework Validation

According to Cooper & Schindler (2013) the interview method is commonly conducted for data collection to validate produced PMS as a result of research. As stated by the author, the interview approach is an interaction between two people to obtain specific data to discover interviewees' opinions. As stated by Almahmoud, et al. (2012) and Cha & Kim (2011), the interview approach is considered to be one of the most significant sources to gain data and information. Interview methods can be conducted using three techniques. These are "structured", "semi-structured", and "unstructured" interviews (Fellows & Liu, 2008). Dawood & Sikka (2009) mentioned that structured interviews are one of the most important tools in interview methods and are deemed as an essential approach for knowledge of research methodology. They can be used in two ways, either for acquisition of data or for providing data.

The face-to-face technique was utilised, because it is advised that it has high potentials in achieving the best responses and relevant data from participants. Choosing the structured interview technique allowed exploring the research aim to interviewers in an appropriate context and helps to avoid any misunderstanding, as well as enabling exploration of the various experts' views and opinions (Haponava & Al-Jibouri, 2010). Similarly, Almahmoud, et al. (2012) indicated that it useful to select it due to the opportunity to clarify any ambiguities as they arise in the interview rather than being required to follow a rigid script. As a consequence of this, in this research the structured interview was followed by a process where respondents would be asked written questions seeking to gain more details and perceptions of the reliability and applicability of the designed performance measurement framework for municipal projects in SA.

To achieve the aim of this research mentioned in chapter one, the design framework for measuring municipal construction performance was required to be validated. The required data was collected through face-to-face interview of fourteen experts. Deliberate sampling was undertaken, which divided into two focus group, each of them involved seven interviewees as five from municipalities, five from contractors, and four from consultants. The data was gathered by structured and semi-structured interviews with experts from three groups of stakeholders of construction organisations.

The structured interviews consisted of a set of questions designed to facilitate data collection that sought to achieve the research objectives. Part one concerned with personal background, part two related to proposed framework components evaluation and part three concerned with components of proposed framework including CSFs, PMs and PSMs. While, the semi-structured questions of interviews were organised under last part that was aimed to limitations of proposed framework and how to improve the framework. In this study, to obtain perception of interviewees, the results are analysed by means, as well as content analysis. The results of the validation are discussed deeply in Chapter 9.

6.16 Conclusions

This chapter has defined the methods applied to achieve this research, also identified a mixed approaches for data collecting including both quantitative and qualitative data. These approaches executed in the form of qualitative (telephone interview), quantitative (questionnaire survey) and, quantitative and qualitative (focus group interview) are appropriate approaches to avoid any potential weaknesses in one manner. The research process was included preliminary research as field work and literature review to build PMS and then its validation. A structured questionnaire and interviews questions were conducted to assemble both the quantitative and qualitative data, where three main categories of organisations were selected namely, government (municipality) contractor and consultant who are involved in municipal constriction projects delivery. The focus of study was on professional and qualified participants include project director, project manager, civil engineers, architect and mayor were identified as the main respondents for both survey and interviews. The following chapter is related to statistical analysis for collected data.

7. CHAPTER SEVEN: ANALYSIS OF FINDINGS

7.1 Introduction

Data for this study was collected from a quantitative perspective while the resulting model developed was validated from both quantitative and qualitative perspectives. All the quantitative data collected were analysed with the aid of the Statistical Product and Service Solutions (SPSS v20), and the following statistical techniques were applied: -

- Reliability testing.
- Research hypothesis testing;
- Analysis of variance; and
- Factor analysis.

The statistical techniques, their assumptions and analysis are discussed because without the discussions, reliable results cannot be achieved. Descriptive analysis was used to show the statistical distribution of the responses, hence, the variability measures near the mean (variance and standard deviation), and distribution range (minimum and maximum) were helpful in analysing the data. Factor analysis was also used to reduce the number of variables identified in the process of data development.

7.2 Assessing Reliability of Respondents' Answers

Reliability of research relates fundamentally to the credibility of empirical research and collected data. The reliability test is concerned with the results of the research, which can be considered reliable if similar findings can be found where repeat testing is undertaken (Field, 2009, p. 673). Moreover, Robson (2011) indicated that if a study was to be conducted again and the same outcome would be attained again, then the reliability is deemed consistent. Cronbach's Alpha Coefficient is the common statistical technique used to find internally consistent reliability (Field, 2009, p. 674). According to Nunnally (2010) assumed that the reliability should be greater than 0.5. Alternatively, Field (2009, p. 675), the minimum value for reliability for Cronbach's Alpha Coefficient is 0.7; this number and above deems the data to be reliable and acceptable.

In this study, as is recommended for such studies (Pallant, 2010) the internal consistency test is applied to confirm that the Likert scale (1-7) for CSFs and PMs achieve consistent and similar findings over time. The results presented in Table 7-1 and Figure 7-1 that show that the Cronbach Alpha Coefficient are within the range of 0.705 to 0.895, which is deemed as evidence that the data gathered from the survey is consistent and reliable.

Table 7-1: Assessing reliability of respondents' answers

Questions	Cronbach Alpha
General Information	
Received training about PMSs	
Experience in measuring performance	0.895
Practice PMSs in the construction projects	
PMSs known or used	0.759
PMSs and assessment techniques used evaluate project performance	0.720
Obstacles/Barriers facing in municipal construction projects performance	0.705
Measurement Components Process	0.701
Success Factors	0.763
Performance Measure	0.823
Efficiency and Effectiveness Measures	
Efficiency Measures	0.831
Effectiveness Measures	0.890

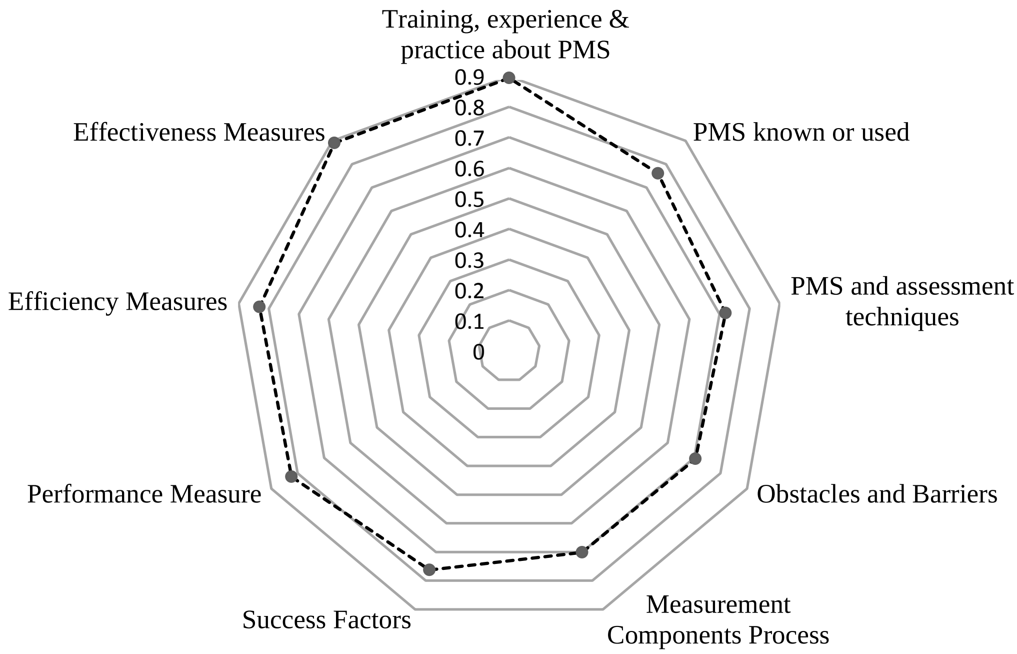

Figure 7-1: Reliability of respondents' answers

7.3 Test of Research Hypotheses

Background literature in the core area of performance measurement shows that a comprehensive PMS can improve performance and lead to successful construction project outcomes. In this section, the hypotheses that were postulated for this study based on the research objectives are tested based on the data that have been collected for the research study. The first test was conducted by ranking the variables based on mean values and then conducting an analysis of variance (ANOVA) test to investigate the participants' perception about how they received training, whether they have experience, and whether they practice the use of performance management systems in construction projects. Moreover, obstacles and barriers that affect the performance measurement of construction projects in Saudi municipalities were examined in terms of their significance, as well as analysis of the significant differences of opinion on the variables. The alternative hypotheses to be tested against the null hypothesis of "no effect", were presented to the research respondents in the questionnaire for the research, in section 1 of the questionnaire from question 1.7 to 1.13 is presented below: -

H1: *Weakness of regulation and poor instructions in their application to construction projects has a negative effect on performance and outcomes.*

H2: *The lack of standards, specification, and data results in unsatisfactory performance and results in construction projects.*

H3: *Poor conditions for awarding contracts, and poor criteria for contractor selection leads to poor performance and outcomes.*

H4: *Inadequate planning and strategies is associated with poor performance and outcomes.*

H5: *Poor management and people skills, also, unqualified managers leads to poor performance and outcomes.*

H6: *The absence of a PMS (in Saudi municipal projects) leads to poor project performance and outcomes.*

To investigate the alternative hypotheses against the null hypotheses, a set of questions were posed to the participants who were divided into three groups (government, contractor, and consultant). Since organisation size is not relevant in this study especially among contractors and consultants, a decision was made to test the hypotheses by organisation type and not by organisation size.

The result of the test of the research hypotheses was undertaken using the following the five steps: -

1. Identification of mean values of the respondents' opinion based on the three groups about the importance of obstacles and barriers affecting the performance of construction project in Saudi municipalities.
2. Identification of differences in the importance of obstacles and barriers affecting the performance of construction projects in Saudi municipalities based on organisation type (government, contractor and consultant).
3. Identification of mean values of the groups' opinions about training, experience and practices in construction project in Saudi municipalities.
4. Investigation of performance measurement systems that are known or used to judge the construction project performance in Saudi municipalities.
5. Investigation of performance measures that are used and the assessment techniques used to evaluate project performance.

In analysing the responses based on the Likert scale of 1 to 7, separate cut-off points were applied to determine the most important factors based on the respondents' perception of obstacles and barriers, CSFs, PMs and PSMs. This is applied according to Barua (2013), who suggested that it is important to set a cut-off point on the items for assessing knowledge, attitude and practice. The cut-off points are based on the Likert Weighted Mean Values in the Table 7-2.

Table 7-2: Likert weighted ranking

Mean value range	Rank	Interpretation of rank	
1.00 - 1.86	1	Not important	Rejected
1.87 - 2.71	2	Slightly important	
2.72 - 3.57	3	Somewhat important	
3.58 - 4.43	4	Moderately important	Accepted
4.44 - 5.29	5	Important	
5.30 - 6.14	6	Very important	
6.15 - 7.00	7	Extremely important	

Therefore, based on the above ranking of the mean values, respondents' perception of obstacles and barriers were determined based on a cut-off point of 4 the Table above, for CSFs, PMs and PSMs, the top 10 factors were judged to be most important based on the cut-off point of between 6 and 7.

7.3.1 Analysis of Obstacles and Barriers Affecting Performance

7.3.1.1 Mean Result

Questions regarding the obstacles to performance measurement were presented to the research respondents in questions 1.13 of the research questionnaire. Based on the overall mean values, the results showed that from the perception of the respondents, the most important obstacles affecting the performance of municipality construction projects in SA are the items numbered 1 to 12 since their overall mean values ranged from 3.58 to 6.55, these obstacles are judged to be the most important obstacles based on the location of their corresponding mean values in the mean value range column in the previous ranking Table. The decisions are based on a cut-off rank of 4 in the Likert Weighted Table above.

Considering the obstacles and barriers affecting the performance measurement of construction projects in Saudi municipalities, the mean values of the research respondents' perceptions are ranked in order of importance in the lists below from the respective perspectives of respondents based on type of industry.

Table 7-3: Government respondents' perception of obstacles and barriers

Obstacles	Mean Values
Weakness in the application of the regulations and instructions	6.53
Bureaucracy and lack of transparency	6.42
Lack of standards, specifications and data	6.37
Weakness of contract document	6.32
Inconsistent measurement approaches	6.11
Insufficient conditions for awarding of projects and criteria for Cont. selection	5.95
Weak government regulations and instructions	4.83
Inadequate planning and strategies	4.16
Lack of motivation to improve and achieve superior performance	4.11
Lack of sufficient skills and training	3.79
Non-cooperation among stakeholders	3.58
Insufficient equipment	2.84
Non conducive organizational culture	2.32

Table 7-3 above on *Government officials'* perception shows the factors they consider to be most important. Based on the Likert Weighted Ranking Table above, only two obstacles fall below the cut-off rank of 4. "Non-conducive organisational culture" is ranked 2 and only considered to be slightly important, while "insufficient equipment" is ranked 3 and is considered to be somewhat important. Four obstacles were perceived by the government officials to be moderately important, since they were ranked 4 in the Likert Weighted Ranking Table, these are "Non-cooperation among stakeholders" with a mean value of 3.58, "Lack of sufficient skills and training" with a mean value of 3.79, "Lack of motivation to improve and achieve superior performance" with a mean value of 4.11, and "Inadequate planning and strategies" with a mean value of 4.16. Only one obstacle is perceived as important by the government officials, and that is "Weak government regulations" with a mean value of 4.83. Also, two obstacles were perceived as very important by the government officials, and had a rank of 6 on the Likert Weighted Ranking Table, these include "Insufficient conditions for awarding of projects and criteria for "Contractor selection" with a mean value of 5.95, and "Inconsistent measurement approaches" with a mean value of 6.11. The top four obstacles that are regarded as very important by the Government officials which are ranked 7 in the Likert Weighted Ranking Table include "Weakness in the application of the regulations and instructions" with a mean value of 6.43, "Bureaucracy and lack of transparency" with mean value of 6.42 "Lack of standards, specifications and data" with a mean value of 6.37, and "Weakness of contract document" with mean value of 6.32.

Table 7-4: Contractors' perception of obstacles and barriers

Obstacles	Mean Values
Lack of standards, specifications and data	6.65
Inadequate planning and strategies	6.45
Insufficient conditions for awarding of projects and criteria for Cont. selection	6.14
Bureaucracy and lack of transparency	6.05
Lack of motivation to improve and achieve superior performance	5.91
Inconsistent measurement approaches	5.86
Lack of sufficient skills and training	5.82
Weakness in the application of the regulations and instructions	5.36
Weak government regulations and instructions	5.18
Weakness of contract document	5.14
Non conducive organizational culture	5.14
Non-cooperation among stakeholders	4.82
Insufficient equipment	3.09

Table 7-4 shows the perception of *Contractors* regarding the obstacles and barriers affecting construction performance. They perceived "insufficient equipment" to be somewhat important with a mean value of 3.09 and is ranked 3 Likert Weighted Ranking Table. Four obstacles were however perceived as moderately important, and therefore ranked 4 on the Likert Weighted Ranking Table, these are “Weak government regulations and instructions” with a mean value of 5.18, “Weakness of contract document” with a mean value of 5.14, also “Non-conducive organizational culture” has a mean value of 5.14, and “Non-cooperation among stakeholders” with a mean value of 4.82. None of the obstacles were perceived as important, but six of the obstacles were perceived to be very important and these include “Insufficient conditions for awarding of projects and criteria for Contractor selection” with a mean value of 6.14, “Bureaucracy and lack of transparency” with mean value of 6.05 “Lack of motivation to improve and achieve superior performance” with mean value of 5.91, “Inconsistent measurement approaches” with mean value of 5.86, “Lack of sufficient skills and training” with mean value of 5.82, and “Weakness in the application of the regulations and instructions” with mean value of 5.36. The two top obstacles which Contractors perceived as extremely important are “Lack of standards, specifications and data” with mean value of 6.65, and “Inadequate planning and strategies” with mean value of 6.45.

Table 7-5: Consultants' perception of obstacles and barriers

Obstacles	Mean Values
Bureaucracy and lack of transparency	6.68
Lack of standards, specifications and data	6.63
Inconsistent measurement approaches	6.63
Weakness in the application of the regulations and instructions	6.63
Weakness of contract document	6.47
Insufficient conditions for awarding of projects and criteria for Cont. selection	6.00
Inadequate planning and strategies	5.89
Non conducive organizational culture	5.16
Lack of motivation to improve and achieve superior performance	5.05
Non-cooperation among stakeholders	4.89
Weak government regulations and instructions	4.83
Lack of sufficient skills and training	4.00
Insufficient equipment	3.32

In Table 7-5 *the Consultants* perceive “Insufficient equipment” as somewhat important since it had a mean value of 3.32 and therefore ranked 3 on the Likert Weighted Ranking

Table. “Lack of sufficient skills and training” which has a mean value of 4.00 is perceived by the Consultants to be moderately important and ranked 4 in the Likert Weighted Ranking Table. Further, the Consultants ranked four obstacles as important to the failure of construction performance, these include “Non-conducive organizational culture” with a mean value of 5.16, “Lack of motivation to improve and achieve superior performance” with a mean value of 5.05, “Non-cooperation among stakeholders” with a mean value of 4.89, and “Weak government regulations and instructions” with a mean value of 4.83.

Two obstacles were perceived as very important by the Consultants and these are “Insufficient conditions for awarding of projects and criteria for Contractor selection” with a mean value of 6.00, and “Inadequate planning and strategies” with a mean value of 5.89. However, four obstacles were perceived to be extremely important, these include “Bureaucracy and lack of transparency” with a mean value of 6.68, “Lack of standards, specifications and data” with a mean value of 6.63, “Inconsistent measurement approaches” with a mean value of 6.63, “Weakness in the application of the regulations and instructions” with a mean value of 6.63 and “Weakness of contract document” with a mean value of 6.47. Furthermore, from Table 22, it is clear that there is no a significant difference between the three types of organisations for most of the questions regarding the obstacles.

7.3.1.2 Factor Analysis Result

To assess the sufficiency of the questionnaires data regarding obstacles and barriers affecting performance of construction projects for factor analysis, the KMO test was used for the 13 obstacles and barriers affecting performance of construction projects. The overall KMO value of 13 obstacles and barriers is 0.654 that is considered as “good”. The value of Barlett Test of Sphericity is 230.665 and associated significant level is small (p=0.000). These suggest that the population correlation matrix is not an identity matrix. As well as, 12 out of 13 obstacles and barriers significant factors were extracted using the principal components (PC) method that was preferred because it analyses all variances in the items to minimise various correlated factors into a smaller number of underlying factors as recommended by Albogamy *et al*. (2013). Using 0.50 as the cut-off value, one items out of the original 13 were deleted and the remaining 12 factors were appropriate for factor analysis.

In this study, Table 19 shows the four principal components for a set of associated variables that were grouped and classified based on their factor loadings which in turn referred to the degree of association of a variable with the component. A variable which appears to have the highest loading in one component belongs to that component. The total variance of the four principal components is almost 61.2% and is divided as 24.98%, 16.54%, 9.89% and 9.74% respectively. The four principal components are: -

- Principal Component 1: Management Capabilities
- Principal Component 2: Regulations and Measurement System
- Principal Component 3: Tendering Process
- Principal Component 4: Standards and Specifications

From the factor analysis of obstacles and barriers it can be divided into four components of which management capabilities have the greatest explanatory power followed by regulations and measurement systems. Referring to Table 7-7, five variables (obstacles) are inserted under *Principal Component 1* which is termed "Management Capabilities". This is due to the fact that the majority of them relate to regulations and instructions, planning and strategies, cooperation among stakeholders and organizational culture which is dominated by managerial capabilities; Weak Gov. regulations and instructions (p = 0.822), Bureaucracy and lack of transparency (p = 0.822), Inadequate planning and strategies (p = 0.805), Non-cooperation among stakeholders (p = 0.724) and Non conducive organizational culture (p = 0.667). *Principal component 2* is termed "Regulations and Measurement System".

It comprises three obstacles that are concerned with measurement approaches and CSFs, regulations and instructions application, and standards, specifications and data; Inconsistent measurement approaches and CSFs (p = 0.874), Weakness in the application of the regulations and instructions (p = 0.829) and Lack of standards, specifications and data (p = 0.569). *Principal Component 3* related to "Tendering Process" including three obstacles. However, two obstacles are retained; Insufficient conditions for awarding of projects and criteria for contractor selection (p = 0.679), weakness of contract document (p = 0.657). Whereas, Lack of motivation to improve and achieve superior performance is excluded as a consequence of its factor loading result is below the cut-off level that is (p = 0.450). *Principal Component 4* is termed "Human resource and equipment", and relates to skills and training, and equipment; Lack of sufficient skills and training (p = 0.791) and Insufficient equipment (p = 0.614).

7.3.2 Hypothesis Testing for *H1* to *H5*

The analysis of variance (ANOVA) statistic was used to investigate views on the obstacles regarding whether they varied significantly with years of experience. No significant differences were found at the 5% level of significance.

For obstacles and barriers affecting the performance of construction projects in Saudi municipalities, all the mean values resulting from the analysis were significantly greater than the midpoint (4) which supported H_1 to H_5, with the exception of H_6. In Table 7-11, H_1 related to “Weak Government regulations and instructions" and “Weakness in the application of the regulations and instructions”, both of which have mean values of 6.18 and 6.13 respectively. H_2 is validated by the result of “Lack of standards, specifications and data”, which has a mean value of 6.55. Furthermore, H_3 is validated by the results of “Insufficient conditions for awarding of projects and criteria for Contractor Selection" and “Weakness of contract document”, which have mean values of 6.55 and 5.93 respectively. Also, Inadequate planning and strategies” supports the acceptance of H_4, which has a mean value of 6.18. H_5 is also supported by the results of five obstacles which include “Bureaucracy and lack of transparency, “Lack of motivation to improve and achieve superior performance”, “Lack of sufficient skills and training”, “Non-cooperation among stakeholders”, and “Non conducive organizational culture, all of which have values of 5.07, 4.92, 4.45, 3.57, and 6.37 respectively.

7.3.3 Discussion of Hypothesis Testing Result for H1 to H5

The perception of the three types of business activities are all slightly similar in ranking of the obstacles as shown in the above three Tables and in the respective discussions. While the perceptions are similar in eight obstacles, there are differences in the perceptions for five obstacles. Table 7-6 shows the comparison of the perceptions concisely. All three business activities perceive “insufficient equipment” as somewhat important, this perception is rather low and contradicts Sugiharto, et al. (2002) who reported that “equipment shortages” are part of the most important factors affecting the construction industry of most developing nations. Also, “Non-conducive organisational culture” were perceived to have low relevance by all three business activities, this also contradicts Sugiharto, et al. (2002) as they also reported that "imbalances in organisational structure" is one of the most important factors affecting the construction industry of most developing nations. More so, organizational culture has been identified as one of the essential factors that affect the efficiency and productivity of a firm. Also, the performance of construction organizations is positively affected by their organizational cultures (Uddin, et al. 2013). Government officials considered "Non-conducive organisational culture" to be slightly important while the Contractors and Consultants regard it as important, this contradiction may have arisen because SA construction organisations regard these obstacles as less important in relation the highly scored obstacles, hence, they are comparing only the obstacles presented to them in the questionnaire.

While Government officials perceived "Non-cooperation among stakeholders" to be moderately important, the Contractors and Consultants perceive it to be important. Also, Government officials and Consultants officials perceived "Lack of sufficient skills and training" to be moderately important, the Contractors perceive it to be very important. However, there is divergence in the perception of all three business activities regarding their perception of "Lack of motivation to improve and achieve superior performance", "Inadequate planning and strategies" and "Weakness of contract document. The perceptions of moderately important, important, very important, and extremely important all support previous research by Al-Khalil & Al-Ghafly (1999a) which highlight them as factors which cause delay in the Saudi construction industry. However, based on the perceptions of the business activities, the leading obstacles that must be considered in the construction project of Saudi municipalities are as follows:

1. Lack of standards, specifications and data;
2. Bureaucracy and lack of transparency;
3. Weak government regulations and instructions;
4. Inconsistent measurement approaches;
5. Weakness in the application of the regulations and instructions;
6. Insufficient conditions for awarding of projects and criteria for Contractor selection; and
7. Weakness of contract document.

These obstacles have been ranked from important, very important and extremely important by each of the business activities respectively and in their overall means. The ranking of these obstacles support previous studies that were conducted to identify the causes of delay in performance of municipality projects in SA (Abd Elshakour, et al. 2012; Al-Kharashi & Skitmore, 2009).

The results of the mean values and their rankings as analysed above are supported by the factor analysis of obstacles and barriers affecting performance of construction projects. The data regarding obstacles and barriers that affect performance of construction projects were classified according to the opinions of the various respondent groups in terms of the degree of their influence on performance. During the analysis, the relationship among the 13 variables of obstacles was also investigated by applying the factor analysis approach to reduce the number of variables. Thus, principal component factor analysis technique was executed to identify interrelated obstacles and barriers that can be dealt with as sub-sets of one component to represent relationships among a group of obstacles and barriers.

Table 7-6: Respondents' perception of obstacles and barriers

No.	Questions	Organisations			Mean	Differences
		Gov.	Cont.	Cons.		
1	Lack of standards, specifications and data	6.37	6.65	6.63	6.55	Gov. to Cont. is (p value <0.524) and cons. is 0.559 Cont. to cons. is (p value 1.000)
2	Bureaucracy and lack of transparency	6.42	6.05	6.68	6.37	Gov. to Cont. is (p value <0.344) and Cons. is 0.611 Cont. to Cons. is (p value 0.051)
3	Weak government regulations and instructions	6.83	5.18	6.83	6.18	Gov. to Cont. is (p value <0.002) and Cons. is 0.986 Cont. to Cons. is (p value<0.001)
4	Inconsistent measurement approaches	6.11	5.86	6.63	6.18	Gov. to Cont. is (p value <0.558) and Cons. is 0.083 Cont. to Cons. is (p value 0.005)
5	Weakness in the application of the regulations and instructions	6.53	5.36	6.63	6.13	Gov. to Cont. is (p value <0.003) and Cons. is 0.951 Cont. to Cons. is (p value 0.001)
6	Insufficient conditions for awarding of projects and criteria for Cont. selection	5.95	6.14	6.00	6.03	Gov. to Cont. is (p value <0.797) and Cons. is 0.984 Cont. to Cons. is (p value 0.888)
7	Weakness of contract document	6.32	5.14	6.47	5.93	Gov. to Cont. is (p value <0.001) and Cons. is 0.868 Cont. to Cons. is (p value 0.000)
8	Inadequate planning and strategies	4.16	6.45	5.89	5.55	Gov. to Cont. is (p value <0.001) and Cons. is 0.000 Cont. to Cons. is (p value 0.087)
9	Lack of motivation to improve and achieve superior performance	4.11	5.91	5.05	5.07	Gov. is significantly lower than others (p value <0.002) and Cont. is significantly higher than Cons. (p value 0.004)
10	Lack of sufficient skills and training	3.79	5.82	4.00	4.92	Gov. to Cont. is (p value <0.001) and Cons. is 0.000 Cont. to Cons. is (p value 0.017)

11	Non-cooperation among stakeholders	3.58	4.82	4.89	4.45	Gov. to Cont. is (p value <0.001) and Cons. is 0.000 Cont. to Cons. is (p value 0.963)
12	Non conducive organizational culture	2.32	5.14	5.16	3.57	Gov. to Cont. is (p value <0.001) and Cons. is <0.001 Cont. to Cons. is (p value 0.997)
13	Insufficient equipment	2.84	3.09	3.32	3.08	Gov. to Cont. is (p value <0.720) and Cons. is 0.335 Cont. to Cons. is (value 0.764)

Table 7-7: Factor analysis of obstacles and barriers

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Obstacles and Barriers	FL
1	Management Capabilities	24.98	24.98	5.52	27.0	Weak Gov. regulations and instructions	0.822
						Bureaucracy and lack of transparency	0.822
						Inadequate planning and strategies	0.805
						Non-cooperation among stakeholders	0.724
						Non conducive organizational culture	0.667
2	Measurement System	41.52	16.54	1.94	15.0	Inconsistent measurement approaches and CSFs	0.874
						Weakness in the application of the regulations and instructions	0.829
						Lack of standards, specifications and data	0.569
3	Tendering Process	51.40	9.89	1.33	10.2	Insufficient conditions for awarding of projects and criteria for contractor selection	0.679
						weakness of contract document	0.657
						Lack of motivation to improve and achieve superior performance	0.450
4	Human resource and equipment	61.15	9.74	1.17	9.0	Lack of sufficient skills and training	0.791
						Insufficient equipment	0.614

KMO Measure of Sampling Adequacy is 0.654;
Barlett Test of Sphericity is 230.665, significant level is ($p<0.001$).

7.3.4 Hypothesis Testing for *H6*

This section presents the results of the test of ***Hypothesis 6***: -

> ***H6****: The absence of a PMS (in Saudi construction municipal projects) leads to poor project performance and outcomes.*

Six questions in the questionnaire were used to collect data for testing this hypothesis, the questions relate to practice, experience and training in PMSs, and the questions asked the respondents whether they have practiced performance measurement, have experience in it or have received training on performance measurement. The results of the questions can be seen in Table 7-8 and Figure 7-2.

Table 7-8: Received training, experience and practiced PMSs

Organisation's Activities	No	Training	Experience	Practice
Government officials	38	0.00%	0.00%	0.00%
Contractors	44	11.36%	6.81%	0.00%
Consultants	38	15.78%	13.15%	5.26%
Total	120	9.04%	6.65%	1.75%

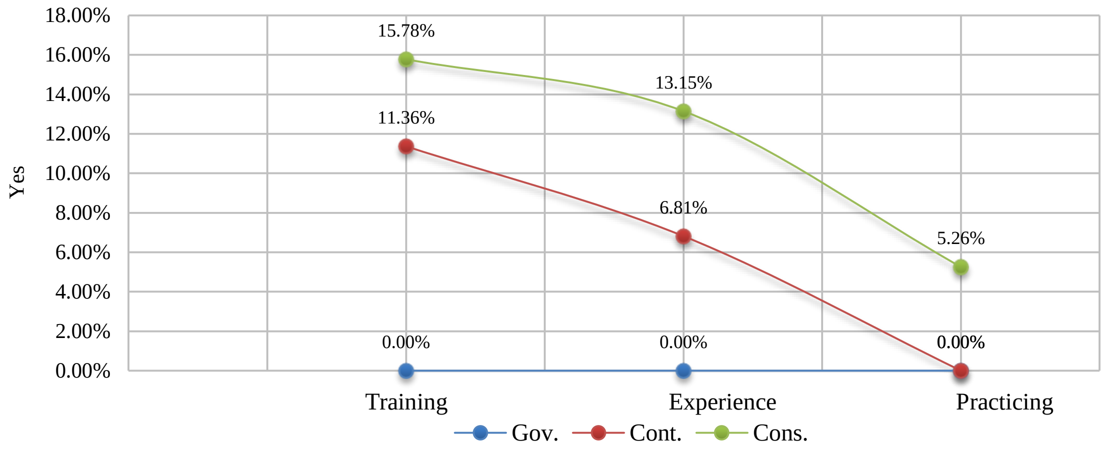

Figure 7-2: Received training, experience and practiced in PMSs

7.3.4.1 Received Training

Regarding training, the respondents were asked to indicate whether they had received any training in PMSs. If respondents answered "Yes", they were asked to specify in greater detail what kind of training they received. The results show that Government officials have not received any training at all on the subject. Only 11.36% of contractors indicated that training was provided to them. Consultants represented the biggest number with 15.78% having received training on PMSs; although, it is still a very small number. Government officials also indicated that they did not practice PMSs, they have no experience in measuring performance, and, as noted above, they had had no training in PMSs. These results are alarming, because, as noted previously, PMSs are a significant component of successful construction project management. Furthermore, there is clearly a lack of training within Saudi construction project management sector.

7.3.4.2 Experience

The subsequent question assessed whether government officials, contractors, and consultants have experience in PMSs. Again, government officials indicated that no training had been provided for them in the subject. Only 6.81% of contractors and 13.15% of consultants had experience in measuring performance of construction projects. Again, government officials indicated that no experience had been provided for them in the subject. Similarly, all three categories of respondents had little knowledge on construction project performance measurement.

7.3.4.3 Practice

This question examined whether respondents practice any PMSs in the construction project context. None of the government officials and contractor answered "Yes" to this question. Only 5.26% of those who responded two consultants (2 of 38) indicated that they measure performance. Once more, these low levels of responses indicate a lack of appreciation of performance measurement of municipal construction projects in SA.

7.3.4.4 Performance Measurement Models Known and Used

This question subsequently elaborated on the subject and asked respondents to indicate whether they were aware of any of the four PMSs:

- Key Performance Indicators,
- Balance Scorecard,
- European Foundation Quality Management, and
- The Malcolm Baldrige National Quality Award.

The respondents were asked to indicate whether they knew these systems and whether they are using them. The results can be seen in Table 7-9.

Again, government officials had the lowest agreement rate. Only (2) of those who responded indicated that they were aware of only Key Performance Indicators. None of the other three PMSs were indicated as known by government officials. Contractors were better placed this time as KPI were known to 23% of them, Balance Scorecards and European Foundation Quality Management System were both known to 9% of them, and the Malcolm Baldrige National Quality Award System was known to (2) of them. However, none of the contractors were using these PMSs. 19% percent of consultants indicated that they knew and used all four PMSs. These results therefore suggest that consultants are ahead in terms of construction project management performance measurement in SA compared to government officials and contractors.

Table 7-9: PMSs Known and Used

Organisation's Activities		KPIs		BSc		EFQM		MBNQA	
		Known	Used	Known	Used	Known	Used	Known	Used
Gov.	**Mean**	0.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	N	38	38	38	38	38	38	38	38
Cont.	**Mean**	0.23%	0.00%	0.09%	0.00%	0.09%	0.00%	0.05%	0.00%
	N	44	44	44	44	44	44	44	44
Cons.	**Mean**	0.26%	0.00%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%
	N	38	38	38	38	38	38	38	38
Total	**Mean**	0.18%	0.00%	0.07%	0.00%	0.03%	0.00%	0.02%	0.00%
	N	120	120	120	120	120	120	120	120

7.3.4.5 Performance Measures practiced and Performance Assessment Techniques

Table 7-10 shows two questions simultaneously assessed which of 10 performance measures and the respondents use assessment techniques to evaluate project performance. Government officials indicated that project time and project costs are the key measures for them. Project quality and initial project viability and feasibility were indicated as being important with response level of 21% and 5% respectively. However, none of the remaining six measures were indicated by government officials as being significant. For contractors and consultants the same two measures came up as being the most significant. Similar to government officials, they indicated project quality and initial project viability and feasibility as also being significant. However, in terms of PMs, contractors indicated nine as opposed to consultants who indicated six measures as being significant. Surprisingly, neither government officials, nor contractors or consultants indicated that they were using any of the assessment techniques to evaluate project performance. This therefore suggests that although certain construction project PMs are important to the parties involved, none of them are using any of these techniques to evaluate project performance.

Table 7-10: Performance measures practiced and techniques

Measures	Organisation's Activities						Total	
	Gov.		Cont.		Cons.			
	Used	Technique	Used	Techniques	Used	Techniques	Used	Technique
Viability and feasibility	0.05	0.00	0.45	0.00	0.16	0.00	0.23	0.00
Construction process	0.00	0.00	0.09	0.00	0.05	0.00	0.05	0.00
Time	1.00	0.00	0.91	0.00	1.00	0.00	0.97	0.00
Cost	1.00	0.00	0.91	0.00	1.00	0.00	0.97	0.00
Productivity	0.00	0.00	0.14	0.00	0.11	0.00	0.08	0.00
Quality	0.21	0.00	0.27	0.00	0.21	0.00	0.23	0.00
Efficiency measures	0.00	0.00	0.05	0.00	0.00	0.00	0.02	0.00
Effectiveness measures	0.00	0.00	0.05	0.00	0.00	0.00	0.02	0.00
Stakeholders' satisfaction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Teamwork management	0.00	0.00	0.05	0.00	0.00	0.00	0.02	0.00

Referring to Table 7-8 where practice, experience and training aspects were investigated and the results analysed, the results indicated that there is a severe lack of attention to these aspects. This is confirmed by the results of the questions regarding PMSs known and used in Table 7-9, which found that there is also a weakness and lack of awareness for models practised. In order to be sure to what extent the concept of performance measurement is practised and how performance is judged, the last question asked to the respondents related to what aspects of construction projects that they focused on and also the types of measurement techniques they use as shown in Table 7-10. The results were consistent with the previous answers, which showed that focus is only on some traditional measures, such as cost and time, and with no measurement techniques being mentioned. This illustrates that the various participant groups have the same perception about practice, experience, training, as well as PMSs and types of PMs. Also, for hypothesis H_6, it is clear from *Q13* that the obstacles and barriers affecting the performance of construction projects in Saudi municipalities have mean values that are significantly greater than the midpoint (4), which supports *H6*. As a result, the answers to *Q7* and *Q12* validate hypothesis *H6.*

The results of the sub-hypothesis test are detailed in Table 7-11. This shows that all the alternative sub-hypothesis (*H1-H6*) have been validated and should be accepted. It confirms that poor performance measurement has a direct impact on construction project success in poor municipal construction projects in SA is linked to poor performance measurement. The findings of the test of hypothesis support previous outcomes of studies that show that the municipal construction industry face significant efficiency and effectiveness measurement problems in the implementation of construction projects. Contractors and consultants are heavily involved in project implementation in SA (Al-Khalil & Al-Ghafly, 1999a), unfortunately however, as found by the test of hypothesis in this study, they do not possess some of the necessary skills and competencies such as the understanding and application of performance measurement frameworks, including CSF, PMs and PSMS, and benchmarking, that are required for the achievement of construction project objectives.

It also supports the finding of apathy regarding the lack of application of control and performance measurement techniques in the global construction industry (Haponava & Al-Jibouri, 2009; Beatham, et al. 2004). It is not surprising therefore that these techniques are not applied in the Saudi construction industry. Al-Hammad, (1995) reported that project goals are neither achieved nor integrated with the general economic strategy in SA because of a lack of consideration for project planning at the pre-implementation stage. Further, public officials do not even consider the golden triangle of project management in the award of projects in SA, Assaf & Al-Hejji, (2010) highlighted the absence of basic PMs which include time, cost and quality, and Al-Khalil & Al-Ghafly, (1999a) reported that public authorities in SA do not consider important qualitative and quantitative criteria in the award of projects. Assaf, et al. (1995) reported that poor and insufficient planning are responsible for project failures in SA.

Table 7-11: Hypothesis acceptance result

	Hypothesis	Questions used	Mean values	P values (difference from 4)	Comment
1	***Weakness of regulation and poor instructions in their application to construction projects has a negative effect on performance and outcomes.***	Were Gov. regulations and instruction weak	6.18	<0.001	Accept H_{a1}
		There were weak application of regulations and instruction	6.13	<0.001	
2	***The lack of standards, specification, and data results in unsatisfactory performance and results in construction projects.***	Lack of standards, specifications and data	6.55	<0.001	Accept H_{a2}
3	***Poor conditions for awarding contracts, and poor criteria for contractor selection leads to poor performance and outcomes.***	Weakness of contract document	5.93	<0.001	Accept H_{a3}
		Insufficient conditions for awarding of projects and criteria for contractor selection	6.03	<0.001	
4	***Inadequate planning and strategies is associated with poor performance and outcomes.***	Inadequate planning and strategies	5.55	<0.001	Accept H_{a4}
5	***Poor management skills and people skills, also, unqualified managers leads to poor performance and outcomes.***	Lack of motivation to improve and achieve superior performance	5.07	<0.001	Accept H_{a5}
		Lack of sufficient skills and training	4.92	<0.001	
		Non conducive organizational culture	3.57	<0.020	
		Non-cooperation among stakeholders	4.45	<0.003	
		Bureaucracy and lack of transparency	6.37	<0.001	
6	***The absence of a PMS (in Saudi Municipal Projects) leads to poor project performance and outcomes.***	Inconsistent measurement approaches	6.18	<0.001	Accept H_{a6}
		Questions used	**Per cent**		
		Received any training about PMSs	5.00	<0.001	
		Experience in measuring performance	5.00	<0.001	
		Practice in PMSs in the construction projects	3.40	<0.001	
		PMSs **Known**	7.50	<0.001	
		PMSs **Used**	0.00	<0.001	

7.4 Analysis and Ranking of Variables

7.4.1 Measurement Components Process:

The descriptive result below show the result of the question of the extent to which the respondents agree that the 10 performance measurement processes listed are appropriate and applicable to determine and measure project performance and success across of project stages continuingly. The results show that all three organisations agree totally that the performance measurement process can efficiently and effectively measure a project's performance and success. The mean values of 7.00, 6.95, and 7.00 for government officials, contractors and consultants respectively confirm that all three organisations agree on appropriateness and applicability of these measurement process. The overall mean value of 6.98 also corroborates this result that shown in Table 7-12 and Figure 7-3.

Table 7-12: Respondents' perception for performance measurement processes

Measurement Process:	Organisations			Mean
	Gov.	Cont.	Cons.	
1-Identify what to be measured, 2-Define measures, 3-Collect Data, 4-Calculate measures, 5-Report the result, 6-Analyse the result, 7–Benchmarking, 8-Learn from best practice, 9-Take action & 10-Measure again	7.00	6.95	7.00	6.98

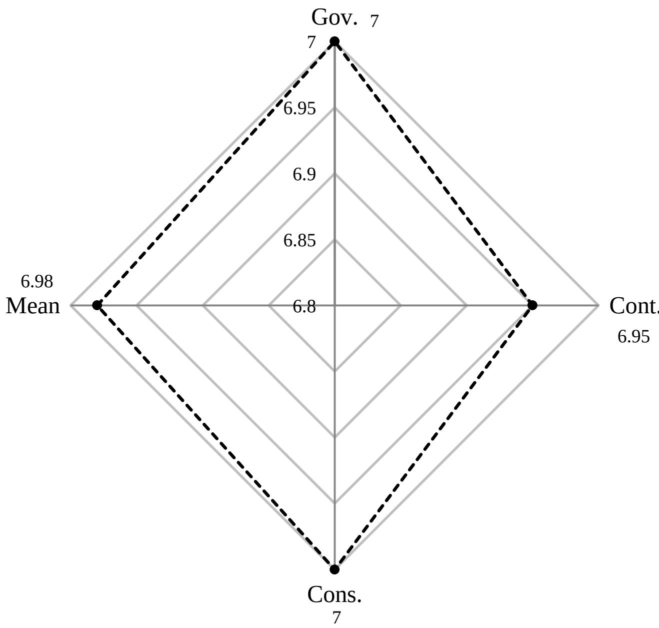

Figure 7-3: Respondents' perception for performance measurement processes

7.4.2 Critical Success Factors at Project Stages

The ANOVA test is performed to examine the perceptions of key stakeholders, including government officials, consultants, and contractors with regards to CSFs in construction projects over different projects stages, are, conceptual, planning & tender, production, and operation.

7.4.2.1 Success Factors of Conceptual, Planning and Tender stage

As can be seen from the Table 7-13 and Figure 7-4, the contractor selection criteria are the key CSF for government officials. The other important CSFs at the conceptual, planning & tender stage are coordination and vision, as well as the integration of the project with national plans. Budget and risk are more important to contractors at the conceptual, planning & tender stages than for consultants and government officials. Adequacy of design details, transparency in the procurement process, as well as strategic alignment of project goals with stakeholders' interests are all significant CSFs for contractors. For consultants, coordination & vision, contractor selection criteria, and adequacy of design are significant CSFs.

The variance of budget at this stage is significant ($P<0.05$) between government officials and contractors, as well as between contractors and consultants. Furthermore, the table shows that transparency in the procurement process and budget are the top priorities for the contractor. The meaningful and subjective CSFs for the government officials are both "transparency in the procurement process" and "project duration". There are also other factors such as standards and specification, contractor selection criteria, and transparency in the procurement process that are not significant ($P>0.05$); in this case the null hypothesis, that there is no differences between the stakeholders in terms of the consideration of these CSFs, is supported. The mean values confirm that the organisations are all agreed that 7 CSFs are extremely important, however, another following six CSFs are ranked as very important, but the variance between them is quite low. The remaining seven CSFs are ranked between important and moderately important.

Table 7-13: Critical success factors of conceptual, planning and tender stage

No.	Critical Success Factors	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	Cont.	Cons.		
1	Contractor selection criteria	7.00	6.77	6.95	6.90	No significant differences
2	Adequacy of design details	6.89	6.86	6.89	6.88	No significant differences
3	Coordination and vision	6.84	6.73	6.95	6.83	No significant differences
4	Integration the project with national plans	6.84	6.68	6.68	6.73	No significant differences
5	Strategic alignment of project goals with stakeholders' interests	6.37	6.77	6.74	6.63	No significant differences
6	Transparency in the procurement process	6.11	6.91	6.79	6.62	Gov. v Cont. P = 0.001
7	Standards and specifications	6.58	6.32	6.58	6.48	No significant differences
8	Budget	5.53	6.77	5.63	6.02	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
9	Project duration	6.11	6.73	4.42	5.80	Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001
10	Top management support	5.74	5.32	6.21	5.73	Cont. v Cons. P < 0.002
11	Procurement & delivery strategy	6.00	5.05	5.79	5.58	Gov. v Cont. P < 0.004
12	Risk	4.11	6.32	5.74	5.43	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
13	Relationship among stakeholders	3.95	5.95	5.89	5.30	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
14	Fast decision making process	4.11	5.45	5.68	5.10	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
15	Transfer of experience and best practice	5.37	4.45	5.37	5.03	No significant differences
16	Economic (stable economic conditions and economic policy)	4.89	3.82	5.26	4.62	Gov. v Cont. P = 0.003, Cont. v Cons. P < 0.001
17	Comprehensive project review and feedback	3.16	4.05	5.84	4.33	Gov. v Cont. P = 0.004, Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001
18	Training	2.21	4.23	4.84	3.78	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
19	Project attributes (type, size, objective, location)	2.84	4.00	4.16	3.68	Gov. v Cont. P < 0.004, Gov. v Cons. P < 0.002
20	Innovation	2.58	2.23	5.63	3.42	Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001

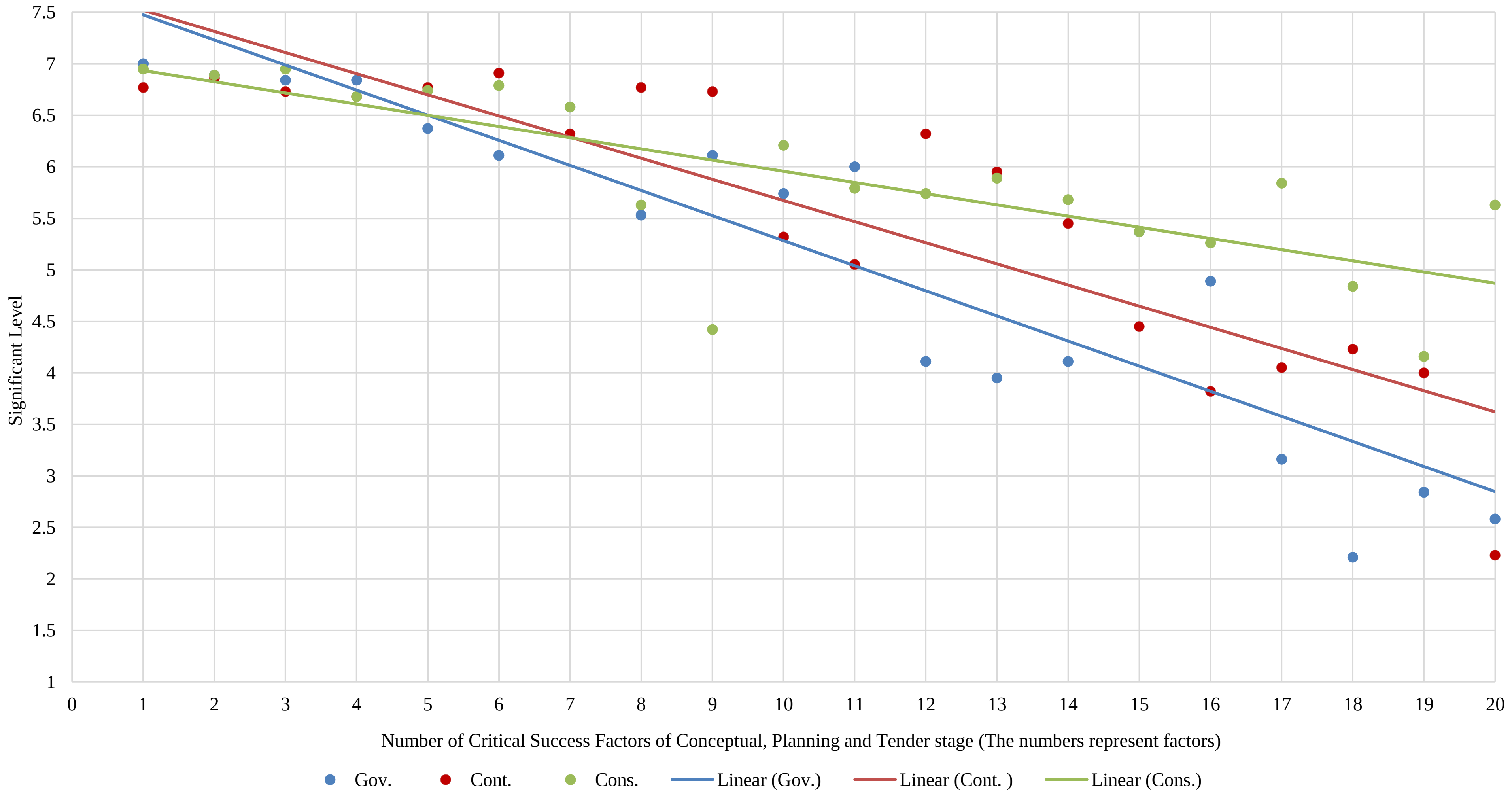

Figure 7-4: Critical success factors of conceptual, planning and tender stage

7.4.2.2 Critical Success Factors of Production Stage

In the production stage, it is shown in Table 7-14 and Figure 7-5 that participants representing key stakeholders differ in their perception of the importance of certain CSFs. These CSFs are risk and speed of delivering the product to end use ($p<0.5$). The latter is particularly important for government officials (the client) rather than other stakeholders. Project duration, budget and standards & specification are high in the agenda for all the key stakeholders at the production stage. The seven top CSFs listed are ranked as extremely important with no significant differences among the three organisations, the next seven factors are graded as very important while the variance between the three organisations are slightly different in some of the CSFs, in others there are no noticeable differences at all. The next fifteen CFSs are considered as important, while the last eight are moderately important, both two last groups are generally slightly varied between the three groups' perceptions.

The table also illustrates that various participant groups have the same perception about CSFs for large-scale construction projects. In this stage, the most important factors are project duration, budget, standards and specifications, adequacy of design details and specifications, schedule of project construction, sequencing of work according to schedule, and sufficient work skills and mechanisms have the same priorities for all stakeholders.

Table 7-14: Critical success factors of production stage

NO	Critical Success Factors	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	Cont.	Cons.		
1	Project duration	6.95	7.00	6.95	6.97	No significant differences
2	Budget	6.95	7.00	6.95	6.97	No significant differences
3	Standards and specifications	6.74	6.82	6.95	6.83	No significant differences
4	Adequacy of design details	6.63	6.77	6.84	6.75	No significant differences
5	Schedule project construction	6.47	6.86	6.79	6.72	No significant differences
6	Sequencing of work according to schedule	6.42	6.41	6.47	6.43	No significant differences
7	Sufficient work skills and mechanisms	6.68	6.14	6.42	6.40	No significant differences
8	Sufficient resources allocation	5.84	6.05	5.42	5.78	No significant differences
9	Quality control	5.11	5.73	5.79	5.55	No significant differences
10	Documentation and Reports	5.11	5.59	5.58	5.43	No significant differences
11	Speed of deliver the product to end-users	6.84	4.09	5.37	5.37	Gov. v Cont. $p < 0.001$, Gov. v Cons. $p = 0.001$, Cont. v Cons. $p < 0.001$
12	Fragmentation of project activities	5.11	5.00	6.00	5.35	Gov. v Cons. $P = 0.003$, Cont. v Cons. $p < 0.002$
13	Adequate team capability (technical skills, communication, commitment, experience and qualification)	4.89	5.86	5.16	5.33	Gov. v Cont. $P = 0.005$
14	Capability of project manager	5.00	5.82	5.00	5.30	No significant differences
15	Cash flow	4.84	5.23	5.68	5.25	Gov. v Cons. $p = 0.006$
16	Disputes between owner and project parties	5.16	5.64	4.89	5.25	No significant differences
17	Good project management structure	4.84	5.14	5.58	5.18	No significant differences
18	Risk	4.05	5.73	5.26	5.05	Gov. v Cont. $p < 0.001$, Gov. v Cons. $p < 0.001$
19	Efficiency in problem solving process	5.11	5.32	4.63	5.03	No significant differences
20	Transfer of experience and best practice	4.21	5.00	5.84	5.02	Gov. v Cont. $p = 0.007$, Cont. v Cons. $p < 0.005$, Gov. v Cons. $p < 0.001$
21	Absence of conflicts	4.68	5.32	4.89	4.98	No significant differences
22	Innovation	4.26	4.86	5.79	4.97	Cont. v Cons. $p = 0.004$, Gov. v Cons. $p < 0.001$,
23	Comprehensive project review and feedback	5.00	4.32	5.32	4.85	Cont. v Cons. $p < 0.002$

24	Relationship among stakeholders	4.05	4.91	5.32	4.77	Gov. v Cont. p = 0.005, Gov. v Cons. p < 0.001
25	Fast decision making process	3.79	4.86	5.63	4.77	Gov. v Cont. p < 0.001, Gov. v Cons. p < 0.001
26	Application of health and safety system	4.42	4.32	5.53	4.73	Gov. v Cons. p = 0.003, Cont. v Cons. p < 0.002
27	Sustainability	5.74	3.09	5.16	4.58	Gov. v Cont. p < 0.001, Cont. v Cons. p < 0.001
28	Project organization structure	4.37	5.05	4.05	4.52	No significant differences
29	Accessibility to reach to the site (location of project)	4.05	4.68	4.53	4.43	No significant differences
30	Top management support	4.21	3.45	5.68	4.40	Cons. v Gov. p < 0.001, Cons. v Cont. p < 0.001
31	Site meetings	2.79	4.82	5.32	4.33	Gov. v Cons. p = 0.001, Gov. v Cont. p < 0.001
32	Wastes around the site	4.11	4.00	4.84	4.30	Cont. v Cons. p < 0.007
33	Training	4.05	3.91	4.79	4.23	Cons. v Cont. p = 0.003
34	Quality training/meeting	2.95	3.91	4.79	3.88	Gov. v Cons. p < 0.001
35	Project attributes (type, size, objective, location)	2.32	5.23	3.79	3.85	Gov. v Cont. p < 0.001, Gov. v Cons. p < 0.001, Cont. v Cons. p < 0.005
36	Weather condition in the site	2.89	4.86	3.32	3.75	Gov. v Cont. p< 0.001, Cont. v Cons. p < 0.001
37	Using up to date technology	3.53	3.86	3.63	3.68	No significant differences

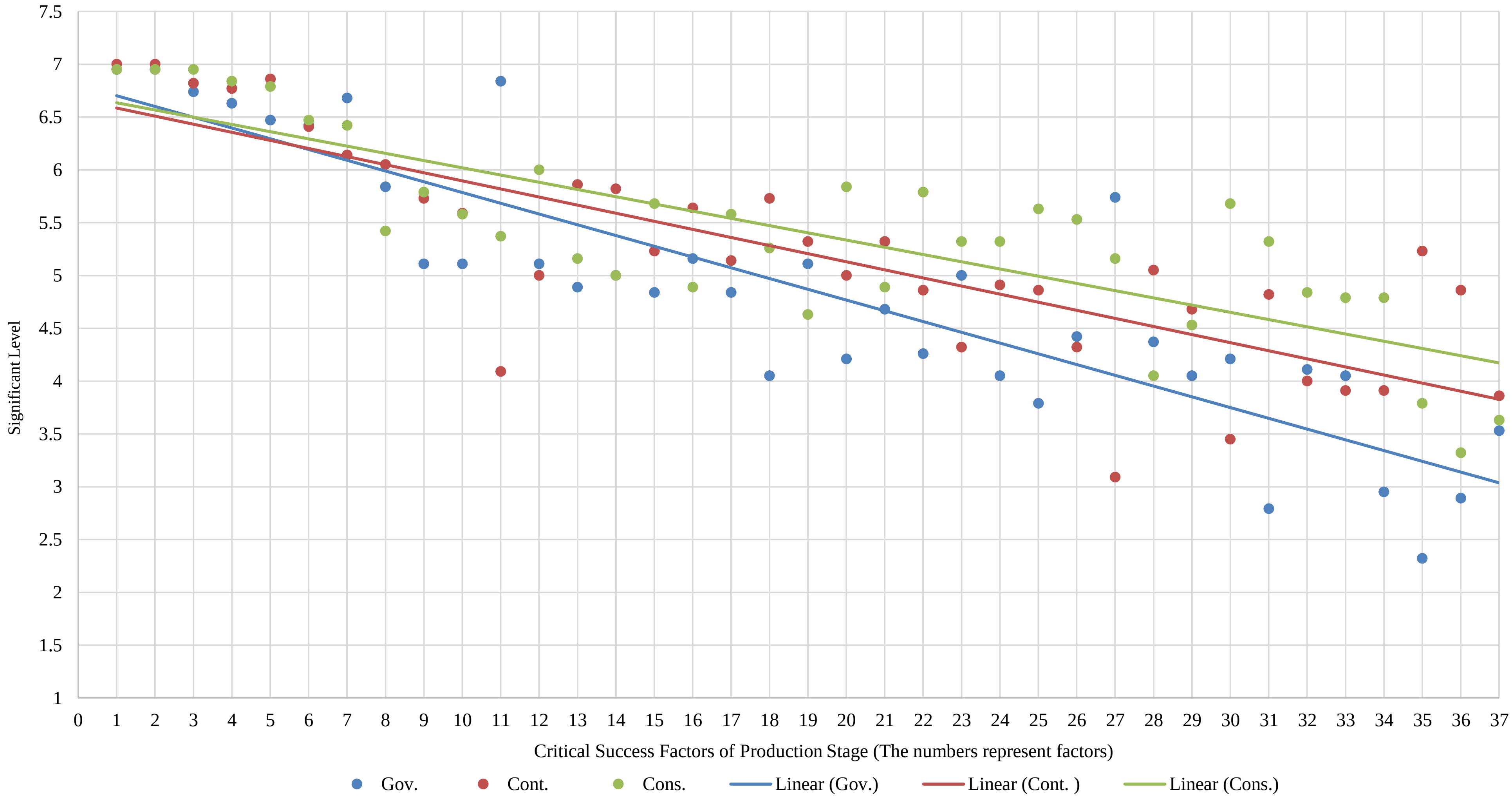

Figure 7-5: Critical success factors of production stage

7.4.2.3 Critical Success Factors of Operation Stage

Displayed in Table 7-15 and Figure 7-6 are a number of different CSFs with a range of levels of importance in the operation stage. Maintenance cost, speed of delivering the product to end-users, integrating the project with national plans and application of health and safety system take the priority especially for government officials and consultants but not for the contractor. At this stage, there are also some more noticeable differences between the rankings of CSFs across various stakeholders. While it is extremely important for the government officials and consultants, the contractors only consider them as important. Also, the regulatory documentation is higher in the agenda for consultants than application of health and safety systems, and the factor project attributes (type, size, objective and location) are of less importance for all stakeholders. The government officials and consultants are unanimous in their perception of the entire CSFs regarding their importance, but the contractors disagree with this perception. However, all three organisations agree that the bottom three CSFs are slightly important.

Table 7-15: Success factors of operation stage

NO	Critical Success Factors	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	Cont.	Cons.		
1	Maintenance cost	6.95	6.82	6.74	6.83	No significant differences
2	Maintenance time	6.79	6.77	6.74	6.77	No significant differences
3	Speed of deliver the product to end-users	6.68	5.86	6.72	6.42	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
4	Integration the project with national plans	6.58	5.14	6.68	6.13	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
5	Application of health and safety system	5.42	5.68	5.95	5.68	No significant differences
6	Documentation and Reports	4.84	2.73	6.26	4.52	Significant at P < 0.001 Gov. v Cont. P <0.001, Cont. v Cons. P < 0.001, Gov. v Cons. P < 0.001
7	Sustainability	4.84	3.23	4.42	4.12	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
8	Comprehensive project review and feedback	5.58	3.91	1.53	3.68	Significant at P< 0.001 Gov. v Cont. P <0.001, Cont. v Cons. P < 0.001, Gov. v Cons. P < 0.001
9	Waste around the site	3.37	2.82	4.11	3.40	No significant differences
10	Relationship among stakeholders	1.79	2.82	4.11	2.90	Gov. v Cont. P = 0.001, Cont. v Cons. P < 0.001, Gov. v Cons. P < 0.001
11	Innovation	2.32	1.91	3.11	2.42	Cont. v Cons. P < 0.001
12	Standards and specifications	1.79	1.73	3.11	2.18	Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001
13	Project attributes (type, size, objective, location)	1.95	1.45	1.68	1.68	No significant differences

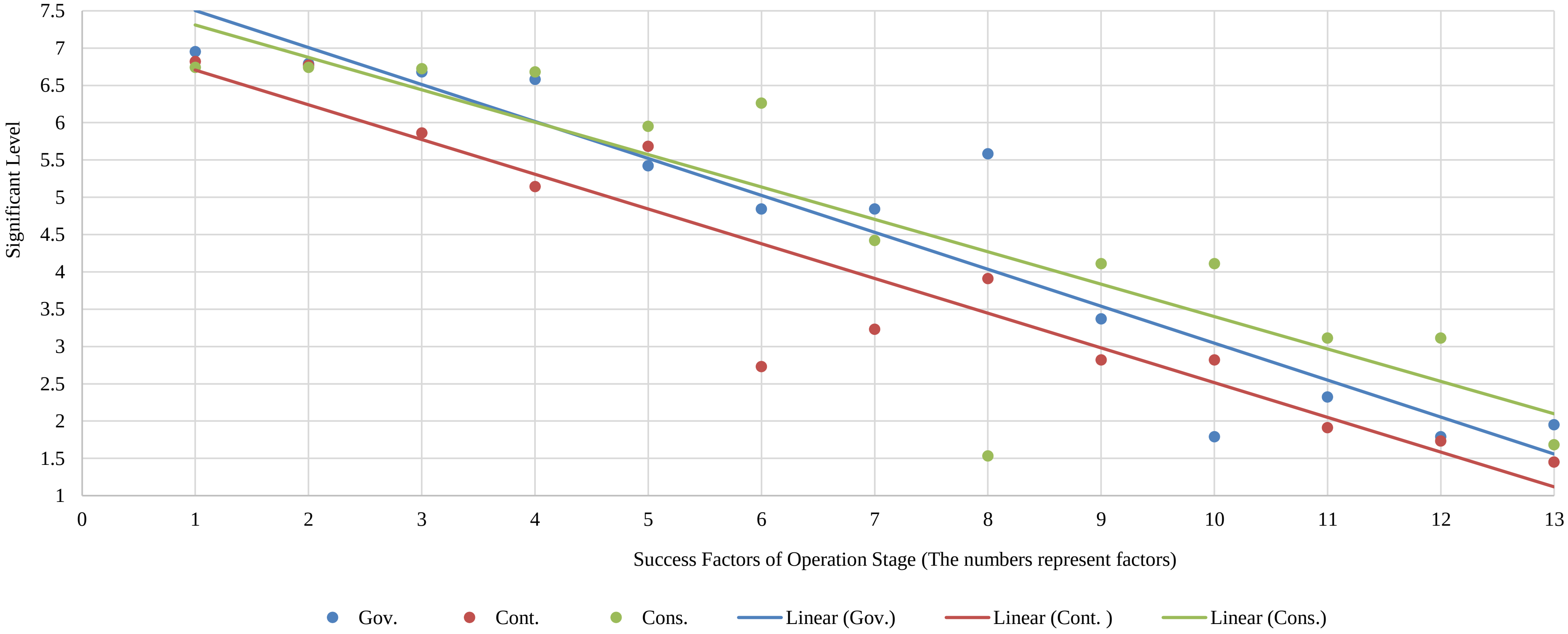

Figure 7-6: Success factors of operation stage

7.4.3 Project Performance Measures at Project Stages

After going over the detailed literature review, 77 important PMs were identified for construction projects. Respondents were asked to mark down their opinion, in terms of significance, of those PMs for SA's construction projects on a 7-point Likert scale. The scale ranks from 1 to 7, with 1 meaning "not important" to 7 meaning "extremely important". Furthermore, to examine the variance between the mean values of all the participants, ANOVA tests were undertaken. All of the questions were partially closed-ended questions in nature so that respondents could easily understand and answer them, thereby bringing an improvement to the response rating.

7.4.3.1 Measures of Conceptual, Planning and Tendering Stage

Table 7-16 and Figure 7-7 shows the list of 14 PMs for conceptual, planning, and tendering stages. Ranking of the total mean scores was done in accordance with their importance levels. From these 14 variables, eight of them were ranked to be "extremely important". For the top four measures, which were design cost, design time, tendering requirements, and relationship among stakeholders (average mean value = 6.85, 6.82, 6.78 and 6.62 respectively) there were not significant differences between the group of respondents (government officials, consultants and contractors). The next four measures were also rated as "extremely important". These were availability of contractor selection criteria, alignment of stakeholder's requirements, availability of specifications, and standards and planning. However, there is no consensus on the rank of importance among respondents in the three groups. Stakeholder involvement and leadership are considered as "very important" measures and ranked in the ninth and tenth positions with means 5.98 and 5.65 respectively. Regarding the stakeholder involvement measurement, there is a significant difference (p value less than 0.05) between government officials, consultants and contractors.

Table 7-16: Performance measures of conceptual, planning and tendering stage

No.	Measures	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	Cont.	Cons.		
1	Design Cost	6.89	6.77	6.89	6.85	No significant differences
2	Design Time	6.79	6.73	6.95	6.82	No significant differences
3	Tendering requirements	6.79	6.86	6.68	6.78	No significant differences
4	Relationship among stakeholders	6.53	6.59	6.74	6.62	No significant differences
5	Availability of contractor selection criteria	6.74	5.82	6.58	6.35	Gov. v Cont. P < 0.001, Cont. v Cons. P = 0.003
6	Alignment of stakeholder's requirements	5.95	6.41	6.58	6.32	Gov. V Cons. P = 0.023
7	Availability of specifications and standards	6.00	6.05	6.84	6.28	Gov. v Cons. P = 0.001, Cont. v Cons. P = 0.001
8	Planning	5.89	5.95	6.74	6.18	Gov. v Cons. P = 0.05, Cons. v Cont. P = 0.007
9	Stakeholder involvement	4.84	6.41	6.63	5.98	Gov. v Cont. P< 0.001, Gov. V Cons. P<0.001
10	Leadership	5.11	6.00	5.79	5.65	Gov. V Cont. P = 0.014, Gov. v Cons. P= 0.092
11	Risk rate	4.11	6.14	4.79	5.07	Significant at P<0.001 Gov. v Cont. P <0.001, Cont. v Cons. P < 0.001, Gov. v Cons. P = 0.063
12	Project attribution	5.16	6.18	3.00	4.85	All comparisons significantly different
13	Safety requirements	3.00	5.36	4.58	4.37	All comparisons are significantly different
14	Environmental FAQ	3.95	3.14	4.68	3.88	All comparisons significantly different

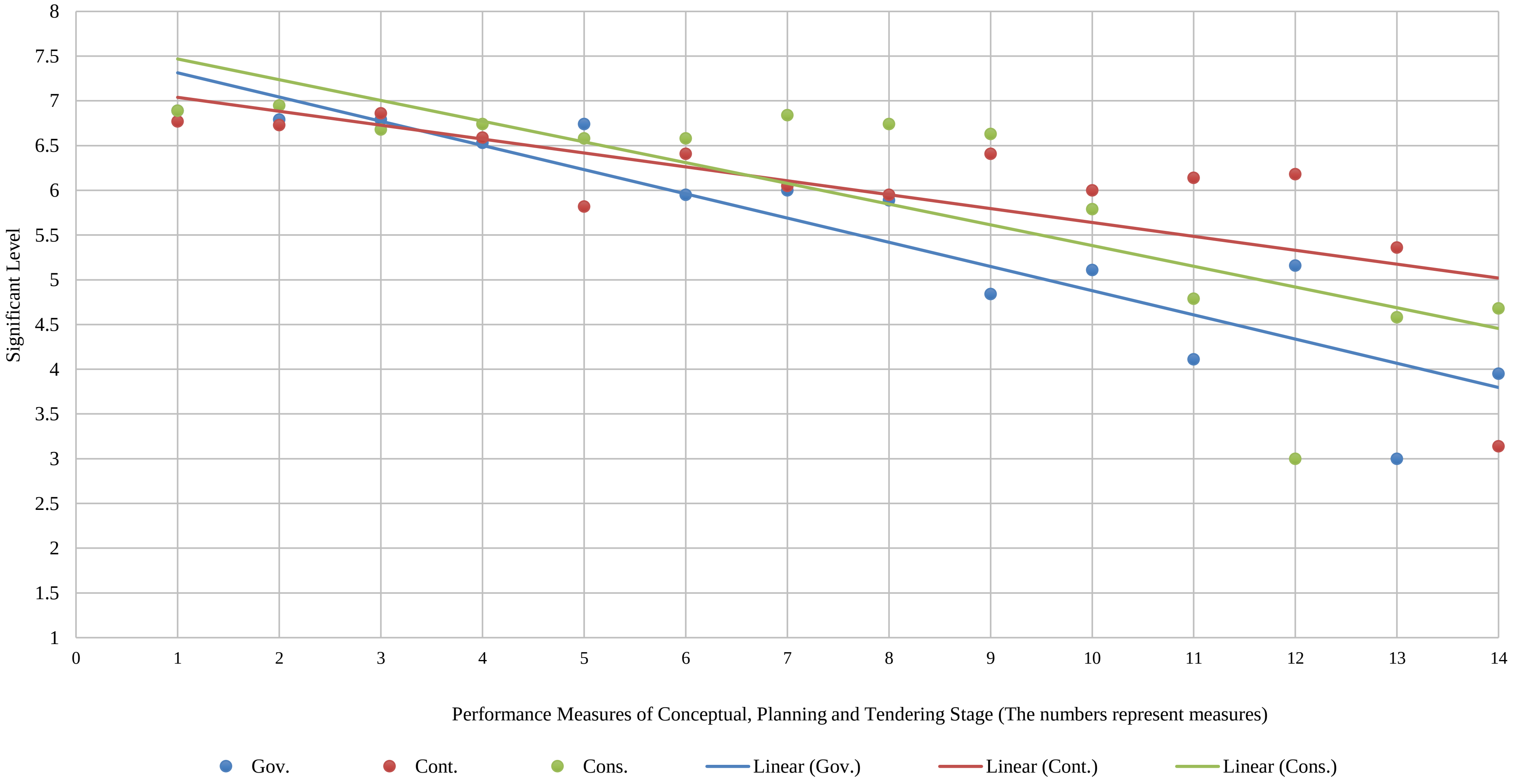

Figure 7-7: Performance measures of conceptual, planning and tendering stage

7.4.3.2 Performance Measures of Production Stage

Table 7-17 and Figure 7-8 details participants' opinions on the importance of certain measures for municipal construction project during the construction stage, these measures represent seven performance measurement dimensions which are time, cost, stakeholder's satisfaction, business, quality, management and project production. All the respondents in each of the groups were unanimous in their opinion that the top eleven measures were extremely important as their overall mean values were all greater than 6.14. As a confirmation of this, it was observed through the result of ANOVA tests that the different groups of respondents do not have any significant difference in regards to their opinions of the ratings, except for time to rectify defects, where contractors and consultant feature a P- value of 0.004, as well as contractor satisfaction – payment, where government officials and consultants have a P-Value < 0.001 and government officials and consultant have a P-value < 0.001.

The second level of significance is "very important", where twelve measures were rated as such by respondents; however, there is significant variance between groups in evaluating these measures. The remaining 25 measures were considered to have less impact and regarded not be key measures. As a consequence of this, they were excluded from further analysis. From these results, it is clear that municipal construction projects in SA greatly place emphasis on traditional measures as this form the top ten measures as shown in the Table; these include time, quality, and cost, along with specifications and standards, productivity, and client satisfaction. However, there are some noteworthy differences statistically in participants' rating regarding the rest of the 48 measures, which show that each of the respondent groups may not apply any other measures apart from the top seven identified measures.

Table 7-17: Performance measures of production stage

No.	Measures	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	Cont.	Cons.		
1	Construction cost	7.00	7.00	6.95	6.98	No significant differences
2	Availability of specifications and standards	6.95	6.91	7.00	6.95	No significant differences
3	Construction time	6.95	6.91	6.95	6.93	No significant differences
4	Productivity	6.89	6.95	6.89	6.92	No significant differences
5	Quality assurance systems	6.63	6.59	6.74	6.65	No significant differences
6	Project schedule and monitoring (procedure and process)	6.58	6.64	6.74	6.65	No significant differences
7	Time to rectify defects	6.42	6.95	6.26	6.57	Cont. v Cons. P = 0.004
8	Integration of design and construction	6.53	6.55	6.63	6.57	No significant differences
9	Client satisfaction (standard criteria)	6.47	6.5	6.63	6.53	No significant differences
10	Client satisfaction (specific criteria)	6.47	5.86	6.53	6.27	No significant differences
11	Contractor satisfaction – payment	4.74	7.00	6.68	6.18	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
12	Conflicts and claims	5.95	6.64	5.74	6.13	Gov. v Cont. P = 0.044, Cont. v Cons. P < 0.007
13	Profitability	5.16	6.68	6.21	6.05	Gov. v Cont. P < 0.001, Gov. v Cons. P = 0.001
14	Relationship among stakeholders	6.00	6.09	6.00	6.03	No significant differences
15	Team performance	4.95	6.68	5.68	5.82	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001, Gov. v Cons. P = 0.014,
16	Cost to rectify defects in the maintenance period	5.79	6.32	5.16	5.78	Cont. v Cons. P < 0.001
17	Solving site problems	4.84	6.5	5.37	5.62	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
18	Planning	5.89	4.82	6.11	5.57	Gov. v Cont. P < 0.001, Cons. v Cont. P < 0.001
19	Waste of resources and materials	5.84	6.00	4.79	5.57	Gov. v Cons. P < 0.002, Cont. v Cons. P < 0.001
20	Cash Flow	5.79	5.05	5.68	5.48	No significant differences
21	Risk rate	4.26	6.64	5.26	5.45	All comparisons are significantly different
22	Alignment of stakeholder’s requirements	5.05	5.59	5.47	5.38	No significant differences
23	Leadership	4.05	5.91	6.05	5.37	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
24	Defects	5.37	5.18	4.95	5.17	No significant differences
25	Safety requirements	4.63	5.23	5.58	5.15	No significant differences
26	Reportable accidents	6.05	4.18	5.32	5.13	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001, Gov. v Cons. P = 0.038
27	Number of training	3.95	5.14	6.05	5.05	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.002
28	Change orders	3.05	6.59	5.05	4.98	All comparisons are significantly different

29	Quality issues at available for use	5.84	5.00	3.58	4.82	Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001, Gov. v Cont. P = 0.010
30	Stakeholder involvement	4.16	5.45	4.63	4.78	Gov. v Cont. P < 0.001, Cons. v Cont. P = 0.022
31	Environmental FAQ	4.53	4.00	5.42	4.62	Gov. v Cons. P = 0.012, Cons. v Cont. P < 0.001
32	Decision making procedures	4.05	4.77	4.53	4.47	Gov. v Cont. P = 0.003, Gov. v Cons. P = 0.085
33	Energy and water use	3.11	5.64	4.42	4.45	All comparisons are significantly different
34	Project organization structure	2.63	5.64	4.32	4.27	All comparisons are significantly different
35	Construction method and technology	3.00	4.23	4.95	4.07	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001, Cons. v Cont. P = 0.022
36	Fatalities	4.16	4.73	3.05	4.02	GO v Cons. P = 0.005, Cons. v Cont. P < 0.001
37	Rework	2.95	5.00	3.95	4.02	All comparisons are significantly different
38	Documentation and Reports	3.00	4.32	4.42	3.93	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
39	Innovation	3.89	3.00	4.95	3.90	Gov. v Cons. P = 0.001, Cont. v Cons. P < 0.001, Gov. v Cont. P = 0.005
40	Rate of site meetings	2.16	4.45	4.74	3.82	Gov. v Cont. P < 0.001, Gov. v Cons. P < 0.001
41	Sustainability	4.42	1.55	5.79	3.80	All comparisons are significantly different
42	Project attribution	4.00	3.41	3.68	3.68	No significant differences
43	Waste Percentage (Landfill)	4.21	1.68	5.05	3.55	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001, Gov. v Cons. P = 0.011
44	Records of complaints regarding environmental issues	3.53	1.73	5.37	3.45	All comparisons are significantly different
45	Transfer of experience and best practice	2.74	2.73	4.63	3.33	Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001
46	Design cost	1.89	4.73	1.79	2.90	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
47	Applying a new products and technology	1.95	2.77	4.00	2.90	Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001, Gov. v Cont. P = 0.016
48	Design time	1.63	1.73	1.79	1.72	No significant differences

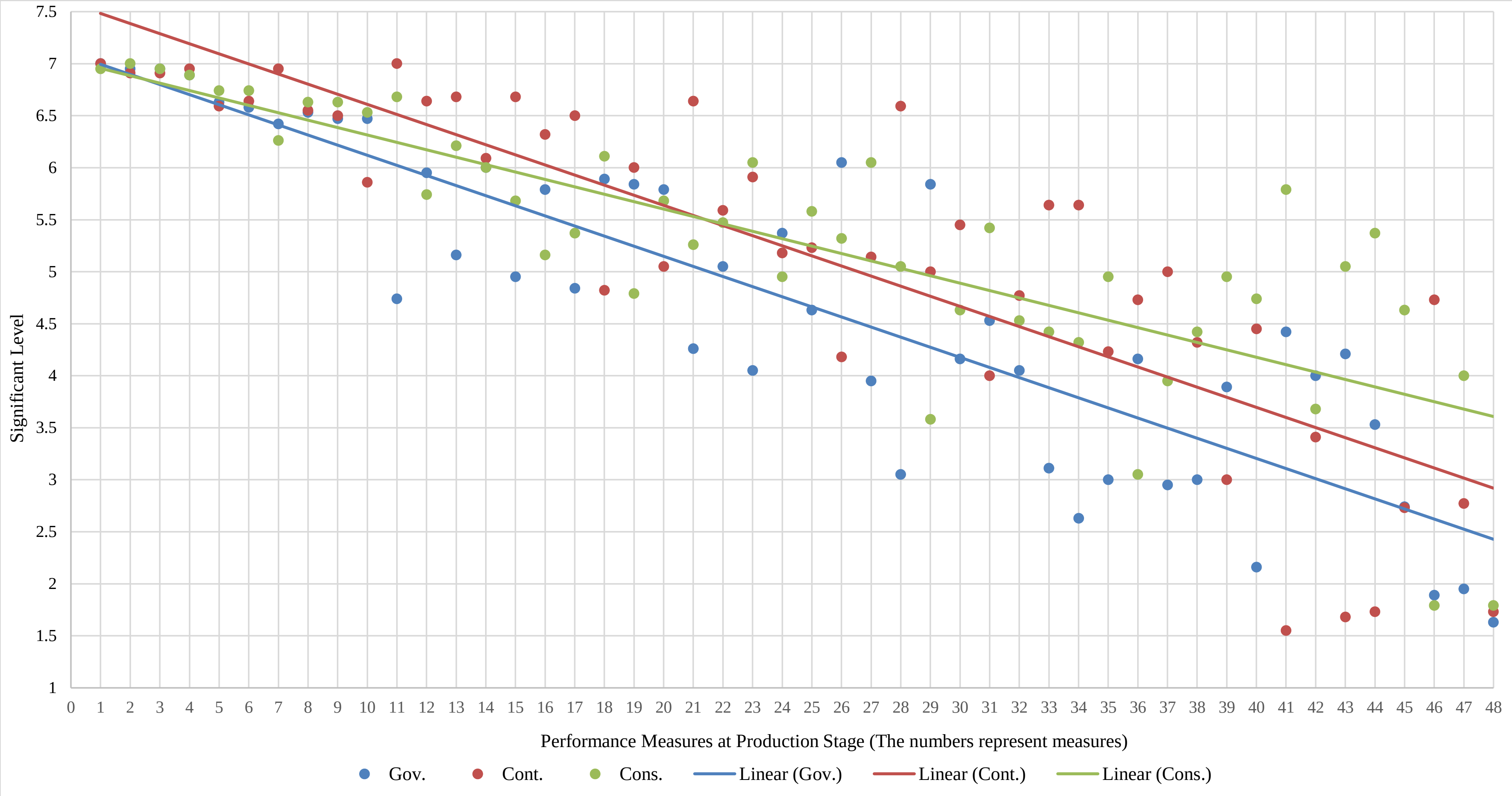

Figure 7-8: Performance measures of production stage

7.4.3.3 Measures of Operation Stage

In this stage, 15 PMs were identified from extensive reviewing of previous research in developed and developing countries. After conducting a mean value comparison approach based on organisation types (government officials, consultants and contractors) to identify the most important measures that are believed to be appropriate to judge construction project success, the 15 measures were ranked according to the mean score as displayed in Table 7-18 and Figure 7-9. It can be seen from the results that satisfaction measures both for users and clients were placed in the first and second ranking levels each with average mean values of 6.40 respectively. While quality issues available for use was located third, with a mean value of 6.32. Despite this, these measures are considered extremely important based on average means of participants' perceptions. Surprisingly there were significant differences between participants (government officials, consultants and contractors).

Table 7-18: Performance measures at operation stage

No.	Measures	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	Cont.	Cons.		
1	End-user satisfaction (user expectations)	6.84	5.77	6.68	6.40	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
2	Client satisfaction (standard criteria)	6.74	5.82	6.74	6.40	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
3	Quality issues at available for use	6.68	6.27	5.74	6.23	Gov. v Cons. P = 0.002
4	Integration of design and construction	6.63	5.36	6.58	6.15	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
5	Time to rectify defects	6.63	5.32	6.53	6.12	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
6	Defects	6.53	6.64	4.84	6.03	Gov. v Cons. P < 0.001, Cont. v Cons. P < 0.001
7	Cost to rectify defects in the maintenance period	6.47	4.82	6.68	5.93	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
8	Client satisfaction (specific criteria)	6.74	4.86	6.32	5.92	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
9	Safety requirements	6.00	5.50	5.63	5.70	No significant differences
10	Sustainability	6.00	1.86	6.26	4.57	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
11	Energy and water use	5.16	1.77	5.89	4.15	All comparisons are significantly different
12	Records of complaints regarding environmental issues	4.00	1.95	5.47	3.72	All comparisons are significantly different
13	Conflicts & claims	4.05	1.95	3.79	3.20	Gov. v Cont. P < 0.001, Cont. v Cons. P < 0.001
14	Environmental FAQ	3.05	1.91	4.74	3.17	All comparisons are significantly different
15	Fatalities	3.11	2.09	2.68	2.60	Gov. v Cont. P = 0.004

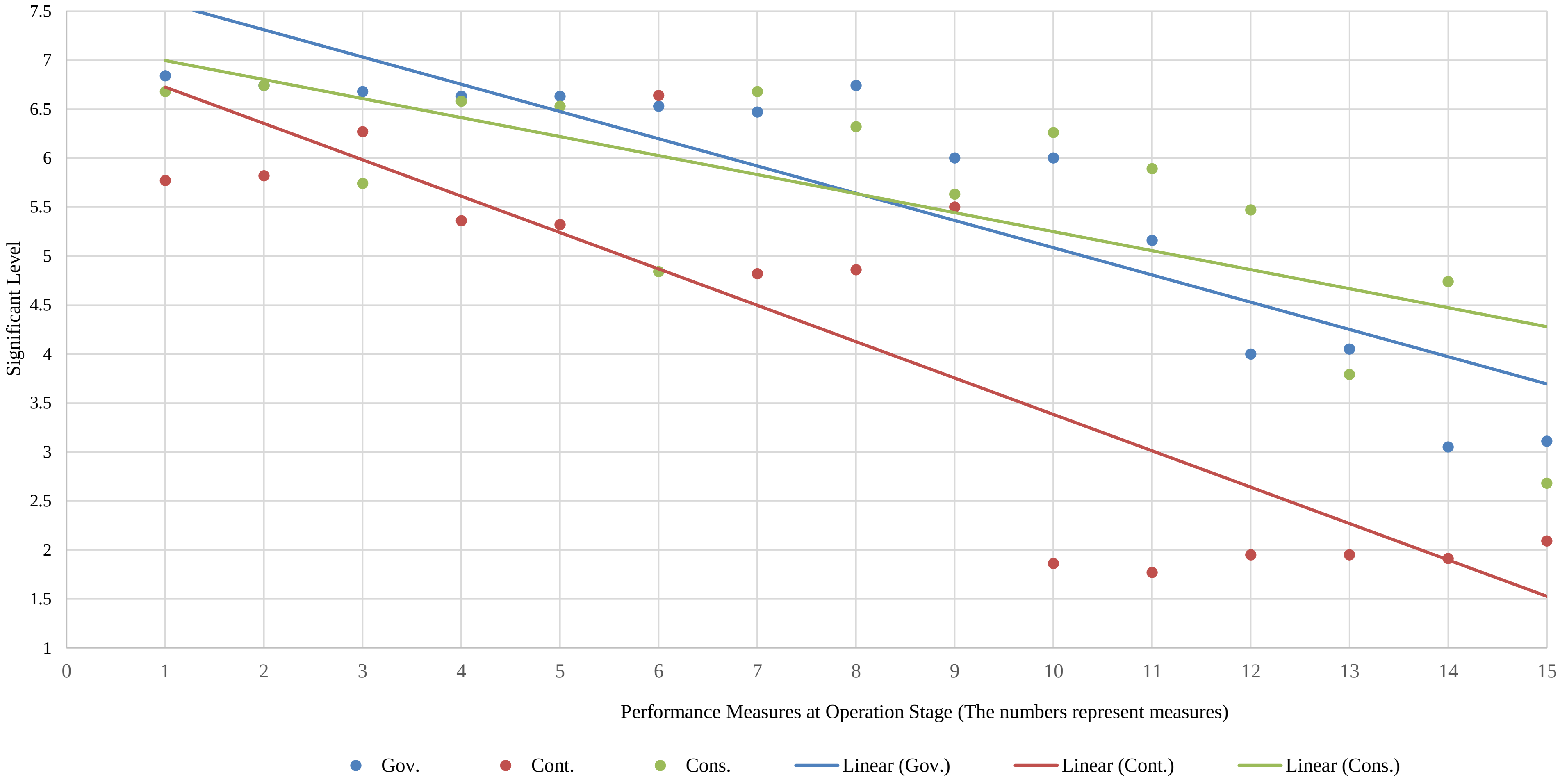

Figure 7-9: Performance measures at operation stage

7.4.4 Project Success Measures

7.4.4.1 Efficiency Performance Measures at Production Stages

These set of questions examined the key efficiency measures used by the organisation to measure construction project success or failure. Interestingly, as the results in the table above suggest, “meets time”, “meets budget”, “high project productivity”, “minimum amount of disputes”, and “minimum amount of wastages” are the top five efficiency and effectiveness PMs for all three categories of respondents. On the other hand, efficiency in utilization of manpower, fast decision-making process, and minimum effect on the environment were identified as the least important measures. This therefore suggests that “timing”, “budget and productivity” are the most important effectiveness factors regardless of the respondents’ views, while “environmental issue” is the least important. This result is presented in Table 7-19 and Figure 7-10.

Table 7-19: Efficiency performance measures at production stages

No	Efficiency Measures	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	**Cont.**	**Cons.**		
1	Meets time	7.00	6.95	7.00	6.98	No significant differences
2	Meets budget	6.95	6.91	6.95	6.93	No significant differences
3	High project productivity	6.32	6.50	6.89	6.57	No significant differences
4	Meets technical specification	5.79	5.91	6.42	6.03	No significant differences
5	Meets safety requirements	5.89	5.05	6.11	5.65	No significant differences
6	Minimum amount of disputes	3.74	6.18	5.63	5.23	Gov. v Cont. $P < 0.001$, Gov. v Cons. $P < 0.001$
7	Minimum amount of wastages	4.05	6.14	5.32	5.22	Gov. v Cont. $P < 0.001$
8	High quality of workmanship	4.11	5.05	5.42	4.87	Gov. v Cont. $P < 0.001$
9	Minimum scope changes	3.47	5.82	5.16	4.87	Gov. v Cont. $P < 0.001$, Gov. v Cons. $P < 0.001$
10	Efficiency in utilization of manpower	4.68	4.77	4.32	4.60	No significant differences
11	Fast decision-making process	3.53	4.68	4.84	4.37	No significant differences
12	Minimum effect on the environment	3.26	2.45	4.53	3.37	Gov. v Cont. $P < 0.001$, Cont. v Cons. $P < 0.001$

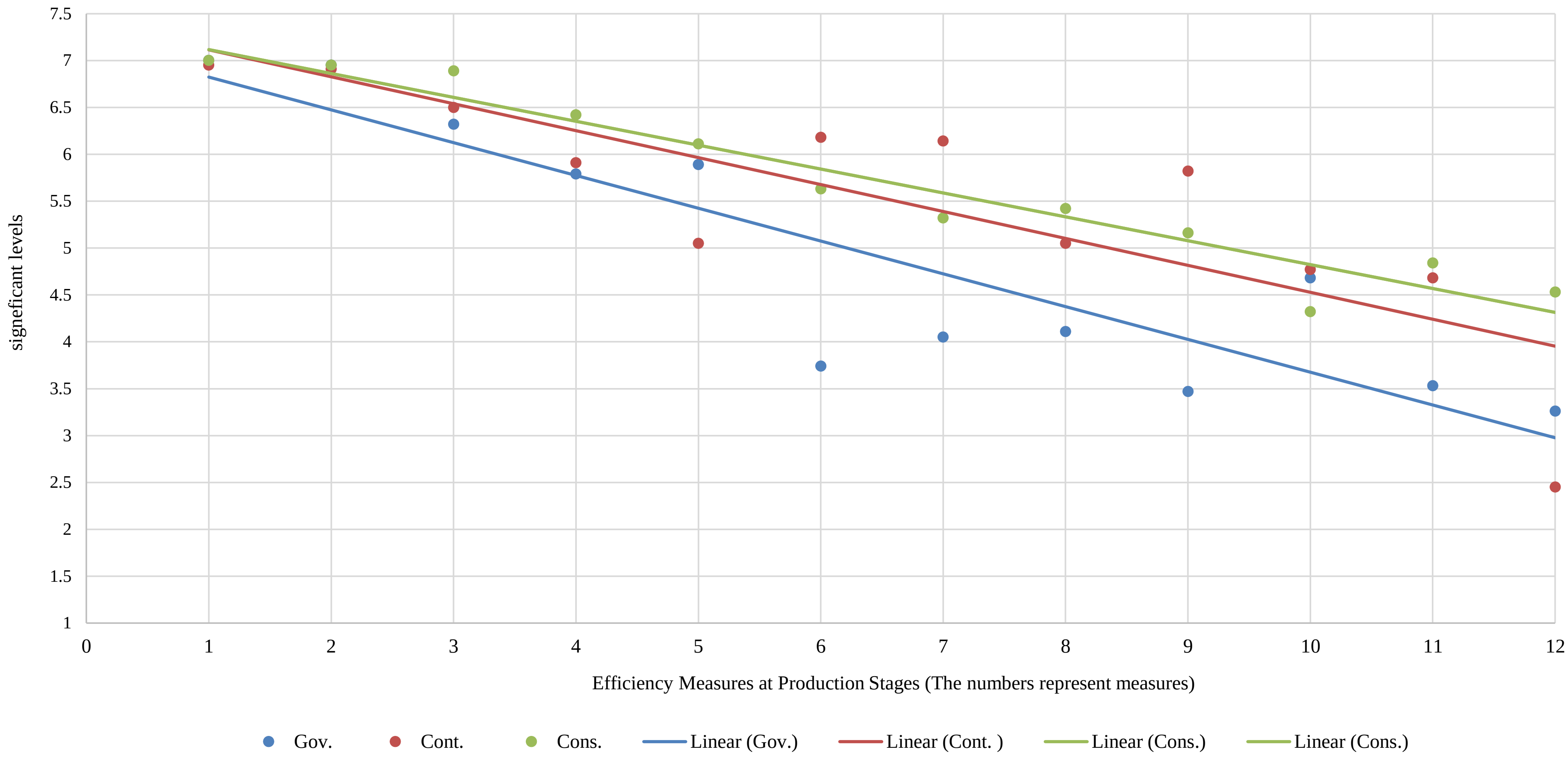

Figure 7-10: Efficiency measures at production stages

7.4.4.2 Effectiveness Performance Measures at Operation Stage

In terms of effectiveness measures, as the results suggest there is less unanimity of opinion between the respondents. According to the government officials, ‘meets stakeholders’ needs’ & ‘expectations’, ‘meets client satisfaction on product’, ‘meets pre-stated objectives’, ‘project functionality’ and ‘Integrated with national plans’ and ‘fit with purpose’ are the top five, while ‘free from defects’, ‘pleasant environment’, and ‘easy to maintain’ are the least important effectiveness PMs. For contractors, ‘meets pre-stated objectives’, ‘meets stakeholders' needs & expectations’, ‘meets client satisfaction on product’, ‘project functionality’, and ‘meets client satisfaction on service’ are the most important, and ‘flexible for future expansion’, ‘easy to maintain’, and ‘pleasant environment’ are the least important effectiveness PMs. Following responses from consultants, ‘meets pre-stated objectives’, ‘Integrated with national plans’ and ‘fit with purpose’, ‘meets stakeholders’ needs & expectations’, ‘meets client satisfaction on product’, and ‘project functionality’ are the main effectiveness PMs. ‘Flexible for future expansion’, ‘easy to maintain’, and ‘pleasant environment’ are the least important effectiveness PMs for consultants. Although different respondents identified different effectiveness measures, which are important to them, as a group, they are most concerned with meeting pre-stated objectives, stakeholders’ needs & expectations, and client satisfaction. On the other hand, they are least concerned with flexibility for future expansion, ease of maintenance, and environmental issues. Table 7-20 and Figure 7-11 show this result

Table 7-20: Effectiveness measures at operation stage

No	Effectiveness Measures	Organisation's Activities			Mean	Differences if Significant at the 5% level
		Gov.	Cont.	Cons.		
1	Meets pre-stated objectives	6.89	6.91	6.95	6.92	No significant differences
2	Meets stakeholders' needs & expect	6.95	6.86	6.89	6.90	No significant differences
3	Meets client satisfaction on product	6.95	6.68	6.79	6.80	No significant differences
4	Project functionality	6.79	5.68	6.79	6.38	Gov. v Cont. $P < 0.001$, Cont. v Cons. $P < 0.001$
5	Integrated with national plans and fit with purpose	6.68	5.14	6.95	6.20	Gov. v Cont. $P < 0.001$, Cont. v Cons. $P < 0.001$
6	Meets client satisfaction on service	6.68	5.45	6.58	6.20	No significant differences
7	Fast rectification of defects	6.53	5.05	6.05	5.83	Gov. v Cont.
8	Free from defects	6.32	4.64	6.00	5.60	Gov. v Cont. $P < 0.001$, Cont. v Cons. $P < 0.001$
9	Flexible for future expansion	6.58	4.41	5.21	5.35	Gov. v Cont. $P < 0.001$, Gov. v Cons. $P < 0.001$
10	Easy to maintain	3.74	4.23	4.05	4.02	No significant differences
11	Pleasant environment	3.95	3.18	3.95	3.67	No significant differences

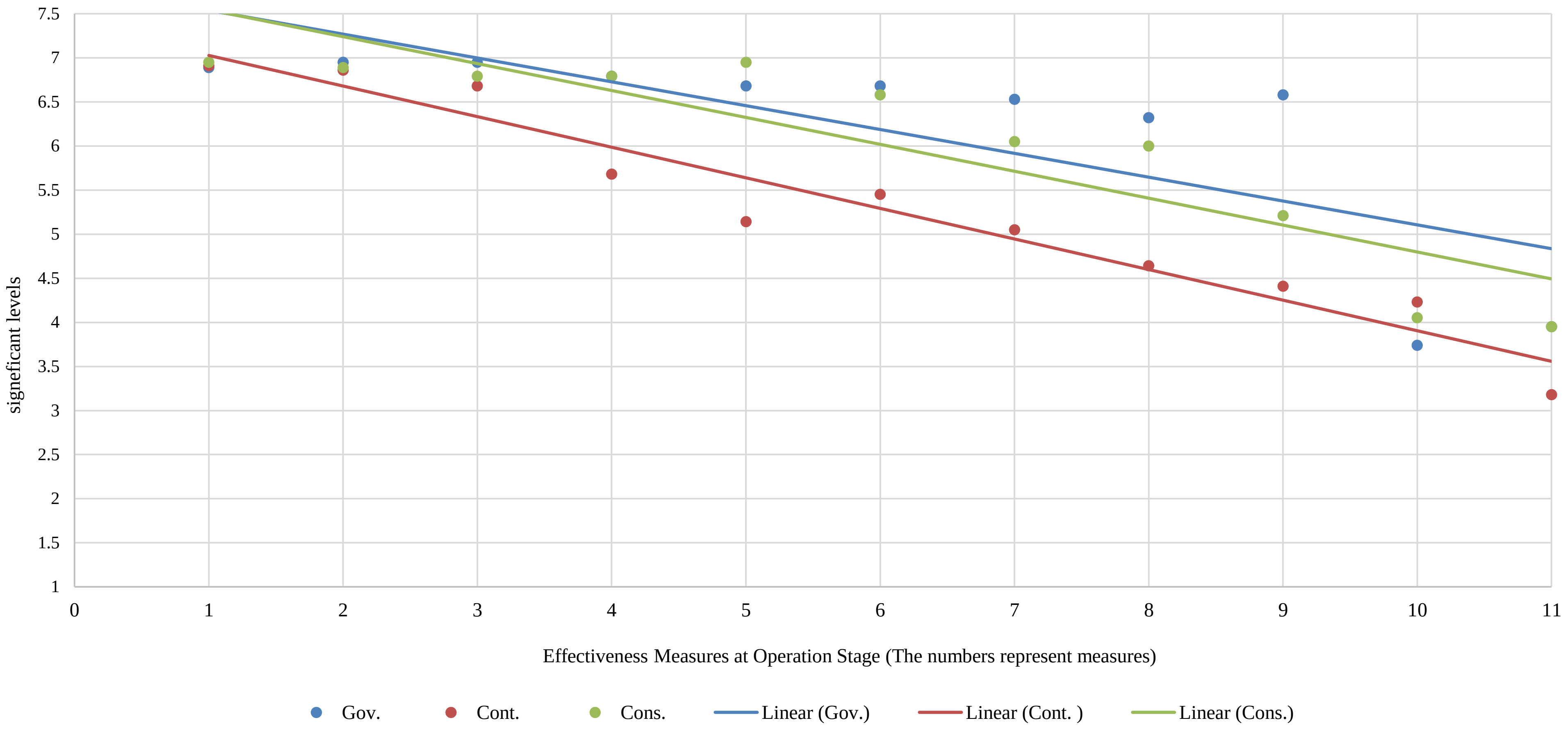

Figure 7-11: Effectiveness measures at operation stage

7.5 Factor Analysis Approach Result

Factor analysis is a popular multivariate analytical technique for identifying strong relationship among variables (Albogamy, Scott, Dawood, & Bekr, 2013). The technique selects significant variables according to the mean method result to determine which variables are the most significant for municipal construction project at the three stages of its life cycle, factor analysis is required to explore whether or not the variables can be tested to group them in key components for the variables (obstacles and barriers and CSFs, PMs, efficiency measures and effectiveness measures) so that the main factors could be identified. Thus, the factor analysis technique was carried out to derive a cluster of any multivariate interrelationships existing among CSFs at construction project stages. Based on the suggestion that the value of Kaiser-Meyer-Olkin (KMO) should be greater than 0.5 for acceptable factor analysis (Lin, et al. 2011), the common factors in the principal components were extracted based on their Eigen value of 1 and more to meet the criterion to be extracted.

The scree plot test is used to identify the optimum number of factors to be retained by looking for a relatively large interval between Eigen values, the rationale for the Scree test is that since the principal component solution extracts factors in successive order of magnitude, the substantive factors appear before the numerous trivial factors which have small Eigenvalues that account for a small proportion of the total variance (Fellows & Liu, 2008). In this study, the Scree test was derived by plotting the latent roots against the number of factors in their order of extraction, and the shape of the resulting curve is used to evaluate the cut-off point as recommended by Hair et al. (1998, p. 112). The varimax orthogonal rotation of principle component analysis was further applied to interpret these factors. The variables which are consisted in order under these grouping based on their factor loadings. The values in the columns of factor name are the correlation between original variables and common factors. A factor loading indicates the degree of association of a variable with the component and the percentage variance of the component that is explained by the variable. For each factor, all items with a load equal to or greater than 0.50 were assigned to the corresponding factor (Quesada-Pineda & Madrigal, 2013).

7.5.1 Success Factors

The results of the factor analysis for extracting multivariate interrelationship existing among success factors at the three stages of municipal construction projects lifecycle is presented in this section. The technique helped to resolve the problem of large number of variables (success factors) which was addressed by identifying a set of common basic components, termed "principal components" including sub-factors for three construction projects stages; Conceptual, Planning and Tender Stage, Production Stage and Operation Stage as follow;

7.5.1.1 Conceptual, Planning and Tender Stage

Factor analysis was conducted to explore relationship among 20 variables of success factors at Conceptual, Planning and Tender Stage to group them in key components. These twenty variables were subjected to a principal component factors analysis to help reduce the variables to a relatively smaller number of factors that can be used to represent the relationships that exist among these variables which can be respectively described as a separate critical success factor. The appropriateness of the factor analysis was determined through KMO and Bartlett's Test of Sphericity. The value of KMO measure of sampling adequacy is 0.886 which is more than 0.5, hence, as considered by Lin et al. (2011) that the data is acceptable for factor analysis. While, the result of of Barlett Test of Sphericity = 550.764 is large, associated significant level is small (p=0.000), suggesting that the population correlation matrix is not an identity matrix.

The varimax rotation of principal component analysis was used to interpret the components, to group the factor. Table 7-21 shows the results of Principal Component Method conducted. Twenty factors loadings range from 0.305 to 0.810. However, seventeen out of twenty factors were retained, while, the remaining three variables were excluded, due to the fact that these factors have significant correlation less than 5 percent level. The excluded factors are; Adequacy of design details (p = 0.320), Project attributes (type, size, objective, location) (p = 0.435) and Budget (p = 0.305). The retained factors are extracted and composed into six principal components. Six Principal Components are extracted with Eigen values greater than 1, explaining 65.41% of the variance. In Figure 7-12 it is presented that there is a distinct break between the steeps lope of the large components and the gradual tailing off of the rest of the components. It is evident that a six-component represents the proper number of components.

Principal Component 1: ‘management capabilities-related’ accounts for 17.96% of the total percentage variance, it consists of five sub-CSFs; Relationship among stakeholders (p = 0.810), Training (p = 0.806), Strategic alignment of project goals with stakeholders’ interests (p = 0.759), Economic (stable economic conditions and economic policy) (p = 0.758) and Top management support (p = 0.570). *Principal Component 2*: ‘Contractor selection criteria and vision-related’ accounts for 15.56% of the total percentage variance, it comprises four sub-CSFs; Contractor selection criteria (p = 0.798), Coordination and vision (p = 0.714), Transparency in the procurement process (p = 0.711) and Procurement & delivery strategy (p = 0.710). *Principal Component 3*: ‘decision sources and support-related’ accounts for 8.77% of the total percentage variance, it contains two sub-CSFs; Fast decision making process (p = 0.755) and Risk (p = 0.752). *Principal Component 4*: ‘accessibility of experience and specifications-related’ accounts for 8.08% of the total percentage variance, it contains three sub-CSFs; Transfer of experience and best practice (p = 0.737), Standards and specifications (p = 0.606) and Comprehensive project review and feedback (p = 0.650). *Principal Component 5*: ‘project attributes and procurement-related’ accounts for 7.78% of the total percentage variance, it contains two sub-CSFs; Project duration (p = 0.803) and Innovation (p = 0.650); and, *Principal Component 6*: ‘national plans-related’ accounts for 7.25% of the total percentage variance, it includes one sub-CSF; Integration the project with national plans (p = 0.739).

Table 7-21: Analysis of success factors at conceptual, planning and tender stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Success Factors	FL
1	Management capabilities	17.96	17.96	7.16	20.9	Relationship among stakeholders	0.810
						Training	0.806
						Strategic alignment of project goals with stakeholders' interests	0.759
						Economic (stable economic conditions and economic policy)	0.758
						Top management support	0.570
2	Contractor selection criteria and vision	33.52	15.56	3.35	16.8	Contractor selection criteria	0.798
						Coordination and vision	0.714
						Transparency in the procurement process	0.711
						Procurement & delivery strategy	0.710
						Adequacy of design details	0.320
3	Decision sources and support	42.29	8.77	1.78	8.9	Fast decision making process	0.755
						Risk	0.752
4	Accessibility of experience and specifications	50.38	8.08	1.49	7.4	Transfer of experience and best practice	0.737
						Standards and specifications	0.606
						Comprehensive project review and feedback	0.650
5	Project attributes	58.16	7.78	1.21	6.0	Project duration	0.803
						Innovation	0.650
						Project attributes (type, size, objective, location)	0.435
						Budget	0.305
6	National plans	65.41	7.25	1.09	5.4	Integration the project with national plans	0.739

KMO Measure of Sampling Adequacy is 0.886;
Barlett Test of Sphericity is 550.764, significant level is ($p<0.001$).

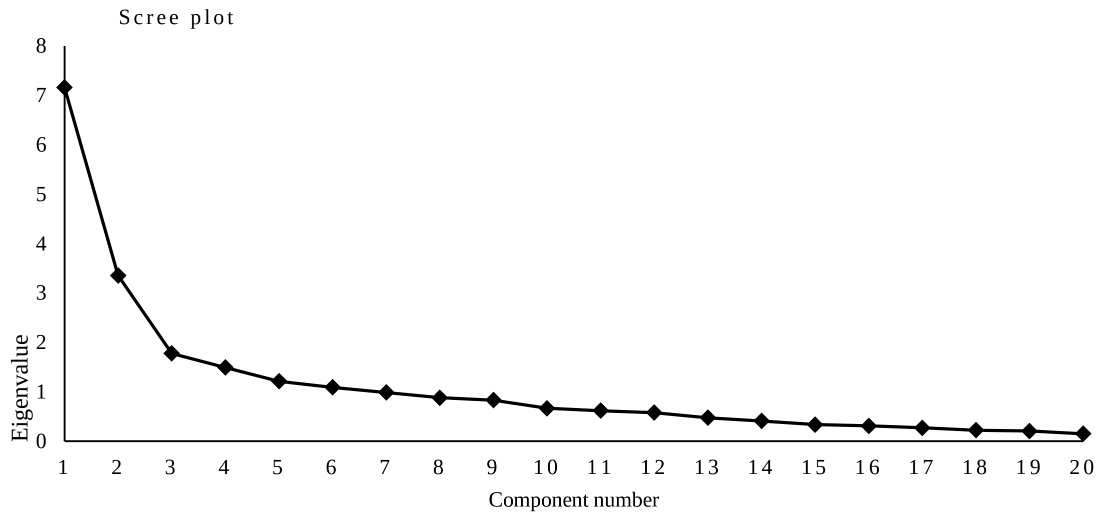

Figure 7-12: Scree plot of success factors at conceptual, planning and tender stage

7.5.1.2 Production Stage

Despite that there are many success factors at the production stage of the construction project; they were reduced by applying the factor analysis technique. The value of KMO measure is 0.602 which is more than 0.5; consequently, the data is acceptable for factor analysis. The Barlett Test of Sphericity is 2113.864 which is large enough, but the associated significant level is small ($p=0.000$), suggesting that the population correlation matrix is not an identity matrix. Out of forty-seven success factors, thirteen principal components were detected that were termed principal component and forty-four are retained as shown in Table 7-22. However, three success factors in this stage were excluded because their factor loadings were less than the cut-off that is 0.5, these are; application of health and safety system ($p = 0.441$), risk ($p = 0.409$) and wastes around the site ($p = 0.372$).

In the results of Principal Component Method conducted; forty-seven success factors loadings range from 0.372 to 0.973. However, forty-four out of forty-seven factors were retained, while the remaining three variables were excluded, because these factors have significant correlation of less than 0.5. The retained factors are extracted and composed into thirteen principal components. The thirteen Principal Components that were extracted had Eigen values greater than 1, which explains 75.37% of the variance. Further, Figure 7-13 illustrates the total variance associated with each factor, also it shows a clear break between the steep slope of the large factors and the gradual trailing off of the remaining factors. Moreover, it confirms that the thirteen principal components model should be sufficient for the research model.

Principal component 1 refers to ‘Project Production and Management’, and it accounts for 12.63% of the total percentage variance. This group consists of eight variables (Success Factor), and they include: Quality Control ($p = 0.816$), Sequencing of work according to schedule ($p = 0.799$), Capability of the project manager ($p = 0.732$), Adequate team capability (technical skills, communication, commitment, experience, and qualification) ($p = 0.721$), Site meetings ($p = 0.717$), Good project management structure ($p = 0.577$), Quality training/meeting ($p = 0.503$).

Principal component 2 related to ‘Project duration and budget’ and accounts for 7.51% of the total percentage of the variance explained. The five sub-factors grouped in this component: Project duration (*p* = 0.829), Budget (*p* = 0.719), Schedule project construction (*p* = 0.542), Cash flow (*p* = 0.540), and Sufficient resources allocation (*p* = 0.536). *Principal Component 3* refers to 'Design details and specifications' accounts for 7.38% of the total variance explained, and the four components grouped under this component are: 'standards and specifications' (*p* = 0.973), 'sufficient work skills and mechanisms' (p = 0.973), 'adequacy of design details' (p = 0.560).

Principal Component 4 concerned with 'Project structure' accounts for 5.63% of the total variance explained, and consisted of two sub-factors these are: 'fragmentation of project activities' (p = 0.789) and 'project organization structure' (p = 0.639). *Principal component 5 refers* to 'Documentation', and it accounts for 5.56% of the total percentage variance. This group consists of eight variables (Success Factor), and they include: 'documentation and reports' (p = 0.773) and 'disputes between owner and project parties' (p = 0.709).

Principal Component 6 referred to 'Relationship among stakeholders' accounts for 5.17% of the total variance explained, and consisted of three sub-measures these are: 'relationship among stakeholders' (p = 0.790), 'top management support' (p = 0.578), and 'fast decision making process' (p =0.516). P*rincipal component 7* refers to 'Transfer of experience', and it accounts for 4.81% of the total percentage variance, and consists of one sub-factor related to transfer of experience and best practice (p = 0.831).

Principal Component 8 concerned with 'Technology' accounts for 4.73% of the total variance explained, and consists of two sub-factors these are: using up to date technology (p = 0.820), speed of delivery of the product to end-users (p = 0.538). Principal Component 9 concerned with 'Project attributes' which accounts for 4.67% of the total variance explained, and consists of three sub-factors these are: project attributes (type, size, objective, location) (p = 0.811), accessibility to reach to the site (location of project) (p = 0.592).

Principal component 10 refers to 'Learning and innovation', and it accounts for 4.64% of the total percentage variance. It consists of two sub-factors: comprehensive project review and feedback (p = 0.768), and training (p = 0.617). *Principal component 11* related to 'Sustainability', accounts for 4.48% of the total percentage variance. It consists of only one sub-factor: Sustainability (p = 0.882). *Principal Component 12* referred to 'Disputes solution' accounts for 4.26% of the total variance explained, and consists of two sub-measures these are: efficiency in problem solving process (p = 0.692), and absence of conflicts (p = 0.686). *Principal component 13* related to 'Weather' and accounts for 3.90% of the total variance explained and involved two sub-factors; weather condition in the site (p = 0.740) and innovation (p = 0.661).

Table 7-22: Factor analysis of success factors at production stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Success Factors	FL
1	Project production and management	12.63	12.63	8.96	16.1	Quality control	0.816
						Sequencing of work according to schedule	0.799
						Capability of project manager	0.732
						Adequate team capability (technical skills, communication, commitment, experience and qualification)	0.721
						Site meetings	0.717
						Good project management structure	0.577
						Quality training/meeting	0.503
						Application of health and safety system	0.441
2	Project duration and budget	20.14	7.51	4.59	12.4	Project duration	0.829
						Budget	0.719
						Schedule project construction	0.542
						Cash flow	0.540
						Sufficient resources allocation	0.536
3	Design details & specifications	27.52	7.38	2.79	7.5	Standards and specifications	0.973
						Sufficient work skills and mechanisms	0.973
						Adequacy of design details	0.560
						Risk	0.409
4	Project structure	33.15	5.63	2.09	5.7	Fragmentation of project activities	0.789
						Project organization structure	0.639
5	Documentation	38.71	5.56	1.96	5.3	Documentation and Reports	0.773
						Disputes between owner and project parties	0.709
6	Relationship among stakeholders	43.88	5.17	1.75	4.7	Relationship among stakeholders	0.790
						Top management support	0.578
						Fast decision making process	0.516
7	Transfer of experience	48.70	4.81	1.59	4.3	Transfer of experience and best practice	0.831
8	Technology	53.42	4.73	1.47	4.0	Using up to date technology	0.820
						Speed of deliver the product to end-users	0.538
9	Project attributes	58.09	4.67	1.21	3.3	Project attributes (type, size, objective, location)	0.811
						Accessibility to reach to the site (location of project)	0.592
						Wastes around the site	0.372
10	Learning and innovation	62.74	4.64	1.18	3.2	Comprehensive project review and feedback	0.768
						Training	0.617

11	Sustainability	67.21	4.48	1.11	3.0	Sustainability	0.882
12	Disputes solution	71.47	4.26	1.10	3.0	Efficiency in problem solving process	0.692
						Absence of conflicts	0.686
13	Weather condition	75.37	3.90	1.09	3.0	Weather condition in the site	0.740
						Innovation	0.661
KMO Measure of Sampling Adequacy is 0.602; Barlett Test of Sphericity is 2113.864, significant level is (p<0.001).							

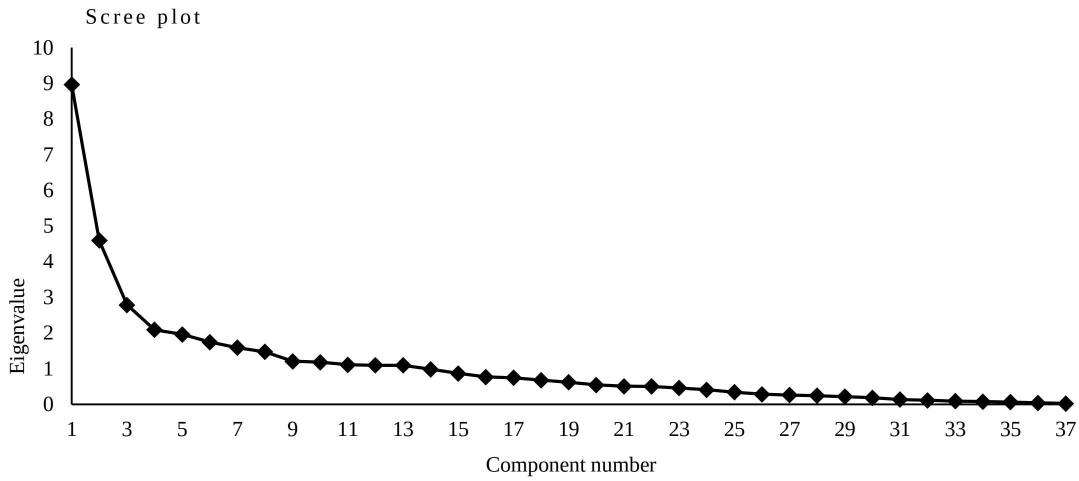

Figure 7-13: Scree plot of success factors at production stage

7.5.1.3 Operation Stage

The factor analysis approach was undertaken and it produced three principal components extracted from twelve success factors at operation stage. The appropriateness of the factor analysis was determined through KMO and Bartlett's Test of Sphericity. The value of KMO is 0.782 which is satisfactory for factor analysis; also Barlett Test is 294.683 which is large enough to explain relationships between variables. However, its associated significant level is small (*p*=0.000), this suggest that the population correlation matrix is not an identity matrix. The principal component analysis was conducted and its result is shown in Table 7-23. Component Method conducted for thirteen success factors loadings range from 0.486 to 0.869, and just one variable was less than 0.5 of significant correlation and this is Wastes around the site (p = 0.486), thus, it was excluded. The scree plot 40 suggested retention of three principal components and considered these components are most appropriate Figure 7-14.

The twelfth retained factors are extracted and grouped into three principal components. These Principal Components had Eigen values greater than 1, and the total variance of the three Principal Components is 63.36% and variance is divided as 31.48%, 21.51% and 10.37% respectively. *Principal Component 1* relates to national plans, Maintenance cost & time' including; Integration the project with national plans (p = 0.849), Maintenance cost (p = 0.813), Maintenance time (p = 0.811), Speed of deliver the product to end-users (p = 0.809), Sustainability (p = 0.806), and Documentation and Reports (p = 0.792). *Principal Component 2* relates to 'feedback and stakeholders relationship' and consisted from four sub-factors which are; Comprehensive project review and feedback (p = 0.869), Relationship among stakeholders (p = 0.834), Standards and specifications (p =0.715), and Innovation (p = 0.517) and, *Principal Component 3* relates to 'project attributes and safety' and comprised from two sub-factors which are; Project attributes (type, size, objective, location) (p = 0.763) and Application of health and safety system (p = 0.654).

Table 7-23: Factor analysis of success factors at operation stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Success Factors	FL
	National plans and Maintenance cost & time	31.48	31.48	5.23	35.3	Integration the project with national plans	0.849
						Maintenance cost	0.813
						Maintenance time	0.811
						Speed of deliver the product to end-users	0.809
						Sustainability	0.806
						Documentation and Reports	0.792
						Wastes around the site	0.486
2	Feedback and stakeholders relationship	52.99	21.51	2.01	18.3	Comprehensive project review and feedback	0.869
						Relationship among stakeholders	0.834
						Standards and specifications	0.715
						Innovation	0.517
3	Project attributes and safety	63.36	10.37	1.17	9.7	Project attributes (type, size, objective, location)	0.763
						Application of health and safety system	0.654

KMO Measure of Sampling Adequacy is 0.782;
Barlett Test of Sphericity is 294.683, significant level is (p=0.000).

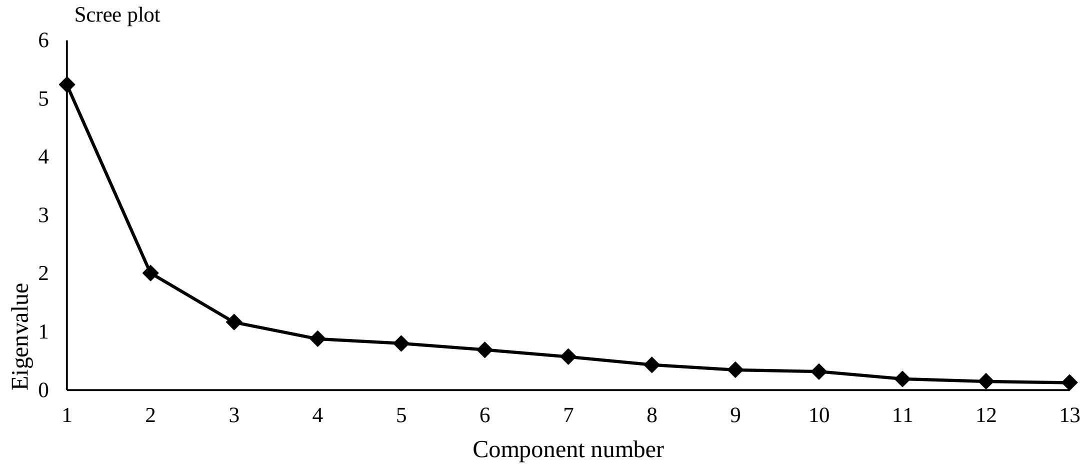

Figure 7-14: Scree plot of success factors at operation stage

7.5.2 Project Performance Measures

Since this study was conducted on municipal construction projects in SA to determine the most important measures across of project lifecycle (three stages) by implementing a factor analysis method. The three stages are Conceptual, Planning and Tender Stage, Production Stage and Operation Stage. However, to ensure that the data are suitable for factor analysis, the variables were tested using both KMO and Bartlett's test of sphericity. This is considered appropriate because according to Hair, Tatham, Anderson, & Black, (1998) the factor analysis method is considered suitable if the values are above one-half for either the entire matrix or an individual variable.

7.5.2.1 Conceptual, Planning and Tender Stage

At Conceptual, Planning and Tender Stage, the data validity for factor analysis was examined by using both KMO and Bartlett's test of sphericity. Thus, the outcome is a KMO value of 0.587 and a Chi-Square value of 190.005 with a significance value of 0.000. This indicated that the data could be used with factor analysis (Hair, et al. 1998). Thus, in this stage, the principal components were driven fourteen variables (measures), also they were determined using an Eigen value over one as an extraction criterion.

The relationships among fourteen measures were investigated to discover the similarity and correlation among measures whereby measures could be included under each component, thus, the principal components were extracted from the fourteen measures that were ordered according to the highest loading for each component separately. This is determined by conducting correlation coefficients or partial correlation coefficients of the variables as recommended by Field (2009). Consequently, four principal components were obtained that accounted for about 56.07% of the variation as seen in Table 7-24 and Figure 7-15, it is presented that a four-component model represents the proper number of components.

The four Principal Components are concerned with performance measurement at conceptual, planning and tender Stage. The four Principal Components are: -

- Principal Component 1: Tendering requirements
- Principal Component 2: Stakeholder Objectives
- Principal Component 3: Specifications
- Principal Component 4: Project attribution

The variances found for the four Principal Components were 17.76%, 16.66%, 12.15% and 9.5%. Three PPM in this stage have less than 0.5 for factor loading, therefore they were not retained as impotent measures. Two of them came under component 2; safety requirements (p = 0.444) and environmental FAQ (p = 0.420), and one under component 1; risk rate (p = 0.431). Three sub-measures came under *Principal Component 1*, which was associated with ‘tendering’ aspects; tendering requirements (p = 0.804), design cost (p = 0.764), and availability of contractor selection criteria (p = 0.630). *Principal Component 2* consisted of four measures, which were associated with ‘alignment of stakeholder’s requirements’; alignment of stakeholder’s requirements (p = 0.834), stakeholder involvement (p = 0.752), design time (p = 0.611), and planning (p = 0.534). *Principal Component 3* consisted of five measures which related to ‘specifications’; availability of specifications and standards (p = 0.636), relationship among stakeholders (p = 0.615), leadership (p = 0.525). *Principle Component 4* related to ‘project attribution’ include; project attribution (p = 0.753).

Table 7-24: Performance measurement at conceptual, planning and tender stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Performance Measure	FL
1	Tendering requirements	17.758	17.76	4.89	20.7	Tendering requirements	0.804
						Design cost	0.764
						Availability of contractor selection criteria	0.630
2	Stakeholder objectives	34.42	16.66	2.33	16.6	Alignment of stakeholder's requirements	0.834
						Stakeholder involvement	0.752
						Design time	0.611
						Planning	0.534
3	Specifications	46.57	12.15	1.47	10.5	Availability of specifications and standards	0.636
						Relationship among stakeholders	0.615
						Leadership	0.525
						Safety requirements	0.444
						Environmental FAQ	0.420
4	Project attribution	56.07	9.50	1.17	8.3	Project attribution	0.753
						Risk rate	0.431

KMO Measure of Sampling Adequacy is 0.587;
Barlett Test of Sphericity is 190.005, significant level is (p=0.000).

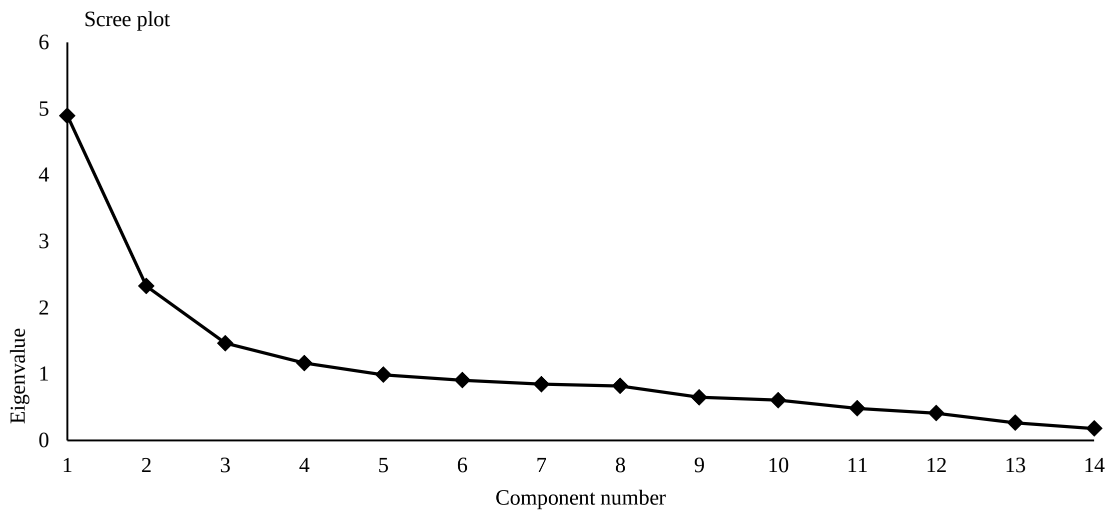

Figure 7-15: Scree plot of PMs at conceptual, planning and tender stage

7.5.2.2 Production Stage

Given that there are many measures that are comprised in the production stage measures of project performance, factor analysis is used to reduce the forty eight measures that were considered in the survey to a manageable number of principal components. The appropriateness of the factor analysis was determined through KMO and Bartlett's Test of Sphericity. The value of KMO measure is 0.518 which is more than 0.5, consequently, that the data is acceptable for factor analysis. While, Barlett Test of Sphericity is 2093.950 that is large, associated significant level is small (p=0.000), suggesting that the population correlation matrix is not an identity matrix.

The results of Principal Component Method conducted showed forty-seven success factors loadings which range from 0.389 to 0.911. However, 41 out of 44 factors are retained, while, the remaining eight variables were excluded, due to that these factors had significant correlation less than 0.5. The retained factors were extracted and grouped into fourteen principal components. Fourteen Principal Components were also extracted with Eigen values greater than 1, explaining 77.78% of the variance. Table 7-25 further to Figure 7-16 illustrates the total variance associated with each factor; also it shows a clear break between the steep slope of the large factors and the gradual trailing off of the remaining factors. Moreover, it confirms that the fourteen principal components model should be sufficient for the research model. The principal components analyses were relabelled as can be seen in Table 38.

Principal component 1 refers to ‘Project Production and Management’ accounts for 19.99% of the total percentage variance. This group consists of sixteen variables (measures), and they include: Construction time (p = 0.872), Quality assurance systems (p = 0.864), Productivity (p = 0.838), Construction method and technology (p = 0.768), Team performance (p = 0.755), Time to rectify defects (p = 0.745), Construction cost (p = 0.744), Change orders (p = 0.692), Integration of design and construction (p = 0.665), Leadership (p = 0.650), Project schedule and monitoring (procedure and process) (p = 0.617), Defects (p = 0.602), Number of training (p = 0.596), Solving site problems (p = 0.579), Waste of resources and materials (p = 0.529) and Risk rate (p = 0.505). While, two measures were included under this components, however, their factor loading are below acceptance cut-off level that is 0.5 these are; Rework (p = 0.460) and Decision making procedures (p = 0.398).

Principal component 2 concerned with ‘Stakeholder objectives’ accounts for 13.13% of the total percentage variance. This consists of eleven variables (measures), eight measures were retained and three were excluded. The remaining measures include: Stakeholder involvement (p = 0.861), Alignment of stakeholder’s requirements (p = 0.753), Contractor satisfaction – payment (p = 0.723), Client satisfaction (specific criteria) (p = 0.679), Applying a new products and technology (p = 0.653), Project organization structure (p = 0.646), Documentation and Reports (p = 0.625), Planning (p = 0.622), Safety requirements (p = 0.482), Profitability (p = 0.479). Whereas, the excluded measures are; Relationship among stakeholders (p = 0.402).

Despite that this *Principal Component 3* was extracted with Eigen values greater than 1, explaining 4.98% of the variance, it was excluded because it has just one measure that is Conflicts & claims (p = 0.490), that is below cut-off level of factor loading. *Principal component 4* concerned ‘Waste-percentage’ accounts for 4.09% of the total percentage variance. It includes only one measure that is Waste-percentage waste to landfill (m3) (p = 0.826). *Principal component 5* refers to ‘Quality issues’ accounts for 4.05% of the total percentage variance. This group consists of four variables (measures), and they include: Quality issues at available for use (p = 0.770), Availability of specifications and standards (p = 0.647), Cost to rectify defects in the maintenance period (p = 0.583), however Client satisfaction (standard criteria) was excluded as a consequence of factor loading result (p = 0.443).

Principal component 6 refers to ‘Project attribution’ accounts for 3.94% of the total percentage variance. This consists of one variable (measures): Project attribution (p = 0.770). *Principal component 7* related with ‘Stakeholder objectives’ accounts for 3.77% of the total percentage variance. This contains of three variables (measures); Reportable accidents (p = 0.803), Records of complaints regarding environmental issues (p = 0.571) and Fatalities (p = 0.427). *Principal component 8* related to ‘Profit predictability’ accounts for 3.60% of the total percentage variance and consists of one measure; Cash Flow (p = 0.852). *Principal component 9* related to ‘Transfer of Experience’ accounts for 3.59% of the total percentage variance and compares of two sub-measures: Transfer of experience and best practice (p = 0.767) and Rate of site meetings (p = 0.603).

Principal component 10 related ‘Innovation’ accounts for 3.58% of the total percentage variance and consists of one measure; Innovation (p = 0.699). *Principal component 11* related to ‘Environment’ accounts for 3.42% of the total percentage variance and consists of one measure; Environmental FAQ (p = 0.865). *Principal component 12* related to ‘Design cost’ accounts for 3.28% of the total percentage variance and consists of one measure; Design cost (p = 0.890). *Principal component 13* related to ‘Sustainability’ accounts for 3.27% of the total percentage variance. It consists of Sustainability (p = 0.885) and Energy and water use (p = 0.462). *Principal component 14* related to ‘Design time' accounts for 3.09% of the total percentage variance. It consists of one measure; Design time (p = 0.911).

Table 7-25: Factor analysis of performance measure at production stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Performance Measure	FL
1	Project production and management	19.99	19.99	10.72	22.3	Construction time	0.872
						Quality assurance systems	0.864
						Productivity	0.838
						Construction method and technology	0.768
						Team performance	0.755
						Time to rectify defects	0.745
						Construction cost	0.744
						Change orders	0.692
						Integration of design and construction	0.665
						Leadership	0.650
						Project schedule and monitoring	0.617
						Defects	0.602
						Number of training	0.596
						Solving site problems	0.579
						Waste of resources and materials	0.529
						Risk rate	0.505
						Rework	0.460
						Decision making procedures	0.398
2	Stakeholder objectives	33.12	13.13	6.98	14.6	Stakeholder involvement	0.861
						Alignment of stakeholder's requirements	0.753
						Contractor satisfaction – payment	0.723
						Client satisfaction (specific criteria)	0.679
						Applying a new products and technology	0.653
						Project organization structure	0.646
						Documentation and Reports	0.625
						Planning	0.622
						Safety requirements	0.482
						Profitability	0.479
						Relationship among stakeholders	0.402
3	Conflicts	38.10	4.98	3.00	6.2	Conflicts & claims	0.490
4	Waste-percentage	42.20	4.09	2.24	4.7	Waste-percentage waste to landfill (m3)	0.826
5	Quality issues	46.25	4.05	1.95	4.0	Quality issues at available for use	0.770
						Availability of specifications and standards	0.647
						Cost to rectify defects	0.583
						Client satisfaction (standard criteria)	0.443
6	Project attribution	50.18	3.94	1.83	3.8	Project attribution	0.800
7	Fatalities	53.95	3.77	1.70	3.6	Reportable accidents	0.803
						Records of complaints regarding environmental issues	0.571
						Fatalities	0.427
8	Profit predictability	57.55	3.60	1.54	3.2	Cash Flow	0.852
9	Transfer of Experience	61.14	3.59	1.44	3.0	Transfer of experience and best practice	0.767
						Rate of site meetings	0.603
10	Innovation	64.72	3.58	1.37	2.9	Innovation	0.699

11	Environment	68.14	3.42	1.26	2.6	Environmental FAQ	0.865
12	Design cost	71.42	3.28	1.15	2.4	Design cost	0.890
13	Sustainability	74.69	3.27	1.12	2.3	Sustainability	0.885
						Energy and water use	0.462
14	Design time	77.78	3.09	1.05	2.2	Design time	0.911
KMO Measure of Sampling Adequacy is 0.518							
Barlett Test of Sphericity is 2093.950, significant level is (p<0.001).							

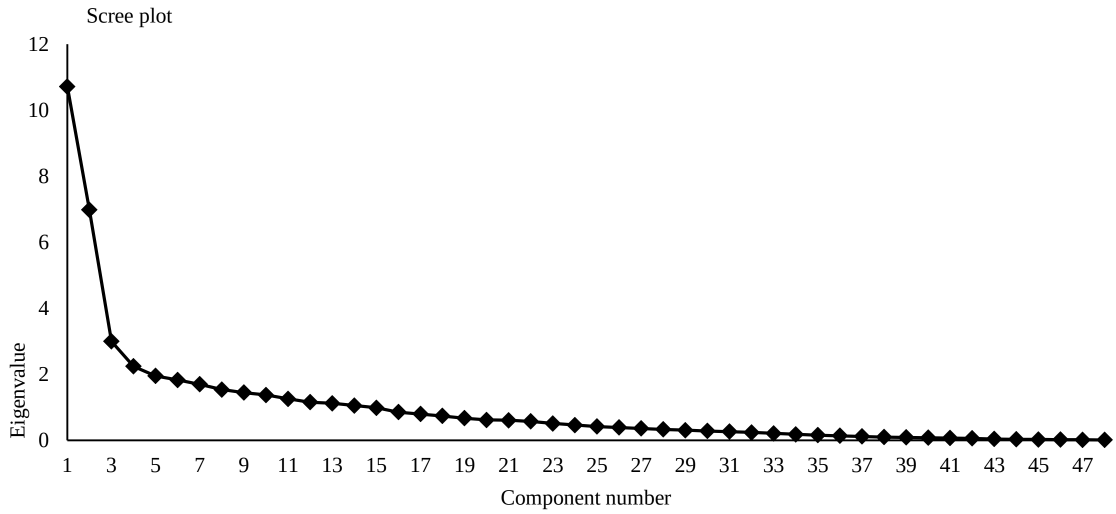

Figure 7-16: Scree plot of performance measures at production stage

7.5.2.3 Operation Stage

In the Operation Stage, fifteen PMs identified were subjected to factor analysis using principal components and varimax rotation. The data collected was valid and acceptable to be used by factor analysis method according to result of KMO which is 0.886, which according to Hair et al (1998) is satisfactory for factor analysis. In addition, the value of Barlett test of sphericity is 550.764 and associated significance level is small (p<0.001), this suggests that the population correlation matrix is not an identity matrix as stated Hair, Tatham, Anderson, & Black (1998). Thus, in this stage, the principal components were driven by fifteen variables (measure), also they were determined using an Eigen value over one as an extraction criterion.

As summarised in Table 7-26, three principal components which are composed of the remaining fourteen measures and just one measure under component 3 was excluded that is energy and water use (p = 0.360). These components accounts for 66% of the total variance (34.58%, 21.23%, and 10.19%). Figure 7-17 confirms that a three-component model should be sufficient for the research model.

The three Principal Components are: -

- Principle Component 1: relates to user and client satisfaction,
- Principle Component 2: relates to defects, and
- Principle Component 3: relates to safety requirements and environment.

The grouping of components (measures) is based on their loadings. Nine sub-measures came under *Principal Component 1*, which was associated with 'user and client satisfaction'; end-user satisfaction (user expectations) (*p* = 0.813), sustainability (*p* = 0.794), client satisfaction (standard criteria) (*p* = 0.758), integration of design and construction (*p* = 0.729), client satisfaction (specific criteria) (*p* = 0.715), conflicts & claims (*p* = 0.714), quality issues at available for use (*p* = 0.712), time to rectify defects (*p* = 0.624), and safety requirements (*p* = 0.590).

Principal Component 2 is consisted of three sub-measures which related to defects; defects (*p* = 0.890), cost to rectify defects in the maintenance period (*p* = 0.824), and fatalities (*p* = 0.637). *Principal Component 3* is comprised of three sub-measures associated with safety requirements and environment; records of complaints regarding environmental issues (*p* = 0.837), environmental FAQ (*p* = 0.525).

Table 7-26: Factor analysis of performance measure at operation stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Performance Measure	FL
1	User and client satisfaction	34.58	34.58	7.02	46.8	End-user satisfaction (user expectations)	0.813
						Sustainability	0.794
						Client satisfaction (standard criteria)	0.758
						Integration of design and construction	0.729
						Client satisfaction (specific criteria)	0.715
						Conflicts & claims	0.714
						Quality issues at available for use	0.712
						Time to rectify defects	0.624
						Safety requirements	0.590
2	Defects	55.81	21.23	1.73	11.5	Defects	0.890
						Cost to rectify defects in the maintenance period	0.824
						Fatalities	0.637
3	Safety requirements and environment	66.00	10.19	1.20	7.7	Records of complaints regarding environmental issues	0.837
						Environmental FAQ	0.525
						Energy and water use	0.360

KMO Measure of Sampling Adequacy is 0.886;
Barlett Test of Sphericity is 550.764, significant level is (p<0.001).

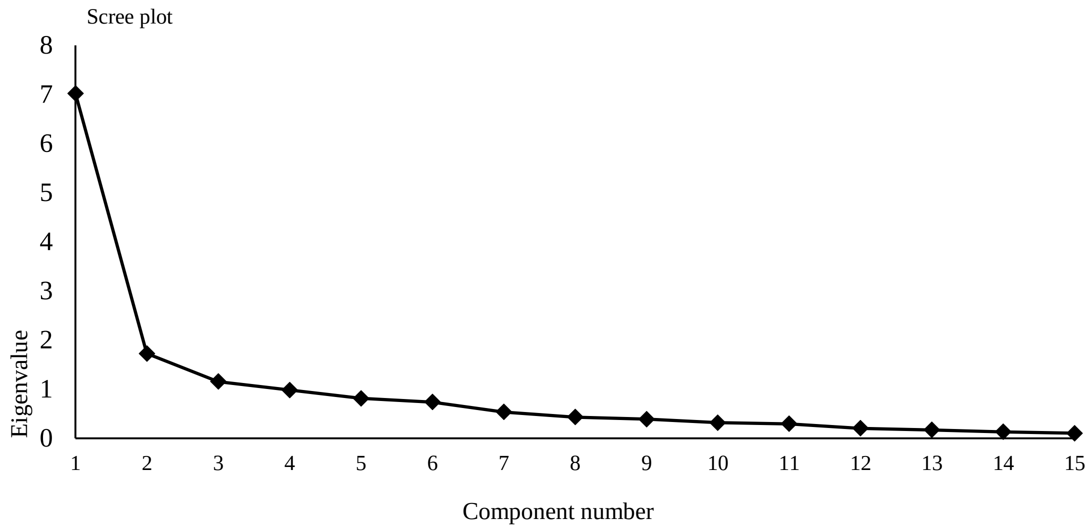

Figure 7-17: Scree plot of performance measure at operation stage

7.5.3 Efficiency and Effectiveness Measures

7.5.3.1 Efficiency Measures

Table 7-27 summarises the factor analysis results of efficiency measures conducted utilizing the principal component method. The appropriateness of the factor analysis was determined through KMO and Bartlett's Test of Sphericity. The value of KMO measure of sampling adequacy is 0.559 that is more than 0.5, hence, as considered by Lin et al. (2011) that the data is acceptable for factor analysis. While, the result of Barlett Test of Sphericity = 144.859 is large, associated significant level is small (p=0.000), suggesting that the population correlation matrix is not an identity matrix.

Principal components were extracted with Eigen values greater than 1, and accounting for 58.65 of the variance, the variance accounted for by the four principal components were 22.71%, 13.08%, 12.71% and 10.16% respectively. Figure 7-18 shows that the four principal components model should be sufficient for the research model. The four components were grouped based on their factor loadings greater than 0.5, where out of twelve variables, eleven variables are extracted as significant measures.

Principal Component 1 relates to 'resource utilisation'; Minimum amount of wastages (p = 0.810), Meets budget (p = 0.777), Efficiency in utilization of manpower (p = 0.733), Meets time (p = 0.625) and Minimum scope changes (p = 0.604). *Principal Component*

2 relates to 'productivity'; High project productivity (*p* = 0.754) and High quality of workmanship (*p* = 0.712). *Principal Component 3* relates to 'meets specification'; Meets technical specification (*p* = 0.652), Minimum amount of disputes (*p* = 0.648) and Fast decision-making process (*p* = 0.574) and *Principle Component 4* related to 'safety requirements'; Meets safety requirements (*p* = 0.885), whereas just one variable (performance measure) Minimum effect on the environment was not included due to its factor loading is below cut-off (*p* = 0.434).

Table 7-27: Factor analysis of efficiency measures at production stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Efficiency Measures	FL
1	Recourse Utilisation	22.71	22.71	3.89	24.1	Minimum amount of wastages	0.810
						Meets budget	0.777
						Efficiency in utilization of manpower	0.733
						Meets time	0.625
						Minimum scope changes	0.604
2	Productivity	35.78	13.08	1.59	13.2	High project productivity	0.754
						High quality of workmanship	0.712
3	Meets Specification	48.50	12.71	1.40	11.7	Meets technical specification	0.652
						Minimum amount of disputes	0.648
						Fast decision-making process	0.574
4	Safety Requirements	58.65	10.16	1.15	9.6	Meets safety requirements	0.885
						Minimum effect on the environment	0.434

KMO Measure of Sampling Adequacy is 0.559;
Barlett Test of Sphericity is 144.859, significant level is (p=0.000).

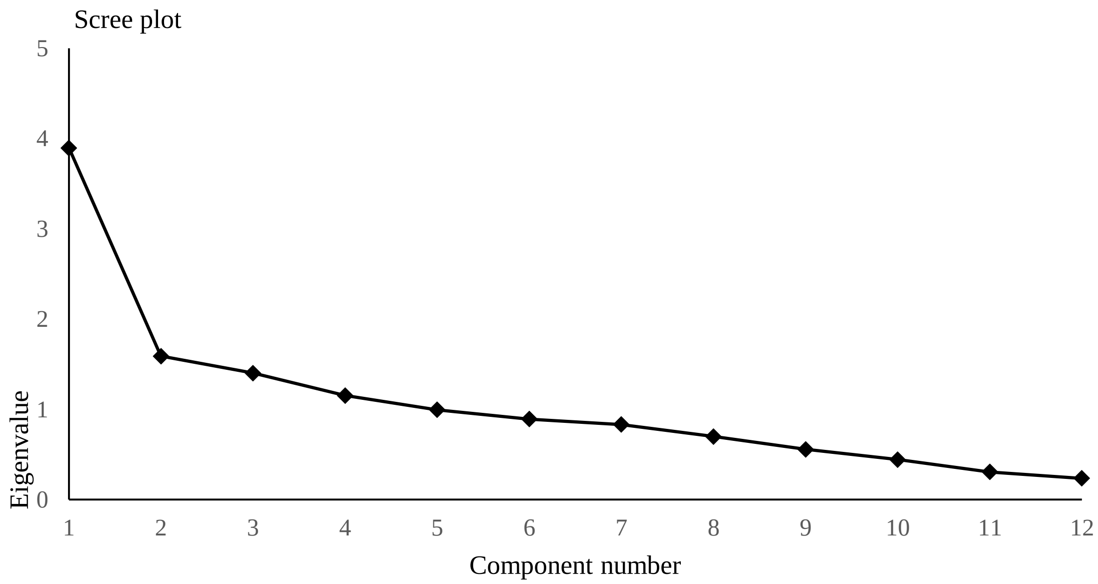

Figure 7-18: Scree plot of efficiency measures at production stage

7.5.3.2 Effectiveness Measures

The result of data analysis of effectiveness measures by the principal component approach is shown in Table 7-28 The value of KMO measure is 0.727 which is higher than 0.5, consequently, that the data is acceptable for factor analysis. While, Barlett Test of Sphericity is 138.700 which is large enough, and associated significant level is small (p=0.000), suggesting that the population correlation matrix is not an identity matrix. Figure 7-19 illustrations that the four principal components model should be sufficient for the research model. Four principal components were grouped based on their factor loading greater than 0.5. The variance accounted for by the four principal components was 20.71, 17.39, 15.47 and 10.81 respectively.

Principal Component 1 relates to stakeholders satisfaction; Meets stakeholders' needs & expect (p = 0.784), Meets client satisfaction on product (p = 0.728) and Meets pre-stated objectives (p = 0.690). *Principal Component 2* relates to project reliability and durability; Project functionality (p = 0.809), Integrated with national plans and fit with purpose (p = 0.556), Pleasant environment (p = 0.542) and Free from defects (p = 0.531). *Principal Component 3* relates to flexible for future expansion; Flexible for future expansion (p = 0.854) and Fast rectification of defects (p = 0.751). *Principal Component 4* relates to serviceability; Easy to maintain (p = 0.793) and Meets client satisfaction on service (p = 0.634).

Table 7-28: Factor analysis of effectiveness measures at operation stage

No	Principal Components	CPV	PoVE	Eig,	% of VA for	Effectiveness Measures	FL
1	Stakeholders Satisfaction	20.71	20.71	4.23	29.33	Meets stakeholders' needs & expect	0.784
						Meets client satisfaction on product	0.728
						Meets pre-stated objectives	0.690
2	Project Reliability and Durability	38.10	17.39	1.61	14.60	Project functionality	0.809
						Integrated with national plans and fit with purpose	0.556
						Pleasant environment	0.542
						Free from defects	0.531
3	Flexible for Future Expansion	53.57	15.47	1.21	10.99	Flexible for future expansion	0.854
						Fast rectification of defects	0.751
4	Serviceability	64.38	10.81	1.04	9.47	Easy to maintain	0.793
						Meets client satisfaction on service	0.634

KMO Measure of Sampling Adequacy is 0.727;
Barlett Test of Sphericity is 138.700, significant level is (p=0.000).

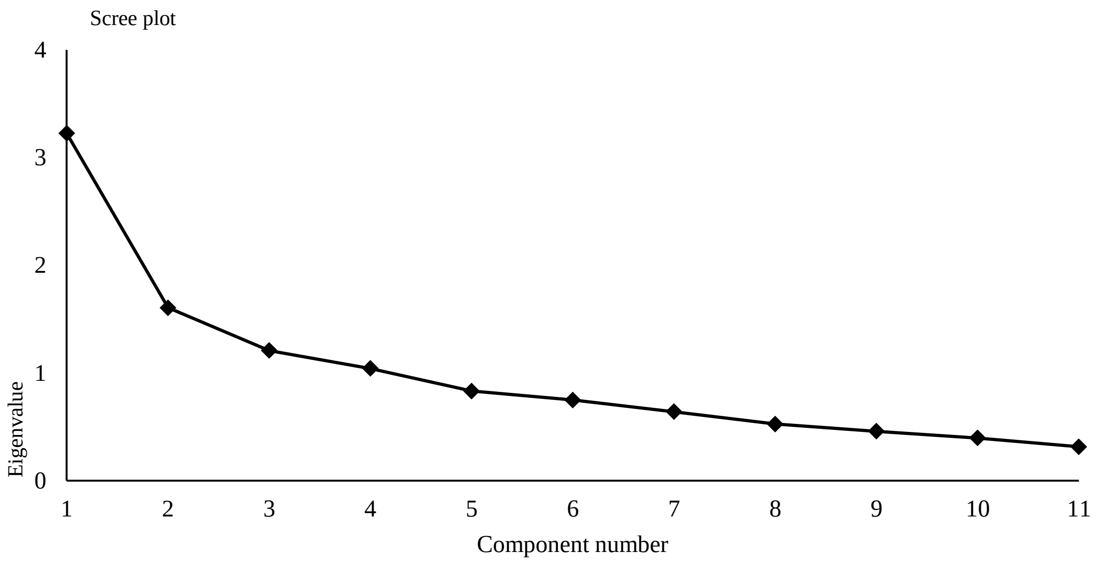

Figure 7-19: Scree plot of effectiveness measures at operation stage

7.6 Conclusion

This chapter considered data analysis based on research data collected in the questionnaire survey. The data was provided by participants who are involved in the delivery of municipal construction projects in SA namely; Government (Municipality), Contractor and Consultant. The data analysis provided sufficient evidence to support that municipal construction sector currently suffering from lack of performance measurement framework for measuring project performance over project lifecycle. The analysis produced several CSFs and sub-factors, PMs and sub-measures, and PSMs (efficiency and effectiveness) and sub-measures across of construction project stages, which ranked according of participants' perception.

The result of mean method analysis was used together with the findings of factor analysis approach to develop a framework for measuring and evaluating municipal construction project. However, many of these significant variables are reduced with the aid of the Factor Analysis method. In general, the responses means result and variances among of respondents perception regarding framework components (CSFs, PMs, PSMs, project stages and key stakeholders) are investigated by organisation type. These components are needed to be integrated to develop the framework. The next chapter is concerned with interpretation and discussion of described and analysed data in this chapter.

8. CHAPTER EIGHT: INTERPRETATIONS AND DISCUSSIONS

8.1 Introduction

The following discussion chapter is outlined to pull together variable of this study that aimed to achieve these aims, this study intends to meet specific objectives. This includes, literature review finding regarding existing performance measurement framework being used in the construction industries in developed countries and in municipalities in SA. The discussion chapter has two viewpoints, first dimension is concerned with identifying the procurement system, project stages and stakeholders of construction projects in SA municipalities. The second dimension focus on the CSFs, the PMs and PSMs in the implementation of municipality construction projects in the SA.

8.2 Critical Evaluation of Performance Measurement System

Performance measurement systems provides the essential evidence that helps to enhance process control, it facilitates the formation of challenging and practicable goals, and enhances communication between different managerial levels (Neely, et al., 2000). Due to its diverse nature in construction, the applicability of performance measurement is viewed from different levels of generalisation, while Yang et al., (2010) identified project, organisational and stakeholder levels.

Performance measurement is being applied in public agencies to attain stakeholders and citizens' satisfaction in terms of efficiency and effectiveness of delivered services, and to enhance accountability (Kloot, 1999). While, in construction industry, the PM has been practiced to increase productivity during project execution, improve quality and meet customer needs. However, the application of PM in both government and construction has not received attention when contrasted with the manufacturing industry; this is resulted from several factors. In the public sector and in the municipalities particularly, this weakness is due to reasons, and most significant of them are: lack of transparency, bureaucracy, and ignorance targets and method of application, whereas, in construction projects weakness is consequences of lack of information, training, and also the complexity and continuous change in construction projects (Löfgren & Eriksson, 2009).

In majority of construction projects, performance is measured through financial indicators, they are considered lagging indicators focused on past events. Further weaknesses include poor strategy, lack of information on environment, cooperation between partners and quality (Cheung, et al. 2004). To overcome these weaknesses the design of performance measurement framework should include a variety of conventional performance indicators such as time, cost, quality, safety, contractor selection criteria and environment while covering new subjective parameters of communication and dispute resolution. However, the framework is implemented in seven main steps including measurement process and benchmarking these are; 1- Identify what to be measured 2 - Define measures 3 - Collect Data 4 - Calculate measures 5 - Report the result 6 -Analyse the result 7 -Benchmarking 8 - Learn from best practice 9 - Take action 10 - Measure again.

In the same context, Chan & Chan (2004) highlighted the practical difficulties of performance measurement to include the fact that some project information and measures defined by KPIs cannot be calculated practically, while Kagioglou et al., (2001) argued that they offer little indication from a business point of view, and that they lack a holistic perspective on the relationship between the different indicators, also that none of the indicators deals with the "innovation and learning perspective". In particular, Robinson, et al., (2002) stated that KPIs have been rated lower by construction firms than the BSC model and the EFQM excellence model.

Given that benchmarking is a basic component of the PMSs, benchmarking is an approach for assessing performance, delivered services and the process of production against similar producers to gain the best practices for good performance. It is noted that main purpose behind using benchmarking in the private sector is to achieve excellence and be the best, while in the public sector it is only to be good or at least not to be the worst. Although the importance of benchmarking is affected by several factors that hinder its use in the public and private sector that are absence of an appropriate understanding of benchmarking by practitioners, ambiguity surrounding what must be done to complete the process of benchmarking and lack of information and data, which is due to the nature of the construction sector which does not document and build up data. In public sector services the benchmarking approach is being imposed to compare the strategies and functions by contrast, it is focused on project performance to increase productivity.

As noted in previous studies, success of construction projects mainly rely on existing PMSs as mentioned by (Clifton, 2010) *"if you can't measure it, you can't manage it",* as well as, "*You cannot manage what you do not measure; consequently, you cannot measure what you do not define"* (Fink, 2006). Despite the significance of PMS, it has not been applied in the Saudi construction sector. This logically explains the poor performence of construction projects and its failure to achieve goals, whether in government or the private sector. Thus, there is urgent need to include benchmarking as part of measurement concept for measuring performance in Saudi construction as suggested by (Ahcom, 2004).

8.3 Limitation of Current Performance Measurement Systems

Traditional measures have been applied to measure financial aspects such as profit and turnover, and thus they are appropriate to businesses. Despite their importance in strengthening the financial aspects, they do not raise the level of competition and technology. Moreover, they have been criticized for encouraging short-term goals, focusing on minimisation of conflict rather than continuous improvement and being internal focused.

In terms of PMS application, lack of information and insufficient training on how to use them remain the major barriers (Costa et al., 2004) whereas Neely et al. (2000) identified three obstacles, i.e. non-acceptance of performance measurement, computerised problems and weak commitment of senior managers. In line with their findings, Bracegirdle (2003) has also opined that resistance towards the acceptance and application of PMS from the managers was a vital factor. Pollanen (2005) has taken a broader view and identified four categories of obstacles which prevent performance measurement's acceptance and execution. These are;

1- Institutional, such as resistance to transparency;
2- Technical, for example, lack of specifications and standard;
3- Financial, for instance, significant investment of resources and time, and
4- Pragmatic, such as insufficient convenience and reliability.

The use of performance measurement is thus limited as a consequence of difficulties in measurement, long duration and costly expenditures being needed, and difficulties created in the process of performance measurement by being an inherently project-directed business (Ankrah and Proverbs, 2005).

According to Nudurupati et al. (2007) the key restrictions for PMSs in the construction industry are resource allocation, record and storage of data and information, and the logistics. Construction projects in both public and private sectors have been facing challenges and obstacles as performance has not been measured due to the lack of methods and approaches to discover the strengths and weaknesses (Luu et al., 2008). Other significant potential sources of problems that hinder the construction projects are the lack of consensus on defining the concept of project success among stakeholders before beginning of the project, thus do not achieve desired goals, accordingly, critical success factors and success criteria must be determined at pre-project phase (Lim and Mohamed, 1999).

To sum up, the challenges of execution and improvement of PMSs can be seen clearly in some key areas such as the consumption of time and resources, difficulties in data gathering, enabling the citizen role in using performance measurement output and moreover creating a sense of performance measurement inside the governmental authorities (Bracegirdle, 2003).

8.4 The key Components of Successful Performance Measurement Framework

Having identified the major frameworks of performance management models and methodologies, and given the low level of the application of performance measurement in the SA, it is important to provide a layout of the essential components of successful performance measurement which are proposed for application in the SA construction industry and municipal agency projects in particular.

Literature on PMSs in construction identified three levels of implementation, and these are project, organisational and stakeholder levels (Yang, et al. 2010). At project level, performance measurement involves measuring both the project's implementation progress and its results, and from organisational perspective, performance measurement involves reflecting the organisation's aims and objectives in its productivity, effectiveness, efficiency and the quality of the final product or services, while at stakeholder level, performance management is based on pre-defined the measurement and monitoring of a project's performance based on predefined criteria developed by the stakeholders (Barclay & Osei-Bryson, 2010; Saqib, et al. 2008). According to Ghobadian & Ashworth (1994) the performance measurement process consists of four main phases which include the determination of the requirements and identification of PMs, the identification of desired goals, monitoring achievements, and continuous reviews with the aim of identifying areas of failure.

For the performance measurement process to be effective, it must include specific features which help to determine project position, communicate the position, and identify priorities within the project to enhance progress. The process must be easily understandable and acceptable to all project stakeholders, needs to highlight the financial and non-financial parts of the project, information on the project must be current and up-to-date highlighting the main processes as well as stating the relationship between cause and effect in performance so that it is easily comparable (Bititci, et al. 2000; Amaratunga and Baldry, 2002; Ankrah and Proverbs, 2005). Fundamentally, in the performance measurement process, an industry overview perspective should identify the leading and lagging indicators subjectively and objectively, measures can then be used to benchmark performance both internally and externally, and the selected measures should support the decision makers with updated relevant information.

The entire process should be comprehensively collated from a stakeholder perspective in order to optimise project outcome within municipalities. Hence for the performance measurement process to be comprehensively effective, Sinclair & Zairi, (1995) argued that there must be extensive strategy and goal development, process management and measurement, performance appraisal and management, break-point performance assessment, and reward and recognition.

It is obvious that performance management involves a consistent set of established measures and indicators that are generated based on predefined rules and guidelines which influence performance. Kulatunga et al., (2011) highlighted that performance management combines leading indicators (such as resource allocation and utilisation, time commitment of the team members and absence ratio) and lagging indicators (such as achievement of deliverables and milestones). They explained further that lagging indicators informs the success of activities carried out, as well as, initiatives taken and modifications made within a project, hence the lagging indicators show the effect of achievement of required performance. On the other hand, leading indicators highlight the performance of the team, processes and direction of resources; therefore they help in taking corrective actions before overall performance is affected. When this procedure is applied to municipality construction projects, adequate definition of leading indicators within municipal performance management systems would enhance taking initiatives and making modification with the aim of keeping the entire project within expected goals. Hence, the application of leading and lagging indicators within municipal projects ensures the proper flow of project activities.

In the same context, a key component of successful performance measurement framework for municipality construction projects is benchmarking. There are three variants of benchmarking (Takim, Akintoye, & Kelly, 2003; Mohamed, 1996), and several scholars have suggested various steps among them (Gleich, et al. 2008; Lam, et al. 2007). The process of benchmarking was originally developed for the private sector but has been increasingly applied in the public sector (Jones & Kaluarachchi, 2008). However, the benchmarking process applicable in the public sector is different compared to the private sector, the unique rule based nature of public sector processes requires that the process of benchmarking be adapted for it to be workable in the public sector. But the ease with which the application of benchmarking can generate unhealthy competition among several municipal departments must be noted and prevented so that benchmarking does not create unnecessary hostility among municipal departments since the criteria for comparison may be different and projects are also unique in their features and environments.

KPIs are also a key component of successful performance measurement framework construction projects, and according to Beatham et al., (2004) it takes into consideration measuring performance across different project stages to achieve stakeholder needs and expectations. Also, it is a veritable tool for improving the various processes involved in construction projects regarding effectiveness, efficiency and decision making (Ibrahim, et al. 2010). KPIs are increasingly applied in public sector projects for the purposes of achieving best practice and continuous development of financial and non-financial benefits. Mainly, they are used to enhance profitability and competitiveness in order to achieve process improvements; hence measures are taking which are then benchmarked with predefined criteria (Enoma & Allen, 2007).

It is important for project output to satisfy the users whose needs the project is meant to satisfy, hence satisfactory results are important for PMSs such that in the event of their being applied to the project, the project aims and objectives are considered to be fulfilled. According to Swindell et al (2002), citizens' satisfaction is paramount in measuring the performance of municipality projects and should be a main yardstick for decision making in the municipality. PMSs are generally used to enhance productivity and cost effectiveness in construction projects with the aim of eliminating inefficiency (Cha & Kim, 2011). Hence, stakeholders in municipality projects must apply PMSs to measure efficiency and effectiveness to improve the success of their projects in terms of both financial and non-financial inputs (Takim, et al. 2003). Further, they can also judge public sector services with respect to their quality, impact, productivity and effectiveness by applying citizen, customer, or client surveys (Kouzmin, et al. 1999).

Although, construction projects are unique, their processes are similar; however, it is important that there is agreement among project stakeholders that the project meets specified expectations. Literature on construction project lifecycle highlighted that a typical construction project is divided into various stages but at different levels of depth (Popov, et al. 2010; Fleming, 2009), but there is a general consensus that monitoring and PMSs are essential for each stage in order to achieve stakeholders' expectations (Haponava, et al. 2012). A dissection of several different studies which highlight several project phases shows that these phases in the various studies can be reduced to three main phases as seen in Appendix 4 which are:

- Initial Phase
- Construction Phase; and
- Operation Phase.

To measure project performance, it is essential to install performance metrics in each stage of the project, these metrics include stakeholder objectives which highlight the success factors integrated with PMs that are benchmarked against the outcomes in each stage.

8.5 Construction Project Performance Success and Project Success

Success is an important factor in construction projects, it is normally pursued with extensive vigour in all project sectors (Nguyen, Ogunlana, & Lan, 2004). In the construction sector, success broadly refers to the extent to which a project's objectives have been achieved based on the norms of the iron triangle of time, cost and quality (Arslan & Kivrak, 2009). Construction project success is generally influenced by a set of factors such as project attributes such as size, cost, environment, contract and specifications, the relationship and cooperation between stakeholders, qualification of engineers, and teamwork (Cheung, et al. 2004). Hence measuring project success remain unclear given that project attributes vary in types and number, and success factors vary between project stakeholders and the project stakeholders' objectives vary within project stages Nguyen et al (2004). However, it is generally acknowledged that the success of construction projects is achieved when the projects is accomplished within time, budget, specifications, clients are satisfied, contractors attain satisfactory profit levels, no claims made, and the project achieved the planned purpose (Nguyen, Ogunlana, & Lan, 2004).

The success of projects can be seen from micro and macro dimensions of construction projects (Toor & Ogunlana, 2009) reveal that the two levels of success are; the micro viewpoint is concerned with the success of project stages and sub-stages, while the macro viewpoint is related to the extent to which the original project's aims and objectives were achieved. Therefore, the success of construction projects can be measured under two distinct definitions during project lifecycle, namely *project success* and *project performance success* which are both important for overall success measurement. Takim et al (2003) also introduced the idea of tangible and non-tangible project success, and Chan and Chan (2009) highlighted four time periods of success within a project. Generally, these scholars agree that project success and project performance success can be measured at different stages of a project's life, but have only referred to these stages by different names.

Due to its multi-actor, multi-stage and dynamic nature, the construction industry is generally deemed to be complex and risky (Löfgren & Eriksson, 2009). Specifically the key barriers to performance measurement in the construction industry include lack of agreement in defining the project's concept of success among stakeholders during the project's design stage; several others include poor relationships and poor collaboration between contractor and client due to lack of trust, ineffective communication, and a lack of customer focus. This is in spite of the fact that construction projects that were judged to be outstanding in achieving success and satisfying costumers' expectations derived through higher productivity and performance in terms of quality, time and cost from superior partnering and collaboration between stakeholders (Löfgren & Eriksson, 2009). Other areas where problems were highlighted in the construction industry include resource allocation, documentation, data storage and management, and logistics (Nudurupati, Arshad, & Turner, 2007).

8.6 Critical Success Factors and Success Measures in Construction

8.6.1 Critical Success Factors

Generic CSFs have been identified to include elements such as knowledge, skill, behaviour, methods and attributes that have an impact resulting in performance or project success. Within the construction industry, the generic factors are identified as those objective or subjective factors that have significant impact on a project's success, and they include planning effort (construction), planning effort (design), project manager goal commitment, project team motivation, project manager technical capabilities, scope and work definition, and control systems (Nguyen, et al. 2004).

Globally, several different factors are identified as critical to the success of a construction project, they are used in optimising organisational strategy, and to produce outstanding performance levels, however their efficacy remain in doubt if they are not applied comprehensively together (Jacobson & Choi, 2008), therefore they must be relevant and reliable to be applicable in municipality construction projects. This is because of the finding reported by Lehtiranta et al. (2012) that there is correlation between success factors, project success, and stakeholder satisfaction. This then calls for the development of a reliable and efficacious framework which is based on the relationship between CSFs and KPIs so that their application in municipal projects can contribute to effective achievement of goals.

8.6.2 Performance Measures

Performance Measures were emerged from benchmarking in the process of comparing project outcomes with best practice measures; they are principles or standards by which anything can be judged Lim & Mohamed (1999). In the construction industry, PMs are a measurement which indicates the measurement of the performance of a project or a company against critical criteria to confirm whether the performance meets improvement targets, the aim is to apply such indicators to measure one or more aspects of a project. Although the traditional criteria are cost time and quality, the applicable PMs in the construction industry are budget performance, schedule performance, client satisfaction, functionality, contractor satisfaction and project manager/team satisfaction (Nguyen, et al. 2004).

In SA, construction companies rely on the use of financial measures to evaluate their organisation and projects. However, globally, several different studies identified various PMs (Haponava & Al-Jibouri, 2009), those identified in the global arena include mathematical formulae for monitoring construction time, construction speed, time variation, unit cost, percentage net variation over final cost, net present value, accident rate, and environmental performance as well as the opinions and personal judgement of the stakeholders of quality, functionality, and satisfaction. In addition, applying the leading and lagging measures helps to avoid unexpected diversions and failures during project progress across the various stages in the project. These has been supported in research studies and are therefore applicable for measuring municipality projects in the construction industry in SA.

8.6.3 Success Measures (Efficiency and Effectiveness)

Application of PMs in the public sector are viewed from different perspectives, from the "Three Es" of economy, efficiency and effectiveness in the 1980s to today's measures of non-financial process measurement, output measures, and outcomes measures (Kouzmin, et al. 1999). While economy relates to cost control in relation to profits, efficiency refers to ratio of inputs to outputs while effectiveness is the relationship between a responsibility centre's outputs and the achievement of its objectives. Also, process measures refer to the relationships between inputs and outputs, output measures are concerned with current level of work achieved, and outcome measures indicate effectiveness of outcomes. Therefore, efficiency and effectiveness measures are the ultimate aim of comprehensive PMSs in general, but particularly for municipality projects. Project success is achieved when all of these measures can be identified in a construction project. This was supported by Opoku & Fortune (2011) sustainable development aims to achieve end-users' satisfaction, which can also contribute to improved life quality and economic growth.

8.7 Extraction Criteria for the Variables in the Developed Framework

To extract the variables that form the research framework for this study, a decision was taken to limit the variables to the most important variables that the respondents consider as such based on their perceptions. Ankrah & Proverbs, (2005) highlighted that the variables to be applied in the implementation of projects should be limited to the most important ones. Similarly, Chan & Chan (2009) suggested that the variables applied in construction project management should be focused on the most critical aspects of output, and should be limited and manageable in number, and maintainable for regular use. Therefore, the variables of CSFs, PMs and PSMs across the three project stages that are to be applied in developing the framework in this study will be the most important variables that are ranked as such according to the perception of the research respondents. The results of the means and the factors analysis will be jointly analysed to determine the most important variables that are confirmed by both results, and the most important variables are those ranked within the cut-off 4 on the Likert Weighted Ranking Table 8-1

Table 8-1: Likert weighted ranking

Mean value range	Rank	Interpretation of rank
1.00 - 1.86	1	Not important
1.87 - 2.71	2	Slightly important
2.72 - 3.57	3	Somewhat important
3.58 - 4.43	4	Moderately important
4.44 - 5.29	5	Important
5.30 - 6.14	6	Very important
6.15 - 7.00	7	Extremely important

8.7.1 Factors Influencing Municipal Construction Projects Performance

Tables 8-2 presents the different factors from the statistical analysis of the research. Here the mean values of the responses were calculated and ranked on the basis of these values to assess their importance. A more thorough comparison was made of the ranking order, since using the data of the different groups depending only on the mean ranking method to determine which variables have the most significance would be without meaning. Hence, the ANOVA analysis method was utilised to analyse the variables of CSFs so that the main factors could be identified.

It is possible to assemble all participants together to establish the status of CSFs on the basis of the general samples because no significant difference in the viewpoint of various participant groups about CSFs was found as shown in Table 7-13, 7-14 and 7-15. The tables show the mean scores and relevant ranks of success factors for the overall sample as well as for different participant groups. Many investigators have used this ranking technique successfully (2010).

8.7.1.1 Conceptual, planning and tender stage

It is noteworthy that all respondent groups have given considerable importance to management and strategic aspects in the conceptual, planning and tender stage. An analysis of the mean values side-by-side with the factor analysis of the success factors at the Conceptual, Planning and Tender stage reveal that the factor analysis result support the results of the factors perceived by the respondent groups as "very important" CSFs. In Table 7-13, the CSFs that are considered as "very important" are the first 13 factors based on the overall cut-off point of 4 on the Likert Weighted Ranking Table. These factors include: "Contractor selection criteria", "Coordination and vision", "Integrate the project with national plans", "Strategic alignment of project goals with stakeholders' interests", "Transparency in the procurement process", "Standards and specifications", "Budget", "Project duration", "Top management support", "Procurement & delivery strategy", "Risk", and "Relationship among stakeholders".

An examination of the results of the factor analysis result show that the CSFs with the highest mean values are categorised under "management capabilities" and "contractor selection criteria and vision" components. Of the 5 factors grouped under "management capabilities" components, only "Training" is not regarded as "very important" by the respondents, therefore, this success factor will be excluded from the research framework being developed for this study.

Further, all the factors grouped under "contractor selection criteria and vision" component are regarded as "very important" by the respondents, hence these factors will all be included in the research framework. In "decision sources and support" component, only one success factor, "Risk" is regarded as "very important" therefore, "fast decision making process" will be excluded from the research framework, also, the component factor of "Accessibility of experience and specifications" has only one factor "Standards and specifications" considered as "very important" while the remaining two will be excluded from the framework. Under the "Project attributes" component, two success factors, "project duration" and "budget" are considered to be "very important" by the respondents and are included in the framework. The only success factor under the "National Plans" component is "Integrate the project with national plans", as this is considered "very important" by the respondents, it will be included in the research framework.

This supports the study by Haponava & Al-Jibouri (2009), who identified the KPIs based on the key factors affecting pre-project stage in construction, and they identified the following as being relevant for process control in the pre-project stage process in construction projects: "Initial definition of project aims", "Client requirements", "Stakeholder needs alignment", "project design", and "stakeholder involvement". They argued that these factors provide a basis for future development to improve process transparency as well as explain the relationships between various sub-stages in the conceptual and planning stage of construction projects. Al-Reshaid, et al., (2005) suggested that preconstruction factors identified in the early stages of the project enables the project practitioners to obtain successful performance of construction projects and achieve desired outcomes. This position regarding the implementation of construction projects is one in which success factors in preceding stage are considered as leading factors and enablers that impact the subsequent stages in the project. Beatham et al., (2004) explained that leading indicators should be linked to relevant CSFs that provide chance for changing performance and consequently will enhance project success.

The results of the factor analysis in this study regarding the component of "management capabilities" support Iyer & Jha, (2005) who studied the factors affecting the cost performance evidence from the Indian construction industry, the factor analysis component of "Leadership" in their study consists of "coordinating ability", "training", "human resource capability", and top management support. Also, according to Opoku & Fortune (2011) leadership is vital contributed factor in the construction industry that provide the collective vision, strategy and direction towards the common goal of a sustainable future. The success factors grouped in "contractor selection" component in this study confirms the grouping in Chan, et al., (2004) which groups procurement, tendering and contractor selection under the "procurement related factors" component. The study also listed risk as a critical success factor for construction projects. The result in this current study is not surprising because this stage refers specifically to the planning stage (paper work) which is aimed at achieving a solid foundation for the commencement of the project, and it includes coordination, alignment of stakeholders interests, clearly defined objectives and goals, as well as the early stages of tendering and contractor selection as claimed by Haponava & Al-Jibouri (2009), and Othman, et al., (2006) that planning aspects is essential at the early stages of project implementation. Toor & Ogunlana, (2009) also found that adequate communications and clearly defined goals and stakeholder priority are important success factors, they highlighted that this is to be strategically aligned with project goals. Based on the perception of the respondents in Saudi municipalities, the results of this stage agree with these previous findings.

8.7.1.2 Production Stage

In the production stage, of all the 8 factors grouped under the “Project production management” component, only four factors are regarded as “very important” by the respondents, and these are “Sequencing of work according to schedule”, Site meetings”, “Adequate team capability (technical skills, communication, commitment, experience and qualification)”, and “Capability of project manager”, hence, only these four factors will be included in the research framework under this component, while the remaining factors will be excluded. It is however surprising that “Quality control” and “Quality training” are not important for the respondents at this stage, despite the study by Toor & Ogunlana, (2009) finding these to be an essential factors. However, the four factors chosen by the respondents are in agreement with the finding by Lehtiranta et al., (2012). For the “Project duration and budget” component, four factors, “Project duration”, “Budget”, “Schedule project construction”, and “Sufficient resource allocation” are regarded as “very important”, and therefore will all be included in the research framework, while “Cash flow ” will be excluded since it is only regarded as important by the respondents. Lim & Mohamed, (1999) confirmed “project scheduling” as a crucial factor in the construction process, while the remaining three were confirmed as essential factors by Nguyen, et al., (2004).

Regarding the “Design details & specifications” component, three factors “Standards and specifications”, “Sufficient work skills and mechanisms”, and “Adequacy of design details” are regarded as very important, and will therefore be included in the research framework. The study by Toor & Ogunlana, (2009) backs this finding. “Risk” factor will be excluded, however, the perception of the respondents that “Risk” is not very important at this stage is surprising in spite of the its importance highlighted in the conceptual, planning and tendering stage, also a high volume of studies have discussed the impact of risk management in construction projects. In the “Project structure” component, only “Fragmentation of project activities” will be included in the research framework, while

"Project organisation structure" will be excluded. This supports the Work Breakdown Structure principle as highlighted in Toor & Ogunlana, (2009).

Also, for "Documentation" component, only one factor "Documentation and Reports" is relevant for the framework, Haponava & Al-Jibouri (2009) study also found documentation as an essential factor. Within the "Technology" component, the respondents consider only the factor of "Speed of delivering the product to the end users" as "very important", this will therefore be included in the research framework. However, in the "Resource management", "Transfer of experience", "Project attributes", "Learning and innovation", "Sustainability", and "Disputes Resolution", and "Weather condition" components, all the factors are not "very important" to the respondents and will therefore be excluded from the research framework. However, "Sustainability", is considered as important element that balances social, environmental and economic objectives, therefore, it is now firmly on the agenda of the UK construction industry.

Within construction project life cycle, the production stage is related to field work (shovelling activities), hence there is a necessity to give consideration to the application of health and safety systems to protect the human resource (labour), also, the effect of environment and weather conditions has potentially extensive impact on the effective and efficient progress of the project and the project team's productivity as well. These have not been considered as very important as they were not given priority by the respondents, Chan, et al., (2004) suggested that health and safety, and environment and weather conditions must be given high priority during the project implementation stage. Furthermore, project organization structure, experience, and using up to date technology are all essential for the construction project process and location activities, based on the perception of the respondents, these were not considered as very important in the construction production stage, however, these have been given essential recognition in the study by Chan, et al., (2004).

In summary, most consideration is given to time, budget, design details, and specifications in addition to resource allocation, sufficient working skills, project scheduling, and control mechanisms and monitor in the production stage, are confirmed by a majority of studies mentioned previously in chapter four.

8.7.1.3 Operation Stage

The operation stage is considered as the final stage and is directly related to the project outcomes where users are involved, and are looking to achieve their needs and expectations as defined in the project requirement documentations. As a result of this, integration of the project with national plans, and speed of delivering the product to end-user has high priority that is confirmed by the mean and factor analysis results based on the perception of the respondents. Cooke-Davies (2002) emphasised the importance of integrating the project results with the predefined objectives that were set at the planning stage based on national strategy in order to determine whether the project outcome conforms to the expectations of the stakeholders. Maintenance cost & time is also considered as an important contributor to the achievement of stakeholder satisfaction in this stage as emphasised by Kaare & Koppel (2012). They are only four aspects in the operation stage, which are Maintenance cost & time, deliver the product to end-users, integration of the project with national plans, and application of health and safety systems. It is clear that the same ratings for the success factors have been given by different participant groups. The results in the tables are consistent with previous studies that were carried out in other parts of the world.

The operation stage has rather few "very important" factors according to the perception of the respondents. In the "National plans, Maintenance cost & time and sustainability" component, only three factors "Maintenance cost & time", "Speed of deliver the product to end-users", and "Integration the project with national plans" are "very important" to the respondents and will be included in the research framework, hence the other three will be excluded. According to analysis result, all the factors grouped under the "Feedback and stakeholders relationship" component are not "very important", as well as the "Project attributes (type, size, objective, location)" factor grouped under "Project attributes and safety", these will be excluded, whilst "Application of health and safety system" will be included in the project framework.

The fact that only four of the CSFs are "very important" to the respondents in this stage is surprising given the importance of most of the other factors within the construction industry. Three factors that are most confusing among the list are "sustainability", "comprehensive project review and feedback", "Project attributes (type, size, objective, location)", these are critical issues that cannot be ignored within construction project context, especially when the project has been delivered and user has taken delivery.

"Sustainability" has to do with the impact of the project on the environment especially regarding ecology and land use, Lehtiranta, et al., (2012) emphasised on the need for environmental issues to be adequately considered, while Gyadu-Asiedu, (2009) mentioned the factors related to the environment to include political, economic, social, technological, and nature/weather.

These are all important factors that are considered while identifying best practice issues in today's construction environment (Ortiz, Castells, & Sonnemann, 2009). Chan et al., (2004) also emphasised project attributes as essential for determining project success and its flexibility for adjustments and future extension. The relationship among stakeholders is also essential for efficient commitment within the project, according to Nguyen et al., (2004), commitment within the project is important to enhance communication within the project and guide it towards expected direction and goals as well as address emerging issues during the project adequately. Also, there is a need for comprehensive review of the entire project and feedback provided for making necessary corrections and for application in future projects. The project attributes as a success factor is also a critical issue since it mainly defines the most important aspects of the project.

Finally, it can be said that different stakeholders may have different viewpoints about project success as well as the CSFs for the three stages in the Table 8-2. Therefore, as the nature of the construction and participant companies are different for different projects, it is not easy to make a comprehensive list of CSFs.

Table 8-3: Most significant CSFs (factor analysis integrated with mean result)

No	Principal Components	Success Factors
Conceptual, Planning and Tender Stage		
1	Management capabilities	Relationship among stakeholders Strategic alignment of project goals with stakeholders' interests Top management support
2	Contractor selection criteria and vision	Contractor selection criteria Coordination and vision Transparency in the procurement process Procurement & delivery strategy Risk
3	Accessibility of experience and specifications	Standards and specifications
4	Project attributes	Project duration
5	National plans	Integration the project with national plans
Production Stage		
1	Project production and management	Quality control Sequencing of work according to schedule

		Capability of project manager Adequate team capability (technical skills, communication, commitment, experience and qualification)
2	Project duration and budget	Project duration Budget Schedule project construction Sufficient resources allocation
3	Design details & specifications	Standards and specifications Sufficient work skills and mechanisms Adequacy of design details
4	Project structure	Fragmentation of project activities
5	Documentation	Documentation and Reports
6	Technology	Speed of deliver the product to end-users
Operation Stage		
1	National plans and Maintenance cost & time	Integration the project with national plans Maintenance cost Maintenance time Speed of deliver the product to end-users
2	Project attributes and safety	Application of health and safety system

8.7.2 Project Performance Measures

Tables 8-3 present the different PMs from the statistical analysis of the data for the study. Here the mean values of the responses were used to rank the measures on the basis their significance. A more thorough examination of the data showed that the ranking of the data provides more information. Hence, the ANOVA analysis method was utilised to analyse the variables of PMs so that the key measures could be identified. Also, the result of the factor analysis of the data supports the results of the mean value ranking that was implemented on the data. Many researchers have used these approaches composedly to determine the most significant measures such as (Iyer & Jha, 2005; Nguyen, et al. 2004).

8.7.2.1 Conceptual, Planning and Tendering Stage

The respondents consider all the PMs in the "Tendering requirements" and "Stakeholder objectives" to be "very important", therefore, they will all be included in the framework, on the other hand, only three of the five measures in "Specifications" will be included, while none of the two measures in the "project attribution" component will be included in the research framework. The "Tendering requirements" components consists of "Tendering requirements", "Design cost", and "Availability of contractor selection criteria", whilst "Stakeholder objectives" consists of "Alignment of stakeholder's requirements", "Stakeholder involvement", "Design time", and "Planning". This stage is aimed at selecting the contractors and to determine the stakeholders' needs, as a result of this, the practitioners and participants gave them more consideration as supported by Takim & Akintoye (2002). Haponava & Al-Jibouri (2012) found that these measures are important at the pre-project stage, and they highlighted that it is one of the three stages of a project where the client requirements are to be identified, prioritized and converted into solution-neutral project requirements. The respondents considered "Risk rate", "Project attribution", "Safety requirements", and "Environmental FAQ", and found them to be not "important" PMs in the early stages of the project. Takim & Akintoye (2002) found that "Risk rate" should be included in this stage to determine the stage's success, but none of the others were included as important at this stage. This theme in this stage is focussed on planning, administrative, and procurement aspects, this result is confirmed in the CSFs section where the same dimensions were focussed on in the Conceptual, Planning and Tendering Stage. However, other dimensions relating to environment and safety are not considered as important in measures as well as in CSFs.

8.7.2.2 Production Stage

Eighteen measures are grouped under the "Project production and management" component, however, only twelve of these are "very important" to the respondents, these include: "Construction cost", "Construction time", "Productivity", "Quality assurance systems", "Project schedule and monitoring (procedure and process)", "Time to rectify defects", "Integration of design and construction", "Team performance", "Solving site problems", "Waste of resources and materials", "Risk rate", and "Leadership" these will be included in the framework while the others will be left out. In the "Stakeholder Objectives" component, four measures out of the eleven measures are "very important" to the respondents, they include: "Client satisfaction (specific criteria)", "Contractor satisfaction – payment", "Planning", and "Alignment of stakeholder's requirements", while these are included in the research framework, the others will be excluded.

In the "Quality issues" component, two of the four measures: "Availability of specifications and standards" and "Cost to rectify defects in the maintenance period" that are grouped here are "very important" to the respondents and will therefore be included in the framework while "Quality issues available for use" and "Client satisfaction (standard criteria)" are not "very important" to them will be excluded. Also, "Project attribution" measure which is the only one grouped under "Project attribution" component will be excluded from the framework because it is not "very important" to the respondents, the same applies to "Reportable accidents", "Records of complaints regarding environmental issues", and "Fatalities" that are grouped under the "Fatalities" component. The "Cash Flow" measure grouped under "Profit predictability" component will be included in the framework since it is very important to the research respondents, however, all the remaining measures that left in the different components in the factor analysis will all be excluded from the research framework.

The measures agreed to by the respondents as "very important" in the "Project production and management" and the "stakeholder objectives" components are supported in previous studies. Takim (2005) identified "team commitment", "reliable project management structure", "Cost control", "community involvement" and "overall managerial structure" as essential measures for the project production phase, these constitute a combination of measures from user and construction company perspectives. Also, Almahmoud et al., (2012) mentioned team performance, quality management, and off-site performance as essential measures for the project implementation phase in construction projects, Haponava (2012) mentioned quality management and the management of stakeholders which he found to be essential measures for construction projects. Ugwu & Haupt (2007) explained that these measures account for indicators under project administration and as well constituting pre-requisites for achieving sustainability objectives.

Team performance and leadership are integral parts of human resource management that enhance productivity and raise efficiency (Opoku & Fortune, 2011). The respondents regarded "construction method and technology" and "Applying a new product and technology" as not "very important" for the production stage, but Chan & Hiap (2012) highlighted that technology is essential for increased productivity in terms of reduced costs, and new production and construction methods. Other measures regarded as not "very important" by the respondents include "Project organization structure", "Safety requirements", "Quality issues at available for use", "Reportable accidents", "Fatalities", "Transfer of experience and best practice". It was expected to see the selected measures by the respondents as very important, since this stage is oriented towards achieving some targets enhanced by these measures directly. However, the nature of this phase is such that there are specific objectives that must be achieved, and these measure that key aspects of project production that were included in the questionnaire, but the respondents were not concerned with these aspects that are needed to be achieved. It is worthy to note that the measures selected in the Conceptual, Planning and Tendering Stage were not considered as very important in the production stage, this is because the production stage has some requirements that should be undertaken in field work (project location). This dimension is related to the link between project activities, productivity, leadership, scheduling, project, specification, and other relevant dimensions.

8.7.2.3 Operation Stage

In this stage, seven of the nine measures grouped under the "User and client satisfaction" component are "very important" to the respondents correspondently, these include "End-user satisfaction (user expectations)", "Client satisfaction (standard criteria)", "Integration of design and construction", "Client satisfaction (specific criteria)", "Quality issues at available for use", "Time to rectify defects", and "Safety requirements". The two to be excluded are "Sustainability" and "Conflicts and claims". Safety aspects were emphasised by the respondents as a Critical Success Factor in this stage, this matches the perception of the respondents in the operation stage as the same set of requirements were also emphasised, this is a strong evidence that safety measures are required during the operation stage. Further, the evidence suggests that the theme in this stage centres on stakeholder satisfaction that are affected by the success factors such as "Maintenance cost and time", "delivery speed" and "health and safety" that were selected based on the perception of the respondents in this stage. Chan & Chan (2004) discussed the benefits project to stakeholders, and they suggested that the most notable benefits include satisfaction, utility, and operational maintenance.

Health related issues impact on productivity to a great extent, this may be the research for which the respondents have emphasised on it, according to Ugwu & Haupt, (2007) health and safety related issues direct the attention of management toward the need to take proactive actions at the site operational levels as part of ensuring the safety of users. The fact that the respondents perceived "Safety requirements and quality" as being not "very important" This also shows a strong linear relationship between PMs and success factors in this stage.

The three measures in "Defects", two will be included in the research framework, and these include "Defects", "Cost to rectify defects in the maintenance period". It is important to deliver projects with zero defects at end of the execution stage to users as well as control cost of maintenance at the operation stage. Similar to the finding in the current study, Butcher & Sheehan, (2010) found that the aspirations toward zero defects is always on construction customers' mind as it is a useful tool for managing behaviours. They argued that an excellent performer would naturally make deliberate efforts to avoid defects that would impact negatively upon stakeholders' satisfaction. The third measure in "Defects", "Fatalities" will be excluded.

However, all the measures grouped under "Environment" are not "very important" to the respondents and will therefore excluded from the research framework. They include: "Records of complaints regarding environmental issues", "Environmental FAQ", and "Energy and water use". However, "Environmental dimensions" was totally ignored by the respondents, this highlights the fact that participants in the Saudi construction industry are facing more serious challenges that are concerned with quality, qualification, and management (Al-Otaibi & Price, 2009), and are therefore not concerned with issues such as the environment and sustainability.

In summary, there is a consensus among researchers regarding the inadequacy of the traditional measures of time, cost and quality to reflect the success of projects performance properly (Yang, et al. 2010). The current field work which collected data on practitioners' perspectives divided into three groups regarding the identified measures from the literature review are as shown in Tables 7-16, 7-17 and 7-18. It can be noted in the analyses that government officials, consultants and contractors remain concerned with cost and time especially in the first and second stage.

These findings are consistent with those previously reported in the literature reviews (Eriksson & Westerberg, 2011). Each stage is concerned with particular measures and this is based on the objectives that would be achieved at this stage. The first stage focuses on administrative and planning aspects; the second stage emphasises constructive aspects that include construction cost and time, specifications and standards, productivity, quality and satisfaction. The last stage deals with the level of satisfaction and achieving quality. Result of factor analysis integrated with mean result for PMs are shown in the Table 8-3.

Table 8-4: Most significant PMs (factor analysis integrated with mean result)

No	Principal Components	Measures
Conceptual, Planning and Tender Stage		
1	Tendering requirements	Tendering requirements Design cost Availability of contractor selection criteria
2	Stakeholder objectives	Alignment of stakeholder's requirements

		Stakeholder involvement Design time Planning
3	Specifications	Availability of specifications and standards Relationship among stakeholders Leadership
Production Stage		
1	Project production and management	Construction time Quality assurance systems Productivity Team performance Time to rectify defects Construction cost Integration of design and construction Leadership Project schedule and monitoring (procedure and process) Solving site problems Waste of resources and materials Risk rate
2	Stakeholder objectives	Alignment of stakeholder's requirements Contractor satisfaction – payment Client satisfaction (specific criteria) Planning
3	Quality issues	Availability of specifications and standards Cost to rectify defects in the maintenance period
4	Profit Predictability	Cash Flow
Operation Stage		
1	User and client satisfaction	End-user satisfaction (user expectations) Client satisfaction (standard criteria) Integration of design and construction Client satisfaction (specific criteria) Quality issues at available for use Time to rectify defects Safety requirements
2	Defects	Defects Cost to rectify defects in the maintenance period

8.7.3 Project Success Measures

Takim et al (2003) stated that efficiency and effectiveness are considered as two elements for measurement of a project's success. The "processes" (efficiency in the strategic planning, management and utilisation of resources) are measured under efficiency elements which are related to project outputs. These measures could be calculated if methodology, system of measures, and standards are given for benchmarking.

8.7.3.1 Efficiency Measures at Production Stages

Two of the five efficiency measures at the production stage are grouped under the "Resource utilisation" component as being "extremely important" and will be included in the research framework, they include: "Meets budget" and "Meets time". The remaining three measures "Minimum amount of wastages", "Efficiency in utilization of manpower", and "Minimum scope changes" will be excluded from the framework. According to Takim and Akintoye (2002), efficiency can only be achieved by complying with schedules and budgets, which can be achieved by optimising the utilisation of available resources. In the other three components, namely "Productivity", "Meets specification", and "Safety requirements" only one of the measures in each of these are "very important" to the respondents and will be included in the research framework, however, all others will be excluded from the framework. In the "productivity" component, the respondents identified with "High project productivity" as a performance related measure, Basheka & Tumutegyereize, (2013) reported that efficient use of material and human resources relates to productivity, and in particular, Chan & Hiap, (2012) suggested that increasing productivity in construction involves developing new methods or technique for achieving objectives.

Under the "Meets specification" component, the respondents identified with "Meets technical specification", this is important because it relates to the decisions on design configurations, construction processes, and material specifications, all of these are measures that must be monitored in the project from the beginning to the end in order to measure the progress of the project and guide it towards successful completion. According to Basheka & Tumutegyereize, (2013), a construction project is acknowledged as successful when it is completed on time, within budget, and in accordance with specifications and stakeholder's satisfaction. Specification is therefore an essential measure to determine construction project completion success. The Safety requirements component includes "Meets safety requirements which the respondents identified with. This is also an essential measure in construction project success, this refers to the successful completion of a project with little or no major accidents and has safety as its main focus (Chan & Chan, 2004). The respondents have highlighted the importance of safety in municipality construction projects in SA.

8.7.3.2 Effectiveness Measures at Operation Stage

In this stage, all the effectiveness measures that were grouped under “Stakeholders Satisfaction” component namely: “Meets pre-stated objectives”, “Meets stakeholders' needs & expectations”, and “Meets client satisfaction on product” are all “very important” to the respondents, hence, they will all be included in the research framework, however, only three of the four measures grouped under “Project Reliability and Durability” component “Project functionality” and “Integrated with national plans and fit with purpose” and “Free from defects” are “very important” to the respondents, and will be included in the research framework while the other two will be excluded. Further, the two measures grouped in “Flexible for Future Expansion” component are “very important”, while only one component in the “Serviceability” component is “very important”, this is the “Meets client satisfaction on service” measure, hence, they will be included in the framework, while the others will be excluded.

Takim et al., (2004) studied effectiveness as a measure of construction project success, client and user satisfaction were found to be critical measures of project success, and these related to project functionality and meeting pre-stated objectives. The finding in this study is similar to that of “Free from defects”, the “Stakeholder satisfaction” component in this study relates to measures such as “meeting stakeholders' needs & expectations”, “meeting client satisfaction on product”, and “meeting pre-stated objectives”. With the level of importance accorded this measure, it is suggested that these measures are adopted in sustaining excellent project performance in Saudi municipality construction projects. The “Project reliability and durability” component consists of factors such “Project functionality”, “Integrated with national plans and fit with purpose”, and “Free from defects”.

Takim et al., (2004) found “project functionality” and “fitness for purpose” to be of critical importance to the respondents of the study, this finding is confirmed in the current study. This means that the fact that functionality and fitness for purpose are important in Saudi municipality projects is not surprising since it is confirmed in a previous study. “Flexibility for future expansion” component emphasises flexibility and easy rectification of defects, while in “Serviceability” component the respondents emphasise the satisfaction of the client on service. These are important effectiveness measures from the perspective of the respondents, flexibility in future expansion relates to the ease with which a construction project can be amended in future due to an expansion or reduction of purpose of the project (Folan & Browne, 2005).

Outcome measures indicate the influence and impact of delivered services on the quality of end-users' lives, that is, its effectiveness. Despite the significance of both efficiency and effectiveness measures, Pollanen (2005) noted that effectiveness measures were implemented more frequently than efficiency measures and that this was to be expected given that measuring outcomes is ambiguous and more complex than measuring outputs. Table 8-4 shows the results of the factor analysis integrated with mean result for PSMs.

Table 8-5: Most significant PSMs (factor analysis integrated with mean result)

No	Principal Components	Measures
Efficiency Measures		
1	Recourse Utilisation	Meets budget Meets time
2	Productivity	High project productivity
3	Meets Specification	Meets technical specification
4	Safety Requirements	Meets safety requirements
Effectiveness Measures		
1	Stakeholders Satisfaction	Meets stakeholders' needs & expect Meets client satisfaction on product Meets pre-stated objectives
2	Project Reliability and Durability	Project functionality Integrated with national plans and fit with purpose Free from defects
3	Flexible for Future Expansion	Flexible for future expansion Fast rectification of defects
4	Serviceability	Meets client satisfaction on service

8.8 Conclusion

The data collected for this study have been analysed in-depth in order to further enhance the achievement of the objectives of the study. Three levels of performance measurement in construction were identified and discussed, and these are: project, organisational and stakeholder levels, and a typical performance measurement exercise must include specific features which help to determine project position, communicate the position, and identify priorities within the project to enhance progress and eventual success. The main components applicable for successful performance measurement framework for municipalities' construction projects were identified and discussed, they include: CSFs, PMs and PSMs. A review of previous studies showed that the general phases in a typical construction project are three, and these are: initial, construction, and operation phases.

The review also showed that the success of construction projects can be measured under two distinct definitions during project lifecycle, namely: project success and project performance success which are both important for overall success measurement. A review of the CSFs and success measures in construction project also identified and discussed CSFs, PMs, and project output and outcome success measures. A critical evaluation of PMS showed that construction project performance is measured through lagging indicators focused on past events, and usually require documentation which have time and cost implications.

The result of the data that was collected was used to extract the criteria for the variables that are to be included in the research framework for this study. First, the factors influencing municipal construction projects performance were extracted for the conceptual, planning and tender stage, the production stage, and the operation stage. Likewise, the PMs were extracted for the research framework in the three stages. Also, success measures were extracted for efficiency PMs at production and operation stages. The extracted components will be applied in developing the research framework that is expected to be part of the outcome of this study. This chapter contributed to the in-depth analysis and discussion of the data that was collected for the study, and showed clearly that the practice of measuring performance at any stages of a construction project does not exist in SA. It also explained why the construction industry within the country faces a myriad of problems. The proposed framework and its validation are presented in next chapter.

9. CHAPTER NINE: PROPOSED FRAMEWORK AND VALIDATION

9.1 Introduction

The previous chapter provided the interpretation and discussion of the result of the questionnaire survey that was administered on municipal construction projects in KSA, based on six major areas of the research (CSFs, PPM outcome success measures, stakeholder involvement, measurement process and project stages). Consequently, this chapter provides analysis based on the outcomes of data that was collected and have been analysed and discussed in the previous chapter. It seeks to introduce a project performance measurement framework that will be effective and applicable to municipal construction projects in SA. It also provides solutions to the barriers and obstacles identified in the research questionnaires and improvement of project performance and project outcomes.

This chapter reports the development of a framework for municipal construction project performance measurement in SA. The performance measurement framework is useful for securing a coherent performance management system, it is a valuable technique for the collection, analysis, utilization and reporting of performance on a project and the different phases contained within the project. Therefore the framework being proposed in this study potentially enhances the management and improvement of municipality projects within SA by measuring the extent to which project needs and expectations are being achieved based on the results provided by the performance measurement process. Literature on the Saudi construction industry has largely highlighted the failings of the industry, which are mainly delays, failures, and cost overruns. Solutions are constantly proffered to these challenges, and they are based on frameworks that provide procedural approaches through which the challenges are reduced to a minimum while implementing construction projects. The framework presented in this chapter is aimed at supporting the findings of this study and its contributions to the body of research as well.

The framework is proposed based on the theory that: *"if you can't measure it, you can't manage it",* and that, "*You cannot manage what you do not measure; consequently, you* *cannot measure what you do not define"* (Fink, 2006; Behn, 2003). The ability to measure performance is an important approach to managing performance. Therefore, this chapter posits a performance measurement framework with the aid of important variables from the results of the data analysis and interpretation that emerged from this study after the interview and questionnaire were administered on the key stakeholders (Government, Contractors and Consultants) that were identified in the study. The variables applied in this study to achieve success include: project stages, and key stakeholders involved in delivering municipal construction projects CSFs and PMs, Efficiency and Effectiveness measures. The stages of a typical construction project that were identified in this study include: Conceptual, planning, and tendering stage, Production stage and the Operation stage. Emerging data from the analyses were extracted and applied in constructing a framework of performance measurement for municipal construction projects in SA based on the identified stages and stakeholders in a construction project.

9.2 Framework Design and Development Principles

A framework is a tool used to help practitioners integrate skills and competences into realist work environments, it also helps to synchronise skills, knowledge, experience, data, and responsibility during high level decision making procedure. It enhances the search for desirable expectations from researchers, practitioners, and managers to achieve desirable expectations. According to Yang et al., (2010), frameworks help to generate data and information for performance measurement, and they help to answer questions regarding what factors affect performance of projects/organisation/stakeholder. As such, frameworks help to determine the effectiveness of the resources that have been allocated to main indicators are contributing to performance improvement, and if this is not the case, the variables that need to be controlled are easily identified. Haapasalo et al., (2006) suggested that frameworks help to check whether a plan is a complete representation of the kind of goals that must be applied in achieving long-term goals.

Current literature highlights several definitions of framework, Fayad et al., (1999) defined framework as *"a reusable design of all or part of a system that is represented by a set of abstract classes and the way their instances interact"*. Also, they viewed it as *"the skeleton of an application that can be customized by an application developer"*. Frameworks are generally regarded as a constructed frame that allow practitioners to create part of a method and add further variables and details when needed, they are becoming more important and are being continuously applied in several fields (Zhang & Kim, 2006). Frameworks also play key role in achieving practitioners' requirements.

According to Pfeffer & Sutton (1999) measurement systems affects what people do, as well as what they notice and ignore. What is measured is presumed to be important because what gets measured gets attention, that is to say, what is not measured tends to be ignored. Effective measurement systems that will drive behavior need to be simple enough to focus attention on key elements as well as being fair such that people believe they can affect the measures. However, no measurement system can capture all the important elements of performance or all the activities that people need to perform for the projects to be successful. Thus, framework should be guides, helping to direct behavior, but need not become substitutes for the judgment and wisdom that are also necessary to acquire knowledge and turn it into action. There is no doubt that knowing what to do is important. However, this is not enough, therefore, it is important to be able to identify, interpret and apply knowledge to solving problems. Pfeffer & Sutton, (1999) argued that there is a large gap between knowing that something is important and actually doing it and who is to do it (from Knowing to Doing) as seen in Figure 9-1.

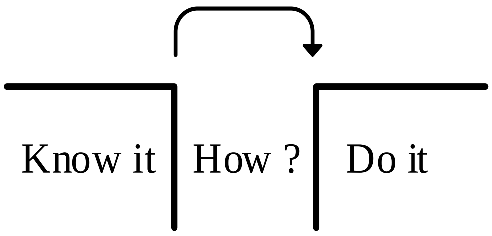

Figure 9-1: The gap between knowing and doing (Pfeffer & Sutton, 1999)

Consequently, the measurement framework have been regarded as a bridge between current practices and what should be achieved as successful and satisfied performance and outcomes. The developed framework is considered as gridlines and method to answer the question ***How*** to achieve the success in municipal construction project as seen in Figure 9-2. The framework developed for this research is comprised of the components that emerged from the mean and factor analysis result implemented in this study and shows how these components interacted with each other, it also shows how and when the responsibilities of stakeholders should be identified and distributed. This research is aimed to develop performance measurement framework for municipal construction projects that is consisted of two main parts. Each principal part of framework has some components. The combination of primarily qualitative and main quantitative data from interview and questionnaire, then qualitative data collected by focus group provided a basis for building the framework being suggested in this study. Appendix 9 illustrate the proposed framework which is applicable under any municipal construction projects for practitioners (government, contractor and consultant). This approach corresponds to the previous studies conducted by (Takim, 2005), in which multiple data collection methods provided strong evidence based research that enhances confidence in the findings produced.

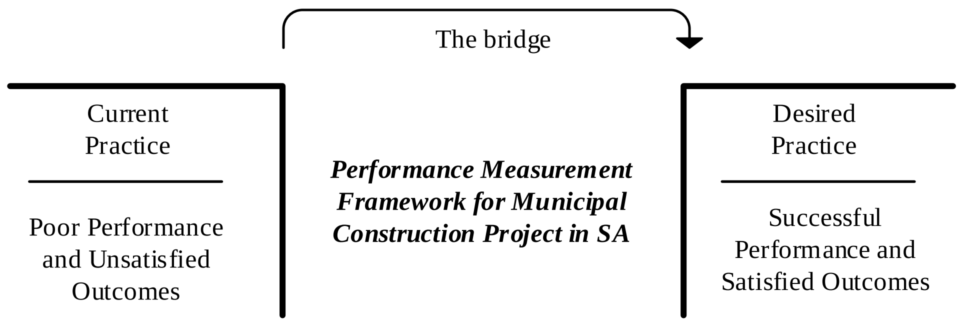

Figure 9-2: Bridge the gap between current and desired practise

The first data collection exercise implemented for this study was through interview and questionnaire survey method in which three groups of project practitioners in SA (Government, consultants and contractors) were asked about their perceptions of the variables associated with the key areas of research (stakeholder involvement, the relationship among them, procurement system, project stages, CSFs, PMs, outcome success measures,). The data collected was tested and analyzed using statistical analysis from a qualitative and quantitative perspectives and the findings produced were synchronized with the results of mean companied by ANOVA and factors analysis that was performed on the same data set. Subsequently, qualitative data was collected and this was implemented by utilizing the focus group method, interviewing professionals who were directly involved in delivering municipal construction projects. The comparative analysis revealed that there is unanimity of perceptions and opinions among the practitioners. Hence, the development of performance measurement framework is based on the notion that the pattern from two data source (interviews and questionnaire survey) is corroborated by the evidence from another source (focus group interviews). However, all these processes and approaches are based on the literature review.

9.3 Framework Purpose

The overall aim of the study is to develop a framework which by municipal construction project performance can be measured at any stage of a project according to stakeholders'' perspectives and, to enhance its post-delivery performance, and specifically to increase the effectiveness and efficiency to the satisfaction of citizens and all stakeholders in the project. Consequently, in order to achieve the framework purpose, there are several objectives that must be considered and investigated; these objectives are classified under two thematic dimensions which are:

9.3.1 Performance measurement system in the developed countries

- Review existing performance measurement framework being used in the construction industries and public authorities of the developed countries including the performance measurement process, CSFs, and PMs and PSMs.

9.3.2 Current practice in municipalities organisations in SA

- Identify project stages, key participants and stakeholders involved in the delivering of municipal construction project and the relationship among them,
- Identify the procurement and execution procedures of construction projects in municipalities in SA;
- Examine the current process and approach to managing and measuring construction projects in municipalities in SA and problematic areas;
- Explore and determine the performance measurement process, CSFs, and PMs and PSMs in the implementation of municipal construction projects;

9.4 Benefits of the Model

It is expected that the proposed framework will increase project performance success during performance progress “efficiency” and success project outcomes "effectiveness" in municipal construction projects in SA. Consequently, this success of public construction project delivery by municipal organizations will generate benefits that lead to increase in citizens’ quality of life. The framework provides the following benefits;

- A systematic evaluation base which by performance of projects can be measured. Also, a guideline for municipal organisations to improve their construction projects.
- Constructive and integrated components for measuring project performance over its life cycle divided into three stages (conceptual, planning and tender, production and operation stages);
- Address efficiency and effectiveness concerns of municipal construction projects;
- Ensure stakeholders involvement in planning and reviewing of projects;
- It is applicable to all type of municipal construction project whether simple, large, mega or complex projects.
- It is an approach for determining targets and benchmark them against internal and external competitors to obtain best practice.
- It helps to identify the number of CSFs and measures covering different aspects in project life cycle.
- It helps to control and monitor project progress to avoid any deviations and failures.
- It is a standardized process of measurement.
- It serves as a systematic documentation platform for generating reports and feedback.
- It is a potential platform for integrating national plan and citizen’s needs.

The project performance framework being proposed has been subjected to validation by interviewing experts from three organizations - municipalities, contractors, and consultant, thus, it is believed that the perception of the experts in municipal construction projects could help to justify the importance and the applicability of the model in a project environment.

9.5 Framework Structure and Components

The framework is developed as a holistic integrated system consisting of components that influence municipal construction projects. These components are structured and provide guidelines that facilitate the development of a framework that seeks to achieve outstanding project performance and satisfied outcomes. The components were derived from analysis of data which suggested a number of factors that should be involved in the framework. These components were previously presented based on the result of preliminary research (interview) and main survey (questionnaire) and secondary research (literature review), a number of CSFs, PMs and PSMs were discussed in Chapter six and seven.

The unique nature of the construction project highlights the fact that three main stakeholders are involved in project delivery, especially in SA; these are the government, contractors and the consultants. The responsibilities of the three stakeholders in this stage vary according to their involvement with the project. The contractors bring together various expertise across a range of professions such as civil engineers, architects, and surveyors, as well as the material, equipment and masonry to be involved in the project construction process. The consultants have the responsibility of monitoring progress and approving the work done so far in accordance with the objectives, CSFs, and measures. They then report on the progress work on a regular basis, and make recommendation of approval for the contractor’s bill of payment to the municipal team who have responsibility to visit the project site to confirm that the progress work meet pre-set requirements according to the project objectives after which payment can be expedited and confirmed.

The framework, shown in Appendix 9, consists of two principal parts, each of these parts in turn is comprised of sub-elements, namely:

- Process of Construction Project Activities Management, and
- The Measurement Tools and Process.

9.5.1 The Process of Construction Project Activities Management

- Conceptual, planning, and tendering Stage;
- Production Stage; and
- Operation Stage.

9.5.1.1 The Conceptual, Planning and Tendering Stage

This stage is broken into four parts; they are functionally related sub-stages that highlight the activities that take place starting with the formulation of the project concept through funding, planning to tendering and identifying the project scope and objectives.

The First sub-stage: Concept and Funding

The first sub-stage of the stage consists of the responsibility for conceptualizing the project and securing funding from the national government. The conceptualization and valuation of the project among the owners of the project based on citizens' needs are considered by the following:

- Peoples' Representatives;
- The Municipal Team;
- National and Regional Strategic Planning Teams;
- Ministry of Municipal and Rural Affairs, and the Ministry of Finance.

In the concept and funding sub-stage, the first three contributors above which are the Peoples' Representatives, The Municipal Team, National and Regional Strategic Planning Teams are responsible for determining the scope and budget of the project, whereas the lower two are responsible for confirming the funds needed and that there are available funds to implement the project. The final design of the project will be ready at this stage, and if the project readiness cannot be confirmed. There must be confirmed specifications that highlight the concept of the project which must be easily understood by the various team-members involved in the project, also the estimates of the funding required must have been determined along with the specifications.

The Second sub-stage: Planning

The planning stage consists of

- The Mayor,
- The Municipal Team, and
- Consultants.

All of them have the responsibility for developing the project objectives, CSFs, PMs and PSMs for the first stage sharing responsibilities between the mayor, municipal team and set-up a Three-Year Framework Agreement with the consultants before the commencement of the current project. The budget for the project is scrutinized and confirmed for each part of the project to ensure that there are no over or under - valuation of funding for sections of the project. The determination of the projects objectives, CSFs, PMs and PSMs is essential to be determined in this stage because of the need to monitor and control the project progress on an on-going basis.

The Third Sub-stage: Tendering

The tendering stage consists of

- Municipal Team;
- Consultants and
- Contractor.

In the tendering stage, the proposed project is awarded through open competition in one of two ways: Design and Construct or Construct only. The design and construct contract refers to the contractor assuming responsibility for designing and constructing the project whereas the construct only contract refers to the situation in which the design of the project is already determined and the contractor will only take responsibility for building the project. The municipal team and consultants have responsibility for designing and making available the tender requirements and contract documents to be provided to the competing contractors.

The Fourth sub-stage: Identifying Objectives – CSFs, PMs, and PSMs

This is the last sub-stage in the Conceptual, Planning and Tendering Stage, the principal actors here are:

- Municipal Team,
- Contractors,
- Consultants

These are the project stakeholders who determine the objectives of the project. Their main responsibilities include finding and aligning the project objectives with that of each of stakeholder group in order to determine the CSFs based on the objectives, project features and general stakeholder interests driven from the National Development Plans as stated in Figure 26. The measures are then determined based on the CSFs. The outcome of this sub-stage consist of the project objectives, CSFs, PMs, and PSMs. These group interacts with the two stages in the construction process, namely the production and operation stages.

9.5.1.2 The Production Stage

The production stage represents the typical stage in a generic construction process consisting of actualizing the construction procurement activities. It involves the interaction of various stakeholders with one another as well as with the construction processes, and the most notable of the stakeholders include the owners (Saudi Municipality), contractor team and consultant team. The activity milestones are then subject to conformance with the identified CSFs, PMs and PSMs, this procedure continues in a backward and forward loop into the delivery and operation phase of the project, and the efficiency measures that were pre-determined for the project.

9.5.1.3 Operation Stage

The operation stage involves the project delivery and use of the fully designed project that has been fully built; the project's completion follows the completion of all required paperwork and documentation, including payments to the contractor. As soon as the user starts to occupy the project or is commissioned for public use, a warranty period begins for a period of one year, within which liability for defects lies on the contractor. This is to ensure that the final product meets specifications and pre-set objectives to the satisfaction of all stakeholders that are included within the contract.

The responsibility of the contractor will come to an end at the end of the first year of operation stage, the responsibility of the municipal team then starts from this period onwards to put in place a maintenance contract for keeping the project in a usable state at all times. The result of this stage is determined by the outcome of the effectiveness measures assessment on the project and how the project impact on the lives and well-being of the users regarding whether the quality of life of the users has been positively impacted by the project. Hence, the project delivery can be regarded as the successful delivery of a public project that delivers citizen satisfaction, and is then integrated into the national plan as a part of a wider development program for the country.

9.5.2 Measurement Process and Tool

9.5.2.1 Measurement Process

This part of the framework consists of the measurement tool and the success factors, PMs and PSMs by which the performance of construction projects can be measured. The overall measurement process highlights the procedure for measuring the project stages using the measurement variables based on the success factors, PMs and PSMs in each of the stages. The measurement process consists of the following procedure:

1. Identify what is to be measured
2. Define measures
3. Collect data
4. Calculate measures
5. Report the result
6. Analyse the result
7. Benchmarking
8. Learn from best practice
9. Take action
10. Measure again

This process, broken down into ten stages highlights the activities to be implemented in the measurement process. It is important to develop a standardized procedure which integrates the perspectives of each of the stakeholders into the measurement process, such that all parties concerned are able to understand the outcomes of the measurement process. Based on the expectation that the contract documents regarding the project would highlight the critical areas of the project, these should be identified and set aside for measurement. The descriptions of these critical areas would have been previously elaborated in the Methods of Measurement books in which the measurement tools would also be highlighted. The measures will be defined based on the applicable measurement tools in each stage of the project, the data collected from the project are manipulated and calculated based on the measures and the result reported. Analysis of the report will concentrate on the weakness areas and the potential areas for improvement, through a benchmarking procedure.

The benchmarking procedure can be divided into internal and external parts. While the internal benchmarking concerns pre-set targets and standards, the external benchmarking refers to industry targets and standards. In external benchmarking, comparison is carried out between similar construction projects within other municipalities and ministries. The results of the benchmarking procedure allows the project stakeholders to learn from best practice within the industry by identifying performance gaps that need to be closed, action that needs to be taken to close the identified gaps, after which the measuring procedure is implemented again to confirm that the project stage conforms to pre-set standards (internal and external).

9.5.2.2 Measurement Tools

Critical Success Factors

The success factors identified through the mean accompanied by ANOVA and factor analysis in Chapter 7 and the discussion of the analysis are classified according to the factor analysis classification of the principal components, hence, each component has specific success factors attached to them which can be used to measure each of the stages identified in municipal construction projects.

- *The key components in the Conceptual, Planning and Tender Stage include:*

  a) Management Capabilities;
  b) Contractor selection criteria and vision;
  c) Accessibility of experience and specifications;
  d) Project attributes; and
  e) National plans

The managerial nature of this stage require a precise definition of user requirements based upon sufficient pre-tender detailed design specifications and output specifications. Applying these factors on the municipal construction projects will enhance the achievement of key objectives for the Conceptual, Planning and Tender Stage.

- *The components in the Production Stage include:*

  a) Project production and management;
  b) Project duration and budget;

c) Design details & specifications;
d) Project structure;
e) Documentation; and
f) Technology

This is the actual production stage of municipality construction project; the CSFs in this stage need to be tailored according to the practised procurement method (Design-bid-Build and Design-and-Build) being adopted by the stakeholders in constructing the municipality project. The success factors applicable in this stage should be determined during the fourth sub-stage of the Conceptual, Planning, and Tendering Stage. This will help to ensure that the progress of each work package in the construction production stage is adequately implemented in accordance with the pre-set specifications and scheduling to enhance the achievement of the Production Stage objectives. This increases the probability of success, and prepares the entire project for handover to the Operation Stage.

- *The components of the Operation Stage include:*

a) National plans and Maintenance cost & time;
b) Project attributes and safety.

The operation stage is a major milestone in municipality construction projects, it is important that project evaluation and feedback information are developed in order to appraise the operational performance of the project. This will be implemented based on the CSFs of the Operation Stage to ensure that the project complies with the handover and operation specifications that were pre-set at the Conceptual, Planning, and Tendering Stage.

Project Performance Measures

The PMs were highlighted through the mean accompanied by ANOVA and factor analysis in Chapter 7. Also, the discussion of the analyses are classified according to the factor analysis classification of the principal components. These measures as grouped under each component has measures attached to them which can be used to measure each of the stages identified in municipal construction projects, these measures will be used to benchmark the project's performance against pre-set internal and external standards:

- *The key components of measures in the Conceptual, Planning and Tender Stage include:*

  a) Tendering requirements;
  b) Stakeholder objectives; and
  c) Specifications;

These measures help in tracking the municipality construction project's metrics at the conceptual, planning and tender stage, in order to measure performance as the project progresses. This is important in order to monitor and report the results of the construction process. The work processes for gathering, analysing and reporting these measures will need to be established and the corresponding success factors attached to them in order to facilitate the application of the measures in this stage.

- *The components of measures in the Production Stage include:*

  a) Project production and management;
  b) Stakeholder objectives;
  c) Conflicts & claims;
  d) Quality issues;
  e) Profit Predictability; and
  f) PSMs.

The components of PMs in the production stage are used to establish priorities among projects activities in order to provide useful information on the project, these are used in comparison against internal and external standards to evaluate progress in achieving pre-set targets, as well as to assess trends in performance over time, or weigh the performance of one organization against another.

- *The components of the Operation Stage include:*

  a) User and client satisfaction; and
  b) Defects.

The measures at the operation stage help to ensure stakeholder satisfaction by collecting information regarding the performance of the project after delivery and commissioning. The process involves monitoring of the project's performance at the operation stage to ensure that there are no defects or other serious health and safety issues resulting from the project's operation.

Project Success Measures

Similar to PMs, the PSMs highlighted in the mean companied by ANOVA and factor analysis exercise have been grouped under various component factors that are listed here as efficiency and effectiveness measures. The PSMs that are developed here are meant to measure the construction project success in order to account for subjective and objective metrics based on feedback from the project stakeholders. This is based on the need to understand the overall success, failures, challenges and lessons learned in the project, these are documented and stored for current analysis and future application in solving other emerging challenges. The success measures applied include: Efficiency and effectiveness

- *The components of the Efficiency Measures include:*

  a) Resource Utilisation
  b) Productivity
  c) Meets Specification
  d) Safety Requirements

These measures are based on the need to understand the overall success, failures, challenges and lessons learned. They measure how the organisation uses the various resources that are available. The most important resources being measured here include time, cost, and quality objectives, quality of the management process, and satisfaction of project stakeholders needs in relation to the project management process.

- *The components of Effectiveness Measures include:*

  a) Stakeholders Satisfaction
  b) Project Reliability and Durability
  c) Flexible for Future Expansion

d) Serviceability

Effectiveness measures generally measure the extent to which the project's objectives have been achieved; this involves measuring the project's success based on feedback from the project stakeholders (users). It is important that the measures are valid, reliable, understandable, timely and directly focused on the areas of performance they are required to measure.

9.6 Framework Validation

9.6.1 Validation aim and Objectives

9.6.1.1 Validation Aim

The main aim of the framework validation was to determine the acceptance level of framework through which municipal construction project performance in SA can be measured and improved in terms of practicality, clarity, applicability, comprehensiveness, and appropriateness to the Saudi municipal construction projects.

9.6.1.2 Validation Objectives

To accomplish the main aim of validation, the following specific objectives were proposed which are as follows:

- *Identify expert participants' perception towards validity of proposed framework in terms of its practicality, clarity, applicability and comprehensiveness.*
- *Confirm the key participants of the construction projects in the proposed framework.*
- *Confirm the key stages and stakeholders of the construction projects in the proposed framework.*
- *Collect data on the expert participants' opinions towards validity of proposed performance measurement process.*
- *To determine the extent to which the expert participants agree on the significance of the CSFs, PMs and PSMs (efficiency and effectiveness). This is based on the result of original primary data that was collected for this study.*

9.6.2 Validation Approach

Validation refers to the process of determining the degree of framework accuracy to practicality in implementation (Thacker, et al., 2004). Also, it helps to ensure that the framework will provide the same result if performed in real world and under the same conditions (Varshney et al., 2013). Therefore, the acceptance of the experts is considered as a key factor for the success of the framework and its validity when applied in public construction projects (Pidd, 2009). According to Luu et al., (2008), the validated framework must achieve an agreement rate of at least 50% on ability to measure and improve municipal construction projects performance. In the same context, it is indicated that the framework deemed as valid when there is a consensus about acceptance of framework among experts. However, the design of workshop and the characteristics of the invited participants to the judgements session are vital factors that can help in achieving effective and realistic framework assessment (Pidd, 2009).

The focus group approach has been recommended because it allows participants to express independent opinions and allows the sharing of experiences cross-fertilization of ideas among the participants, also, it provides suitable atmosphere for fruitful discussion rather than individual interview (Ritchie & Lewis, 2003). Although, the interview method is considered as a suitable method for collecting different data based on the requirements (Luu et al., 2008), structured interviews are specifically carried out to evaluate the degree of applicability and importance of each stage of the framework. The workshop was used to judge research results based on primary data (questionnaires) and secondary research (literature review). Thus, to capture significant judgement for the proposed framework, shared and open discussion among expert participants was considered and appropriate technique to be applied during workshop sessions to ensure that it is entirely accepted.

The focus group approach was applied to collect feedback and comments on the proposed framework for municipal construction projects. In addition, it was also used to identify its consistency with the participants' respondents' based on their experience and knowledge. The main performers in public construction sector in SA were convened to validate the framework in a convenient time and place in two focus sessions conducted over three weeks. Workshop sessions were attended by the experts who regularly participate in construction projects and were from three organisations: government, contractors and consultants. They were provided with a presentation to clarify and explain the framework, its concept and components and what they were expected to do, which was to seek their cooperation by expressing their perception about the framework's applicability in municipal construction projects. The validation process was comprised of six phases described below in Figure 9-3.

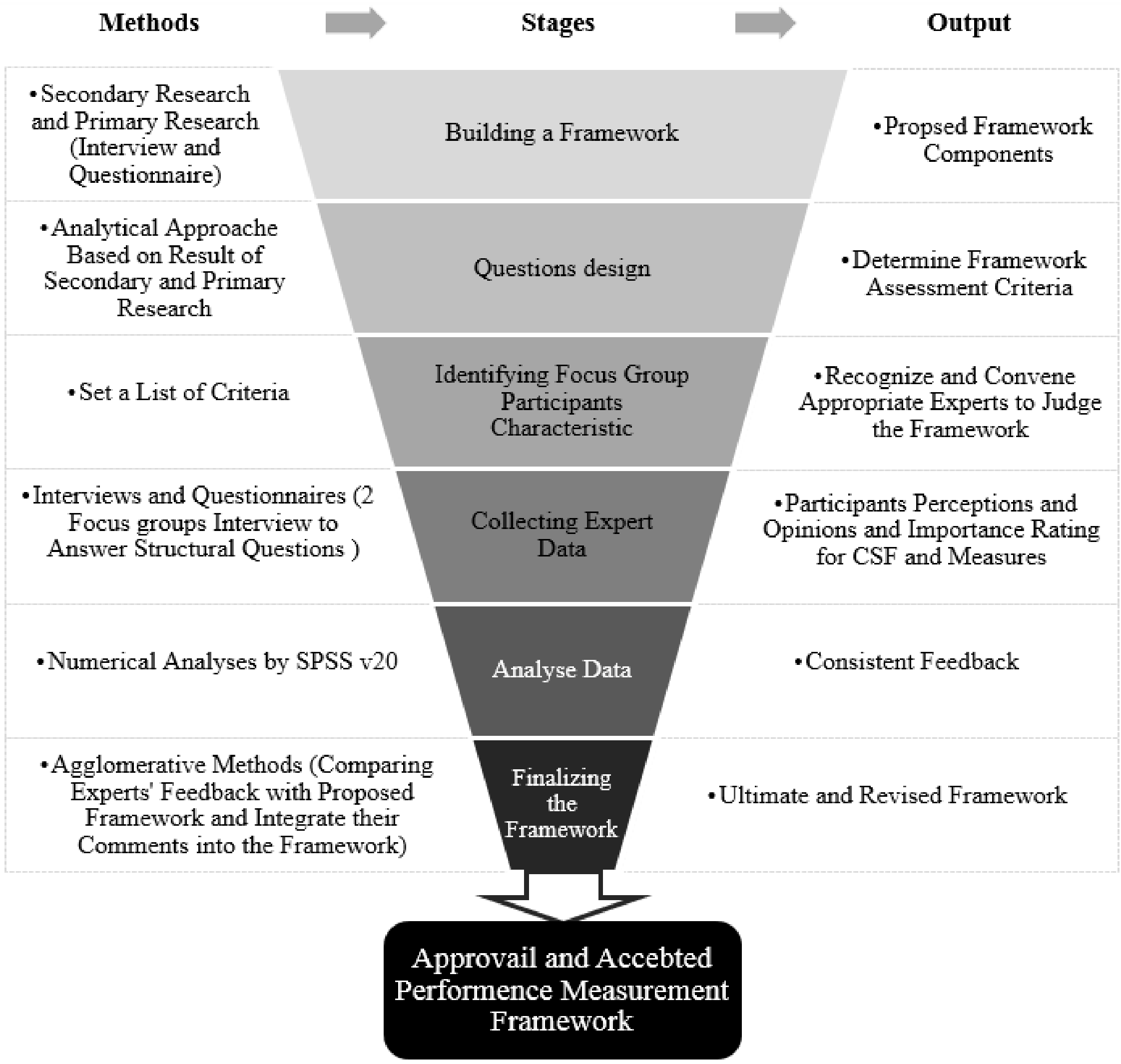

Figure 9-3: Validation Process

9.6.3 Validation Interview Questions Design

As shown in the questionnaire, each question in the second part has a seven- point Likert scale to indicate relative agreement. In this study, focus group and semi-structured interviews were applied. To avoid any ambiguities which might occur in the assessment questions or framework, the focus group approach was chosen as it provides the opportunity to clarify them (Almahmoud, et al. 2012). Dawood & Sikka (2009) indicated that the face to face interview technique is practised, because, it achieves best return from participants. The validation questions employed a 7-point Likert-scale because that a 7-point likert scale increase variability of responses and it is herein used because it provides more research validity and reliability (Kim S. , 2010). The judgement tool based on to what extent agree, the 7-point Likert scale ranges from 1=not agree, 2=slightly agree, 3=somewhat agree, 4=moderately agree, 5= agree, 6= very agree and 7=extremely agree. The interview questions were structured in four main sections are; personal background, evaluation of proposed framework, success factors, PPM, outcomes measures (efficiency and effectiveness) and general comments (Appendix 8). The main group discussion was focused on the main components of the framework which include sub-components. In all 14 interviews were conducted, and the interviewees were asked to answer the following questions:

- ***First:*** Interviewees were asked questions regarding their personal background, job title, experience, and nationality of origin.
- ***Second:*** Are the components of performance measurement framework practical, clear, applicable and comprehensive?. Interviewees were also asked to determine to what extent the proposed performance measurement framework for municipal construction project including first part which involves performance measurement process, CSFs, PMs and PSMs, as well as project stages and participants is accepted and successful in their opinion.
- ***Third:*** Who can be involved? Interviewees were asked to determine the appropriate people to deliver municipal construction project (government, contractors and consultant).
- ***Fourth:*** How many stages there are in construction project? Interviewees were also asked to determine the appropriate stages to deliver municipal construction project.
- ***Fifth:*** Is the list of CSFs completed? Interviewees were asked to check the initial list of CSFs to see whether there were any CSFs missing from the list or any CSFs in the list that are not important in their opinion. The reason why CSFs should be added or deleted was also asked;
- ***Sixth:*** Is the list of performance measures completed? Interviewees were asked to check the initial list of PMs to see whether there were any other measures missing from the list or any measures in the list that are not important in their opinion. The reason why measures should be added or deleted was asked;

- ***Seventh:*** Is the list of project success measures (efficiency and effectiveness) completed? Interviewees were asked to check the initial list of efficiency and effectiveness measures to see whether there were any other efficiency and effectiveness measures missing from the list or any measures in the list that are not important in their opinion. The reason why efficiency and effectiveness measures should be added or deleted was also asked.

To construct the evaluation result for municipal construction project performance, the SPSS V20 statistical software was employed to implement the validation analysis employing mean technique to identify essential framework components. Analysis of variance was not performed to ascertain if various respondent groups had a general agreement in perception, however, an alternative approach of comparison of means minimum and maximum was carried out by dividing the respondents into different groups based on type of organizations (government, contractors and consultants).

9.6.4 Characteristics of Experts Participants

9.6.4.1 Participants

In this research, semi-structured interviews were mainly conducted in order to determine the level of acceptance of managerial practice for performance measurement framework. As explained previously in this research, 14 experts were asked to evaluate a list of the framework components. The assessment was conducted face-to face with mayors, project directors, project managers and engineers. The respondents were invited to indicate their evaluation in terms of four criteria: practicality, clarity applicability and comprehensiveness about entire framework. The framework included six aspects which are: construction project stages and stakeholders' objectives, performance process, CSFs, and PMs and PSMs, they were subjected to overall appraisal to ensure that they are all effective and properly fit the framework.

The focus group interviews involved fourteen managerial staff of three organisations. They are all responsible for delivering municipal construction projects in their organisations and involved directly with arranging, managing, and implementing as well as, evaluating project performance. Participants in the framework assessment were divided into three organisations which are government as a client, contractor and consultant. However, the validation approach set certain criteria for participants' selection. The selection is restricted to practitioners who have long period of experience and wide knowledge in delivering construction projects in general and in municipalities in particular. Those types of practitioners were chosen to avoid any error of the data and information provided. One of the vital factors for success of validation process is selecting appropriate participants. Thus, top management officials were invited to attend focus group sessions, given the likelihood that they have knowledge and better understanding of the projects practice at all stages. The focus group exercise was conducted to extract experts' view and opinion regarding the performance measurement framework proposed, therefore, the questions for structured interview were sent to the experts to prepare their responses following the suggestion by Dawood & Sikka's (2009).

Fourteen of the practitioners who were involved in delivering municipal construction projects were invited to attend the validation workshop; hence, there were 14 interviewees in total; 5 practitioners from government, 5 practitioners from contractor organisation and 4 practitioners in consultant organisations. They were divided equally to two groups for two sessions, where each session involves 7 interviewees. Expert participants were allowed to critic the framework for its practicality, clarity, applicability and comprehensiveness based on their experience.

9.6.4.2 Responses

During the focus group session, questionnaires were distributed personally to ensure that the questions were completely answered. As stated earlier, the fourteen experts who participated in the assessment of the framework were invited to represent three types of organisations. The practitioner that groups that were included were divided into: five expert practitioners from government and 5 experts working in contracting organisations while 4 were from consultant organizations. The participants' years of experiences were between eighteen and thirty-six, however, the average of their experience was 27.9 years. Each focus group session included seven participants and consisted of attendees from three organisations, the first group comprised three experts from government (2 municipality mayor and projects director who have more than 25 years of experience), two experts from contractor organisation (architect and projects director with 18 and 20 years of experience respectively) and two from consultant (projects director and civil engineer with 18 and 20 years of experience respectively). The second focus group involved seven practitioners from government (deputy mayor and projects director who have more than 30 and 28 years of experience), three experts from contractor organisation (project manager, projects director and civil engineer had years of working experience as 32, 30 and 27) and two from consultant (architect and projects director 21 and 35). Table 9-1 shows the type, experience and number of participants who involved in validation session.

Table 9-1: Personal background

Expert Organisation	Position	Session	Participant Experience (Years)	Experience average
Government	Municipality mayor	1	26	27.9
	Projects Director		32	
	Municipality mayor		25	
	Deputy Mayor	2	30	
	Projects Director		28	
Contractor	Projects Director	1	18	
	Architect		20	
	Project Manager	2	32	
	Projects Director		30	
	Civil Engineer		27	
Consultant	Projects Director	1	36	
	Civil Engineer		29	
	Architect	2	21	
	Projects Director		35	

9.6.5 Analysis of Validation Data

As stated earlier, the research aim was to build a rational framework that would help manage and improve municipal construction project performance from a holistic perspective. The first step towards achieving this purpose was to investigate the validity of proposed framework components. The research reveals that these methods can provide a practicable framework for measuring project performance through identifying the relationship and integration among these elements. The findings highlight that the link between the process enablers and the project outcomes is valid.

The interview text was sorted into five contents areas: about the participants' background, participants' perception about measurement process, CSFs, PMs and PSMs. To obtain the perception of interviewees, the interviews were read through many times and then analysis of the interview data in four steps. Firstly, it was recorded and transcribed from raw data and information to present key and specific themes, terms and words. Secondly, keyword codes were used to extract the participants' concepts. Systematic analysis technique was made in five areas of investigation: framework component evaluation, project stage and participants, CSFs, PMs and PSMs. Thirdly, the data was inserted into Statistical Package for Social Sciences (SPSS) software V20. Finally, the data was analysed by means combined with Std. Deviation.

9.6.5.1 Components of Proposed Framework

The participants' feedback on the proposed framework was obtained by means of the validation sheet distributed to be completed within the workshop. The entire perception of participants was very positive, it can be seen that respondents' mean were placed closely to maximum rate of agreement. According to this, it is believed that proposed framework is practical, clear, applicable and comprehensive.

9.6.5.2 Framework components evaluation criteria

The framework was assessed in terms of its practicality, clarity and applicability and comprehensiveness; it gained an average scores of 6.71, 6.79, 6.75 and 6.14 respectively as seen in Table 9-2. The validation outcome revealed that the practicality and applicability of the framework are ranked equally as a score 6.71; the clarity of the framework also achieved highest rate by the participants, where it a score 6.79. In the participants' perception, framework comprehensiveness is rated as the lowest score 6.14.

Accordingly, there is a collective and correspondent acceptance among all the experts which being regarded from maximum and minimum method. Their perception scores are centred between 6 and 7, except the minimum for comprehensiveness which is scored 5. However, the dispersion of ranking of data from its mean what is shown from standard deviation is calculated with is below 1%. Moreover, all value of mean are above 6.13 as an average of three types of group, as well as, the respondents‘ mean ratings were all close to the high rating. This means that there is no difference in the respondents' perceptions. It is shown that the whole of experts believe that framework components are adoptable and practical. Consequently, the analysis concluded that the focus group results for framework are reliable and valid with respect to its construction and components, hence valid conclusions about the level of the perceived agreement of framework could be drawn.

Analysis of the respondents' answers regarding the list of the framework elements provided indicated that all respondents agree with the list and that no measures and CSF were required to be added. The generic list presented to the respondents contained six key instruments which have to be integrated fundamentally to build successful framework. This list was composed and prioritized based on literature and interviews with other experts in an earlier research stage.

In summary, from the experts the initial framework elements have a significant outcome and can be used in an effective manner for providing outstanding performance during project progress and superior outcomes which attain stakeholders' satisfaction. The feedback led ultimately to the conclusion that the final evaluation is wholly positive.

Table 9-2: Framework acceptance and PMs

Criteria	N	Minimum	Maximum	Mean	Std. Deviation
Clear	14	6	7	6.79	.426
Practical	14	6	7	6.71	.469
Applicable	14	6	7	6.71	.469
Comprehensive	14	5	7	6.14	.535

9.6.5.3 Key participants and project stages components

In the first part of the validation questionnaire, the participants were asked to verify key participants and the main stages in municipal construction project as illustrated in Table 8-3. Both focus group demonstrated obvious unanimity in their responses, 100% of interviewed experts agreed that there were three performers and three stages in municipal construction projects in SA. As a consequence of these experts' opinions, it is accepted that the key participants involved in the delivery of municipal construction project are government, contractors and consultant. Also, the main stages in construction project are conceptual, planning and tender, production and operation stage. It was also confirmed that the two components of the proposed framework that connected the key participants and project stages are approved and valid.

Table 9-3: The key participants and main stages in municipal construction project

	Questions	Number of participants	Yes	No
1	There are three key participants involved in the delivering of municipal construction project (government, contractors and consultant)	14	14	0

2	There are three main stages in construction project (conceptual, planning and tender, production and operation stage).	14	14	0

9.6.5.4 Critical Success Factors component

Tables 9-4 illustrates 30 validated CSFs covering three key construction project stages which are selected by practitioners in primary research that was conducted previously. There was a compulsion to identify and rank each of the CSFs to each perspective, thus, their ranking was derived from the respondents' perception, and they are top professional engineers and managers providing projects regarding the importance of each component. By using a seven-point Likert scale, the scores provided by all the respondents were averaged to produce a prioritized list.

CSFs at conceptual, planning and tender remain related to management capabilities and tendering requirement such as contractors' selection criteria, transparency and procurement process, clear vision and alignment of needs are also related as they are driven from national plan and stakeholders expectations. Despite that some factors' position have been changed, all of them are considered as extremely significant factors to achieve first stage purposes. The experts' perception moved up the integration of the project with national plans and strategic alignment of project goals with stakeholders' interests from fourth and fifth places respectively to be in the first positions equally with contractor selection criteria and coordination and vision which maintained their places from before. By contrast, Adequacy of standards and specifications is moved backward from second place to be at the end of list, nevertheless, however, it is still deemed as extremely important.

Regarding production, CSFs were to slight alteration and no of them left of extremely significant ranking. However, a few factors were subjected to change, noteworthy among them were budget and project duration which were maintained first equally. Likewise, quality control, sequencing of work according to schedule, capability of project manager, adequate team capability (technical skills, communication, commitment, experience and qualification) are placed in first positions. In addition to, schedule project construction, standards and specifications and adequacy of design details. This result is logically considered as justified by the fact that construction stage is technical and site-related stage.

Operation stage factors are ranked as extremely important. Integration of the project with national plans, maintenance cost, and maintenance time speed of deliver the product to end-users gained the maximum significant rate, however, application of health and safety system is also considered as extremely important. During both focus group sessions, the participants indicated that identified CSF should be increased, and that there is need to add some other CSFs such as follow up regularly to the project operation integrating all stakeholders. Consequently, to fulfil this consideration identified CSFs list from literature review that distributed previously in data collection stage were discussed. The respondents reviewed and considered these factors to determine what in their view are needed to be added to the current list. After discussion three success factors were added and ranked as extremely significant to achieve municipal project outcomes, these are; Documentation and Reports, comprehensive project review at production stage and feedback and application of health and safety system at operation stage.

Table 9-4: Result of Factor Analysis integrated with mean result for CSFs

No	Principal Components	CSFs	N	Min.	Max.	Mean	Std. Deviation
Conceptual, Planning and Tender Stage							
1	Management capabilities	Relationship among stakeholders	14	7.00	7.00	7.00	.000
		Strategic alignment of project goals with stakeholders' interests	14	7.00	7.00	7.00	.000
		Top management support	14	7.00	7.00	7.00	.000
2	Contractor selection criteria and vision	Contractor selection criteria	14	7.00	7.00	7.00	.000
		Coordination and vision	14	7.00	7.00	7.00	.000
		Transparency in the procurement process	14	6.00	7.00	6.79	.426
		Procurement & delivery strategy	14	7.00	7.00	7.00	.000
		Risk	14	4.00	7.00	5.50	.760
3	Specifications	Standards and specifications	14	6.00	7.00	6.93	.267
4	Project attributes	Project duration	14	7.00	7.00	7.00	.000
5	National plans	Integration the project with national plans	14	7.00	7.00	7.00	.000
Production Stage							
1	Project production and management	Quality control	14	7.00	7.00	7.00	.000
		Sequencing of work according to schedule	14	7.00	7.00	7.00	.000
		Capability of project manager	14	7.00	7.00	7.00	.000
		Adequate team capability (technical skills, communication, commitment, experience and qualification)	14	7.00	7.00	7.00	.000
2	Project duration and budget	Project duration	14	7.00	7.00	7.00	.000
		Budget	14	7.00	7.00	7.00	.000
		Schedule project construction	14	7.00	7.00	7.00	.000
		Sufficient resources allocation	14	6.00	7.00	6.86	.363
3		Standards and specifications	14	7.00	7.00	7.00	.000

	Design details & specifications	Sufficient work skills and mechanisms	14	6.00	7.00	6.93	.267
		Adequacy of design details	14	7.00	7.00	7.00	.000
4	Project structure	Fragmentation of project activities	14	6.00	7.00	6.86	.363
5	Documentation	Documentation and Reports	14	6.00	7.00	6.86	.363
6	Technology	Adequacy of design details	14	7.00	7.00	7.00	.000
Operation Stage							
1	National plans and Maintenance cost & time	Integration the project with national plans	14	7.00	7.00	7.00	.000
		Maintenance cost	14	7.00	7.00	7.00	.000
		Maintenance time	14	7.00	7.00	7.00	.000
		Speed of deliver the product to end-users	14	7.00	7.00	7.00	.000
2	Safety	Application of health and safety system	14	6.00	7.00	6.86	.363

9.6.5.5 Performance Measure component

Table 9-5 shows 38 validated PMs relating to three key construction project stages that were selected by practitioners in primary research conducted previously. The interviews revealed that extracted PMs are essential PMs to determine project progress. The mean scores for these measures ranged between 5 as very agree to 7 extremely agree. As expecting to see them remaining as extremely important in experts' opinion because that these elements are determined by practitioners in the data collection stage. Results shown in the Table illustrate that there is a unanimous agreement in the opinion of experts in regard to the significance of PMs.

PMs in conceptual, planning and tender stage remained as extremely important despite replacement of their orders. Seventh measures achieved the top scores that 7, however, design cost, time and leadership have same mean value 6.93. Nevertheless, they are extremely important. The production stage measures are subjected to slight modification. All of them are deemed as extremely important where eight measures are scored as 7 point that is the maximum ranking in seven-point Likert scale. Likewise, in operation stage there is no noteworthy where all measures were ranked with 7 as extremely important.

During the focus group meeting, two measures, “increase or decrease of floor area ration and alteration in town planning legislations” were raised as important. After discussions, these measures were linked to the existing list of measures and should be taken in consideration in national plan in first stage. Two interviewees from the government departments raised a question about operation costs for municipalities’ administration as project supervision costs, which seem to be important measures, are not included.

According to the consensus during the focus group meeting, one of the reasons is that it is impossible to identify the cost of the services provided by municipal organisations departments. It is pointed out that the design should be done before starting project, however, it was argued that for flexibility purposes the framework should be included as an option in case the design is not yet completed.

Table 9-5: Result of Factor Analysis integrated with mean result for PMs

No	Principal Components	Measures	N	Min.	Max.	Mean	Std. Deviation
Conceptual, Planning and Tender Stage							
1	Tendering requirements	Tendering requirements	14	7.00	7.00	7.00	.000
		Design cost	14	6.00	7.00	6.93	.267
		Availability of contractor selection criteria	14	7.00	7.00	7.00	.000
2	Stakeholder objectives	Alignment of stakeholder's requirements	14	7.00	7.00	7.00	.000
		Stakeholder involvement	14	7.00	7.00	7.00	.000
		Design time	14	6.00	7.00	6.93	.267
		Planning	14	7.00	7.00	7.00	.000
3	Specifications	Availability of Specifications and standards	14	7.00	7.00	7.00	.000
		Relationship among stakeholders	14	7.00	7.00	7.00	.000
		Leadership	14	6.00	7.00	6.93	.267
Production Stage							
1	Project production and management	Construction time	14	7.00	7.00	7.00	.000
		Quality assurance systems	14	7.00	7.00	7.00	.000
		Productivity	14	7.00	7.00	7.00	.000
		Team performance	14	7.00	7.00	7.00	.000
		Time to rectify defects	14	7.00	7.00	7.00	.000
		Construction cost	14	7.00	7.00	7.00	.000
		Integration of design and construction	14	7.00	7.00	7.00	.000
		Leadership	14	7.00	7.00	7.00	.000
		Project schedule and monitoring	14	7.00	7.00	7.00	.000
		Solving site problems	14	7.00	7.00	7.00	.000
		Waste of resources and materials	14	6.00	7.00	6.86	.363
		Risk rate	14	6.00	7.00	6.93	.267
2	Stakeholder objectives	Alignment of stakeholder's requirements	14	7.00	7.00	7.00	.000
		Contractor satisfaction – payment	14	7.00	7.00	7.00	.000
		Client satisfaction (specific criteria)	14	6.00	7.00	6.86	.363
		Planning	14	7.00	7.00	7.00	.000
3	Quality issues	Availability of specifications and standards	14	7.00	7.00	7.00	.000
		Cost to rectify defects in the maintenance period	14	7.00	7.00	7.00	.000
4	Profit Predictability	Cash Flow	14	7.00	7.00	7.00	.000
Operation Stage							
1	User and client satisfaction	End-user satisfaction (user expectations)	14	7.00	7.00	7.00	.000
		Client satisfaction (standard criteria)	14	6.00	7.00	6.93	.267

		Integration of design and construction	14	7.00	7.00	7.00	.000
		Client satisfaction (specific criteria)	14	6.00	7.00	6.93	.267
		Quality issues at available for use	14	7.00	7.00	7.00	.000
		Time to rectify defects	14	7.00	7.00	7.00	.000
		Safety requirements	14	7.00	7.00	7.00	.000
2	Defects	Defects	14	7.00	7.00	7.00	.000
		Cost to rectify defects	14	7.00	7.00	7.00	.000

9.6.5.6 Project Success Measures component

With regards to project success measures that are termed as efficiency and effectiveness measures, the majority of both measures gained the entire points scale from all three types of experts (government, contractors and consultants). Table 9-6 shows that there is a clear consensus that listed efficiency and effectiveness measures as extremely significant to determine outcomes success. As a result of this participants perception it can be suggested that these PSMs comprising efficiency and effectiveness dimensions are valid, applicable and effective. Thus, according to their opinion, these measures should be a part of the framework that is being proposed to measure municipal construction projects.

Table 9-6: Result of Factor Analysis integrated with mean result for PSMs

No	Principal Components	Measures	N	Min.	Max.	Mean	Std. Deviation
Efficiency Performance Measures							
1	Recourse Utilisation	Meets budget	14	7.00	7.00	7.00	.000
		Meets time	14	7.00	7.00	7.00	.000
2	Productivity	High project productivity	14	7.00	7.00	7.00	.000
3	Specification	Meets technical specification	14	7.00	7.00	7.00	.000
4	Safety	Meets safety requirements	14	7.00	7.00	7.00	.000
Effectiveness Performance Measures							
1	Stakeholders Satisfaction	Meets stakeholders' needs & expect	14	7.00	7.00	7.00	.000
		Meets client satisfaction on product	14	7.00	7.00	7.00	.000
		Meets pre-stated objectives	14	7.00	7.00	7.00	.000
2	Project Reliability and Durability	Project functionality	14	7.00	7.00	7.00	.000
		Integrated with national plans and fit with purpose	14	7.00	7.00	7.00	.000
		Free from defects	14	7.00	7.00	7.00	.000
3	Flexibility	Flexible for future expansion	14	7.00	7.00	7.00	.000
		Fast rectification of defects	14	7.00	7.00	7.00	.000
4	Serviceability	Meets client satisfaction on service	14	7.00	7.00	7.00	.000

Results shown in Table 9-4, 9-5 & 9-6 indicate that there are no significant differences among the respondents going by their opinions on their rating perceptions of CSF, PMs and PSMs when they are tested based on organisation type (Government, Contractor and Consultant). Likewise, there were no differences in rating perceptions observed when the test conducted for experience personnel. This illustrates that various construction-related stakeholders (Government, Consultants, and Contractors) have not substantially differed perception on the CSF, PMs and PSMs. According by focus group, the results of the evaluation showed that a full picture of construction project success can be drawn by utilizing these CSF, PMs and PSMs. The participants all indicated that the project performance results directly and extremely impacted by tenth identified CSF. However, each stage is characterised and focused on themes that are related to targeted objectives from this stage.

As can be seen in the Tables mentioned, the mean scores for CSFs, PMs and PSMs are ranged from 5 being very agree to 7 extremely agree. It was no surprise to see these elements remain and obtain significant importance in validation stage. Likewise, it was expected to see CSF, PMs and PSMs are placed on a higher degree of importance and at the top because these elements extracted by practitioners from long list before in data collection stage. The interviews revealed that there are direct relationships between these identified elements and framework success.

The results demonstrate that these CSF and Measures are useful to solve the problems encountered in the performance measurement of construction projects in SA. In this study, it was found that CSF, PMs and PSMs are the most influential instruments affecting all project performance seeking to achieve desired outcomes. Accordingly, it is clear all the respondents' opinion revolved around 6 points and 7 points.

9.6.6 Suggestions to improve the framework

Experts were asked to articulate their perceptions regarding the improvement of the proposed framework to provide additional evaluation not included in the open-ended questions to raise its capability and effectiveness. The results of the validation workshop expressed some idea in which the experts believed that the framework can be improved. Two suggestions were received as shown below:

- The participants suggested that the framework will be more constructive and effective when applied and practiced by using software programme (application). Contractors' organisations and consultants' organisations that are involved in providing the projects are of the opinion that this framework will definitely lend itself to being developed into a software program for application in Saudi municipalities.

- The participants also pointed out that framework can be progressively developed through trial and error. This can be achieved through regular meeting for practitioners to articulate there experience to impact the development of the software project.
- It was also suggested that the framework should be included to sub-CSF, sub-PMs for project progress and sub-PSMs which is related to sub-stages as well.
- Another suggestion is focused on providing calculation and methods of mathematical data.
- One suggestion also focussed on the limited measures for first sub-stage in first stage that is related to value of funds approved by finance ministry measures that relates to success of followed project activities as example of this aspects
- Data collection process must be simple and clear as possible.
- It is suggested by experts that training has a key role within performance measurement process to facilitate employee to understand, develop seeking to attain outstanding practise. As well as, learn how to determine and perform set of PMSs components including; objectives CSFs, PMs and PSMs.

After extracting the CSFs, PMs and PSMs the framework was constructed and finalised as seen in Figure 50. The last chapter is concerned with the conclusion and recommendation which will be extracted of this research.

10.CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS

10.1 Introduction

The key focus of this research was to investigate the current practices in municipal construction projects in SA, starting from the worldwide construction knowledge and research data. Based on the findings, a framework to measure construction project performance in municipalities in SA was introduced and developed, in order to achieve stakeholder needs and expectations. The aims and objectives that were drawn for the research study have been attained through the completion of the five steps discussed previously in this thesis. This chapter presents a summary of research method as well as the achievements of this study. The limitations of this research are highlighted; while it also recommended realistic courses of actions that can be adopted by the Saudi municipal construction sector. The chapter also drew attention to areas where further research is needed within the body of research and that can be conducted based on limitations and findings of this study.

10.2 Summary of the Research Process

The concept of construction refers to a process in which preparations are made for the formation of a building, facility, or any other physical structure. It commences with the planning, designing, organising, coordinating, and financing of resources for the construction project. Resources generally include men, money, machine, materials, and other essential resources such as power, technology, utilities, and time. The coordinators of the construction project organise relevant stakeholders that are integrated into the project with the aim of completing the construction project on schedule, within budget, and according to pre-agreed standards of quality and performance between the designers and the builders, after which the project is ready for delivery and operation. Every construction project is implemented based on a life cycle system which consists of several stages that are uniquely different from one another, and are in the main not repetitive in nature.

A typical construction process will usually overlap from one stage into another in a continuous flow of activities that cover a wide range from slow, certain, and simple (stodgy) projects on one hand to quick, uncertain, and complex (dynamic) projects on the other (Ballard & Howell, 1998). Several management activities occur in a construction process that are centred on coordination between organisations or teams (stakeholders) with varied or divergent backgrounds, objectives and interests, and that are primarily controlled from a central plan that sets sequences, and determines when each activity will commence. Also, benefits, costs, errors, and learning occur on a continuous basis within the activities. Hence, progress and final completion reports derived from measures create challenging problems to prepare, and where they are available are based on subjective approaches that create conflicts and disagreements.

The traditional function of project management has mainly been concentrated on project planning and implementation with activities that are mainly directed towards adherence to specifications, budgets, and time duration. This approach allows the application of some accepted metrics of cost, schedule and performance to assess the success of a construction project. However, measuring project progress in terms of estimates of construction stage completion creates various challenges and is usually misleading because of the lack of unified and standardized measurement. Activities in project management within construction projects should therefore be directed towards developing an integrated system that fosters an environment of continuous and sustainable improvement of the activities of construction output.

Construction projects in SA are mainly implemented by the government, one of the most important of public organisations is municipality. These projects experience delays, cost overruns, and operational issues. Apart from these core problems, lack of experience, insufficiently skilled staff, routinely poor execution process and poor project management practices such as monitoring, control, and performance measurement have been major weaknesses that are generally found within Saudi provincial government construction projects. Therefore, there is urgent need for learning and improvement among stakeholders in the Saudi municipal construction projects, and one important concept that can positively contribute to learning and improvement is the measurement of performance.

Measuring the performance of construction projects requires the application of integrated assessment methods that are based on systematic performance metrics which are tailored for evaluating projects. Although, background literature in performance measurement determines specific performance measurement systems that are applied in construction projects in developing countries, the Saudi construction sector is suffering from the absence of a framework for measuring and evaluating the performance of projects in both the public and private sector. This results in failures during project implementation, and stakeholders' dissatisfaction regarding project outcomes due to these failures. This research gap necessitates the implementation of an in-depth study of the implementation of construction project in Saudi municipalities and the development of a performance measurement framework for this sector of the industry.

This study is based on the lack of planning for projects in the pre-implementation stage, as well as, the failure of projects during the execution and operation stages. It is also based on the finding of a lack of methods and mechanisms to monitor measure and control projects, which is a general problem in developing countries such as SA. It was found from literature that this is partly responsible for failures during project execution and outcome. Thus, this study is aimed to develop a framework for measuring municipality construction project performance over three stages, namely: conceptual, planning and tendering stage, production stage and the operation stage.

To achieve this objective, the study was implemented in five stages: the literature review phase, pilot study phase, data collection phase, data analysis phase, and the framework and framework validation phase. These phases were implemented with the aim of filling the research gap that was identified in both practice and literature in developing countries generally and in SA in particular. To achieve the aim of the research, the following objectives were drawn:

10.2.1 Objectives

In order to achieve the research aim, the following objectives were set: -

- Review existing performance measurement framework being used in the construction industries and public authorities of the developed countries including the performance measurement process, project stages, project stakeholders, CSFs, and PMs and PSMs.

- Identify project stages, key participants and stakeholders involved in the delivering of municipal construction project and the relationship among them,

- Identify the procurement and execution procedures of construction projects in municipalities in SA;

- Examine the current process and approach to managing and measuring construction projects in municipalities in SA and problematic areas;

- Explore and determine the performance measurement process, CSFs, and PMs and PSMs in the implementation of municipal construction projects;

- Develop a practical and affective framework for evaluating municipal construction projects performance in SA;

- Evaluate and validate the proposed performance measurement framework through experts' opinion and perceptions; and

- Conclude result of study and recommend further investigation in the field of construction projects performance measurement and other in relation.

These were integrated into an interview and questionnaire that was administered on municipal construction project participants and practitioners with the aim of examining the key stages of construction projects and key the stakeholders involved in delivering municipal projects and the relationship among them, as well as to identify CSFs, PMs and PSMs. The resulting framework from the research process is proposed based on the rule by Clifton, (2010), that: *"if you can't measure it, you can't manage it",* as well as, "*You cannot manage what you do not measure; consequently, you cannot measure what you do not define"* (Fink, 2006).

10.3 Achievement of Research Aim and Objectives

This section highlights the main findings of the research regarding how and the extent to which the aim and objectives of the research study have been achieved. The achievement of the research objectives helped to enhance the achievement of the research aim, the results of the tasks that were undertaken to achieve the research objectives are as follows:

10.3.1 Literature Review Findings

Objective One*: Review existing performance measurement framework being used in the construction industries and public authorities of the developed countries including the performance measurement process, project stages, project stakeholders, CSFs, and PMs and PSMs.*

The task under this objective is to review existing performance measurement framework being used in the construction industries of the developed countries. The purpose of this objective is to present an in-depth review of existing performance measurement frameworks that are being applied in the different construction industries in developed countries. The review showed that the majority of developed frameworks are mostly useful for financial oriented projects and rely on lagging measures instead of leading measures. While a majority of the frameworks are tailored towards measuring organisational performance, only one of them, KPIs, are tailored towards measuring project performance, however, it was not clearly designed to measure the project in stages. For instance, no single measure is specialized only for measuring a particular stage, but as a collection of measures for the whole stages in a project. Further, none of the existing frameworks has considered stakeholder concerns and needs separately or in each of the stages for alignment at the end of the project. They have also not determined specific objectives for each stage of the project. Despite the importance of CSFs in the delivery of successful construction projects in both implementation and final outcome results, none of the systems that are applicable for construction project integrate CSFs with PMs that are based on objectives of each of the separate stages. Municipal organisations have the responsibility to deliver public service efficiently, by providing construction projects for citizens' use, and its success are determined by citizens' satisfactions. The measures for efficiency and effectiveness have not been applied as a part of the existing frameworks that are applicable for measuring municipality construction project outcomes.

10.3.2 Preliminary Data (Telephone Interview)

Objective Two*: Identify the procurement and execution procedures of construction projects in municipalities in SA, as well as, identify project stages, key participants and stakeholders involved in the delivering of municipal construction project and the relationship among them.*

The purpose of this objective was to identify the procurement and execution procedures of construction projects in municipalities in SA. Literature in this field showed that construction project practice in SA relies mainly on traditional construction procurement system which involves a single stage construction contract based on Public Work Contract and three years framework agreement for consultants. Tendering is by open competition method and the lowest bidder wins the contract regardless of experience, expertise and capability to implement the project to successful completion. The production stage remains the most important stage for practitioners, while the planning stage mainly covers tendering activities; however, the operation stage is ignored. In addition to, it is purposed to identify the relationship between decision makers, construction project performers and citizens. Based on the data that was collected for this study, the key players that are involved in the delivery of municipal construction projects are municipal team, contractors, and consultants. The most important of them in terms of key decision making functions is the municipal team. The citizens' representative is only minimally involved at the initial conceptualization stage when citizens' needs are being explored.

10.3.3 Main Survey Data (Questionnaire)

Objective Three*: Explore and determine the performance measurement process, CSFs, and PMs and PSMs in the implementation of municipal construction projects;*

This objective is to explore the process that should conducted to measure project performance, also, to determine critical success factors, performance measures and projects success measures in the implementation of municipal construction projects as a key components to develop the framework. The required data to achieve this objective was collected by distributing 386 questionnaires to three types of organisations – municipalities, contractors and consultants.

10.3.4 Framework Development and Validation

Objective Four*: Develop a practical framework for evaluating municipality construction project performance in SA;*

Objective Five*: Evaluate and validate the proposed performance measurement framework through experts' opinion and perceptions; and*

These objectives were purposed to develop a practical framework for measuring municipal construction project performance in SA. The framework that was developed and validated in this study is presented in chapter nine. It is a composition of six components which are CSFs, project performance measures and project success measures which can be used to measure the outcome of the stages of municipal construction projects in SA according to the result of data collected from the research respondents. The framework identifies three main stages in a municipality construction project in SA: the first is the Conceptual, Planning and Tendering stage, the Production stage and the Operation stage. Also, it considers the inputs of stakeholder needs and expectations in each stage of a construction project as well as the efficiency and effectiveness measures, both are applied for measuring each of the production and operation stages separately.

10.4 Contributions of the research and findings to knowledge

Generally, this research study has achieved its overall aim and objectives, in addition, the major achievements in terms of contribution to knowledge fall within two main categories:

10.4.1 Overall knowledge

This research brought to light some areas within construction project performance measurement that had previously been obscured by the golden triangle of cost, time, and quality. The major contribution of this study to the body of knowledge of performance measurement in the management of projects is that it highlighted the need to consider stakeholders needs and expectations at every stage of a project's lifecycle, mainly from the conceptual and tendering stage through the production and operation stages. Based on these needs and expectations, the CSFs are determined and applied to highlight the areas that need improvement in order to guide the project towards success. Further, the project performance is measured in order to determine its progress in meeting performance requirements within three stages that were identified in this study. The first stage is the conceptual, planning and tendering stage where the project is initiated and its form determined, the second is the production stage, which is measured based on the resource requirements, and the operation stage in which the project performance is measured based on the outcome requirements of efficiency and effectiveness. All these elements are integrated within a holistic framework of performance measurement combined with measurement process to determine project performance success and overall project success.

10.4.2 Contribution to the Saudi Municipal Construction Projects

This study identified a yawning gap in the management of municipal construction projects in SA. Overall, an absence of performance measurement concept process permeates the management of construction projects in SA and in the municipal construction projects in particular. To close this gap, this study was embarked upon to investigate and identify the various performance measurement approaches and framework that are used to support the guidance of project performance toward success. Notably, this study emphasises the importance of stakeholder needs and expectation forming the bases of municipal construction projects in SA. Specifically, this study suggests that the measurement of project performance in municipal construction projects in SA should be integrated in a holistic framework containing several elements that will help to guide construction projects toward success. Based on these elements, a construction project is broken down into three stages, with each stage aiming to achieve specific purposes that contribute to the achievement of success in the subsequent stages, and which then contribute to the overall success of the project's performance and hence the project's success. Each of these stages aligns the stakeholders' objectives, the design of CSFs, the PMs, and PSMs which were identify in this study as a part of the contribution, all of these must be planned and determined in the conceptual, planning and tendering stage, as well as the measurement process that shows how the measurement is conducted continually and frequently.

10.5 Limitations of the research

A number of significant limitations are identified in the current study. The proposed framework has a number of constraints terms of its conduct and scope as outlined below:

- Because of the municipal projects located in different regions over a wide area of SA, workshop validation was conducted in two regions and was limited to seven participants.
- The research was restricted to one municipal construction projects. Therefore, other public projects are not included, thus, the findings are cannot be applied to the construction industry as a whole.
- The CSFs, PMs and PSMs have no weights or sub-measures that can be used to evaluate impact weights.

- Despite the fact that there have been a number of publications in relation to project performance measurement and project success, there is a dearth of research publications on the Saudi construction industry in general, and municipal sector particularly in the field of project performance and project success.

10.6 Recommendations and future work

Objective Six*: Conclude result of study and recommend further investigation in the field of construction projects performance measurement and other in relation.*

During the progress of the research study, a number of areas were identified as limitations of this research. Based on these limitations which are outlined above, the key relevant subjects are suggested and recommended for investigated in future, these are in relation to the three performance levels: municipal project, construction industry in SA and wide knowledge over the world:

- It is suggested that the operation stage of municipal construction project should be investigated. The importance of this investigation lies in the potential for providing more consideration on an area that has not been previously studied because it is the last stage of the project delivery process and it becomes stakeholder responsibility at the end on first year of operation stage and is a defect liability period. Such a study will potentially highlight this stage that has been ignored in previous studies. Furthermore, the study will provide a valuable result that potentially serves to enhance operational team performance to increase effectiveness of the delivered service.
- In line with previous studies that are discussed in chapters 2, 3 and 4, it is recommended to reduce the number of selected CSFs and PMs for first and second stages.
- Considerably more work needs to be done to determine correlation among the factors affecting project performance and project outcomes within each stage, also, among factors and measures between stages. The linkage between these stages' components offers the opportunity for achieving desired results of construction projects as well as opportunity for project process.

- Further research is required to determine methods and approaches to calculate identified performance measures and project success measures.
- This research identified the CSFs, Project Performance Measures and Project Success Measures for measuring municipal construction projects in SA. However, further research is required to identify the specific and sub-CSFs and sub-measures.
- It is recommended that research on severity and weight of CSFs impact, including the weight of performance and success measures in determining project performance success and outcome success.
- The framework can be developed into software a program to facilitate the usefulness of the framework in measuring project performance from a systems perspective. The software model can include calculation of measures and sub-measures based on their weights. It should provide and serve performance evaluation report to stakeholder and participants.
- A further research is also recommended for focusing on measuring performance of four areas, these are: municipal authorities, construction companies, construction consultancy and national construction industry in SA.
- Further work is needed to transfer the framework to software program.

Given that the SA construction industry still depends heavily on the traditional systems of project execution in which the practiced roles and instructions in SA government for planning, implementation and delivering of public infrastructure projects (construction projects) is highly centralized in terms of funding, whereas, different public authorities are responsible to handle various types of construction projects. Thus, the different public authorities are involved in several different types of construction projects. It suggested to be better group all public construction project under responsibility of one organization to enhance their performance and to achieve the success.

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Appendix 1

Success Factors

Authors	Critical Success Factors
Lehtiranta, Kärnä, Junnonen, & Julin (2012)	Project management – was systematic and methodical, Reporting and documenting were well carried out, Risk management was systematic and extensive, The construction schedule was well managed, Quality assurance was carried out systematically and efficiently, Additional works were carried out flexibly and efficiently, Subcontractors were efficiently instructed, The need for plans was clearly indicated, The contractor's quality of work was high Collaborative working – Cooperation was service-oriented and flexible, The client's objectives were well understood, The client received an adequate data about the factors influencing the project result, The contractor presented feasible alternative solutions, The contractor solved problems efficiently, The contractor took good care of information flow during the project Staff and skills – Management was skilled and professional, Workers were skilled and professional, Sub-contractors were skilled and professional, Staff were reliable and responsible, Organization and distribution of duties were clear, Project was allocated enough resources Environment and safety – The site was clean and in good order, Occupational safety matters were well taken care of, Environmental matters were well taken care of Finishing and handover [question only in final feedback] – Handover controls and inspections were well carried out, The level of handover material and documentation was good, The quality requirements set for the building and premises were well met, The requirements set for the functionality of building service technology were well met, As a whole, the construction process was well managed
Gyadu-Asiedu (2009)	**Factors related to the project –** Project type, Project value, Uniqueness of project activities, Project duration and Urgency **Factors related to the project manager/consultant –** Ability to coordinate, Ability to delegate authority, Ability to take decisions when necessary, Ability to trade-off among competing requirements, Competence and Commitment **Factors related to the project team members –** Technical background, Communication, Relationship among them, Commitment, Competence and Ability to work as a team **Factors related to the client organisation** – Top management support throughout the project life, Project organization structure, Functional manager's support and Relationship with project team members **Factors related to the environment –** Political, Economic, Social environment, Technological environment, Nature/weather, Client, competitors and Sub-contractors
Toor & Ogunlana (2009)	Effective project planning and control, Sufficient resources, Clear and detailed written contract, Clearly defined goals and priorities of all stakeholders, Competent project manager, Adequate communication among related parties and Competent team members Knowing what client really wants, Responsiveness of client, Awarding bids to the right designers/contractors, High-quality workmanship, Regular client consultation, Top management sponsorship, Learning from previous experiences, Building a balanced and winning team, Client acceptance of plans, Reliable estimates by quantity surveyors, Positive organizational culture for effective project management, Clear prioritization of project goals by the client, Requiring the use of facts and data to support actions at all levels of decision making, Creating accountabilities, expectations, roles, and responsibilities for the organization, Feedback capabilities in the system, Clearly written lines of responsibility, Mutual trust among project stakeholders, Strategic alignment of project goals with stakeholders' interests, Proven methodology (that includes a vision process) of project management and project procurement, Conducting regular reviews to assure and verify progress on project, Proper dispute resolution clauses incorporated in the contract, Frequent meetings among various stakeholder to evaluate overall performance, Fast trouble-shooting capabilities in the system, Adequate WBS linked with OBS, Clearly designed and coordinated technical tasks, Absence of bureaucracy from the work place, Effective change management, Effective project control mechanics, Developing positive friendly relationships with project stakeholders, Standard software infrastructure and adequate use of IT, Benchmarking firm's performance against successful projects, Using up to date technology and automation for construction work
Iyer & Jha (2005)	**Factors affecting the whole performances of projects –** Project manager's competence, Top management support, Project manager's coordinating and leadership skill, Monitoring and feedback by the participants, Coordination among project participants owner's competence, and Favourable climatic condition **Factors affecting the cost performances of projects –** Conflict among project participants, Ignorance and lack of knowledge, Presence of poor project specific attributes and nonexistence of cooperation, Hostile socio economic and climatic condition, Reluctance in timely decision, Aggressive competition at tender stage, and Short bid preparation time.

Takim (2005)	**Strategy Formulation-Phase –** Corporate missions, Corporate objectives, Project objectives Procurement-Phase – Client attributes, Project attributes, Procurement & delivery strategy, Project feasibility, Project viability, Development of clear and precise project brief, and Comprehensive briefing process **Implementation Phase –** Champion leadership style, Good project management structure, Fragmentation of project activities, Conflicts resolution skill, External forces, Responsiveness to client, Competency of project manager, Top management support, Fast decision making process, Efficiency in prob1em solving process, Adequate team capability, Absence of lengthy bureaucracy, Good communication and reporting, Closer working relationship, Committed team members, Supportive employees, Sufficient resources allocation, Co-operation from various stakeholders, High interaction among team members, Adequate skill and sub-skill manpower & staffing, Shared understanding of scope, Adequate financial support, Up-to-date project management plan, Experienced consultants, Experienced contractor and good track record, Ability to deliver on time, Cost control mechanism, Quality control mechanism, Constructability program, Approval of technology used, Minor pressure from communities, Supportive community involvement, Feedback capabilities, Integrate Improvement Programmes. **Project Completion-phase –** Emotional issues, Intellectual issues, Comprehensive commissioning plan, Defect rectification programme, Learning and growth, Comprehensive project review and feedback
Chan, Scott, & Chan (2004)	Project-Related Factors – Type of project, Nature of project, Number of floors of the project, Complexity of project, and the Size of the project Procurement-Related Factors – Procurement method, and Tendering method, Project Management Factors – Communication system, Control mechanism, Feedback capabilities, Planning effort, Organization structure, Safety and quality assurance program, Control of sub-contractors' works, and Overall managerial actions Project Participants-Related Factors (Client-related) – Client's experience and ability, Nature of client, Size of client organization, Client's emphasis on cost, time and quality, and Client contribution to the project. Project Participants-Related Factors (Leaders-related) – Project team leaders' experience and skills, Project team leaders' commitment on time, cost and quality, Project team leaders' involvement, Project team leaders' adaptability and working relationship, and Support of the project team leaders' parent companies. External Factors – Economic environment, Social environment, Political environment, Physical environment, Industrial relation environment, and Level of technology advanced
Nguyen, Ogunlana, & Lan (2004)	Clear objectives and scope, Commitment to project, Top management support, Timely, valuable information from different parties, Effective strategic planning, Awarding bids to the right designer/contractor, Continuing involvement of stakeholders in the project, Frequent progress meeting, Adequate funding throughout the project, Availability of resources, Absence of bureaucracy, Community involvement, Clear information and communications channels , Accurate initial cost estimates, Systematic control mechanisms, Competent project manager, Multidisciplinary/competent project team, Comprehensive contract documentation, Up to date technology utilization, and Proper emphasis on past experience
Takim & Akintoye (2002)	Client attributes, Project attributes, Delivery Strategy, Management Structure & Project interfaces, Fragmentation and Conflicts, External Forces, Contractors' Performances Stakeholders' attributes, Communities' attributes
Cooke-Davies (2002)	Factors Project Management success-related – Defining of the term risk management, Development of organisation, Visible risk , Risk management plan, Appropriated documentation and Performance measurement Factors individual project success-related – Successful benefit delivery Corporate success – Link the project with strategic plans and learning and experiences
Chan et al (2001)	Teamwork commitment, Contractor's capability, Risk evaluation, Client capability, End-user's needs and Users conditions
Cheng et al (2000)	Successful communication, sufficient resources, Management support, commitments, Coordination and vision
Lim & Mohamed (1999)	Marco perspective – (execution stage) – Time (economy, management, supervision, weather), Satisfaction (convenience, location, prestige, paring, cost) Micro perspective (conclusion stage) – Time, Cost, Quality, Performance, Safety, Technical, Commercial, Finance, Risk, Environmental and Human
Songer and Molenaar (1997)	Define scope, Set up budget, Set up delivery, Design Speculations, Technology, Owner flexibility, Project size, Contract format, Agreement on scope and Funding support

Belassi and Tukel (1996)	Project's attributes – Size, Value, Activities' uniqueness, Project's density, Life cycle, Necessity Project manager factors – Ability, Trade off, Coordinate, Responsibilities' perception, and Competence, Commitment Team members – Technical skills, Communication, and Commitment. Organisation – Top Management support, Organizational structure, and Functional manager's Support. Environmental – Political, Economic, Social, Technology, Nature, Consumer, and Competitors.

Appendix 2

Project Performance Measures

Authors	Success Criteria
Haponava & Al-Jibouri (2012)	**Pre-project stage –** Problem definition, Management of client requirements, Management of design solution, Alignment of stakeholders' requirements, and Stakeholder involvement. **Design stage –** Management of design interactions, Management of project value, Control management programme, and Management of project requirements. **Construction stage –** Management of internal and external stakeholders, Management of time and costs, Quality management, and Information management.
Chan & Chan (2012)	**Time –** Time to rectify defects, Time predictability – design and construction, and Time for construction. **Cost –** Number of change orders generated, Cost per m2, Consultant fee, Development fee, Cost of superstructure, Occurrence and magnitude of disputes and conflicts, and Cost predictability – design and construction, Cost exceeding GMP / target cost or not, and Cost for construction **Quality –** Aesthetics, Quality management system, Quality issues at end of defect rectification period, Defects (Number / Severity), and Quality **Satisfaction –** Conformance to stakeholders' expectations, Contractor's satisfaction, and Client's satisfaction. **Health, Safety and Environment –** Quantity of waste generated, Environmental performance, Lost time accidents, Reportable accidents, Safety. **Others –** Profit predictability (project), Training days, Staff turnover, Productivity performance, and Contractor involvement.
Abd Elshakour , Al-Sulaihi, & Al-Gahtani (2012)	**Financial –** Profitability, Growth, Financial stability, Cash flow, Reliability of financial performance, Interest cover, Capital, and Investment in development of new markets **Customer –** Quality of service and work, External customer satisfaction, Market share, Internal customer satisfaction, Number of new customers, Hassle-free relationship, Competitive price, and Value of money. **Internal business –** Safety, Business efficiency, Effectiveness of planning, Labour efficiency, Successful tenders rate, Managers competency, Innovation, Productivity, Resource management, Staff turnover, Research and development, Defects, Quality control and rework, Number of high-performance professionals, and Technological capability. **Learning and growth –** Organization competency in management human resources, Continuous improvement, Investors in people, Empowered work force, Information, Human resource training and development, Motivation. **Environment –** Risk control, Partnership and suppliers, Policy or law of government, Impact on biodiversity, Main water use Energy use, Waste, Impact on society, and Competitors.
Chan & Hiap (2012)	**Financial perspective –** Annual construction demand from public sector, Annual construction demand from private sector, Ratio of value of contracts awarded to Malaysian contractors vs foreign, Total annual value of overseas construction projects, Productivity—value-added per worker (RM per worker), Productivity growth rate (annual change in productivity), Profitability—company (revenue as a percentage of sales), and Return on equity (revenue as percentage of equity). **Customer perspective –** Predictability cost—design, Predictability cost—construction, Predictability cost—project, Predictability time—design, Predictability time—construction, Predictability time—project, QLASSIC score, Time for approvals (weeks), Performance ratings, Client satisfaction—products and services. **Internal perspective—innovation –** Construction R&D per RM1m of project value, Percentage of IBS/precast/prefabrication, Number of patents registered locally. **Operations –** Labour productivity (man-days per sq. m of completed works), Labour productivity growth rate (annual change in productivity), Number of construction companies with ISO9001 certification, and Number of construction companies with ISO14001 certification, Number of construction companies with OSHMS/OHSAS certification. **Occupational health and safety –** Number of accidents (per 100 000 workers), and Employee fatality (per 100 000 workers) **Learning and growth perspective –** Workers accreditation by CIDB (accredited/registered), Supervisors accreditation by CIDB (accredited/registered), Staff turnover, Number of training days per worker per year, Total ICT spending of the construction industry (per RM1m of project value), and Inputs from the ICT industry to the construction industry.
Cha & Kim (2011)	**Cost –** Cost Efficiency, Cost Effectiveness, Cost Rate, Design Cost Predictability, Construction Cost Predictability, Financial Cost Ratio, and Budget Reduction Rate. **Time –** Schedule Efficiency, Schedule Effectiveness, Design Schedule Predictability, Construction Schedule Predictability, Overtime Work Rate, and Schedule Reduction Rate. **Quality –** Defect Frequency, Rework Rate, and Non-Conformance Rate. **Safety –** Accident Rate, Safety Cost Ratio, and Safety Education. **Environment –** Construction Waste Rate, and Recycling Rate.

	Productivity – Management Productivity, and Labour Productivity. **Risk Containment –** Contingency Rate, and Change Order Cost/Revenue. **Security –** Material Theft Rate, and Material Theft Frequency.
Cha & Kim (2011)	**Budgeted and Actual Project Costs –** Budget, Contingency, Actual Cost, and Field Rework. **Planned and Actual Project Schedule –** Baseline schedule and Actual schedule. **Facility Capacity –** Product quality, Functionality, and Project quality. **Project Outcomes –** Cost Expectations, Schedule Expectations, Safety Expectations, Business Objectives, Quality Goals, Project Teamwork, and Team Communications. **Work hours and Accident Data –** Recordable incident cases, and DART cases. **Project Impact Factors –** Weather/climate, Availability of skilled Labour, Materials availability/cost, Site conditions, Project complexity, Regulatory requirements, Project team expertise, Project team communication, Core project team turnover, Use of offshore engineering, Use of multiple design offices, Material or labour cost escalation, and Construction productivity.
Cha & Kim (2011)	**Economic –** Client Satisfaction, Defects, Cost Prediction, Time Prediction, Profitability, Productivity, Safety, Construction Cot, Construction Time **Respect for People –** Employee Satisfaction, Staff Turnover, Sickness Absence, Safety Working Hours, Qualification & Skills, Equality & Diversity, Training, Pay, Investors in People **Environment –** Impact on the Environment, Energy Use, Mains Water Use, Waste, Commercial Vehicle Movements, Impact on Biodiversity, Area of Habitat Created, Whole Life Performance
Eriksson & Westerberg (2011)	Time, Cost, Quality
Dawood & Sikka (2009)	**Time** *(Pre-construction & construction stage)* **Safety** *(construction stage)* **Client Satisfaction** *(construction & post-construction stage)* **Planning efficiency** *(construction stage)* **Communication efficiency** *(pre-construction & construction stage)* **Rework efficiency** *(pre-construction & construction stage)* **Cost** *(pre-construction & construction stage)* **Team performance** *(pre-construction & construction stage)* **Productivity performance** *(construction stage)*
Nudurupati, Arshad, & Turner (2007)	**Objective measures –** Construction time, Speed of construction, Time variation, Unit cost, Percentage net variation over final cost, Net present value, Accident rate, Environment impact assessment (EIA) scores **Subjective measures –** Quality, Functionality, End-user's satisfaction, Client's satisfaction, Design team's satisfaction, Construction team's satisfaction
Ugwu & Haupt (2007)	**Economic –** Direct cost, Indirect cost **Environmental –** Land use, Water, Air, Noise, Ecology, Visual impact, Waste management **Societal –** Cultural heritage, Public access, Public perception **Resource utilization –** Site access, Material availability, Type, Constructability, Reusability, Quality assurance **Health and safety –** Occupational , Public **Project management administration –** Contract, Procurement method
Cheung, Suen, & Cheung (2011)	**People –** Perceptive views on the following aspects of the project. Time, Cost, Quality, and Safety. **Cost –** Interim Payment, Variation Order, Cost Claims, and Final Account Forecast. **Time –** Achievement of Critical Dates, Achievement of Milestones, and Turnaround Time for Submissions in the period. **Quality –** Inspections, Non-Compliance Records, Records rectified, Work Rejection, and Survey (Samples) Rejection. **Safety and Health –** Statistics, Monitoring and Compliance, Education, Training, and Campaigns, Inspections and Audits, Complaints and Prosecutions, Complaints and Prosecutions. **Environment –** Compliance, Material Control and Waste Management, Meetings, Education, Training, and Campaigns, Inspections and Audits. **Client Satisfaction –** Product, Project Manager, Contractor and Supplier. **Communication –** Communication and Management.
Chan & Chan (2004)	**Delivery stage –** the process: doing it right **Post-delivery stage –** the system: getting it right **Post-delivery stage –** the benefits: getting them right
Beatham, Anumba, & Thorpe (2004)	Defects, Safety, Productivity, Profitability, Customer satisfaction—product, Customer satisfaction—service, Predictability of construction cost, Predictability of construction time, Construction cost, Construction time, Predictability of design, and Cost of design.
Takim & Akintoye (2002)	**<u>Procurement Stage</u>** **Client –** Client attribution, Project attribution, Procurement & delivery Strategy, Project viability, Contractual arrangement, Briefing Process, Communication, Decision effectiveness, Risks and opportunities, Excessive bureaucracy, Commitment from employees, Interactive Process, and Social Obligations.

	Consultant – Project management capabilities, Good working relationship, Competency, Consultation mode, Commitment, Strategic cost advise, Meeting functional requirements, Meeting technical specification, Proper communication, Interactive process, Efficiency of technical approval, and authorities. **Contractor –** Level of experience, Financial stability & financial management, Past performance, Management capabilities, Performance of project personnel, Construction method and technology, Manpower and technical capabilities, and Project innovation. **Project Stage** **Client –** Management structure, Project interfaces, Fragmentation, Conflicts, Control measures, Political, economic, social, legal & environment influences, Loyalty, Quality of work life. **Consultant –** Team Management, Project interfaces, Coordination, Accountability, Conflicts management style, Communications and reporting, Quality control system, Quality assurance, and Dispute resolution process. **Contractor –** Performance standard, Good working relationship, Construction method & technology, Labour utilisation & relaxation, Productivity rate, Safety, Constructability, Communications and reporting, Cost control mechanism, and Efficiency. **Phasing-Out Stage** **Client –** Meets pre stated objectives, Meets time, Meets budget, Technical specification, Acceptable quality, Meets Corporate priorities, Harmony, Absence of any claims & Proceedings, Reduction of conflicts/ disputes, Transfer of experience, Investment opportunity, and Value for money. **Consultant –** Profitability, Future Jobs, Learning & growth, Generated positive reputation, Harmony, Absence of any legal claims & proceedings, and Increase the level of professional. **Contractor –** Profitability, Achieve business purpose, (strategically, tactically & operationally), Learning and growth, Settlements of conflicts, Minimum risk (reduction of disputes), Business relationship, New market penetration, Generated positive reputation, Develop new knowledge, and expertise.
Lim & Mohamed (1999)	**Macro –** Time, Satisfaction, Utility, and Operation **Micro –** Time, Cost, Quality, Performance, and Safety Construction cost, Construction time, Defects, Client satisfaction (product), Client satisfaction (service), Profitability, Productivity, Safety, Cost, Predictability (const.), Time predictability (const.), Cost predictability (design), and Time predictability (design).

Appendix 3

Project Success Measures (Efficiency and Effectiveness)

Author	Efficiency Measures	Effectiveness Measures
Takim (2005)	- According to schedule - Within budget - Conformity with specifications - Safety - Productivity - External project environment - Degree of interaction - Quality of working environment - Environmental effects - Social obligation	- Client satisfaction on service - User satisfaction with product - Project effectives (achievement of objectives) - Project functionality /Fitness for purpose - Free from defects - Value for money - Profitability - Absence of any legal claims & proceedings - Learning and exploitation - Generate positive reputation
Takim, Akintoye, & Kelly (2004)	- Absence of any legal claims & proceeding - Minimum amount of disputes - High quality of workmanship - Minimum amount of risks - Meets social obligations - High quality of materials and components - Minimum impact from external forces - No tremendous hassles and arguments - Good quality of work life - Minimum scope changes - Zero variation - Comprehensive briefing process - Meets facilities requirements - Meets adequate training programme to users - Meets plant servicing & maintenance program - Minimum effect to the environment - Integration of design and construction - Meets safety requirements - No Plant standing idle - Maximum utilisation of plants & equipment - High project productivity - Maximum utilisation of resources - Efficiency in utilisation of manpower - Minimum amount of wastages - Meets time - Meets technical specification - Meets budget - Efficiency of technical approval authority - Fast decision-making process - Minimum disturbance to main flow of work	- Develop new knowledge & expertise - Increase levels of profess. develop - Generate positive reputation - New market penetration - Develop new business relationship - Value for money - Exploitation of technology - Usable life expectancy - Lower depreciation cost - Benefit to users - Benefit to client - Project functionality - Aesthetic value - Meets client satisfaction on service - Meets client satisfaction on product - Pleasant environment - Easy to maintain - Accomplish core business needs - Meets stakeholders' needs & expect - Meets corporate missions - High profit margin - Meets pre-stated objectives - Supported by warranty programme - Excellent Commissioning prog. - Excellent Close-out process - Fitness for purpose - Fast rectification of defects - Early occupation - Minimum cost of ownership - Flexible for future expansion
Takim & Akintoye, (2002)	- Meets time - Meets budget - Meets technical specifications - Safety - Profitability Absence of any legal claims & proceeding	- Client satisfaction - Use of the project - Fitness for purpose - Free from defects - Value for money - Pleasant environment - Social obligation

Appendix 4

Construction project lifecycle

<table>
<tr><th>Authors</th><th colspan="12">Construction Project Lifecycle</th></tr>
<tr><th></th><th colspan="8">Initial Stage</th><th>Construction Stage</th><th colspan="3">Operation Stage</th></tr>
<tr><td>Haponava et al. (2012)</td><td colspan="4">Pre-project</td><td colspan="4">Design</td><td>Construction</td><td colspan="3"></td></tr>
<tr><td>Kaare & Koppel (2012)</td><td colspan="2">Project evaluation</td><td colspan="2">Commit to invest</td><td colspan="4">Planning & design</td><td>Construction & defect liability period</td><td>Available for use</td><td colspan="2"></td></tr>
<tr><td>Willis & Rankin (2011)</td><td colspan="4">Planning</td><td>Design</td><td colspan="3">Tendering</td><td>Construction</td><td>Defect liability period</td><td colspan="2">Lifetime of project</td></tr>
<tr><td>Popov et al. (2010)</td><td colspan="4">Development and planning</td><td>Design</td><td colspan="2">Economic assessment</td><td>Tendering & negotiators</td><td>Construction</td><td>delivery</td><td>Payment</td><td>Maintenance</td></tr>
<tr><td>Fleming (2009)</td><td>Project Initiation</td><td colspan="2">Planning/ Funding</td><td>Environmental</td><td>Design</td><td>Permitting</td><td>Real Property Acquisition</td><td>Bid & Award</td><td>Construction</td><td>Commissioning</td><td colspan="2">Operation</td></tr>
<tr><td>Haponava & Al-Jibouri (2009)</td><td colspan="8">Pre-project</td><td>In-project</td><td colspan="3">Post-project</td></tr>
<tr><td>Assudani & Kloppenborg (2008)</td><td colspan="4">Pre-Planning</td><td>Design</td><td colspan="3">Procurement</td><td>Construction</td><td>Start up</td><td colspan="2"></td></tr>
<tr><td>Yang & Peng (2008)</td><td colspan="4">Planning & feasibility study</td><td>Design</td><td colspan="3">Tender</td><td>Construction</td><td colspan="3"></td></tr>
<tr><td>Delgado et al. (2005)</td><td colspan="4">Briefing</td><td>Designing</td><td colspan="3">Tendering</td><td>Construction</td><td colspan="3">Commissioning</td></tr>
<tr><td>Takim et al. (2003)</td><td colspan="4">Strategy formulation</td><td colspan="4">Procurement</td><td>Implementation</td><td>Completion</td><td colspan="2"></td></tr>
<tr><td>Pillai et al. (2002)</td><td colspan="8">Project selection</td><td>Project execution</td><td colspan="3">Implementation</td></tr>
<tr><td>Haponava et al. (2001)</td><td colspan="8">Preparation stage</td><td>Project execution</td><td colspan="3"></td></tr>
<tr><td>Raynsford (2000)</td><td colspan="8">Planning & Design</td><td>Construction</td><td>Defect Liability Period</td><td colspan="2">Lifetime of Project</td></tr>
<tr><td>Lim & Mohamed (1999)</td><td colspan="2">Conceptual</td><td colspan="2">Planning</td><td>Design</td><td colspan="3">Tender</td><td>Construction</td><td>Operation</td><td colspan="2"></td></tr>
</table>

Appendix 5

Telephone Interview Response Result

	Interviewees' Positions	Interviewees' Responses
Question 1:	*What are the current procurement system, process and approach practised to manage and deliver construction projects in municipalities in SA?*	
1	Vice Mayor of Sub-Municipalities Agency of Jeddah	Public Works Contract for constructor and Consultants (3 year framework agreements)
2	Head of Construction Project Administration Department in Almandine Municipality Region	For Constructor Public Works Contract For Consultants (3 year framework agreements)
3	Mayor of Sub-Municipalities	One stage contract
4	Mayor of sub-Municipalities	Open competition based on PWC
5	Senior Engineer	Public Works Contract
6	Senior Engineer	Public Works Contract

	Interviewees' Positions	Interviewees' Responses
Question 2:	*How many stages are there in municipal construction projects?*	
1	Vice Mayor of Sub-Municipalities Agency of Jeddah	Frist stage: planning and tendering Second stage: construction and one year defect liability period
2	Head of Construction Project Administration Department in Almandine Municipality Region	Frist stage: planning and contracting stage, second stage: construction and third stage: operation include one year defect liability period
3	Mayor of Sub-Municipalities	Tendering stage, construction stage and one year defect liability period (operation stage)
4	Mayor of sub-Municipalities	Tendering stage, construction stage and one year defect liability period
5	Senior Engineer	Planning stage, tendering stage, construction stage and one year defect liability period stage and operation stage
6	Senior Engineer	Tendering stage, construction stage and one year defect liability period (operation stage)

	Interviewees' Positions	Interviewees' Responses
Question 3:	*How many key participants are involved in the delivering of municipal construction project and stakeholders?*	
1	Vice Mayor of Sub-Municipalities Agency of Jeddah	Three (government, contractor and consultant) and users (citizens)
2	Head of Construction Project Administration Department in Almandine Municipality Region	Four (government, contractor, consultant & citizens)

3 Mayor of Sub-Municipalities	Government, Contractor, consultant and citizens
4 Mayor of sub-Municipalities	government, contractor, consultant and users
5 Senior Engineer	Municipality team, construction contractor, consultant and users (citizens)
6 Senior Engineer	Municipality team, construction contractor, consultant and users (citizens)

Question 4:	*When stakeholders are communicating with each other?*
1 Vice Mayor of Sub-Municipalities Agency of Jeddah	Municipal team and users (citizens) in first stage Municipal team, contractor and consultant in each stage
2 Head of Construction Project Administration Department in Almandine Municipality Region	In all project cycle life (Municipal team) For fund (ministry of municipal and ministry of finance) In construction stage (contractor and consultant)
3 Mayor of Sub-Municipalities	Municipal team and users (citizens) in first stage Government for supervision in all project stages Contractor and consultant in construction stage
4 Mayor of sub-Municipalities	Basically in all stages government, also, in construction stage: contractor and consultant
5 Senior Engineer	Municipal team, contractor and consultant in each stage
6 Senior Engineer	Municipality team for administration and supervision In construction stage: contractor and consultant

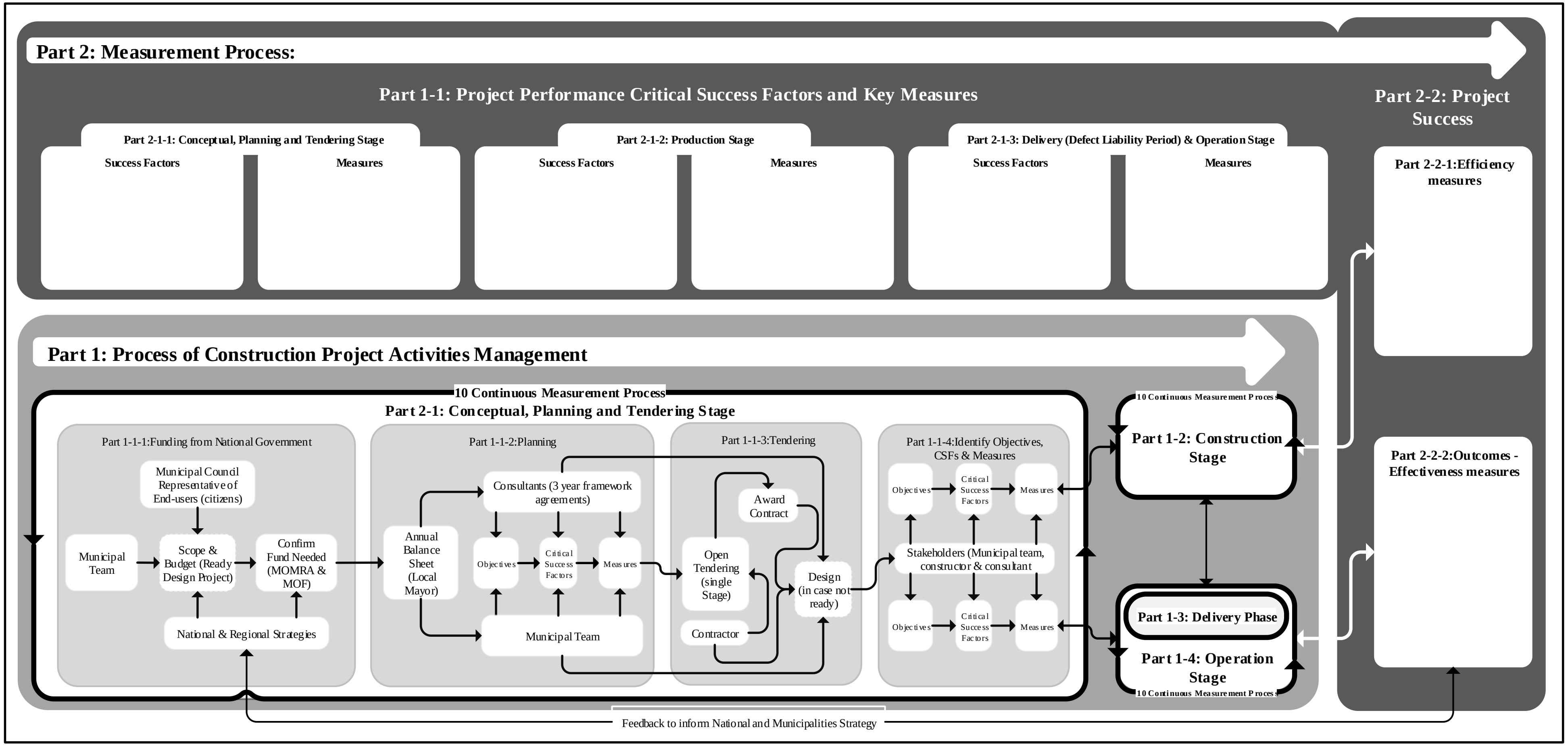
Question 5:	*How the citizens' needs and expectations identified?*
1 Vice Mayor of Sub-Municipalities Agency of Jeddah	Citizens' reprehensive (Municipal council)

2 Head of Construction Project Administration Department in Almandine Municipality Region	Citizens' reprehensive by Identification needs meeting based on national strategic plans at
3 Mayor of Sub-Municipalities	Citizens' reprehensive (Municipal council)
4 Mayor of sub-Municipalities	Municipal council
5 Senior Engineer	Municipal council
6 Senior Engineer	Citizens' reprehensive

Question 6: *If Yes in which stage?*	
1 Vice Mayor of Sub-Municipalities Agency of Jeddah	Frist stage (Need identification sub-stage) and operation stage
2 Head of Construction Project Administration Department in Almandine Municipality Region	Frist sub-stage in planning stage and operation stage
3 Mayor of Sub-Municipalities	Planning sub-stage in first stage and operation stage
4 Mayor of sub-Municipalities	Frist stage and operation stage
5 Senior Engineer	Need identification sub-stage in first stage and usage stage
6 Senior Engineer	Frist stage and operation stage

Appendix 6

Initial proposed performance measurement framework for municipal construction project in SA



Appendix 7

Questionnaire for Developing a Performance Measurement Framework for Municipal Construction Project in Saudi Arabia

I am a Saudi national currently undertaking a PhD research programme at Edinburgh Napier University. As part of my thesis, I am undertaking survey to collect primary data on the current practices for assessment of project performance in construction in SA.

To achieve the aims of the study, I am undertaking a survey of the views of Stakeholders who are currently involved in public sector construction projects in SA. I am in particular trying to examine the views of key stakeholders including: public works clients, contractors, consultants, designers, suppliers, etc. The overall objective of the work is to develop a performance measurement system in order to assist in the improving the delivery of major construction projects.

Thus, this questionnaire seeks your views regarding Construction Project Performance Measurement and Improvement in Municipalities in SA during a project lifecycle.

This questionnaire is in six (6) sections:

Section 1: General Information
Section 2: Measurement Process
Section 3: Critical Success Factors
Section 4: Performance Measures
Section 5: Efficiency and Effectiveness Performance Measures
Section 6: General Comments

I will therefore be most grateful if you could spare some of your time and complete for me the questionnaire that follows. I confirm that your details will remain anonymous and no individual responses will be reported in the study.

I will be most grateful if you could confirm that you understand the purpose of the study and that you have no objection to your responses being used in the analysis by signing the last page of the questionnaire in the space provided.

If you have any queries on the survey, please do not hesitate to contact me on any of the following contact details (Mobile: 00966562060504, Fax: 0096626766565 and Email: ssss1422@hotmail.com or salehassulamy@hotmail.com).

I enclose herewith a stamped self-addressed envelope for your use.

Thank you very much in anticipation of your assistance in this study.

Yours sincerely

Saleh Alsulamy

Section 1: General Information

1.1 Please state your job title:

1.2 Please state the principal business activities of your organisation

Government officials (Specialist, Professional, Mayors & Engineer)	Contractors	Consultants

For respondents employed in Municipalities, please go to question 1.4

1.3 Size of Company measured by annual turnover

Less than SR 10 million	Between SR 10 to 20 million	Between SR 20 to 50 million	Between SR 50 to 100 million	Over SR 100 million.

1.4 Please state number of permanent employees (Specialist and Professional).

1.5 Please indicate the number of years of work experience in construction

No Work experience	Less than 5	6 to 10	11 to 15	Over 15

1.6 State the kind of projects your organization works in.

Buildings	Roads	Electrical Works	Dams, Flood Control Structures, Bridges and tunnels	Landscaping	Planting Parks and Irrigation network

Others please specify…………………………………………...………………………………………….

1.7 Have you received any training about performance measurement systems?

Yes ☐ No ☐ If yes please specify: ……………………..………..……………………..…………

1.8 Do you have experience in measuring performance?

Yes ☐ No ☐ If yes please specify ………………………….………………………..…………

1.9 Do you practice any performance measurement systems in the construction projects?

Yes ☐ No ☐

1.10 Which of the following performance measurement systems you have known or used in past?

Performance Measurement Systems		Known to you	Used by you
1	Key Performance Indicators		
2	Balance Scorecard		
3	European Foundation Quality Management		
4	Malcolm Baldridge National Quality Award		

Please list any other systems which you might be aware of but are not listed here:

…………………………………………………………………………………..…………………..………

1.11 Which of the following performance measures are used by your organization/company and what forms of assessment techniques do you use to evaluate project performance?

Performance Measures		Tick If measured	1.12 Assessment Techniques
1	Measures on initial project viability and feasibility		
2	Measures on the efficiency of process		
3	Measures on project time		
4	Measures on project cost		
5	Measures on project productivity		
6	Measures on project quality		
7	Measures on efficiency performance		
8	Measures on effectiveness performance		
9	Measures on stakeholders' satisfaction		
10	Measures on the project team's control and communications		

Please list others which are relevant (in your views) but not listed here

………

1.13 Please rank the obstacles/barriers in the order of importance affecting the performance measurement of construction projects in Saudi municipalities.

1	2	3	4	5	6	7
Not Important	Slightly Important	Somewhat important	Moderately important	Important	Very Important	Extremely Important

Obstacles		Ranking
1	Lack of motivation to improve and achieve superior performance	
2	Lack of sufficient skills and training	
3	Insufficient equipment	
4	Inconsistent measurement approaches	
5	Non conducive organizational culture	
6	Non-cooperation among stakeholders	
7	Weak government regulations and instructions	
8	Weakness in the application of the regulations and instructions	
9	Inadequate planning and strategies	
10	Insufficient conditions for awarding of projects and criteria for contractor selection	
11	Lack of standards, specifications and data	
12	Bureaucracy and lack of transparency	
13	Weakness of contract document	

Please list others which are relevant (in your view) but not listed here:

………

Section 2: Measurement Components Process:

The following are 10 performance measurement processes. Please to what extend do you agree that they determine and measuring the projects performance and success.

Measurement Process:

Ranking
1= Disagree To 7= Extremely Agree

	1	2	3	4	5	6	7
1-Identify what to be measured, 2-Define measures, 3-Collect Data, 4-Calculate measures, 5-Report the result, 6-Analyse the result, 7–Benchmarking, 8-Learn from best practice, 9-Take action & 10-Measure again							

Please list others which are relevant (in your view) but not listed here or any other comments:

………

Section 3: Success Factors

The following are factors which influence the success or failure of construction (performance factors). Please select those you perceive to be relevant in SA and rank them according to how critical they are in determining the performance of projects.

1	2	3	4	5	6	7
Not important	Slightly important	Somewhat important	Moderately important	important	Very important	Extremely important

	Groups	Success Factors	Project Stage		
			Conceptual, Planning and Tender	Production	Operation
1	Time	Schedule project construction			
2		Project duration			
3		Maintenance time			
4	Cost	Budget			
5		Cash flow			
6		Maintenance cost			
7	Stakeholders Satisfaction	Disputes between owner and project parties			
8		Speed of deliver the product to end-users			
9	Health & safety	Accessibility to reach to the site (location of project)			
10		Application of health and safety system			
11	Environment	Wastes around the site			
12		Weather condition in the site			
13		Sustainability			
14	Innovation and learning	Transfer of experience and best practice			
15		Innovation			
16		Comprehensive project review and feedback.			
17	Business performance	Economic (stable economic conditions and economic policy)			
19		Risk			
19	Quality	Quality training/meeting			
20		Quality control			

Groups		Success Factors	Project Stage: Conceptual, Planning and Tender	Project Stage: Production	Project Stage: Operation
21	Strategies and Management	Contractor selection criteria		X	X
22		Coordination and vision		X	X
23		Procurement & delivery strategy		X	X
24		Integration the project with national plans		X	
25		Standards and specifications			
26		Project attributes (type , size ,objective ,location)			
27		Relationship among stakeholders			
28		Top management support			X
29		Fast decision making process			X
30		Training			X
31		Adequacy of design details			X
32		Transparency in the procurement process		X	X
33		Strategic alignment of project goals with stakeholders' interests		X	X
34		Fragmentation of project activities	X		X
35		Good project management structure	X		X
36		Documentation and Reports	X		
37		Absence of conflicts	X		X
38		Capability of project manager	X		X
39		Efficiency in problem solving process	X		X
40		Adequate team capability (technical skills, Communication, Commitment, experience and qualification)	X		X
41	Project production	Sequencing of work according to schedule	X		X
42		Sufficient resources allocation	X		X
43		Sufficient work skills and mechanisms	X		X
44		Using up to date technology	X		X
45		Site meetings	X		X
46		Project organization structure	X		X

Section 4: Performance Measure

Following measures are used to assess the performance of construction projects in the three-project phases. Please select those relevant in SA and rank them using the order of importance explained below:

1	2	3	4	5	6	7
Not important	Slightly important	Somewhat important	Moderately important	Important	Very important	Extremely important

	Groups	Performance Measures	Project Stage		
			Conceptual, Planning and Tender	Production	Operation
1	Time	Design Time			
2		Construction time			
3		Time to Rectify Defects			
4	Cost	Design Cost			
5		Construction cost			
6		Cost to rectify defects in the maintenance period			
7	Stakeholders Satisfaction	Integration of design and construction.			
8		End-user satisfaction (user expectations)			
9		Contractor Satisfaction – Payment			
10		Client satisfaction (standard criteria)			
11		Client satisfaction (specific criteria)			
12	Business performance	Cash Flow			
13		Profitability			
14		Productivity			
15		Risk rate			
16	Health & safety	Safety requirements			
17		Reportable accidents			
18		Fatalities			
19	Environment	Environmental FAQ			
20		Records of complaints regarding environmental issues			
21		Energy and water use			
22		Sustainability			
23		Waste Percentage (Landfill)			

Groups		Performance Measures	Project Stage		
			Conceptual, Planning and Tender	Production	Operation
24	Innovation and learning	Applying a new products and technology			
25		Transfer of experience and best practice			
26		Innovation			
27	Quality	Quality assurance systems			
28		Quality Issues at Available for Use			
29		Defects			
30	Management	Availability of specifications and standards			
31		Tendering requirements			
32		Relationship among stakeholders			
33		Project attribution			
34		Planning			
35		Alignment of stakeholder's requirements			
36		Stakeholder involvement			
37		Availability of contractor selection criteria			
38		Leadership			
39		Number of Training			
40		Team performance			
41		Conflicts & claims			
42		Solving site problems			
43	Change orders	Change Orders			
44	Project production	Rate of site meetings			
45		Decision making procedures			
46		Documentation and Reports			
47		Construction method and technology			
48		Rework			
49		Project organization structure			
50		Waste of resources and materials			
51		Project schedule and monitoring (procedure and process)			

Section 5: Efficiency and Effectiveness Measures

Project success is measured in terms of efficiency and effectiveness performance. **Measuring Efficiency** means measuring the efficiency in the utilization of equipment manpower, resources, budget and team management and it relates to the project output while **Measuring Effectiveness** means measuring whether projects objectives are fully attained and it relates to the project outcomes which refer to user satisfaction, the use of the project and final impact.

5.1. Efficiency Measures

The following are efficiency measures are used by your organization/company in measuring project success or failure of construction. Please select those you perceive to be relevant in SA and rank them according to how critical they are in determining the performance of projects.

1	2	3	4	5	6	7
Not important	Slightly important	Somewhat important	Moderately important	important	Very important	Extremely important

	Measures	Rank
1	Minimum scope changes	
2	Minimum effect on the environment	
3	Meets safety requirements	
4	High project productivity	
5	Efficiency in utilization of manpower	
6	Minimum amount of wastages	
7	Meets time	
8	Meets technical specification	
9	Meets budget	
10	Fast decision-making process	
11	Minimum amount of disputes	
12	High quality of workmanship	

5.2. Effectiveness Measures

The following are effectiveness measures are used by your organization/company in measuring project success or failure of construction. Please select those you perceive to be relevant in SA and rank them according to how critical they are in determining the performance of projects.

1	2	3	4	5	6	7
Not important	Slightly important	Somewhat important	Moderately important	important	Very important	Extremely important

	Measures	Rank
1	Project functionality	
2	Meets client satisfaction on service	
3	Meets client satisfaction on product	
4	Pleasant environment	
5	Easy to maintain	
6	Meets stakeholders' needs & expect.	
7	Meets pre-stated objectives	
8	Integrated with national plans and fit with purpose	
9	Fast rectification of defects	
10	Flexible for future expansion	
11	Free from defects	

Section 6: General Comments

6.1. Is it possible to improve the existing performance measurement approaches

Yes ☐ No ☐

6.2. Would you support integrated performance measurement system across various project stages and stakeholders?

Yes ☐ No ☐

Please provide any comments on how the Saudi Construction Industry can achieve a better project performance

………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………

I reaffirm that all information given in response to this questionnaire will be treated in full confidence. Please sign below to confirm that you agree to your responses being used in the analysis. Thank you very much for your time.

Signed…………………………………………..Date…………………………….

Thank you very much for your cooperation and help

Appendix 8

Interview Questions for Developing a Performance Measurement Framework for Municipal Construction Project in SA

Part 1: Personal Background

1.1. Name:

1.2. Job Title/Position:

1.3. Years of work experience:

1.4. Type of your origination ☐ Government ☐ Contractor ☐ Consultant

1.5. Contact Number:

Part 2: Proposed Framework Components Evaluation

To what extend do you agree that the proposed framework including first part which involves performance measurement components and process, critical success factors, performance measures and project success measures, as well as project stages and participants is

Ranking
1 = Disagree - 7 = Extremely Agree

	1	2	3	4	5	6	7
1 Practical							
2 Clear							
3 Applicable							
4 Comprehensive							

Part 3: Components of Proposed Framework:

2.1. There are three key participants involved in the delivering of municipal construction project (government, contractors and consultant).

Yes ☐ No ☐ If No please clarify:……..……………………….……………..……

2.2. There are three main stages in municipal construction project (Conceptual, planning and tender, Production and operation stage).

Yes ☐ No ☐ If No please clarify:……..……………………….……………..……

2.3. Success Factors

To what extend do you agree with significance ranking of CSFs

Ranking
1 = Disagree - 7 = Extremely Agree

	1	2	3	4	5	6	7
Conceptual, planning and tender stage							
1 Management capabilities							
1-1 Relationship among stakeholders							
1-2 Strategic alignment of project goals with stakeholders' interests							
1-3 Top management support							
2 Contractor selection criteria and vision							
2-1 Contractor selection criteria							

2-2	Coordination and vision							
2-3	Transparency in the procurement process							
2-4	Procurement & delivery strategy							
2-5	Risk							
3	**Accessibility of experience and specifications**							
3-1	Standards and specifications							
4	**Project attributes**							
4-1	Project duration							
5	**National plans**							
5-1	Integration the project with national plans							
Production Stage								
1	**Project production and management**							
1-1	Quality control							
1-2	Sequencing of work according to schedule							
1-3	Capability of project manager							
1-4	Adequate team capability (technical skills, experience and qualification, etc.)							
2	**Project duration and budget**							
2-1	Project duration							
2-2	Budget							
2-3	Schedule project construction							
2-4	Sufficient resources allocation							
3	**Design details & specifications**							
3-1	Standards and specifications							
3-2	Sufficient work skills and mechanisms							
3-3	Adequacy of design details							
4	**Project structure**							
4-1	Fragmentation of project activities							
5	**Documentation**							
5-1	Documentation and Reports							
6	**Speed of deliver**							
6-1	Speed of deliver the product to end-users							
Operation Stage								
1	**National plans and Maintenance cost & time**							
1-1	Integration the project with national plans							
1-2	Maintenance cost							
1-3	Maintenance time							
1-4	Speed of deliver the product to end-users							
2	**Project attributes and safety**							
2-1	Application of health and safety system							

Is there any success factors needed to be added?

Yes ☐ No ☐ If No please clarify:……..………………………….……………..……

2.4. Performance measures

To what extend do you agree with significance ranking of Performance measures	Ranking 1 = Disagree - 7 = Extremely Agree							
		1	2	3	4	5	6	7
Conceptual, planning and tender stage								
1	**Tendering requirements**							
1-1	Tendering requirements							
1-2	Design cost							
1-3	Availability of contractor selection criteria							
2	**Stakeholder objectives**							
2-1	Alignment of stakeholder’s requirements							

2-2 Stakeholder involvement							
2-3 Design time							
2-4 Planning							
3 Specifications							
3-1 Availability of specifications and standards							
3-2 Relationship among stakeholders							
3-3 Leadership							

Production Stage

1 Project production and management							
1-1 Construction time							
1-2 Quality assurance systems							
1-3 Productivity							
1-4 Team performance							
1-5 Time to rectify defects							
1-6 Construction cost							
1-7 Integration of design and construction							
1-8 Leadership							
1-9 Project schedule and monitoring (procedure and process)							
1-10 Solving site problems							
1-11 Waste of resources and materials							
1-12 Risk rate							
2 Stakeholder objectives							
2-1 Alignment of stakeholder's requirements							
2-2 Contractor satisfaction – payment							
2-3 Client satisfaction (specific criteria)							
2-4 Planning							
3 Quality issues							
4-1 Availability of specifications and standards							
4-2 Cost to rectify defects							
4-3 Client satisfaction (standard criteria)							
4 Profit Predictability							
5-1 Cash Flow							

Operation Stage

1 User and client satisfaction							
1-1 End-user satisfaction (user expectations)							
1-2 Client satisfaction (standard criteria)							
1-3 Integration of design and construction							
1-4 Client satisfaction (specific criteria)							
1-5 Quality issues at available for use							
2 Defects							
2-1 Defects							
2-2 Cost to rectify defects in the maintenance period							

Is there any performance measures needed to be added?

Yes ☐ No ☐ If No please clarify:……..……………………………….…………………..……

2.5. Efficiency and Effectiveness Measures (Outcomes)

To what extend do you agree with significance ranking of CSFs	Ranking 1 = Disagree - 7 = Extremely Agree						
	1	2	3	4	5	6	7

Efficiency Measures

1 Recourse Utilisation

1-1	Meets budget							
1-2	Meets time							
2	**Productivity**							
2-1	High project productivity							
3	**Meets Specification**							
3-1	Meets technical specification							
4	**Safety Requirements**							
4-1	Meets safety requirements							

Effectiveness Performance Measures

1	**Stakeholders Satisfaction**							
1-1	Meets stakeholders' needs & expect							
1-2	Meets client satisfaction on product							
1-3	Meets pre-stated objectives							
2	**Project Reliability and Durability**							
2-1	Project functionality							
2-2	Integrated with national plans and fit with purpose							
2-3	Free from defects							
3	**Flexible for Future Expansion**							
3-1	Flexible for future expansion							
3-2	Fast rectification of defects							
4	**Serviceability**							
4-1	Meets client satisfaction on service							

Is there any efficiency and effectiveness performance measures needed to be added?

Yes ☐ No ☐ If No please clarify:……..………………………..………………..……

Part4: General Comments:

1.1. What are the limitations of proposed framework?

……………………………………………………………………………………………………

1.2. In your view, how to improve the framework

……………………………………………………………………………………………………

1.3. Is there any Comment?

……………………………………………………………………………………………………

Thank you very much in anticipation of your assistance in this study. And contact details (Mobile: 00966564533315, Fax: 0096626766565 and Email: ssss1422@hotmail.com

Yours sincerely

Saleh Alsulamy

Appendix 9

Final proposed performance measurement framework for municipal construction project in SA