DEVELOPMENT OF A PROJECT DELIVERY MODEL FOR UMGENI WATER: INFRASTRUCTURE PROJECTS

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DECLARATION

This dissertation, except where indicated in the text, is the candidate's own work and has not been submitted in part, or in whole, at any other University or University of Technology.

This research was conducted at the Durban University of Technology under the supervision of Dr A.O. Aiyetan.

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DEDICATION

This thesis is dedication to my mother.

ACKNOWLEDGEMENTS

First and foremost, I thank god in giving me the strength and faith to complete this dissertation.

I acknowledge and thank Dr Aiyetan Ayodeji Olatunji for the effort invested in mentoring me and guiding me throughout this period. This would not have been possible without your direction and supervision.

Special thanks to those that participated in the data gathering process of this study.

Most of all, I would like to thank my two daughters, Tristen and Sahara, for their understanding and consideration during my time of studies

ABSTRACT

Project delivery challenges encountered within the built-environment is a global phenomenon. Factors causing project delivery challenges in construction projects differ between countries, due to various fundamental reasons. The fundamental reasons that could exert an influence on project delivery challenges could extend into numerous causes relating to; the client, project planning, risk management, cost estimating, communication, quality and project management approach.

The construction industry is a key component to the economy, however many construction infrastructure projects are hindered because of project delivery challenges and fail to be delivered successfully. This study aims at identifying lack of performance and its effects on project delivery for construction infrastructure projects and to develop a project delivery model to mitigate or minimise these challenges for Umgeni Water.

A typical Likert Scale using a five-point gauge statistical tool was used for the data analysis. The sample population derives from Umgeni Water employees involved in the planning and implementation of construction infrastructure projects. The sample group consists of qualified and experienced professionals that are project managers, civil engineers, planning engineers, quantity surveyors, servitude administrators and environmental project managers.

Findings that were identified as major project delivery challenges at Umgeni Water include the following;

- Insufficient planning and designing done during the project, communication problems within the project;
- Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach;
- Inadequate participation and contribution by the client during the project;
- Project risks that are poorly identified assessed, mitigated and controlled during the project;
- Unsatisfactory cost estimating resulting in errors and oversights, and
- Oversight of critical quality factors during the project.

Recommendations include: (1) the project team must ensure that ample effort is applied at the beginning of the project, sufficient time must be allocated to successfully complete the planning and designing process and consultants must be selected on their experience rather than low bidding; (2) the following courses / modules are recommended for inclusion in built environment tertiary education programmes for all disciplines. They are: design management, quality management, cost management, operational management, resource management and project management; and (3) the model developed should be adopted for use at Umgeni Water for the delivery of projects to minimise project delivery challenges.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the study

A Guide to the Project Management Body of Knowledge defines a project as a brief undertaking to produce a unique item, service or outcome (Project Management Institute (PMI), 2013). The temporary environment of projects specifies that a project has a certain start and completion. The end is achieved when the project goals have been realised. Barron and Barron (2009), state that a project has a beginning, a middle period and finally moving activities to completion and then achieving completion. Abouhenidi (2014) identifies seven primary characteristics of a project, which are: objective, schedule, complexity, size, resources, organisational structure and control systems.

Barron *et al.* (2009) further explain that the project objectives are achieved by the project manager and the project team. PMI (2013) describes a project manager as an individual who is appointed to steer the project team that is accountable for accomplishing the project purposes and has the necessary abilities to apply understanding, capabilities and tools to project activities in meeting project objectives. Too and Weaver (2014) concurs, that project management together with delivery models assist project managers in achieving project objectives, and that project delivery models bring a project together in a systematic sequence to its final completion. Too *et al.* (2014) identifies a successful project delivery model as one that achieves the following: distinguishes the scope of work, splits the work into logical and understandable sections, builds its principles around project management body of knowledge framework, maps the relationship between different sections or phases within the project, takes into account project complexities, presents itself as being understandable, sufficiently simple and consistent.

Naybour (2016) further states that the benefits of using a project delivery model are: identifies clarity on roles within the project team, enables appropriate decision making, directs accountability to people, outlines a clear path of the project, enforces a common set of policies and processes, facilitates with managing project scope, gives confidence in meeting end-user requirements, allows for risks to be identified and prepared for, enables cost control and cost reliability throughout the project and endorses a happier and more encouraged team. Lynn and Kalay (2015) confirm that a strong image and role classification can deliver direction to a team and can confidently influence the capability to succeed. Harris (2012) validates that better decision making comes from reducing uncertainty. According to McCullough (2019) a person should be held accountable on performance and this kick starts a positive chain reaction within teams and in setting goals. Norman, Brotherton and Fried (2008), affirm that having a clear path of the project even before the work begins is more likely to ensure project success. Supporting policies and procedures benefits project delivery as stated by Naybour (2016).

Newton (2015) adds that no matter the type of project, it is important that it be well-defined as correctly as possible and this must be done well in advance of the work commencing and that managing scope ensures that the project includes everything that is required. Takim and Alam (2009) are of the view that there is a strong the link between project success and the ability to work as a team with the client in meeting client expectations and requirements. van der Merwe (2012) emphasises that by managing project risks proactively and regularly, one gives the project a greater chance of success. In respect to cost management, Odendaal, Vermaak and Toit (2015) comment that cost estimating and cost control during the project life cycle are critical to a project's failure or success. Sgroi (2015) concludes that a team that works well together stays together making the environment happier thus having a positive spin on productivity.

Elbeltagi (2009), states that having an effective project delivery model increases the stakes of implementing and completing a successful project. McDowell (2013) describes a project delivery model as a methodology within a framework. This means that a project delivery model must follow a certain process within the boundaries of an established setting.

A common and well-established project delivery model used today is the project life cycle model. PMI (2013) defines a project life cycle as a set of sequential phases that a project goes through from its beginning to its completion. According to Bhunu (2007), project life cycles can adopt a methodology in accordance to project and organisational requirements and further explains that there are various methodologies such as: waterfall, incremental, spiral, evolutionary and agile. However, these methodologies have to be based on a framework. Within South Africa and globally the project management framework is based on the Project Management Body of Knowledge (PMI) issued by the Project Management Institute. McDowell (2013) confirms that PMI is a framework for project management and PMI (2013) affirms that its framework is recognised globally in the project management environment.

1.2 The problem and its setting

1.2.1 Introduction

Palmer (2016) believes that unsuccessful project delivery of an infrastructure project can derive from many critical factors. There are multiple processes involved, from the very start when the project is still a concept, to the very end when the project is closed out. Barron *et al.* (2009) concur and states that those processes incorporate the co-ordination, management and evaluation of resources, deliverables and outputs all within its project lifecycle. Bhunu (2007) maintains that, "a project is a system of people, equipment, materials and facilities organised and managed to achieve a goal". PMI (2013), verifies that within a project is a system of activities which are linked together to achieve the goal or target. The processes are measured in time, cost, quality and safety in determining if the deliverables are successful. In light of this, Aiyetan, Smallwood and Shakantu (2012), confirm that success in reference to delivery of a building project could be specified as the conclusion of a project within specified time, budget limits, quality standards, and void of accidents.

In light of this, those very same processes cannot be easily identified in the current project management method used in Umgeni Water for infrastructure project delivery. This method is the Umgeni Water Project Management Plan (2012). The organisation commonly refers to this document as the PMP. It is evident that the PMP is inadequate to fulfil the requirements to achieve project success, resulting in this phenomenon. Project Smart Executive Brief (2008), states that the management method must be compatible with the project and the organisation. It further elaborates that making the wrong selection could lead to unfavourable results, with delayed deliverables, unhappy clients, project overruns and cancelled projects. Sawant (2013) states that the project management approach is determined by the characteristics of the project and business setting and that project success is determined by the configuration between the project management method with organisational aims and goals. It can be deduced that the project management approach and model used must be compatible to the project and the organisation in realising project success. Therefore, in order to determine a workable project delivery model for the organisation, this study is aimed at identifying the problems that are currently affecting project delivery of Umgeni Water's infrastructure projects.

1.2.2 The statement of the problem

Cost overrun, delays and poor quality are factors that have a negative effect on project delivery. However, there are also a number of other related problems that further affect project delivery, namely: inadequate participation and contribution by the client, insufficient planning and designing, poor risk management, estimating errors and oversights, communication problems, oversight of critical quality factors and weak project management approaches endorsed by the project manager.

1.2.3 The sub-problems

1.2.3.1 Sub-problem 1: Inadequate participation and contribution by the client during the project.

1.2.3.2 Sub-problem 2: Insufficient planning and designing done during the project.

1.2.3.3 Sub-problem 3: Project risks poorly identified, assessed, mitigated and controlled during the project.

1.2.3.4 Sub-problem 4: Estimating errors and oversights made during the project.

1.2.3.5 Sub-problem 5: Communication problems within the project.

1.2.3.6 Sub-problem 6: Oversight of critical quality factors in the project.

1.2.3.7 Sub-problem 7: Weak project management approach endorsed and implemented by the project manager.

1.3 Research questions

The following are the main research questions deduced from the research problems and objectives:

1.3.1 What needs to be considered to improve client participation and contribution during the project?

1.3.2 What is required and needs to be implemented to achieve sufficient planning and designing?

1.3.3 Does risk identification, assessment, mitigation, controlling and monitoring assist in addressing project risks?

1.3.4 What needs to be considered to maintain reliable estimating?

1.3.5 Do communication accuracy, procedures, barriers, understanding, timelines and completeness have any influence regarding communication problems within a project?

1.3.6 What measures can be applied to improve on critical quality factors in the project?

1.3.7 What challenges are hindering the implementation of a good project management approach?

The results of these research questions would make it possible to define and test the proposed model to be developed for Umgeni Water.

1.4 The aim and objectives of the study

1.4.1 Aim

To assess lack of performance and its effects on project delivery for construction infrastructure projects with the view to developing a model to mitigate this for Umgeni Water.

1.4.2 Objectives

The first objective is to identify and assess lack of performance and its effects on project delivery for construction infrastructure projects. With the following sub-objectives:

1.4.3 Sub-objectives

1.4.3.1 Sub-objective 1: To identify and assess factors affecting inadequate participation and contribution by the client during the project.

1.4.3.2 Sub-objective 2: To find and assess factors affecting insufficient planning and designing done during the project.

1.4.3.3 Sub-objective 3: To identify and evaluate issues contributing to project risks that are poorly identified, assessed, mitigated and controlled during the project.

1.4.3.4 Sub-objective 4: To identify and assess factors that contributes to estimating errors and oversights.

1.4.3.5 Sub-objective 5: To detect and gauge reasons contributing to communication problems within the project.

1.4.3.6 Sub-objective 6: To identify and assess factors affecting oversights of critical quality factors in the project.

1.4.3.7 Sub-problem 7: To identify and evaluate challenges which are hindering the implementation of a good project management approach.

The second objective is to attempt to develop a project delivery model for Umgeni Water's infrastructure project.

1.5 The hypotheses

1.5.1 Hypothesis 1: Inadequate participation and contribution by the client significantly effects project delivery.

1.5.2 Hypothesis 2: Adequate effort that is channelled into the planning and designing significantly affects project delivery.

1.5.3 Hypothesis 3: Inadequate management of project risks significantly effects project delivery.

1.5.4 Hypothesis 4: Adequate estimating performed during the project significantly affects project delivery.

1.5.5 Hypothesis 5: Inadequate communication executed during the project significantly affects project delivery.

1.5.6 Hypothesis 6: Oversight of critical quality factors significantly affects project delivery.

1.5.7 Hypothesis 7: Adequate project management approach that is endorsed during a project significantly affects project delivery.

1.6 Significance of the study

The construction industry is under heavy scrutiny because projects are not being delivered within time, budget and quality. In respect to time, Kikwasi (2012) explains that delays and disruptions are among the encounters met when implementing construction projects. In relation to cost, Odendaal *et al.* (2015), emphasise that cost valuation and cost supervision over the life cycle of a project are vital parts of a project and essential to its realisation. Regarding quality, Jha and Lyer (2007), confirm that management plays a significant part in reaching the desired quality and Hoonakker, Carayon and Loushine (2010) further state that more emphasis is required into implementation of quality management in the built environment.

This scrutiny is even greater upon state owned entities or government enterprises, such as Umgeni Water when it comes to project delivery. Gilbert, S. (2013), states that, over and above project delivery, these institutes in the construction sector have an obligation to include the objectives of sustainable development and must thus incorporate their project management models within the sustainability framework.

An interesting study undertaken by Campton (2016), compiling a SWOT analysis of the construction sector in South Africa found that the market capitalisation within the construction sector went down by 38% to the previous study done in 2014 and actually decreased a further 9% in the next four months after. The study further found that skill shortage places extensive strain on project delivery.

Projects undertaken by state owned entities have a direct impact on living standards and basic human requirements. Ahsan and Gunawan (2010), state that projects explicitly planned for social and economic needs are different from commercial or industrial projects and their objective is to improve living standards, providing basic human rights and development of basic and social infrastructure. Furthermore, the South African National Treasury Standard for Infrastructure Procurement and Delivery Management (SIPDM) (National Treasury SIPDM, 2015), validates that there is an association between socio economic development, growth and infrastructure delivery and that the delivery of basic services to the public is influenced as much by the people and the institutions delivering the services as by the physical works they use. National Treasury SIPDM (2015) assessed a study done by government during 2002 to establish gaps and issues in the delivery of infrastructure projects within South Africa and found that there was under performance in successful and systematic delivery systems.

This confirms the need for the study to pursue strategies that will improve project and service delivery in its totality, in compliance with National Treasury's mandate set out for state owned enterprises. Furthermore, the researcher seeks to develop an approach that will be beneficial to Umgeni Water projects that ultimately filter down to providing better service delivery to the organisation's service areas.

1.7 Theoretical framework

Implementing a workable project delivery model or strategy that focuses on achieving the objectives of a project is essential for project success, however researchers (Okoye, Ngwu, and Ugochukwu 2015; Hinze 2004; Nunnally 2004; Ahsan and Gunawan 2010; Chan, Scott and Chan 2004; Kikwasi 2012 and Kujala, Brady and Putila 2014) have identified the challenges faced by project managers and project teams to deliver successful projects. These challenges extended to inadequate participation and contribution by the client, insufficient planning and designing, project risks poorly managed, estimating errors and oversights, communication problems, oversight of critical quality and weak project management approach endorsed and implemented by the project manager.

This study intended to assess these project delivery challenges including causes that impact on those challenges with the view of developing a model to improve on project success in future construction infrastructure projects undertaken by Umgeni Water.

The construction industry is ever evolving in infrastructure development. Project delivery models need to adapt in accordance with meeting these challenges of current times and steps must be taken to address these challenges.

This study also looks at the following theories:

- The Management Theory – Maslow hierarchy of needs model
- The Systems Theory – systems thinking model

In accordance to Maslow's theory, when a human being climbs the levels of the hierarchy having achieved the needs in the hierarchy, one may ultimately achieve self-actualization (Maslow, 1954). Late in life, Maslow came to conclude that self-actualization was not an automatic outcome of satisfying the other human needs (Maslow, 1954). The study analyses Maslow's theory of basic needs in relation to project management by means of interpreting each level of hierarchy. Hence, starting from the bottom-most level and moving up.

Dye, Mills and Weatherbee (2005) state Maslow's hierarchy of needs is ever-present in management teachings and philosophies. It also significantly replicates actualities in management. The hierarchy theory has been enforced and used into a wide assortment of academic or everyday application and the range of the hierarchy's use covers a remarkable variety of topics. Martin and Joomis (2007) further explain that the theory identifies seven categories designed in a pyramid. The theory's intention is to meet the needs at the lower levels of the pyramid and work its way up. Martin *et al.* (2007) further explain that Maslow theorised that all people fit within these seven needs; these needs are: physiological, safety and security, love and belongingness, self-worth and self-esteem, need to know and understand, aesthetic needs and self-actualisation.

Another theory of this study is the general systems theory (GST). The GST was founded by L. Bertalanffy and involves an interdisciplinary practice that describes systems with interacting components (Bertalanffy, 1933). Additionally, Johnson, Kast and Rosenzweig (1964), explain that General systems theory is established around developing a systematic framework for defining common relations of the empirical world. An extensive spectrum of possible successes for such a framework is apparent. Present similarities in the theoretical construction of numerous disciplines can be singled out. Models can be designed and can be applied to numerous fields of study.

According to Jackson (2003), the systems theory and its models developed from the 1970's to overcome flaws in systems thinking making itself more suitable in problem circumstances. When numerous philosophies and methods are collected in a system way and are used to improve a problematic situation it is known as a systems approach. The systems approach is now respected as forming a significant impact to defining a wider range of difficult problems. Looking at four relative systems approaches, Type A: aims to improve goal seeking and feasibility, Type B: dedicated to investigating and make clear the requirements of the stakeholders and their interests, Type C: seeks to enforce unbiased attributes in the systems policy and in the concerns that followed and Type D: targets in providing variety and diversity in problem solving. A different outlook to a project is presented in respect of the systems theory and the project uses the systems view of dividing the project down into phases as elaborated by Bhunu (2007).

1.8 Conceptual framework

The study recognises Maslow's theory of basic needs as an important basis to determine the requirements for a project and will be vital in this research for the development of a project delivery model for Umgeni Water's infrastructure projects. The theory will be useful in this research by providing insight into project interpretation relative to the characteristics of the theory. Viewing a project in pyramid form to display project requirements in hierarchy sequence will prove valuable to this study. The theory will also contribute awareness in satisfying requirements at each hierarchy level in order to progress forward and ultimately to completion, (Orfarno 2013; Hillson 2008; and Anantatmula 2010).

The underpinning theory in this study is the General Systems Theory. This theory is extremely important and will prove useful to this study in providing a framework in developing a project delivery model. A systems approach to a project allows for the breakdown of systems, within a project, into subsystems, and provides the methods and tools which will affect the system, hence considering each systems requirement to proceed. Therefore the study looks into the concepts of the project life cycle in relation to the general systems theory, in the effort of developing a project delivery model (Bunu, 2007).

1.9 Structure of the thesis

A thorough literature review follows the identification and approval of the research problem. Various documents and relevant information are collected. The collected information along with data retrieved from questionnaire respondents are discussed and analysed. The results are interpreted and based on which conclusions and recommendations are made. In general the research thesis is structured into the following seven major chapters:

Chapter 1: Introduction
The introductory chapter provides background information about the problem of project cost overrun, time delay and poor project delivery in South Africa and globally.

Chapter 2: Literature Review - Review of Related Literature
The purpose of this chapter is to discuss the participation of the South African Government together with State Owned Entities responsible for providing infrastructure projects in South Africa.

Chapter 3: Literature Review - Further Review of Literature

The purpose of this chapter is to identify the factors, as exhaustively as possible, that cause delays and cost overrun in construction projects by looking into previous studies made on the subject.

Chapter 4: Research Design and Methodology

The forth chapter discuss the design or the approach adopted in this research for obtaining the information needed to structure the research questionnaire, to collect data, and methods of analysis to achieve reliable results on the study area.

Chapter 5: Data Presentation and Discussion

The fifth chapter provides explanations of the issues related to the way the questionnaires are distributed, responses are retrieved and subsequent analysis of the data collected through the questionnaire survey from professionals working for Umgeni Water who are involved in infrastructure projects in KwaZulu-Natal, South Africa. In addition the main findings are properly described and reported. This chapter also discusses on the results of data analyses and the interpretation of results obtained from the survey under the respective major categories of delay causes.

Chapter 6: Development of a Project Delivery Model

The purpose of this chapter is to discuss the project delivery flowchart model developed including validation of the model that was undertaken.

Chapter 7: Conclusions and Recommendations

Chapter 7 summarizes the whole discussion presented in the report and concisely reflects on the origin of the survey and how the research is designed and conducted, followed by highlights of the results of the survey and concludes that important recommendations that emanate from the main findings of the research are listed.

1.10 Chapter summary

This chapter outlines the background of the study focusing on the importance of implementing a suitable project delivery model when executing projects. The chapter also identifies the main research problems as cost overruns, delays and poor quality which built the framework in establishing the research questions. The above chapter acknowledged the research aims and objectives that will be required during the study. Classification of sub-objectives allowed for the understanding to develop the research hypothesis. The significance of the study was also concluded in detail outlining the need for the study to purse strategies that will improve project service deliver in the built environment. The chapter also focuses on the importance of the theoretical and conceptual framework derived for the study. Lastly the chapter outlines the structure in which the study will be presented.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

This chapter discusses the participation of the South African Government together with State Owned Entities responsible for providing infrastructure projects in South Africa.

2.1 Introduction

Fedderke and Garlick (2008) state that the association between infrastructure and financial development has in current years become a hot topic and infrastructure has been identified as the sixth most significant limitation to progress in South Africa. Fourie (2006) adds that the South African government has begun to focus on infrastructure investment. Fourie (2006) further states that to recognise the most essential zones for infrastructure investment, consideration of the past and present infrastructure developments in South Africa needs to be noted. Due to huge investments throughout the 1960's and 1970's, the adequacy of infrastructure in South Africa was considered adequate and efficient. Fourie (2006) further explains that since 1994, the government increased the availability and access to basic services to many South Africans. Marais (2013) confirms that social improvements were being made and access to basic human needs, were broadened as infrastructure development increased. This is supported by researchers (Bogetic and Fedderke 2006; Calderon and Servon 2004 and Kularatne 2006) have identified challenges within South Africa's infrastructure performance together with the effects of infrastructure development including infrastructure impacts on social and economic growth.

Infrastructure projects in the public sector are also increasing in size, technology and complexity to fulfil the needs of a growing South African public. The public sector can be divided into state owned companies, local government, public entities, provincial departments, national departments and public-private partnerships. Within these divisions between 1998/99 and 2014/15, the public sector spent more than R2.2 trillion on infrastructure as indicated in National Treasury Budget Review (2016).

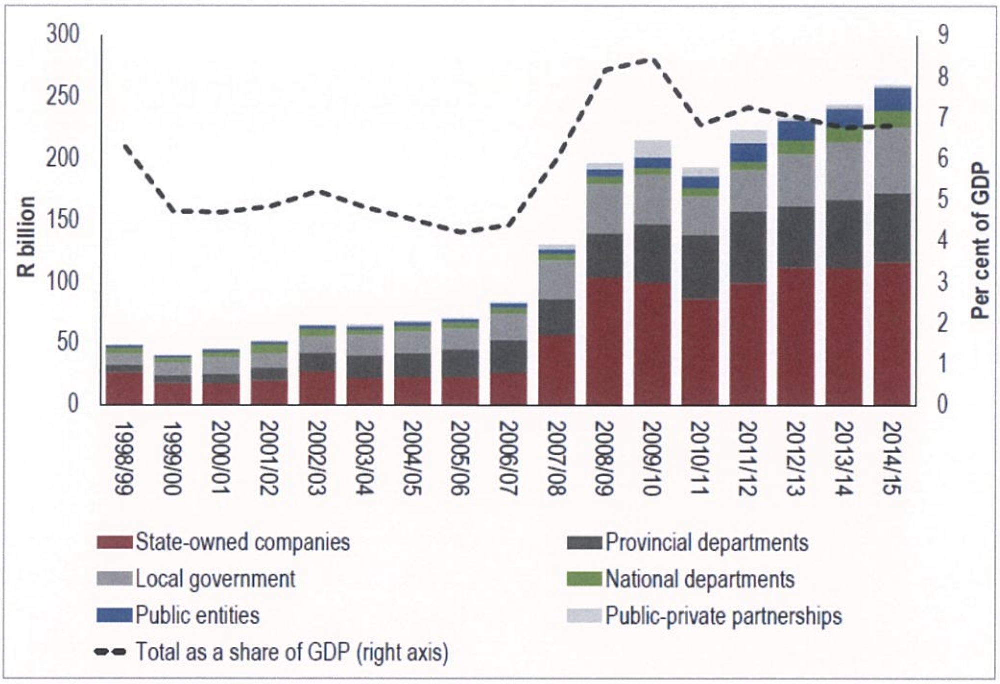


Figure 2.1: Public sector infrastructure spending 1998/99 – 2014/15 (National Treasury Budget Review, 2016)

Expenditure each year increased from R48.8 billion in 1998/99 to R259.7 billion in 2014/15, a yearly increase of 7.5%. State owned establishments have been the major contributors to public sector infrastructure spending.

Table 2.1: Public sector infrastructure expenditure and estimates: 2012/13 – 2018/19 (National Treasury Budget Review, 2016)

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	MTEF
R billion		Outcomes			Estimates			Total
Energy	75.2	69.6	67.8	69.7	50.8	49.9	79.9	**180.7**
Water and sanitation	22.5	25.8	29.5	35.2	43.1	43.1	45.9	**132.1**
Transport and logistics	69.5	76.4	90.9	99.5	96.2	105.3	90.0	**291.6**
Other economic services	9.4	13.5	13.0	16.6	17.2	14.4	14.5	**46.2**
Health	9.7	10.0	7.8	9.2	8.8	9.4	9.8	**28.1**
Education	11.3	13.7	15.4	17.4	17.7	17.8	18.4	**53.9**
Human settlements[1]	15.6	17.0	17.1	18.3	18.3	21.1	22.3	**61.6**
Other social services	13.7	12.9	13.1	16.6	16.0	16.2	17.0	**49.2**
Administration services[2]	6.3	5.0	5.2	8.0	6.6	7.6	7.8	**22.0**
Total	**233.3**	**243.9**	**259.9**	**290.4**	**274.8**	**284.9**	**305.8**	**865.4**
National departments	11.4	11.9	13.5	17.3	19.6	16.4	18.3	**54.3**
Provincial departments	50.3	55.2	56.4	62.7	63.6	69.8	72.9	**206.3**
Local government	41.7	47.1	53.2	56.6	58.2	57.5	59.9	**175.6**
Public entities[3]	16.1	15.4	19.2	28.7	26.2	29.4	30.4	**86.0**
Public-private partnerships	2.6	3.0	1.8	1.7	1.9	2.0	2.1	**6.1**
State-owned companies[3]	111.3	111.2	115.8	123.4	105.2	109.7	122.2	**337.0**
Total	**233.3**	**243.9**	**259.9**	**290.4**	**274.8**	**284.9**	**305.8**	**865.4**

Folifac (2007), reports that prior to 1994 water supply obligation was split with no singular government department accountable for its management. This caused inconsistent levels of service delivery within South Africa. After 1994 the government saw the critical need for new policies for the county which included changes in the water sector. The department of water and sanitation is currently the third largest contributor to public sector infrastructure expenditure, with an estimated value of R132.1 billion between the period 2012/13 to 2018/19. This contribution by the department provides an indication of water infrastructures importance. According to the National Treasury Budget Review (2016), the department of water and sanitation will remain to advance and rehabilitate water projects, comprising of: pipelines, reservoirs, water treatment works, waste water treatment works, pump stations and dams. Ruiters (2013), states that several developing nations including South Africa require water infrastructure to better the lives of their people and to improve their quality of life. According to Petterson (2016), water infrastructure is still one of South Africa's most important requirements and 20% of South Africans live without clean drinkable water. Regrettably Naidoo (2016) reported that in South Africa the delivery of large scale water infrastructure projects decreased by 30% from 2015 to 2016. It is becoming increasingly apparent that currently and in the future, water infrastructure project implementation will be at the forefront of the construction industry, which will require, the need for sound project implementation strategies and models to achieve successful project delivery.

2.2 The South African National Treasury's Infrastructure Procurement and Delivery Management

The South African National Treasury developed and implemented the National Treasury Standard for Infrastructure Procurement and Delivery Management, commonly referred to as SIPDM which was published in November 2015. The aim of the SIPDM is to establish control mechanisms for the planning, designing and construction of infrastructure projects. The objective of the SIPDM is to achieve value for money accompanied with quality service delivery where value for money is viewed as the best use of resources to realise the intended result or outcome. The SIPDM was developed to warrant that the best probable outcomes are achieved from the money spent or greatest benefits are originated from the resources available. National Treasury ensured that the development of the SIPDM forms a mutual approach to project delivery across all state owned enterprises in all industries.

Based on previous studies, the National Treasury found that many State owned entities in South Africa are failing to address project delivery challenges and further went on to develop a model within the SIPDM framework known as the Infrastructure Delivery Management System (IDMS) that focuses on applying best practise project delivery methods for infrastructure management within the government sector and state owned entities. (National Treasury SIPDM, 2015) Government's Infrastructure Delivery Management System (IDMS) comprises of a three core system, as shown in Figure 2.2.

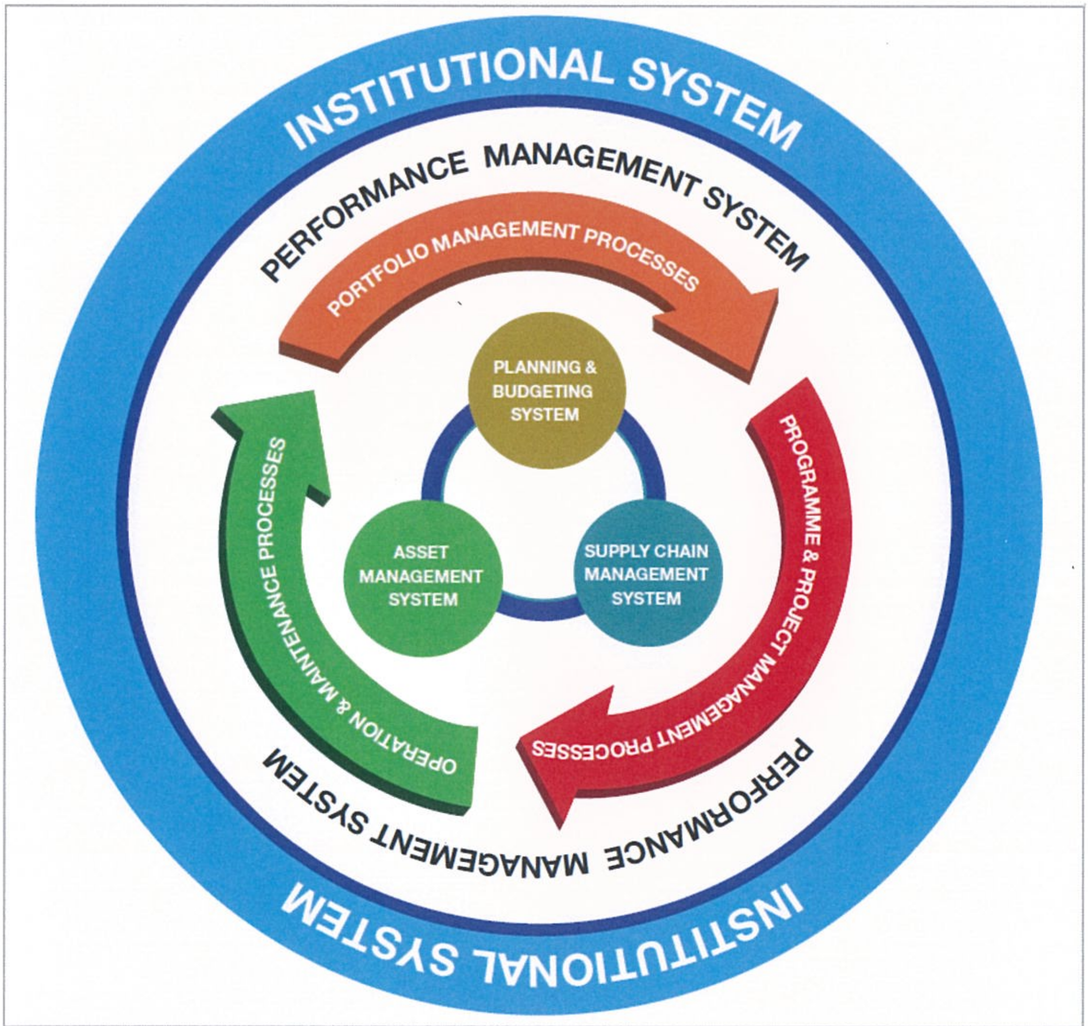


Figure 2.2: IDMS Three Core System (National Treasury, SIPDM, 2015)

Figure 2.2, illustrates namely:

- Planning and budgeting system
- Supply chain management system
- Asset management system

These core systems have a forward and backward relationship. These three systems are found within portfolio, programme and project management, and operation and maintenance processes. Jointly these processes and systems, together with a performance management system, establish the institutional system for infrastructure delivery.

National Treasury's IDMS model addresses a projects life cycle with the inclusion of controlled gate reviews, strategically placed that monitors progress, quality and completeness, as illustrated in Figure 2.3.

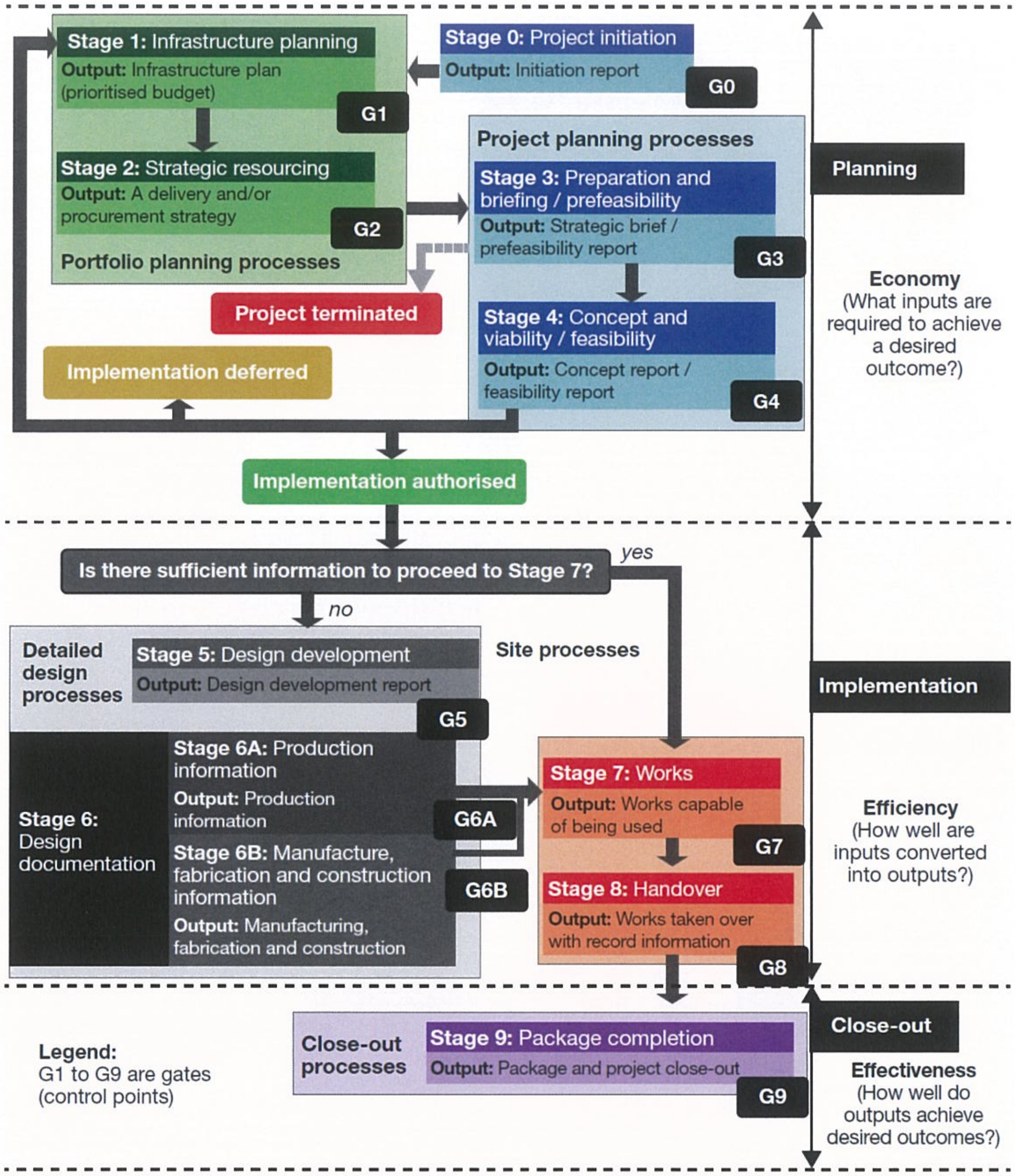


Figure 2.3: Project Life Cycle 9 Stage and Gate Review Control Framework for Infrastructure Delivery Management (National Treasury, SIPDM, 2015)

Figure 2.3, graphically represents the flowchart of national treasury's IDMS project life cycle. The flowchart identifies the various stages from stage 1 to stage 9 and gate reviews after completion of each stage. The diagram also indicates which stages fall within the projects planning, implementation and close-out phases.

National Treasury developed the IDMS model based on best practise project life cycle (PLP) models used locally and internationally as shown in Table 2.2. The IDMS PLP model works around a 9 stage PLP with 9 gate reviews. The objective of the 9 stage IDMS PLP model is to manage and control projects in a consistent, systematic and auditable manner.

Table 2.2: 9 Stage Project Life Cycle (National Treasury, SIPDM, 2015)

Stage			End-of-stage deliverable
No	Name		
0	Project initiation		An initiation report which outlines the high-level business case together with the estimated project cost and proposed schedule for a single project or a group of projects having a similar high-level scope.
1	Infrastructure planning		An infrastructure plan which identifies and prioritises projects and packages against a forecasted budget over a period of at least five years.
2	Strategic resourcing		A delivery and/or procurement strategy which, for a portfolio of projects, identifies the delivery strategy in respect of each project or package and, where needs are met through own procurement system, a procurement strategy.
3	Prefeasibility		A prefeasibility report which determines whether or not it is worthwhile to proceed to the feasibility stage.
	Preparation and briefing		A strategic brief which defines project objectives, needs, acceptance criteria and client priorities and aspirations, and which sets out the basis for the development of the concept report for one or more packages.
4	Feasibility		A feasibility report which presents sufficient information to determine whether or not the project should be implemented.
	Concept and viability		A concept report which establishes the detailed brief, scope, scale, form and control budget, and sets out the integrated concept for one or more packages.
5	Design development		A design development report which develops in detail the approved concept to finalise the design and definition criteria, sets out the integrated developed design, and contains the cost plan and schedule for one or more packages.
6	Design documentation	6A Production information	Production information which provides the detailing, performance definition, specification, sizing and positioning of all systems and components enabling either construction (where the constructor is able to build directly from the information prepared) or the production of manufacturing and installation information for construction.
		6B Manufacture, fabrication and construction information	Manufacture, fabrication and construction information produced by or on behalf of the constructor, based on the production information provided for a package which enables manufacture, fabrication or construction to take place.
7	Works		Completed works which are capable of being occupied or used.
8	Handover		Works which have been taken over by the user or owner complete with record information.
9	Package completion		Works with notified defects corrected, final account settled and the close-out report issued.

The inclusion of control gates is a restraint or review point within the PLP process where:

- Decisions are taken before proceeding.
- Confirmation of quality and conformance is accessed.
- If necessary changes and corrective action can be addressed.

The complete SIPDM together with its IDMS model was implemented by government between the period 1 July 2016 and 1 July 2017, which affects state owned enterprises that are subject to the Public Finance Management Act (PFMA).

The Council for the Built Environment (CBE) that manages the six built environment professional councils in the fields of Architecture, Engineering, Landscape Architects, Project and Construction Management and Quantity Surveying, states that the introduction of the SIPDM in support of the IDMS introduces a good framework within which infrastructure projects can be obtained, provided and maintained and will assist in minimising project delivery challenges. The CBE further comments that government has earmarked R900 billion to be spent on infrastructure development and the use of the SIPDM will ensure value for money, which will filter down into economic growth and job creation (National Treasury SIPDM, 2015).

The Construction Industry Development Board (CIDB) is liable for supporting government in giving essential social and economic projects. At current, construction projects within the public sector are showing shortfalls to Government. Unreliable supplier procurement procedures undertaken by incompetent public sector departments have emphasised the necessity to create and endorse further competence and escalate the level of regulation of procedures and practices. Under-spending of capital expenditure is a continuing matter, mainly at government level. At the same time, crucial state-owned entities have also regularly not achieving projected expenditure targets. For every R1 billion that is not spent by State Owed Entities, the chance to create 8000 full-time jobs are lost annually. In light of this, the CIDB welcomes the SIPDM and has worked closely with National Treasury in the development of the IDMS. The CIDB comments that addressing the three core system in IDMS will strengthen and enhance infrastructure delivery in South Africa (National Treasury SIPDM, 2015).

2.3 The South African Association of Water Utilities

The South African Association of Water Utilities (SAAWU), which was previously known as the South African Association of Water Boards, is a Section 21 company established in March 2001 to represent, endorse, co-ordinate and manage the interests of state owned entities responsible for the delivery of water services in South Africa (Department of Water and Sanitation, 2016).

SAAWU is affiliated with the following South African state owned water utilities companies:

2.3.1 Bloem Water

Bloem Water was born in 1991 to work the Bloemfontein/Caledon Water Scheme, created to deliver water to the zones of Dewetsdorp, Bloemfontein, Botshabelo, Bloemspruit, and Bainsvlei. The company's board reports directly to the Minister of Water and Sanitation. The Southern Free State, townships such as Bethulie and Philippolis were included in the services of Bloem Water in 1995. Thaba 'Nchu region is a district with 42 villages; it is situated 65 km east of Bloemfontein and was also added to spread the service regions of the company. Excelsior, situated in the Eastern Free State, was the last zone to be added to Bloem Water's mandate. Currently, Bloem Water supplies a population greater than 1.2 million, whereby services are offered to the following Municipalities; Kopanong Local Municipality, Naledi Local Municipality, Mantsopa Local Municipality and Mangaung Metro Municipality. The 3 key districts of Modder River, Caledon River and Orange River are functioning with a total of 7 water treatment works. The company's head office is situated in Brandkop which is situated in Bloemfontein (Bloem Water, 2017).

2.3.2 Magalies Water

Magalies Water is a state owned entity. According to statistics documented during the previously done censor, the company serves 90 municipalities with an estimated 24 million individuals, equating to nearly half of the population of South Africa. Magalies Water delivers quality bulk water and secondary services directly to municipalities, mines and other industries which in turn benefits growth of the economy and advance the quality of lives. Magalies Water works in a region of 42 000km2 between 3 provinces being Limpopo, North West, Gauteng and 2 catchments being the Pienaars and Crocodile Rivers (Magalies Water, 2015).

2.3.3 Lepelle Northern Water

Lepelle's mandate is to provide water services to other water service institutions within its region of service. The organisation presently operates 20 water treatment schemes and 5 waste waterworks, within its three operating regions, namely, the

Capricorn, Sekhukhune, Mopani and Waterberg areas in the province of Limpopo. The company's vision is to provide exceptional regional water and sanitation services solutions within its mission statement of bringing cost effective, reasonable, sustainable and quality water and sanitation services to its customers (Lepelle Northern Water, 2013).

2.3.4 Rand Water

Rand Water's supply system embraces pipeline over 3 056 kilometres, serving 58 reservoirs. Its customers are made up of metropolitan and local municipalities, industries including mines and it delivers, around 3 653 million litres of water daily to its customers. From the two key purification plants pump, bulk water is dispersed via the four booster pump station and the VVS sub-system, through a total network of 3500km bulk pipelines and 60 storage reservoirs. 95% of Rand Water's water supply demand is used by their municipal customers, with direct supply to mines making the balance. Rand Water's customers are; Metropolitan Municipal Councils - City of Joburg, City of Ekurhuleni, City of Tshwane; 13 Municipalities - Emfuleni, Govan Mbeki, Lesedi, Madibeng, Merafong, Metsimaholo, Midvaal, Mogale City, Ngwathe, Randwest, Rustenburg, Thembisile Hani, Victor Khanye; Royal Bafokeng Administration; 40 Mines; and 926 industries and direct customers (Rand Water, 2016).

2.3.5 Umgeni Water

Umgeni Water is a public entity that was established in the early 1970's to provide water services to municipalities within its operating areas. The company runs in alignment with the Water Services Act and the Public Finance Management Act amongst others. Umgeni Water's mandate is to supply its customers with safe portable water in the right quantities, at the right time and at the right price. Umgeni Water is the leading bulk water supplier in KwaZulu-Natal and has evolved into the second largest water utility in South Africa, supplying over 453 million cubic litres of bulk potable water annually and producing revenue from their six customers; eThekwini Metropolitan Municipality, iLembe District Municipality, Ugu District Municipality, Harry Gwala District Municipality, uMgungundlovu District Municipality and Msunduzi Local Municipality, which are demarcated in Figure 2.4.

Figure 2.4: Umgeni Water's area of operation (Umgeni, 2016)

To achieve this mandate and in order to meet the demands of their customers, the organisation is required to build the following infrastructure projects; dams, abstraction works, pump stations, pipelines, reservoir's, raw water treatment works and waste water treatment works. In order to meet these construction obligations, the organisation put together two key departments, these being; planning services and the project management office. In order for these two departments to function at an optimal level, they are supported by the environmental department and land servitudes department within the organisation (Umgeni Water, 2016).

2.4 Insight into Umgeni Water

2.4.1 Umgeni Water's Planning Services Department

Planning services monitors and assesses the water demand criteria within Umgeni Water's operating areas and forecasts these estimated predictions over a 30year timeline. Once the water demand need falls within a 5year requirement, the department anticipates the location, capacity, type and size of the required water infrastructure needed to achieve the demand criteria. This ultimately kicks-starts an infrastructure project within Umgeni Water and planning services are responsible for the prefeasibility and feasibility studies for an anticipated project (Umgeni Water, 2017).

Planning services will undertake the prefeasibility study to consider various options for the implementation of the project, with a focus on ensuring that the most fit-for-purpose option or solution is not overlooked. Technical, environmental, desktop geotechnical and social issues are considered to exclude those alternatives with fatal flaws and to narrow down the viable options to a limited shortlist for further consideration (Umgeni Water, 2017).

Once the project moves into the feasibility stage, planning services will ensure that the preferred alternatives developed under the prefeasibility stage, and through further study and investigation refine the engineering and costing to a point where a single accepted project or solution can be identified, having been confirmed through a set of clearly defined parameters. Planning services main purpose of the feasibility study, aside from selecting the above solution, is to determine whether it is feasible to proceed to designing (Umgeni Water, 2017).

2.4.2 Umgeni Water's Project Management Department (Project Office)

The project management office was established within Umgeni Water in 2007 for the specific purpose of implementing and delivering water infrastructure projects. The department focuses on project management based on the PMI framework. The department comprises of the following professional members; project managers, cost engineers, quantity surveyors, schedulers, contractual managers and document controllers. The project management office and planning services interact very closely as projects move from planning to implementation, therefore once a project completes the feasibility phase in the planning department and is deemed to be feasible to continue further, project management office will be the responsible department moving the project forward from that point on until completion (Umgeni Water, 2016).

The department will take the accepted concept or project and thoroughly develop initial engineering designs, specifications, performance parameters etc. to create a comprehensive description of the project and packages for tender and construction purposes, including updated cost estimates and schedules. The project management office will ensure that once the initial design has been confirmed and approved, the final detailed engineering, specifications, tender documents and other information are developed, as required for the construction tender(Umgeni Water, 2016).

The department will be in close-contact with supply chain management during the tender process up until tender award. After the tender process is complete the project management department will push the project into the construction works phase. The works stage covers the construction of the project including testing and snagging, and is completed once the works stage is signed-off in agreement with the contract being utilised. This also includes the handing-over of all documentation such as operating and maintenance manuals, record drawings, warranties, spares schedules, etc. that form the final record of the project once the works phase is complete(Umgeni Water, 2016).

The final responsibility of the project management department will be to be formally and systematically close out at the end of the defects liability period and correction of any defects (Umgeni Water, 2016).

2.4.3 The project management philosophy within Umgeni Water

Umgeni Water's philosophy to project delivery is aimed at meeting the end users' needs by focusing on superior end product value, quality work, sustainable solutions and safety at the workplace, providing front end loading of the project definition and development of activities with rigorous gate reviews between project stages, driving a principle of ownership across functions throughout the project lifecycle, consistent project delivery and outcome focused approach and reporting through all the stages of the project, timely communications with all project stakeholders, timely involvement of various functions that underpin the project lifecycle process, applying only authorised scope, time and costs changes, standardised and streamlined reporting both internally and to stakeholders. (Umgeni Water, 2016).

Trying to meet these needs, the organisation implemented the Umgeni Water Project Management Plan (2012). The company generally refers to this document as the PMP.

2.4.5 The Umgeni Water Project Management Plan

The aim of the Project Management Plan (PMP) is to establish the framework for the execution of the project and introduce the procedures which are in addition to this PMP, required to run the project. It confirms a high level outlook of the project and its key elements. The Umgeni Water PMP methodologies are based around the PMI framework and its implementation strategy is based on a 4 stage project life cycle process, namely; initiate, plan and design, execute and close (Umgeni Water, 2012).

Umgeni Water has identified and accepted a miss-match between the PMP and the operating functions and procedures of departments within the organisation. In light of this, the organisation reviewed its infrastructure project processes from concept to completion in order to identify inefficiencies and shortcomings (Umgeni Water, 2013).

2.5 Chapter summary

The South African Government allocates Billons of Rands each year towards water infrastructure projects within South Africa. These funds are allocated and intrusted to State Owned Entities (SoE's) who are required to upgrade or construct water infrastructure projects for the South African public. Due to challenges encountered during the project life cycle, projects are failing to be delivered on time and within cost. Therefore, The South African National Treasury indorsed and rolled out the Infrastructure Procurement and Delivery Management System to assist State Owned Entities in delivering projects successfully. There are six SoE's under the South African Association of Water Utilities, funded by the South African Government to ensure that water infrastructure projects are implemented. Umgeni Water forms part of the six water boards and is the largest in KwaZulu-Natal.

CHAPTER THREE: FURTHER REVIEW OF LITERATURE

This chapter completes the literature review, focusing on literature with respect to project delivery challenges together with causes and impacts.

3.1 Client participation and contribution

Kulatunga, Amaratunga and Haigh (2008) researched the role of the client in the construction industry and introduces that the client or end-user are nowadays called upon to co-ordinate and navigate the construction proceedings. Kulatunga *et al.* (2008) also state that clients have to be more interactive with the project team and should be hands-on relating to contribution and participation. Kulatunga *et al.* (2008) conclude that the client role and participation should be like a manager and that the client is required to be part of the project delivery team. The authors further state that the understanding brought by the client regarding internal processes, policies and procedures coupled with the gift to lay down the right questions, aided the design team to steer the project in the right direction. Trigunarsyah and Al-Solaiman (2016) describe the major influence that the client has on the project, which determines the project's success or failure and that the clients' participation during the project life cycle provides the fundamental link to the project. Chigangacha (2016) states that the impact of client participation, particularly during many of the most key project events has led to problems experienced on projects; some of which hinder success.

Project owners, clients and end-users seldom have the correct level of experience, knowledge and understanding to fulfil their responsibilities adequately as project stakeholders. According to Chan, Scott and Chan (2004) these factors could be measured as client understanding of design drawings and specifications, awareness of the project processes, authoritative decision making, decisions made in a pressure situation, contribution of ideas, capabilities of understanding project constraints and productiveness of briefings to the project team.

3.1.1 Client understanding of design drawings and specifications

In recent times designing and specifications have become more complex with increased information to meet the demands of an evolving construction industry. This has put strain on the capabilities of clients to fully understand the construction data before them. Engstrom and Hedgren (2012) state that when a client is placed in front of huge amounts of complex construction information, the client tends to show lack of understanding, non-agreement, different views, lack of transparency and ignorance which has a negative impact on project delivery.

3.1.2 Client awareness of project processes

There are several tasks and processes that take place within a project and are typically scheduled out to ensure maximum control and monitoring. de Blois, Herazo-Cueto, Latunova, and Lizarralde (2011) point out that an important factor that can be recognised as a cause of project failure is shifting and moving project processes during the project life cycle. de Blois *et al.* (2011) further state that the client often does this accidentally and without thinking of the consequences due to lack of understanding.

3.1.3 Authoritative decision making by the client

Construction projects need quick, fast and direct decision making in order to avoid delays. Aiyetan (2010) identifies that when a client takes long to assert a decision, normally has a knock-on effect on project delays. Aiyetan (2010) further highlights that when clients avoid making a decision due to it being further consulted with others, also negatively affect the project. Martin, Burrows and Pegg (2006) state that the most common insufficiencies when it comes to poor project delivery stems from clients weak decision making and briefings.

3.1.4 Decisions made by the client in a pressure situation

A construction project is a highly pressurised environment and the outcome of making the incorrect decision in a pressure situation could have undesirable results on the project. Arabiat, Edum-Fotwe and McCaffer (2007) confirm that if clients don't fully understand the impact of their decisions and when taking a decision if thought is given to whether the risk can be efficiently managed or whether the decision will cause further risks down the line.

3.1.5 Contribution of ideas by the client

On a project the client's needs and requirements have to be fulfilled. Boyd and Chinyio (2008) state that clients find it difficult to express what they want and Aiyetan (2010) highlights that the capability of the client to give ideas during the project may result in fewer changes and errors. Phua (2006) states project performance can be attributed to good communication by the client with project stakeholders. Aiyetan (2010) asserts that the client's ability to contribute concepts during the project has a bearing on the outcome of the project.

3.1.6 Clients capabilities of understanding project constraints

Shenoy (2016) identifies that a project has 6 constraints, namely, risk, scope, time, goal, quality and resources with each constraint influencing the other in that any one constraint gets affected by the impact of others. Enterprise Project Management (2009) states that when the client does not have decent knowledge of project management and its processes this could lead to the client affecting one constraint without understanding the repercussions. Aiyetan (2010) concludes that the client's weak understanding of how project constraints relate to each other negatively affects the project.

3.1.7 Productiveness of briefings to the project team

Arabiat*et al.* (2007) identify that there is a mutual misunderstanding between the client and the team regarding short-term and long-term aims and objectives, as that perceptions are not misunderstood regarding efficiency and effectiveness. Arabiat *et al.* (2007) further elaborate that achieving the client's objectives is vitally important in any building project and the way in which the objects are realised comes from the client sending that message from a top structure flowing down stream to the project participants and if not controlled and asserted, can have a negative effect on the project.

3.2 Planning and designing

van der Weijde (2008) investigated the effects of placing enough effort and cost into the early planning and design phases of capital expenditure projects in order to try to eliminate as many problems as possible when executing the project, labelling this process as front end loading (FEL). van der Weijde (2008) confirmed in his results that the FEL process leads to a distinct scope and implementation approach decreasing the number of problems uncounted during construction and investing up-front in the planning and design phases benefits the project in the long run. Serrador (2013) explains that project planning and designing is of great importance to achieving project success and if adequate time is spent on these activities, it will impact positively on reducing risk and increase project success.

Inadequate planning and designing has detrimental consequences on cost, time, quality and results in unsuccessful project delivery. Olawale and Sun (2010) identify some of the measurement factors as amount of effort out-laid at the front end of the project, the amount of time given to plan and design the works, procurement processes that favours the cheapest rather than experienced consultants and skills shortage experienced by consulting firms.

3.2.1 Amount of effort out-laid at the front end of the project

George, Bell and Back (2008) have indicated the value-add of front-end planning at the start of a project because it influences project success and defines front-end planning as the procedure of structuring necessary strategic information for owners and the project team to identify risks. George *et al.* (2008) go on to state that front-end planning is a vital part to overall project success. Jaggernanth (2017) confirms that the front-end loading method has proven to meet project deliverables. Render (2016) endorses that front-end loading establishes a substantial part in realising schedule, cost, and targets during the construction stage and that the project team benefits from front-end loading as the ability to make changes early on in the project is less costly and decisions that are confirmed and planned for at an early stage influences the project down the line.

3.2.2 The amount of time given to plan and design the works

There are various reasons for rushing up the design process, such as the urgent need for construction to commence, availability of resources, financial conditions or market conditions. Dwevedi (2012) shares that designs that are compiled quick and fast are assured to lack quality. Carmichael (2000) states that many blunders are made with hurried designs that cause rework, repairs, modifications with huge cost, time and quality implications.

3.2.3 Favour cheaper rather than experienced consultants

The current economic climate forces clients to look at cheaper consultants but with the expectation to achieve maximum quality and results. Cunningham (2013) states that cost is a driving force in most building schemes and some clients will pursue in the direction of a low price and lower prices often have adverse results on quality and realising greatest value for money. Ames and Heid (2012) highlight that selecting the best qualified consultants and design professionals are essential to the accomplishment of success for any construction project.

3.2.4 Skill shortage of designers in the consulting sector

According to Mateus, Allen-Ile and Lwu (2014) global trends propose that skills shortage is an international phenomenon and organisations and employers worldwide constantly express their concerns regarding shortage of skilled professionals. Tancott (2014), reports on figures issued by the Engineering Council of South Africa, whereby global trends show one engineer per 40 people and in South Africa the trend is at an alarming statistic of one engineer per 2666 people. Tancott (2014) goes on to report that while these results demonstrate the scarcity of qualified engineers, specialised draughtsmen are also diminishing in the engineering industry. Falk (2017) states that while the positive growth of construction projects should be good for the built environment, however, it poses a challenge to consulting and construction firms to procure competent and qualified staff.

3.3 Project risk management

PMI (2013) defines the requirements of risk management are to improve the probability and effect of positive situations and minimise the probability and influence of negative situations during the project. According to Smith, Merna and Jobling (2006) risk management to the project should be accepted and implemented in order to deliver the project manager with significant, acceptable and valuable information on which upcoming decisions are based on. Smith *et al.* (2006) found that implementing a risk management framework on a project gives confidence in decision making and the use of risk management unmistakeably passes numerous benefits, however unless performed constantly it can develop into an ineffective process. The findings by Al-Shibly, Louzi and Hiassat (2013) suggest that there is a direct relationship associated with achieving project success and good risk management and that the impact of not properly identifying, assessing, mitigating and controlling risk often results in project delays and cost overruns.

Weak risk management during the project is due to not having the proper systems and guidelines in place to conduct proper auditing of project risks from the start to the end of the project. Banaitiene and Banaitis (2012) identified that risk management can be analysed and measured according to the following processes; risk identification, risk assessment, risk mitigation and, risk control and monitoring.

3.3.1 Risk identification

PMI (2013) defines risk identification as the method of identifying risks that may affect the task or project and recording their characteristics, which is demonstrated in Figure 3.1. PMI (2013) notes the project team benefits from this process because risks are documented providing knowledge and ability.

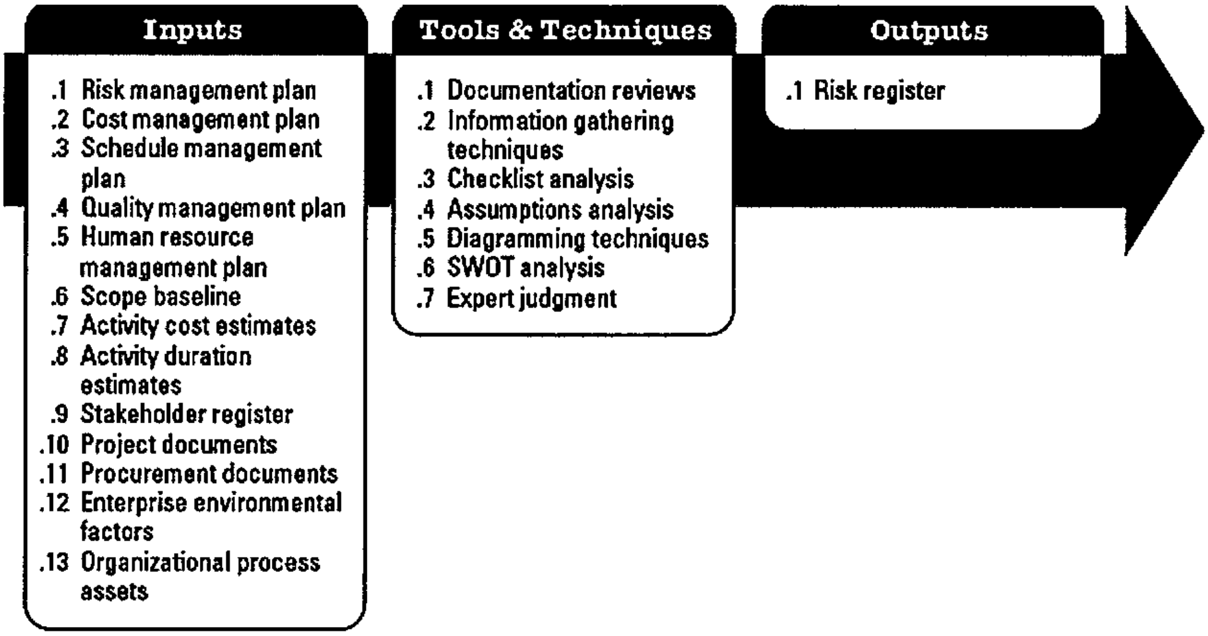


Figure 3.1: Risk identification: inputs, tools and techniques and outputs (PMI, 2013)

Figure 3.1 illustrates the various inputs that are required together with the tools and techniques that are necessary to generate the output of a risk register.

According to Ruijsscher (2016), to measure success on projects, objectives need to be accomplished. These objectives are the traditionally cost, time and quality. Of the three, cost is the most noticeable and constant measure of project success and therefore in identifying effectiveness of risk management it can initially be assessed using that measure. Ruijsscher (2016) goes on to state that the main issues with risk identification is that most risks are identified during the construction phase of the project while ideally those risks should have been identified during the earlier phases of the project life cycle.

3.3.2 Risk assessment

Zavadskas, Turskis and Tamosaitiene (2010) comment that there are various risks associated with construction projects and that risks comes from many sources, moreover, risks are further added due to the increasing size and complexity of projects. Zavadskas *et al.* (2012) define risks assessment as determining the consequences of a risk occurring. PMI (2013) further defines risk assessment as a qualitative risk analysis which is a method of rating the risk according to probability of happening and its impact on the project should it occur. Renuka, Umarani and Kamal (2014) conclude that the project budget and schedule can be controlled, assessed and modified according to the risk assessments to achieve a successful project.

3.3.3 Risk mitigation

Banaitiene *et al.* (2012), support that risk managements weakest component is risk mitigation during the process. It is often not properly identified or defined due to not having the proper procedures in place. Banaitiene *et al.* (2012), further explain that due to these short-falls regarding risk mitigation processes, reducing the adverse effects of risks cannot be achieved. Therefore in order to mitigate a risk, the source of the risk needs to be established and mapped out. (Renuka *et al.*, 2014) shows the knowledge map representing the risk source affecting project success in Figure 3.2.

Sources of Risk

Non Engineering Risk	Engineering Risk
* Country Risk	* Client Risk
* Political Risk	* Design Risk
* Environmental Risk	* Execution Risk
* Geological Risk	*Management Risk
* Natural Hazards Risk	* Tendering Risk
*Compliance Risk	* Resource Risk

IMPACT	
COST	TIME

Affect Project Success

Figure 3.2: The knowledge map representing the risk source affecting project success (Renuka, Umarani and Kamal, 2014)

Therefore, the sources of risk are divided into two categories, namely, non-engineering risk and engineering risk. Risk items under those two categories are listed and their impact in relation to cost and time are determined. From this the effect on project success can be defined.

Mitigating actions can be put into place once the source has been identified and understood. PMI (2013) defines risk mitigation as a risk response plan whereby project stakeholders act to decrease the probability of the risk occurring or impacting the project. PMI (2013) concludes that taking timely directive to decrease the likelihood and effect of a risk happening on a project is more sufficient than attempting to do damage control after the risk has impacted the project. Banaitiene *et al.* (2012), state that all processes within risk management, especially risk mitigation in the construction project management framework is a complete and methodical way of reacting to risk to attain project goals.

3.3.4 Risk controlling and monitoring

Serpella, Ferrada, Howard and Rubio (2014), explains that risk monitoring and controlling is determined by the risk assessment and that the influence of the risk to the project can be controlled and monitored whereby strategies of controlling risk can be identified as; reduction, avoidance, bearing the risk and passing the risk. According to Serpella *et al.* (2014) dependent on the control strategy undertaken, risk monitoring is the continuous monitoring of the efficiency of the risk control measures. Serpella *et al.* (2014) further elaborates that risk monitoring ensures that the risk status on the project does not vary and corresponds to the risk condition anticipated for.

3.4 Project cost estimating

Odendaal, *et al.* (2015) concluded that the initial cost estimates fail to take all costs into account. Costs are generally managed during the execution phase and not sufficiently in the early planning and design phases when 80% of project costs are committed. Cost estimating has a major impact on the current and future status of the project. The project team depends on the reliability of the cost estimate to make significant decisions on how the project moves forward. Torp and Klakegg (2016) identify that the impact of running through the project with incorrect estimates, especially at the earlier stages can have a negative impact to the successful delivery of the project. Torp *et al.* (2016) further explains that when decisions are being made on incorrect cost information this often results in cost overruns and delays.

Ojo and Odediran (2015) identifies some of the main factors that measure cost estimating and cost control; conditions of contract, market requirements, type of project and its complexity, project duration and contract period, error in judgement, lack of historical data, incomplete project information and estimating techniques.

3.4.1 Type of project and its complexity

According to Sridarran (2017) technology is rapidly developing and the construction industry amongst others is becoming greatly complex. Sridarran (2017) go on to say that the construction industry needs to understand project complexity and its characteristics in order to achieve greater accuracy and efficiency in cost estimating. Kujala *et al.* (2014) identify that project complexity has a direct relation to project size, interlinking of various project tasks, unknowns and uncertainties within a project and uniqueness of a project. Findings by Kujala *et al.* (2014) recognises that cost estimating a complex project comes with the following problems; lack of information, uncertainty with resource costing, usage of larger contingencies and doubt in costing for the project management and project team aspects of the project.

3.4.2 Project duration and contract period

Evaluating the correct time a project will take and estimating an accurate construction period timeline at an early stage of the project assists with estimating an accurate cost to be applied accordingly. Martin *et al* (2006) state that time estimating has been realised as one of the main performance factors in relation to providing accurate cost estimates. Odendaal *et al.* (2015) verify that understanding these cost drivers that enhance the estimating process are an essential part of a project and vital to its success. PMI (2013) explains that in order to achieve reliable project costs, it is vitally essential to apply the correct amount of time required to complete the works with the right type and quantity of resources. .

3.4.3 Error in judgement

Ojo *et al.* (2015) state that risk and unknowns are unavoidable at every phase of construction and the cost impact of that risk can be determined, therefore the need to assess these risks in the estimating process for the construction project is vital to the project's success. Ojo *et al.* (2015) further elaborate that risks expose activities within the construction project to economic loss when not properly accommodated and applying risk assessment procedures will lead to improved cost estimating with enhanced decision making, therefore evaluating risk linked with cost estimating will enhance project success in terms of cost. PMI (2013) identifies that risks can either be opportunities or treats and will typically have an impact on project costs; therefore using the project risk register when estimating will assist in producing more accurate estimates.

3.4.4 Lack of historical data

The reliability of cost estimates at the front end of the project is highly reliant upon the quality of historical data. The lack of historical data gives rise to assumptions being made to build up an estimate which could have a negative influence on the accuracy of the estimate. Pickett and Elliott (2007) explain that most project estimators understand the significance of having and using historical data but the difficultly is that very few estimating methods have the approach, measures and systems in place to efficiently use the information to improve project costing. Odendaal *et al.* (2015) list one estimating approach that is commonly used when referring to historical data; the analogy cost estimation method, is when a similar project has been completed in the past and the current estimate is based on the old project with a few changes. Ojo *et al.* (2015) rank lack of historical data as one of the top ten factors that influence cost estimation on projects negatively. PMI (2013) indicates that information from past similar projects gives valuable insight and current estimates can be guided by historical data.

3.4.5 Incomplete project scope definition, design, specifications and information

In any construction project the reliability of the cost estimate is determined by the level presented in the definition of the scope of works. Without a completed project definition and scope, the platform is set for assumptions that lead to unfavourable circumstances as supported by Ahiaga-Dagbui, Smith, Love and Achermann (2015). As with compiling a cost estimate based on incomplete designs and specification, this allows for errors, assumptions, qualifications and misjudgement with the estimate which ultimately steers the reliability of the estimate towards inaccuracy as viewed by Ojo *et al.* (2015). These hurdles encountered during estimating has a major influence on the success of the project as the estimated costs gets committed and used as a baseline in moving the project forward as emphasised by Odendaal *et al.* (2015).

3.4.6 Estimating techniques

PMI (2013) identified earn value management (EVM) as an instrumental estimating technique that is commonly used within the project management environment. Candido, Heineck and Neto (2014) further state that (EVM) is strongly endorsed by the Project Management Institute (PMI). Candido *et al.* (2014) describes EVM as a technique used to measure performance progress relating to cost and time, indicating planned to actual performance, variance and forecasts. Gupta (2014) states (EVM) reports are becoming more and more compulsory within the private and government sectors. Gupta (2014) further explains that (EVM) is a technique, as illustrated in Figure 3.3, used to assist projects in realizing successful delivery and the (EVM) is seen as one of the most productive and powerful concepts used in project cost management and estimating.

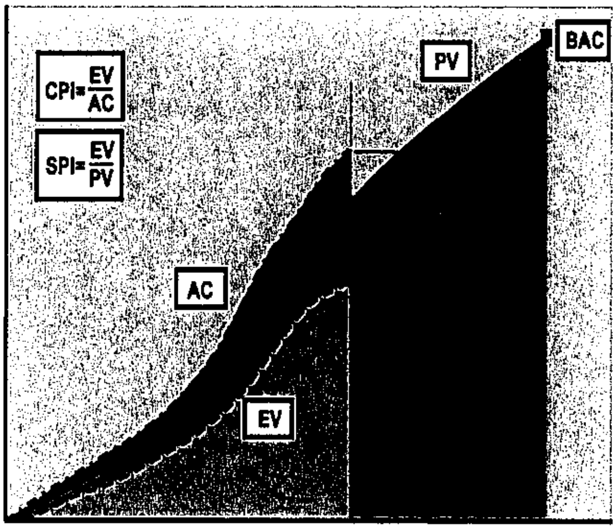


Figure 3.3: Earn Value Management Basics (Gupta, 2014)

Figure 3.3 represents the basic concept around EVM. Horizontal axis representing time and vertical axis representing cost.

3.5 Project communication

According to Hoezen, Reymen and Dewulf (2006) many problems in construction can be a result of communication problems and that the effectiveness and success of project processes greatly relies on the value of communication. Gamil and Rahman (2017) explain that the impact of poor communication has many consequences and effects in the construction environment, such as time overruns, cost overruns, disagreements, and finally project failure.

Communication within the project team is vital for delivering a successful project. Each department needs to come together as a single team and the doors of communication must be left open. It can be identified from Renault and Agumba (2016) certain measurable components within communication in the construction industry; accuracy, procedures, barriers, understanding, timelines and completeness are of vital importance.

3.5.1 Communication accuracy

Cheng, Li, Love and Irani (2001) support the view that communication accuracy is a critical aspect for successful communication within the construction industry.

Thomas, Tucker and Kelly (1998) state that communicating the right information enables the right communication objectives to be obtained. The construction industry is a very technical environment striving for the best possible outcomes, therefore the clarity of communicated information needs to be precise and correct which increases the chances of a more desirable outcome as indicated by Guangdong, Cong, Xianbo and Jian (2017).

3.5.2 Communication procedures

Hoezen *et al.* (2006) explain that construction projects have a network of interconnecting stakeholders and it is necessary to have the right communication procedures in place that ensures correct processes are followed and the right channels are used. Cheng *et al.* (2001) validates that implementing a structured communication procedure framework on a project, increases the chances of successful communication. Thomas *et al.* (1998) indicate that communication procedures also regulate control in the distribution of information and confirm that the correct information is sent and received to the correct stakeholders.

3.5.3 Communication barriers

Thomas *et al.* (1998) describe communication barriers as an obstacle that prevents the flow of good communication to be carried out successfully and identifies one of the main communication barriers within the construction industry to be language. Guangdong *et al.* (2017) share this view and explain that the construction industry is a very diverse environment and breaking through different language barriers can sometimes hinder the flow and accuracy of the communication. Emuze and James (2013) reinforce that the aspect around language and culture plays an essential part in guaranteeing good communication and achieving effective communication is a crucial aspect on a construction site. Ali and Wen (2011) further emphasises that the communication language barrier contributes to poor workmanship on the building site.

3.5.4 Understanding the communication

Cheng *et al.* (2001) state that compiling communication in a plain and simple context allows the receivers of the communication to more easily understand and use the communicated material effectively. Similarly, Guangdong *et al.* (2017) view that in the construction industry, professionals are often confronted with difficult and highly technical matters and these need to be communicated to a variety of stakeholders, regardless of the stakeholders' level of expertise. The effectiveness of the communication depends on how understandable it is presented to them and whether the stakeholders understand the benefits of the communication. Thomas *et al.* (1998) confirm that failing to understand the communication is a major component of unsuccessful communication in the construction industry.

3.5.5 Communication timelines

In the construction industry, time is measured as one of the most significant constraints of the project and this also applies to communication. There are various ways in which time can impact communication; communication needs to be done timeously, understanding the urgency of the communication and communicated instructions need to indicate an action or return time. Cheng *et al.* (2001) reinforce this view and further state that the construction industry is bound by time, contractually or by programme, and abiding by correctly managed communication timelines can enhance the project's communication structure which benefits the project as a whole.

3.5.6 Completeness of the communication

Communication needs to cover all relevant and important aspects with the intention to give a full picture of its intention. Hoezen *et al.* (2006), state that many errors and mistakes made in the construction industry arises from incomplete communication which is a growing concern. Thomas *et al.* (1998) explain that incomplete communication opens the way for misinterpretation, misjudgement and misrepresentation, all of which are avoidable by assuring the completeness of the communication.

3.6 Critical quality factors in the project

Rad and Khosrowshahi (1998) state that project quality is often side-lined and insufficient attention is paid on quality because project teams are more focused on the time and cost factors. Rad *et al.* (1998) further explain that overlooking quality impacts tremendously on wastage. Saeed and Hasan (2012) confirm that quality management in its totality has positive effects on teamwork, project implementation, client satisfaction and project implementation. Saeed *et al.* (2012) conclude that overlooking critical quality factors often results in project failure.

Poor quality is a growing concern, in both the design and construction arena. Delgado-Hernandez and Aspinwall (2008) list some items that need to be addressed in order to improve on quality which positively affects the success of a project and these items are; designs, project management, materials, workmanship, quality management systems and methodologies.

3.6.1 Quality of design work by consultants

Chan *et al.* (2004) view that contractors building a specific product require the correct information from drawings and specifications to achieve their objective and the quality of these drawings and specifications has an influence on the outcome of a project. Chan *et al.* (2004) further elaborates that the effects of poor designing and detailing increases costs, induces delays, brings on rework or abortive work, escalates safety risks and impacts on the quality of the project. Olawale *et al.* (2010) factor poor design work as one of the most import influences on project cost and time overruns. Render (2016) explains that during the design and planning phases of a project, there has to be a process of front-end loading in order to achieve the right level of expected quality.

3.6.2 Quality of the project manager

Jha *et al.* (2006) observe that the project manager portrays the single most important role on the project from the initial phases through to construction then project close-out. All information, risks, communication and processes are coordinated, circulated, handled and observed by the project manager. If the project manager fails to uphold the required duties and responsibilities or does so in lack of quality, this will have devastating consequences on the project. Elbeltagi (2009) identifies that strong leadership amongst others are vital for the success of a project and having a good leader managing the project adds value in achieving a quality product.

3.6.3 Quality of construction materials

Construction materials are a major cost contributor to a construction project and in the construction industry the quality of such materials are linked to its price or rate. Substandard materials generally cost less but lack the quality standards thereof. Using inferior materials of lower quality standards will affect the overall quality of the building project. This view is recognised by Greve (2013) who reports that building failures in South Africa could become more frequent if the use of substandard or inappropriate materials are utilised on construction projects. Jha *et al.* (2006) explain that projects that promote the use of substandard materials for financial gain, seldom succeed due to replacement costs with early deterioration and breakages. Smith *et al.* (2006) identifies usage of incorrect or substandard materials as a major risk factor in construction projects.

3.6.4 Quality of workmanship performance

Ali *et al* (2011), state that poor workmanship performance on building sites is a growing concern in the construction industry and identifies influencing causes that impact on poor workmanship as; poor supervision, lack of skill, lack of experience and time limitation. Ali *et al.* (2011) identified that poor workmanship contributes negatively to the project's quality framework and brings with it extra costs and overrun time due to rework. Chan *et al.* (2004) identify workmanship as a sub-contributing factor that affects the success of a project.

3.6.5 Quality management system

Hoonakker *et al.* (2010) emphasises that in the construction industry, implementing and exercising a sound quality management system (QMS) is extremely important in order to achieve the desired quality levels and standards. Hoonakker *et al.* (2010) explain that the benefit of having a quality management system proves successful in accomplishing good project quality and contributes to project success in its entirety. PMI (2013) defines project as a set of procedures and policies that is used as a framework to implement QMS and works to guarantee that the project quality objectives are met and certified. Mane and Patil (2015) explain that the quality within the construction environment is related with client's fulfilment and the execution of a QMS is a crucial tool in reliably and consistently managing the objective of client satisfaction and that QMS could be applied either at the business level or at project level. PMI (2013) further explains that quality management also identifies and validates the quality of project management within a project and deliverables of the project as demonstrated in Figure 3.4. The quality management system confirms that the project will satisfy the requirements for which it embarks on.

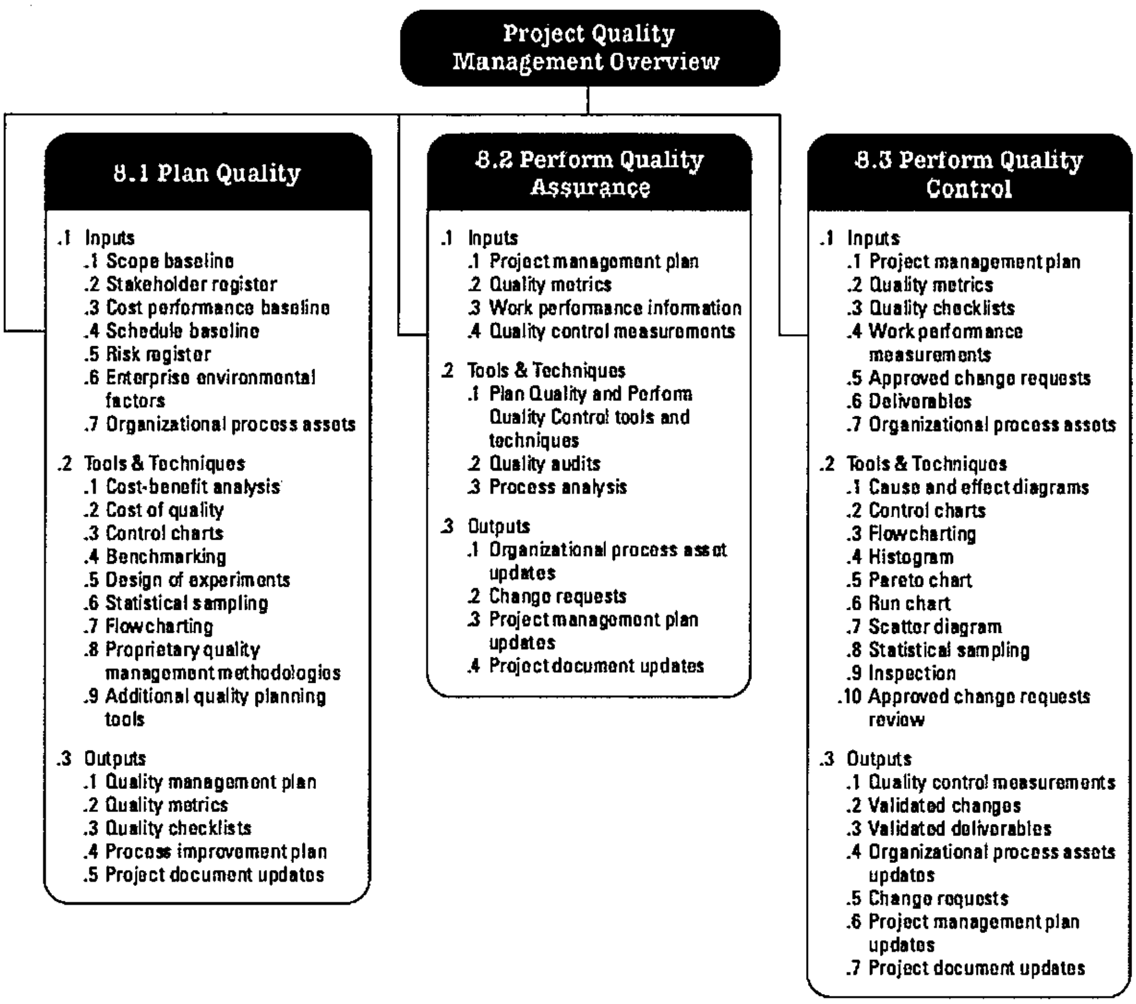


Figure 3.4: Project quality management overview (PMI, 2013)

Figure 3.4 shows a comprehensive overview of project quality management. There has to be a quality plan in place together with quality assurance and quality control measures.

3.6.6 Proprietary quality management methodologies

Mane *et al.* (2015) identify quality management as a continuous development of enhancement linking all characteristics of the project or business. The broader goal of quality management is to avoid blunders before they occur. The methodology driving quality management are quality planning, perform quality assurance and quality control. PMI (2013) describes quality planning as the process involved in identifying requirements and standards within the project and record how the project will comply with the quality requirements. Hoonakker *et al.* (2010) identify performing quality assurance as the methods involved in checking, reviewing and assessing the quality requirements and to ensure that the required standards were used. Mane *et al.* (2015) classify quality control as the methods used to monitor and record results within activities involved in quality. PMI (2013) further explains that results obtained from quality control needs to be assessed and if necessary recommend changes.

3.7 Project management approach

Al Hammadi (2016) validates that being a manager that leads is an important aspect in managing projects and performing at a high level. As a leader it is a vital obligation to ensure the efforts of people are aimed towards the same objective. Otara (2011) reinforces the perception that managers and leaders mould the environment and efficiency of the work surroundings. When it comes to project management there are many planning and controlling techniques that are used today in the project management environment. Maxwell and Oluwayomi (2016) explain the influence of project manager's leadership competencies on projects has serious consequences for the project, if found to be weak. Maxwell *et al.* (2016) confirm that an inadequate project manager poses the single biggest risk to a project and project failure is eminent.

Rozenes, Vitner and Spragget (2006) identify planning, measuring, monitoring and taking action are usually part and parcel of a project management approach and this system gives the ability to monitor the difference between the planned variables and actual outcomes or performance. Hyvari (2006) classifies the causes that are challenging the success to implement a good project management approach as; lack of leadership, failure to coordinate, inexperience, incompetence and lack of commitment.

3.7.1 Leadership attributes of the project manager

The construction industry is a multi-disciplined and complex sector involving various different people to achieve one objective, which is project success. Leadership is the ability to lead people and failing to achieve this objective is eminent should a project manager lack leadership skills. Al Hammadi (2016) reinforce that taking charge is one of the main aspects in project managing construction projects and being an efficient leader is a key responsibility to warrant that work efforts of people are focused, directed and synchronised towards meeting the master plan. Anantatmula (2010) contends that the leadership role is vital to enabling numerous project success factors that influence project performance. Anantatmula (2010) further argues that a project manager's leadership responsibilities and role toward a project team impact project outcomes and performance. Anantatmula (2010) goes on the explain that leadership is about guiding and motivating and that projects fail to meet cost, time and quality milestones due to lack of commitment, poor morale, poor productivity, poor human relations and lack of motivation from the team.

3.7.2 Coordination capabilities performed by the project manager

Failure to coordinate people, teams and tasks within a project can have a detrimental outcome on project performance. Construction infrastructure projects are extremely complex with various phases from conceptual to close-out. Progression into each phase requires coordinating and facilitating various tasks and activities. PMI (2013) refers to this as Project Integration Management. PMI (2013), states that Project Integration Management includes the framework to ensure coordination of several procedures and project management tasks within the project management process. PMI (2013) further elaborates that coordination and integration includes characteristics and actions that are essential to regulate the project through to close-out. Chimoriya (2015) essentially adds that correct coordination directly influences efficiency but indirectly influences other important factors that filter down into teams and the work environment. PMI (2013) adds that when it comes to coordination and integration, project managers should implement a project integration framework, represented in Figure 3.5, to manage coordination.

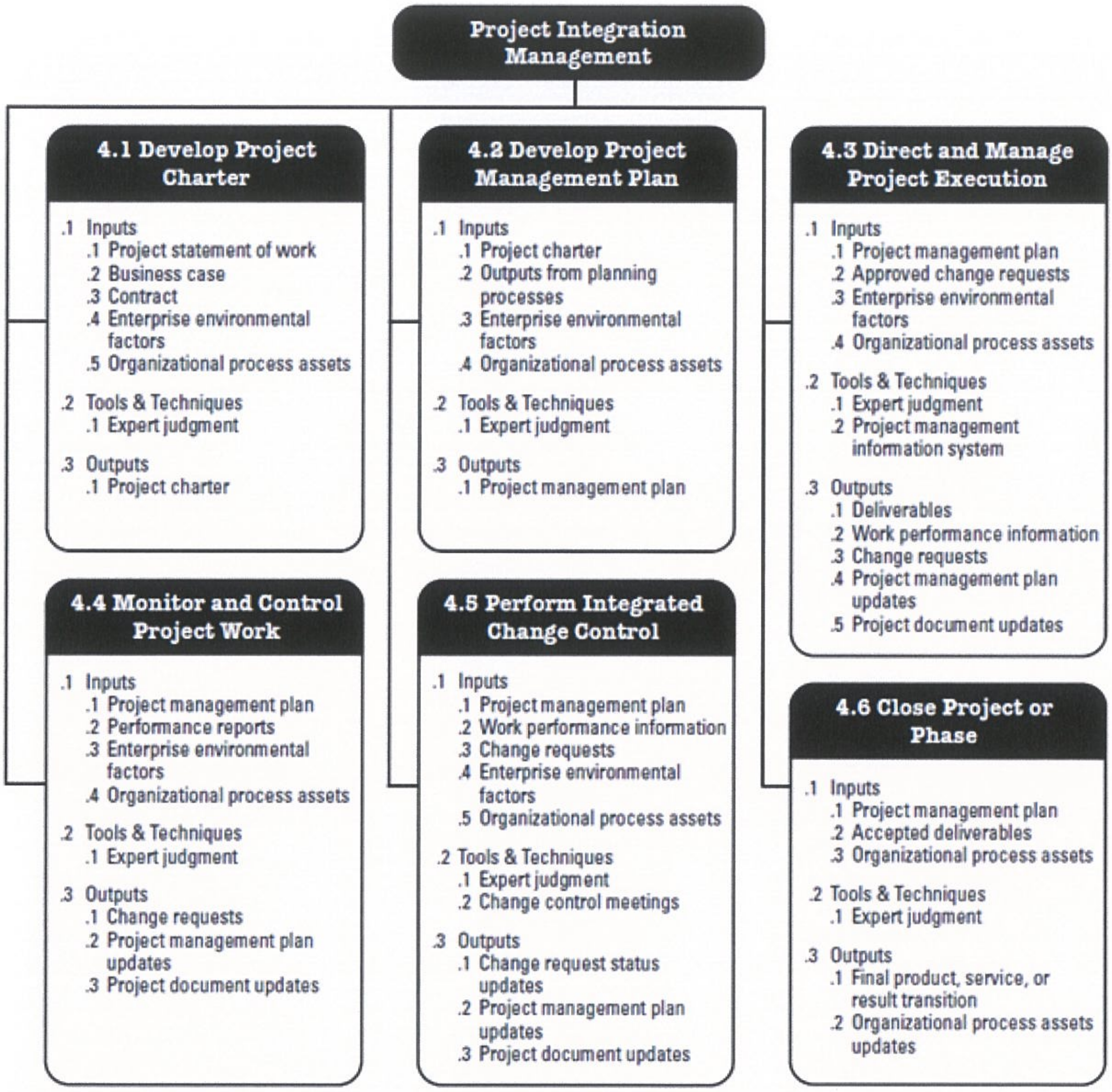


Figure 3.5: Project integration management (PMI, 2013)

Figure 3.5 shows the six key areas that are required in order to satisfy the requirements for project integration management.

3.7.3 Inexperience of the project manager

An inexperienced manager in any sector or industry can prove costly. Inexperience tends to bring many negative factors to the table such as, poor quality of work, bad attitude, weak attendance, poor client relations, weak time management and lack of teamwork skills. When focusing on the construction industry and project managers, a confident hypothesis can be derived that inexperienced project managers lack lessons learned. Jagdev (2012) states that as an added benefit of project management, lessons learned are an effective and efficient method of conveying valued project knowledge and lessons learned involve distributing knowledge about features within a project that worked out correctly, parts that could be enhanced on and plans to address these issues before pushing ahead. Jagdev (2012) explains that the topic of lessons learned is fundamental knowledge and is vital in achieving good results and adds value to achieving project success.

3.7.4 Incompetence of the project manager

Incompetence is the inability to carry out something successfully. When applied to project managers, the factors that are focused on according to Cochran (2014) are weak communication skills, poor personal development, poor leadership capabilities, inability to develop others, cannot adapt to change, insufficient production, weak relationship-building skills and unsuccessful task management. Pitagorsky (2007) posted that a less than competent project manager puts a burden on the other team players and jeopardizes the team's achievement. Pitagorsky (2007) further adds that when an incompetent project manager is in an influential position, it can be the cause of poor decisions which leads the team astray in achieving the objectives.

3.7.5 Commitment shown by the project manager

Commitment exists in every imaginable undertaking let alone project management. Should a project lack the commitment of the project manager, then the project will most likely fail. For a project to be successful it is inevitable that the project manager must be one hundred percent dedicated to the project giving his best and focusing on all project elements. Donagher (2013) posts that lack of project management commitment is routinely listed as one of the major risk factors for a project. Egeland (2014) elaborates that the project manager's commitment to the project, moulds the performance and motivation levels of the other team members. Once other team members are exposed to that environment of commitment that will have a positive effect and increases team drive. Egeland (2014) states that project commitment equals project success.

3.8 Assessment of theories

3.8.1 The Management Theory: Maslow Hierarchy of Needs

This study is anchored on the management theory of Abraham Maslow's hierarchy of needs. In 1943 Abraham Maslow published a paper "A Theory of Human Motivation" better known now as Maslow's Hierarchy of Needs that represents a theory in psychology (Jerome, 2013). The theory behind Maslow's hierarchy of needs suggests that behaviour at a specific moment is established by the strongest need (Dye *et al.*, 2005). Adiele and Abraham (2013) explain that the bottom level of needs must be fulfilled before the upper level needs are activated to start motivating behaviour. Martin *et al.* (2007) support this and state that people must fulfil the needs at the bottom levels before they can effectively be inspired to confront the next levels.

Martin *et al.* (2007) state Maslow illustrated these needs as a hierarchy in the shape of a pyramid as demonstrated in Figure 3.6. According to Jerome (2013), Maslow's theory outlines five key fundamental hierarchical needs. These needs are; physiological needs; safety needs; needs for love, affection and belongingness; esteem needs; and self-actualisation.

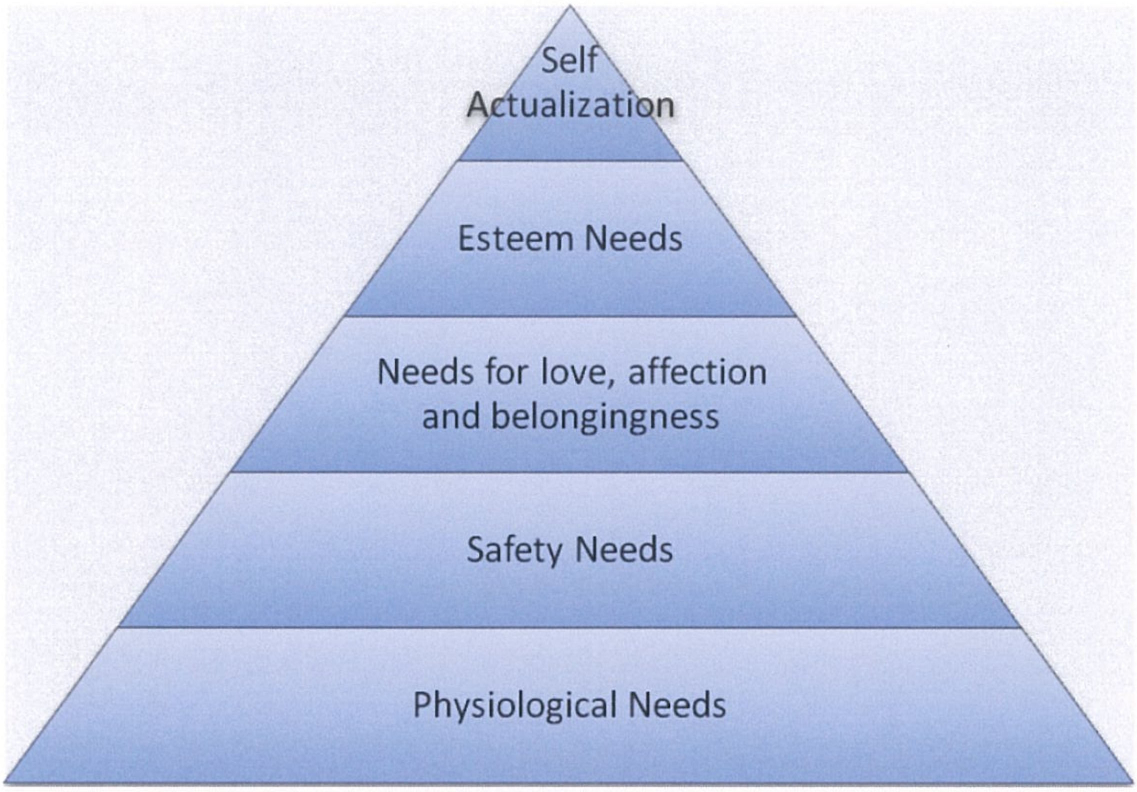


Figure 3.6: Maslow Hierarchy of Needs (Jerome, 2013)

At the bottom of the pyramid representing the pyramids foundation is physiological needs, (Martin *et al.*, 2007). This need suggests that the first and most basic need people have is the need for survival (Kaur, 2013). According to Jerome (2013) people's physiological requirements for food, water and shelter has to be met before they can think about anything else.

Dye *et al.* (2005) explain that safety needs occupies the bottom second level within the hierarchy. Adiele *et al.* (2013) explain that it refers to the need for a safe and secure environment, free from harm and threats. According to Martin *et al.* (2007) the rationale is that if people fulfil safety and security needs, then only can the next level of needs be activated.

Martin *et al.* (2007) explains that once the first two bottom levels of needs are met, a person can be encouraged to meet the needs characterised at higher levels in the hierarchy. The level above safety needs is need for love, affection and belongingness. Kaur (2013) states individuals try to overcome feelings of alienation and loneliness. According to Jerome (2013) this need addresses the desire and longing for friendship, belongingness, affection and acceptance. Adiele *et al* (2013) explains that this level relates to a person's ability to exist in harmony with other people.

Kaur (2013) identified that once a person's needs are met on the below levels, it is at this stage an individual can begin to build positive feelings of self-esteem and self-worth, which includes self-respect and the approval of others. According to Adiele *et al.* (2013) when these needs are met, the individual has a sense of value and feels self-confident.

Jerome (2013) explains that when all the other foregoing needs are addressed and met, then only are the needs for self-actualisation come-up. Martin *et al.* (2007) state that the need for self-actualisation is an individual's yearning to reach one's full potential and achieves everything that an individual is capable of becoming.

3.8.2 The Systems Theory – systems thinking model

Friedman and Allen (2014) describe the systems theory as a means of breaking down increasingly difficult systems into a more manageable range. Friedman *et al.* (2014) further elaborates that the systems theory also facilitates an understanding of the broken-down components together with its dynamics and its relation to the overall system in order to understand complications and develop strategies. Jackson (2003) supports this view and further adds that the main aspects of systems thinking derive from four types of approaches, Type A: aims to improve goal seeking and feasibility, Type B: dedicated to investigating and make clear the requirements of the stakeholders and their interests, Type C: seeks to enforce unbiased attributes in the systems policy and in the concerns that followed and Type D: targets in providing variety and diversity in problem solving. This theory is relative to the study because projects are broken down into phases with each phase being dependent on each other as the project moves forward. Project managers need to understand the dynamics of each project component and derive solutions when problems occur. Bhunu (2007) states that the systems theory offers a different view to that of the

Project Management Institute (PMI), in a way that a project is not just an endeavour undertaken, it's more complex than that. Bhunu (2007) explains that a project undertakes a systems outlook of splitting a project down into phases. Bhunu (2007) further elaborates that a systems method undertaken on a project provides the tools and techniques necessary, hence providing the project manager the capability to consider inputs, outputs and constraints. The systems approach, which is presented in Figure 3.7, further becomes relative to this study in developing a project delivery model for Umgeni Water.

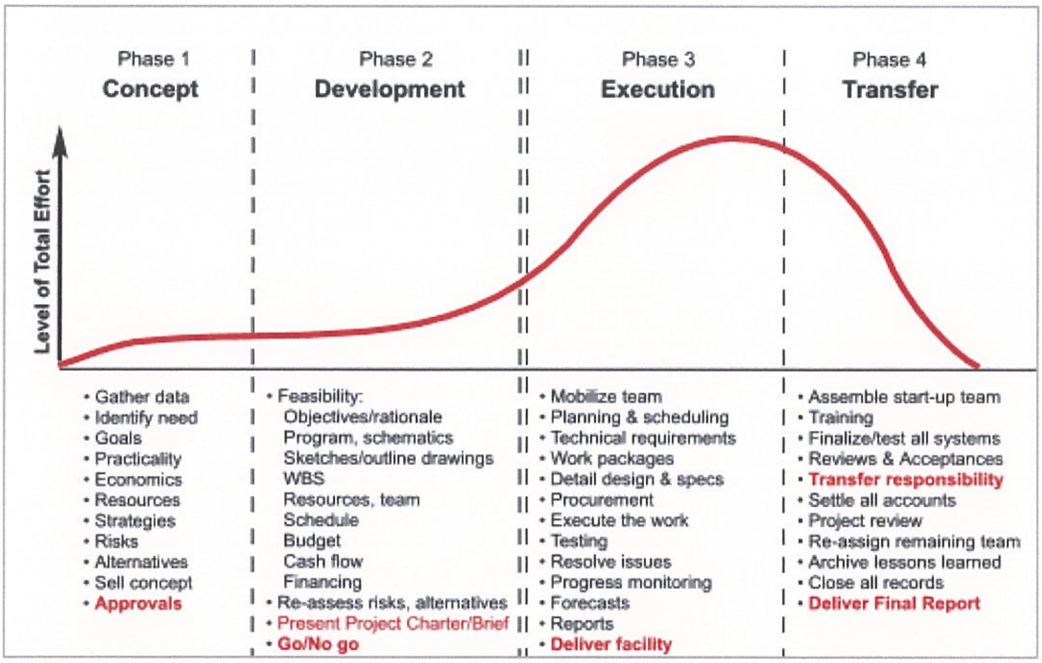


Figure 3.7: Project system thinking approach (Bhunu, 2007)

Figure 3.7 presents a project adopting a systems thinking approach. The project is broken down and divided into four phases; concept, development, execution and transfer. Within each phase there are required deliverables to be achieved in order to move into the next phase.

3.9 Chapter summary

Project delivery challenges encountered within the built-environment is a global phenomenon. Factors causing project delivery challenges in construction projects differ between countries, due to various fundamental reasons. The fundamental reasons that could exert an influence on project delivery challenges could extend into numerous causes relating to; the client, project planning, risk management, cost estimating, communication, quality and project management approach. The chapter addresses Maslow's theory of basic needs as an important basis to determine the requirements for a project and is vital in this research by providing insight into project interpretation relative to the characteristics of the theory. Viewing a project in pyramid form to display project requirements in hierarchy sequence will prove valuable to this study. The theory will also contribute awareness in satisfying requirements at each hierarchy level in order to progress forward and ultimately to completion. This chapter focuses on the General Systems Theory which is the underpinning theory for the study. This theory is extremely important and will prove useful to this study in providing a framework in developing a project delivery model. A systems approach to a project allows for the breakdown of systems, within a project, into subsystems, and provides the methods and tools which will affect the system, hence considering each systems requirement to proceed. Therefore, the above literature review consolidated based on project delivery challenges, causes, impacts and associated theories that have been identified will assist in developing the forth-coming chapters.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

Research methodology is a well ordered approached used to decide an answer for a specific issue. The methodology used in this study specifies the techniques, methods and procedures that were used for achieving the information desired to form the research questionnaire, data collection, analyse data and present findings. The methodologies undertaken in this research are deliberated in the accompanying sections.

4.2 Research design

The research design for this study is an exploratory and descriptive case study that is analysed through a quantitative method to view behaviour, characteristics, opinion of a specific group, or population and detail the account of prevailing conditions. Starman (2013) states that a case study is a general term for the study of an individual, group, institute or phenomenon, therefore, a case study is a complete explanation of an individual case and its analysis. Starman (2013) explains that case studies have often been believed to be part of qualitative research and methodology; they may also be qualitative or cover a mixture of qualitative and quantitative approaches.

4.2.1 Exploratory research

According to Bhattacherjee (2012), this type of research is mainly done in fresh subjects of research, where the research objectives are; to identify the extent of a phenomenon, to produce specific ideas about the problem or phenomenon, or to determine the feasibility of undergoing a more detailed study with regards to that phenomenon. The case study is exploratory because it originated from typical problems and identifies whether the causes of project delivery challenges in the construction industry exist at Umgeni Water.

4.2.2 Descriptive research

Descriptive research is aimed at making attentive observations and comprehensive documentation of a problem or phenomenon. These observations need to be replicable and precise hence must be focused on the scientific method, thus making it more trustworthy than general observations by unskilled people (Bhattacherjee, 2012). The research is descriptive because it attempts to describe the causes that affect project delivery challenges in the construction industry.

4.3 Source of data

4.3.1 Primary data

Data that undergoes observation, experience and recording of a situation or phenomenon is commonly referred to as primary data. Primary data are the initial or first confirmation of a phenomenon (Walliman, 2011). There are four key segments of primary data:

- Measurement – gathering of numbers representing amounts
- Observation – capture of events, phenomenon or situations experienced
- Interrogation – data acquired by probing or asking
- Participation – data developed by experience of doing something

In primary data collection, the data are collected using methods such as; questionnaires, interviews, focus groups, observations, case studies, diaries, critical incidents or portfolios.

4.3.2 Secondary data

Secondary data are data that have been interpreted, deduced, inferred and recorded. Forms of secondary data come from; newspapers, magazines, books, journals, documentaries, advertising and most common today, the internet. The quality of secondary data is greatly reliant on the source and the way in which it is presented. The main reason for using secondary data is to validate the quality of the information or views provided (Walliman, 2011). Advantages of secondary data are:

- Easily collected
- Readily available
- Less expensive than primary data

The primary data for the current case study was obtained by distributing questionnaires. The secondary data used in the study was gathered from numerous international and national sources, inter alia, journals, articles, theses, books, conference papers, standards, reports and the internet. The Durban University of Technology (DUT) Online Library was used to search for information using the following data bases: Science direct, Nexus and Sabinet on-line.

4.4 Research approach

Creswell (2014) defines research approach to be the plan and the process for research that builds the platform from general ideas to in-depth approaches of data gathering, analysis and clarification. Creswell (2014) further states that the choice of a research approach is determined by the type of research problem, the topic being undertaken, the researchers own experiences, and people who are interested in the study. Given this understanding, it was thus evident that a case study strategy was most suitable to the study which was analysed through the following approaches:

4.4.1 Quantitative approach

A quantitative approach is most applicable for the study because the purpose of the research involves explaining of various factors influencing project delivery challenges within the construction industry, furthermore to design a project delivery model that will assist in minimising the occurrence of those challenges within the Umgeni Water project environment. Leedy and Ormrod (2014) explain that when the time available for the field work is limited, the quantitative approach is best suited hence the quantitative approach was selected.

4.4.2 Qualitative approach

A qualitative approach can be adopted in studies to explain the explanatory and descriptive methods implemented. The results of the qualitative methods are more descriptive and the findings can be drawn relatively easy from the data. Leedy *et al.* (2014) state that a qualitative method is a basic way of conducting research as case studies involve a deep insight through understanding of data collection methods. Leedy *et al.* (2014) specify that when you select a qualitative approach for research, the research must be able to fulfil one or more of the following purposes:

- Descriptive –unveiling the complex type of certain circumstances, processes, systems, sceneries, relationships, or individuals.
- Interpretation – assisting to achieve other perceptions about a specific problem.
- Verification – allow checking the validity of particular claims, ideas, norms and concepts that currently exist.
- Evaluation – offering a means to evaluate the efficiency of certain policies, practises or innovations.

4.4.3 Mixed method

The use of the mixed method is when research employs the use of both qualitative and quantitative approaches to address the research questions (Creswell, 2014). Creswell (2014) further states that the combination and use of both approaches in research leads to a more defined result.

4.5 Population and sampling

4.5.1 Sampling frame

The composition of the questionnaire sample frame included Umgeni Water employees between Grade 5 to 9, with post-graduation experience greater than 3 years accompanied by a relevant qualification. The selection of this group gave more credibility to the findings.

Therefore, in this study the sample consisted of the following number of expert professionals employed at Umgeni Water:

Table 4.1: Sample frame

Composition	No
Project Manager (PM)	16
Civil Engineer (CE)	8
Planning Engineer (PE)	7
Quantity Surveyor (QS)	5
Servitude Administrator (SA)	3
Environmental Project Manager (EPM)	5
Total Sample	**44**

4.5.2 Sample

Brink, van Rensburg and van der Walt (2012) defined a population sample as a group of people that is of significance to the research with all the people having some common characteristics. In other words, population sample refers to the group of persons that meet the criteria that the researcher is interested in studying. Therefore, the current case study's questionnaire sample came from Umgeni Water employees associated in the feasibility planning, designing and construction implementation of construction infrastructure projects. The population of the study was situated in Umgeni Water's head office based in Pietermaritzburg, Kwa-Zulu Natal.

1. This guaranteed inclusion of key Umgeni Water project stakeholders.

2. Met the requirements in achieving the research objectives.

4.5.3 Sampling techniques

Probability and non-probability were the two main sampling techniques identified (Leedy *et al*, 2014). For the purpose of this case study, a non- probability sampling technique was employed, namely, a selective method of expert sampling, due to the following;

- Making up the sample from experts and professionals in the field.
- Probability sampling is based on the fact that every member of that population has a known and equal chance of being selected.
- Allows each segment of the population to be represented in the sample.

4.5.4 Sample size

Bhattacherjee (2012) emphasises that sampling is the statistical method of choosing a subset of people, of interest for the purposes of making observations and inferences. The unit of analysis may be a person, group, organisation, country or any other entity. The current case study researched and sampled 44 employees within Umgeni Water using questionnaires. The sample size was determined using a 95% confidence level P value of 0.05 and a precision or e-value of 0.05. The sample size was calculated using the following formula,

$$n= \frac{N}{1+N(e)2}$$

$$n= \frac{50}{1+50(0.05)2}$$

$$n= \frac{50}{1+50\ (1.125)}$$

$$n= 44.44$$

Required sample calculated: 44 (No.)

4.6 Research instrument

The questions were designed to address the research objectives and sub-objectives. The questions presented in the questionnaire was a one-to-one relationship to the research objectives and sub-objectives in order to gain insight from Umgeni Water employees regarding severity around project delivery problems faced at Umgeni Water when implementing infrastructure projects. The questionnaire was structured in two sections. The first section relates to demographic data and the second section consists of study variables regarding challenges and causes within the Umgeni Water infrastructure environment. The Likert five point scale was employed to the questionnaires to assist in determining responses between the minor to major ranges. The options "does not" and "unsure" were also included for all questions.

Table 4.2: Format for answering questionnaires (Aiyetan, 2010)

Factors	U	DN	Minor...Major				
			1	2	3	4	5

4.7 Methods of data analysis

The method of data analysis employed for this study comprises both descriptive and inferential statistics.

4.7.1 Descriptive statistics

Descriptive statistics, which include mean scores (MS) were used to analyse the data obtained from respondents. The MS is originated by assigning numerical values to respondents rating of factors, such as, very low (1 point), low (2 points), moderate (3 points), high (4 points), and very high (5 points).The mean score (MS) for each factor is then determined using the equation:

$$MS = \sum \left(\frac{(fxs)}{N} \; 1 \le MS \le 5 \right)$$

Where: MS = mean score; N = the total number of responses concerning that factor; S = the score given to each factor by the respondents and ranges depending on the ordinal scale in use (1 – 5) and F = the frequency of respondents rating (1 – 5) for each factor. The t-test was used to test for any agreement in the ranking of factors at a 5% level of significance.

4.7.2 Inferential statistics

Inferential statistics is a statistical method that deduces from a small but representative sample the characteristics of a bigger population. In other words, it allows the researcher to make assumptions about a wider group, using a smaller portion of that group as a guideline.

The inferential analysis was adopted to analyse scores from the respondents. Placing of "unsure" responses in the midpoint of the scale may be justified in that the respondents are believed to be neither certain or not, therefore assumed to be neutral. Figure 4.1 illustrate show responses were consolidated and scored on the Likert scale prior to interpretation.

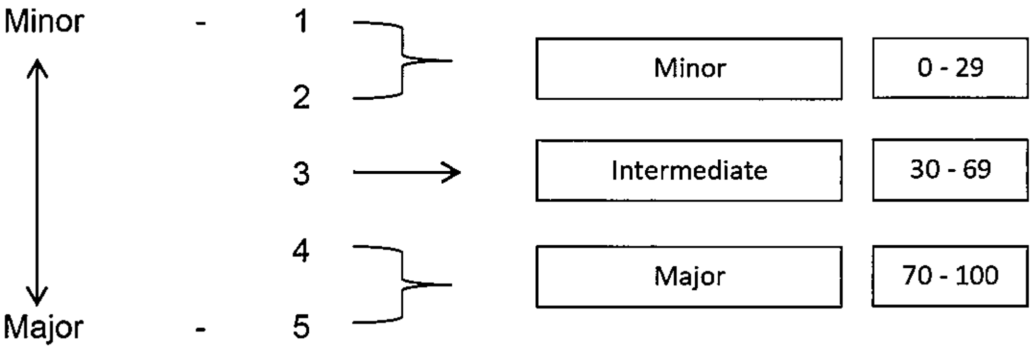


Figure 4.1: Scoring of responses on the Likert scale (Aiyetan, 2010)

Figure 4.1 is an example of how the score of one of the responses was calculated.

Where (R) = Responses received and (UR) = Unsure Responses received

$$\frac{[(3\ R \times 1) + (7\ R \times 2) + (12\ R \times 3) + (1\ UR \times 3) + (11\ R \times 4) + (10\ R \times 5)]}{(44\ R \times 5)}$$

68%

By adjudicating this score to the scoring categories in Figure 4.1, it is established that it will fit into the intermediate category.

Making sure that an adequate level of consistency is necessary to satisfy the findings, it was therefore necessary to facilitate interpretations of R^2 and a range of practical significance was suggested as presented in table 4.3.

Table 4.3: Interpretation of R^2 for practical significance

Range	Effect
< 0.099	No effect
0.01 to 0.089	Weak effect
0.09 to 0.249	Moderate effect
0.25 >	Strong effect

Practical significance, as indicated in Table 4.4, of t-test results can be found using the Cohen's d statistical technique. It establishes the practical significance statistics for sample mean score.

Table 4.4: Interpretation of R^2 for practical significance

Value	Effect
20 – 49	Weak
50 – 79	Medium
80 >	Strong

Cronbach's alpha test is used to test internal consistency of data including its reliability. Cronbach's alpha range must be greater than or equal to 0.70. For this study, a reliability of .70 was used as a cut-off value to indicate the reliability of the individual measuring instrument. Thus the internal reliability of the measures relating to the indices all exceeded this cut-off point and are regarded as acceptable.

A correlation between variables indicates that as one variable changes in value, the other variable tends to change in a specific direction. This is useful because it can use the value of one variable to predict the value of the other variable. The Chi Square statistic is used for testing relationships between categorical variables. The null hypothesis of the Chi-Square test is that no relationship exists on the categorical variables in the population; they are independent. Factor analysis is a technique that is used to reduce a large number of variables into fewer numbers of factors. This technique extracts maximum common variance from all variables and puts them into a common score. The variable should have a rotated factor loading of at least |0.4| meaning ≥ +. 4 or ≤ –cut-offs depends on whether you are running a confirmatory or exploratory factor analysis, and on what is usually considered an acceptable cut-off in your field.

4.8 Reliability and validity

Kimberlin and Winterstein (2008), explain that measurement is the allocating of figures to observations in order to calculate unknowns and the main signs of the quality of a measuring tool are the validity and reliability of the results.

In terms of reliability, according to standard test theory, any score attained by a measuring tool is composed of both the "true" score which is unknown and "error" in the measurement method.

Employees that make up the population size that are involved in project implementation and delivery at Umgeni Water was estimated at 50 people. Therefore, from the 50 questionnaires that were distributed, 44 participants returned their completed questionnaires making the study valid, based on a confidence level of 95% (0.05) and population size of 50 people. It was further established that questionnaires had no missing data and all questions had been answered accordingly. The focus of the questionnaires was directed towards suitably qualified, experienced and knowledgeable individuals that are currently engaged in infrastructure project delivery at Umgeni Water. This in turn increases the reliability of data received.

4.9 Chapter summary

The research design is an exploratory and descriptive case study that is analysed through a quantitative method. The primary data was obtained by distributing questionnaires. The secondary data used was gathered from numerous international and national sources, journals, articles, theses, books, conference papers, standards, reports and the internet. A quantitative approach was most applicable because the purpose of the research involves explaining of various factors influencing project delivery challenges within the construction industry. The composition of the questionnaire sample frame included Umgeni Water employees between Grade 5 to 9, with post-graduation experience greater than 3 years accompanied by a relevant qualification. A non- probability sampling technique was employed, namely, a selective method of expert sampling. 44 Umgeni Water employees were researched and sampled. Method of data analysis employed comprised of both descriptive and inferential statistics. Cronbach's alpha test was used to test internal consistency of data including its reliability.

CHAPTER FIVE: DATA PRESENTATION AND DISCUSSION

Chapter five displays the findings and discusses the results obtained from the questionnaires in this study. The questionnaire was the instrument tool that was utilised to collect data and was distributed to 50 Umgeni workers. The data gathered from the responses was evaluated with SPSS version 25.0. The results will present the descriptive statistics in the form of graphs, cross tabulations and other figures for the quantitative data that was collected. Inferential techniques comprise the utilisation of correlations and chi square test values; which are deduced using the p-values.

5.1 Response to questionnaire

Two questionnaires were utilised for the research which contains one main and a validation questionnaire which will be analysed in the next chapter.

5.1.1 Response to Main Questionnaire

Response rates from questionnaires at Umgeni Water were distributed as shown on Table 5.1.

Table 5.1: Response rate at Umgeni Water

Department	Sample Size (No)	Questionnaires Received (No)	Response Rate (%)
Project Office	20	16	80.0
Planning Department	8	7	87.5
Engineering Services	9	8	88.9
Quantity Surveying	5	5	100.0
Environmental	5	5	100.0
Land Servitudes	3	3	100.0

Questionnaire success rate = questionnaire received x 100 / (questionnaires administered – returned questionnaires)

44 x 100 / 50 = 88.0%

The questionnaire response rate for the main questionnaire is 88.0%. Hence, due to the number of questionnaires received, the response rate is considered sufficient for the implementation of the statistical analysis.

5.1.2 Steps taken to improve response rate

The following steps were taken in order to improve the response rate:

- The respondents were assured confidentiality by means of remaining anonymous;
- The covering letter was of a humane manner to the respondents and explained what needs to be measured;
- The length of the questionnaire was brief;
- Respondents were constantly reminded about completing the questionnaire through telephonic communication and frequent site visits.

5.1.3 Missing values

Undesirably, missing values in questionnaires can't be evaded, as some respondents had a limited comprehension of some aspects. Therefore, the questionnaire was structured in a manner that provided the respondents with the opportunity to choose the uncertain option instead of rating a factor incorrectly.

5.2 Demographic data

The section describes the demographics of the respondents appraised in the research:

- Respondents' gender;
- Respondents' age;
- Respondents' level of education;

- The total number of years of experience that the respondent possesses;
- The total number of years of the respondents' employment in Umgeni Water;
- The positions held by the respondents;
- The departments in Umgeni Water;
- The type of project that the respondents have been involved in at Umgeni Water.

5.2.2 Gender

Figure 5.1 indicates that the population of the male gender predominates with 77.3% as opposed to the female gender with 22.7%. Implicitly, this confirms that the construction industry is male dominant.

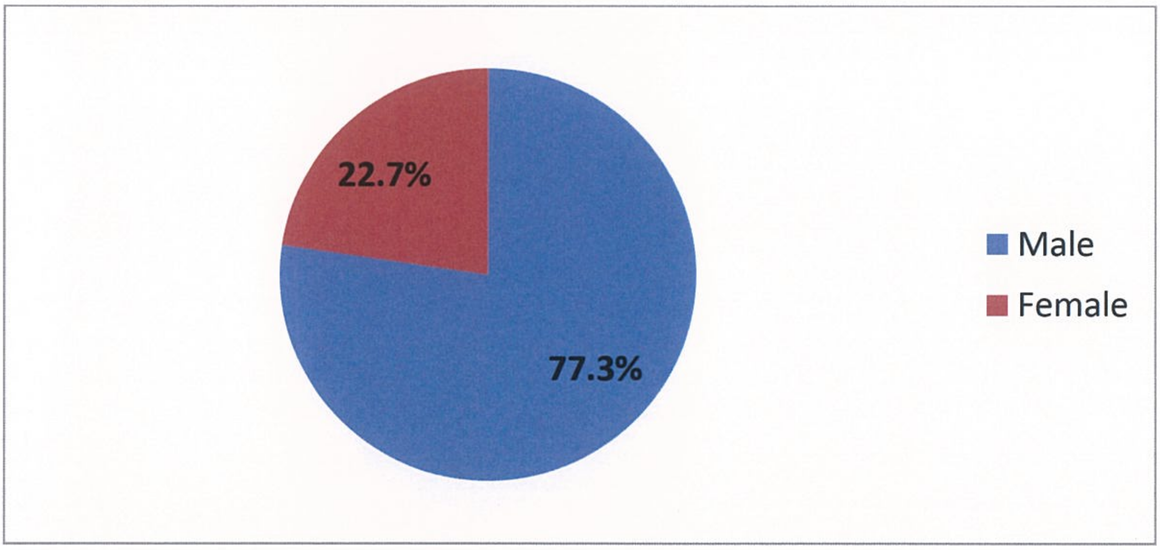


Figure 5.1: Gender distribution of respondent

5.2.3 Respondents' age

Figure 5.2 reveals the frequency of the respondents' age. Respondents between the ages of 30 – 45 are predominant by 43.2 %. Respondents between the ages of 20 – 29 years of age comprise of 36.4 %, whereas the respondents that are over 45 years of age constitute 20.5 %. Thus, the respondents that constitute the survey sample are mature, therefore have a high prospect of responsibility and are appropriately experienced in the construction industry.

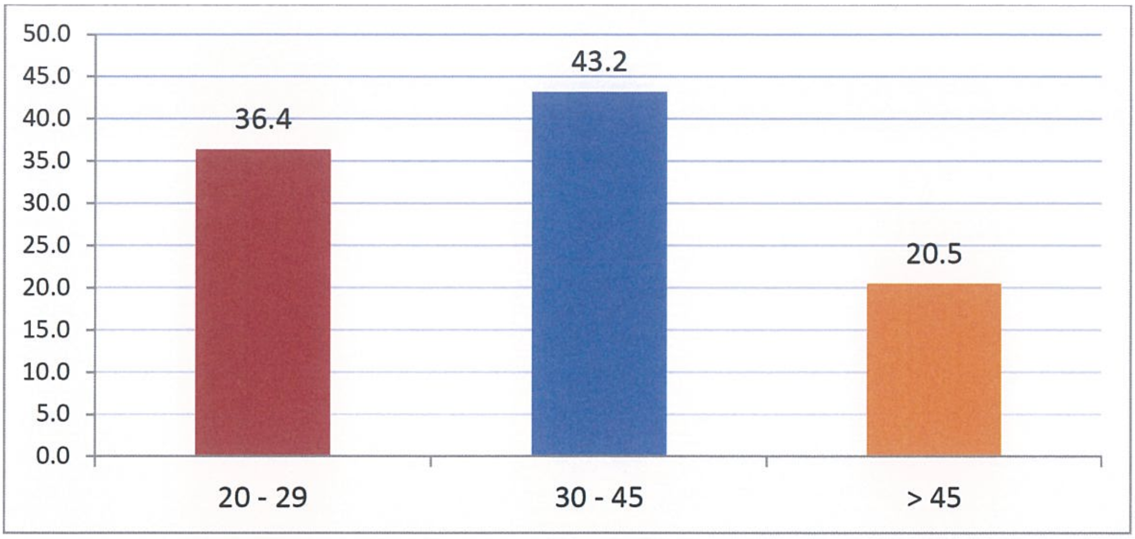


Figure 5.2 Respondents' age

5.2.4 Highest level of education

Figure 5.3 shows the level of education acquired by the respondents. Respondents with a qualification of a Bachelor's Degree are predominant by 31.8 %, followed by respondents with a B Tech Degree, totalling 20.5%. Respondents with a diploma qualification rate next to those who have a B Tech Degree in the form of 18.2 %. A portion of respondents constituting 11.4% have an Honour's Degree, along with respondents who have a Master's Degree also at 11.4 %. Lastly, the count for respondents possessing a Doctoral Degree came up to 6.8 %. Thus, illustrating that highly-qualified people are employed at Umgeni Water, hence performance standards are expected to be high. Furthermore, this means that their inputs can be relied on.

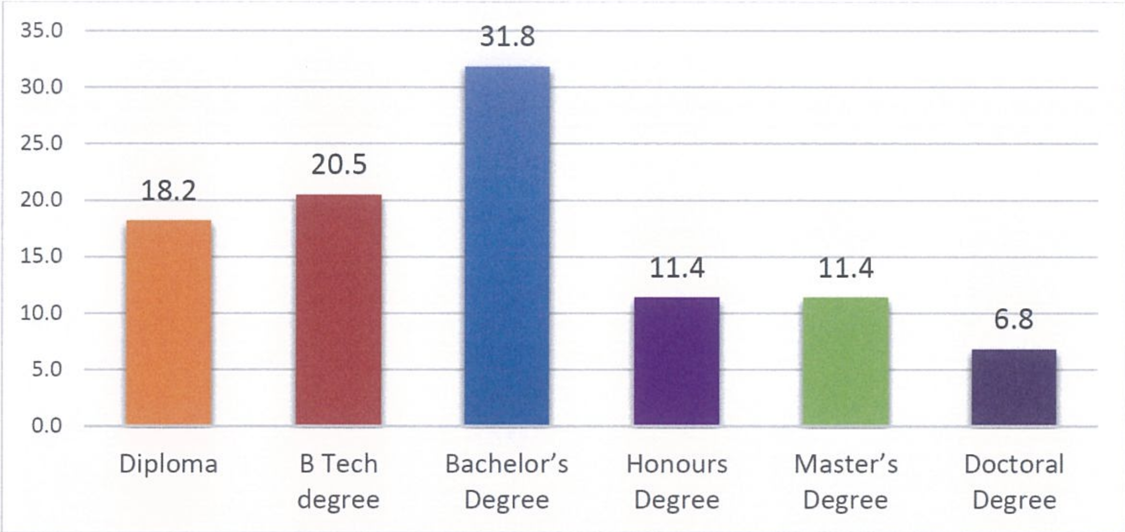


Figure 5.3 Distribution of respondents' qualifications

5.2.5 Respondents' total number of years of experience

Figure 5.4 indicates the respondents experience in the construction industry. Respondents ranging between 6 – 10 years of work experience in the construction industry predominate 45.5%, followed by 25.0 % of respondents with work experience between 11 – 15 years. Subsequently, 20.5% of respondents have work experience in the construction industry ranging between 21 – 25 years. The respondents with the least years of experience constitute 9.1% between 16 – 20 years. This analysis reveals that Umgeni Water is largely dominated by employees who have an adequate number of years of experience in the built environment, hence, the data obtained from the respondents is deemed reliable.

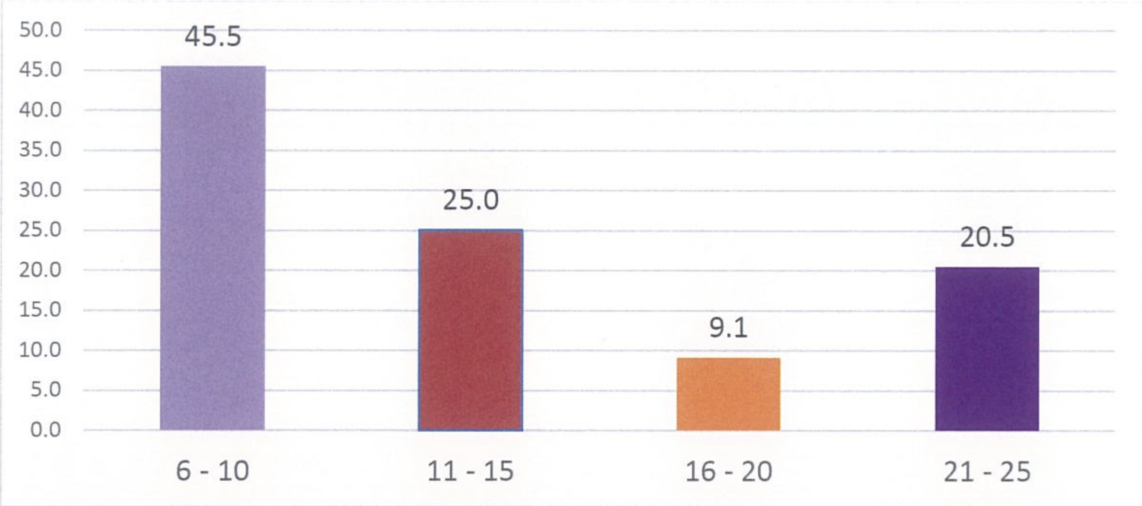


Figure 5.4: Respondents experience in the industry

5.2.6 Number of years employed at Umgeni water

Table 5.2 presents the frequency and percentage of the respondents' number of years of employment at Umgeni Water. Most respondents constituting 43.2% were employed at Umgeni Water for duration of 0 - 5 years, followed by 40.9% respondents who indicated 6 - 10 years of employment with the organisation. Subsequently, 11.4% respondents were employees of Umgeni Water for 11 – 15 years. The least representation of 4.6% respondents was employed with the organisation for 16 – 20 years. The analysis indicates that the organisation has a large quantity of newly employed professionals. Therefore, presumably, the new employees contribute to the evolvement of the organisation through fresh ideas obtained from outside the parameters of the company, thus indicating a non-biased approach to the data received.

Table 5.2: Number of years employed at Umgeni Water

Years	Frequency	%
0 – 5	19	43.2
6 – 10	18	40.9
11 – 15	5	11.4
16 - 20	2	4.6
Total	**44**	**100.0**

5.2.7 Position held at Umgeni Water

Figure 5.5 indicates that most respondents rated at 36.4% were Project Managers (PM), followed by 18.2 % Civil Engineers (CE). Next was 15.9 % Planning Engineers (PE), trailed by 11.4 % Environmental Project Managers (EPM) and 11.4% Quantity Surveying (QS), respondents. The least respondents were Servitude Administrators (SA) with 6.8%. The most respondents were project managers, who are considered to play a vital role in the construction industry. Hence, the high response rate from project managers is advantageous to this study, since the focus lies on the project life cycle and its delivery.

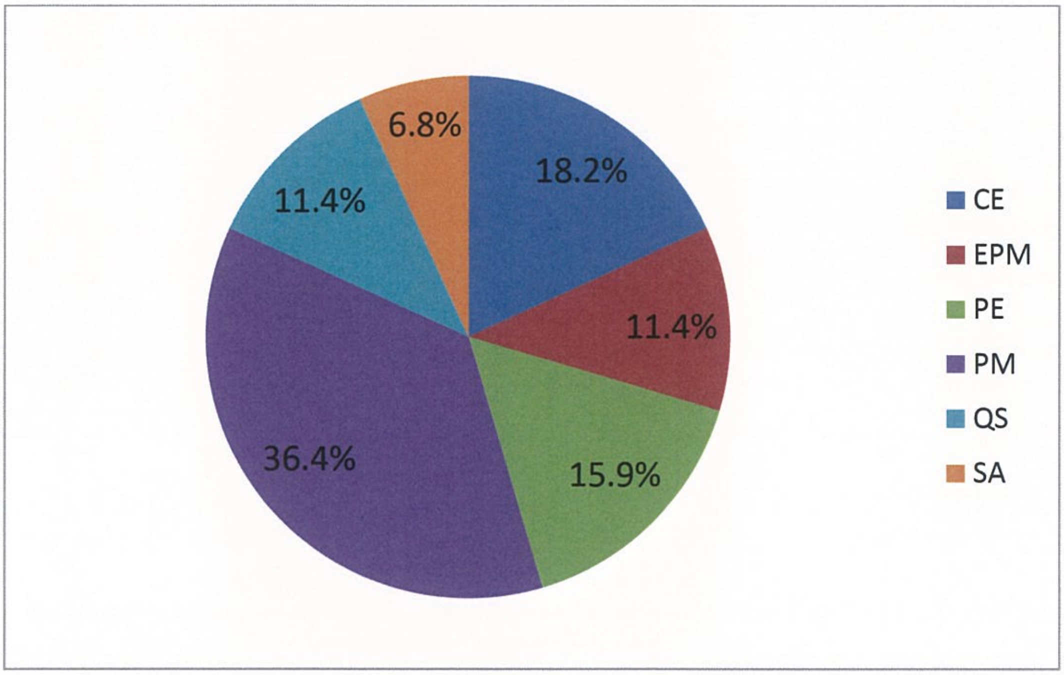


Figure 5.5: Respondents' positions at Umgeni Water

5.2.8 Departments of Umgeni Water

Figure 5.6 indicates that the respondents belong to the following departments at Umgeni Water. The 43.2% respondents belonging to the Project Office (PO) department are predominant. Rated next, is 29.5% respondents from the department of the Engineering Services (ENG), followed by the Planning Department (PD) with 15.9% respondents. The least respondents, constituting 11.4% belonged to the Environmental Department (ENV). Evidently, the Project Office (PO) had the highest response rate therefore indicating Umgeni Water places much emphasis on project implementation, hence the respondents are fully aware of project processes and are therefore a reliable source for this study.

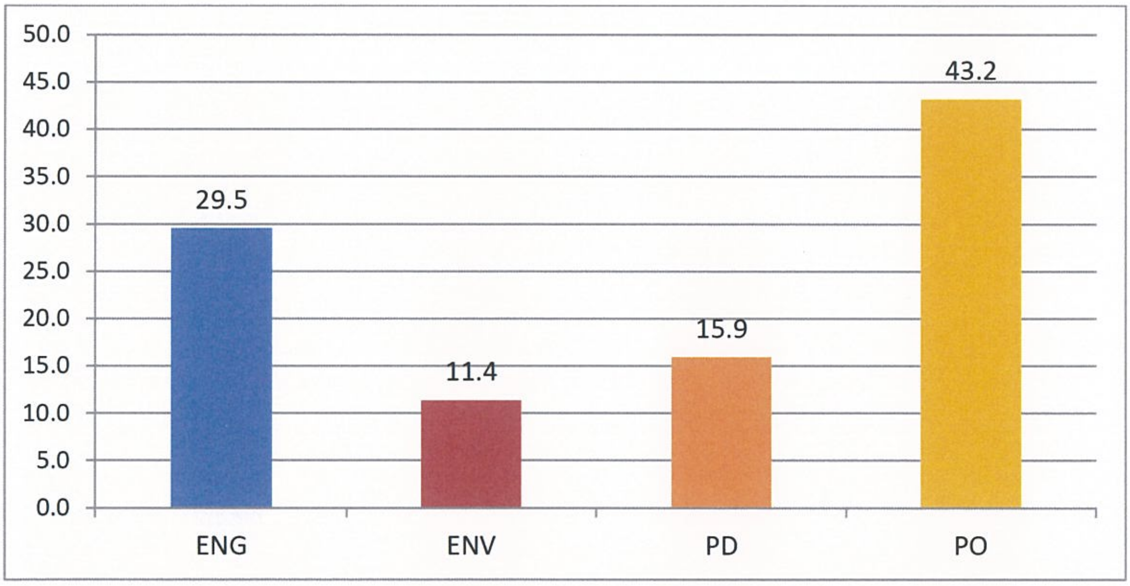


Figure 5.6: Respondents from Umgeni Water departments

5.2.9 Type of infrastructure projects at Umgeni Water

Figure 5.7 indicates the various types of projects respondents were involved in at Umgeni Water. The majority of the respondents comprising of 27.3% indicated that they were involved in all types of projects that Umgeni Water executes. Subsequently, 20.5% respondents were involved in Pipeline construction (PL). Reservoir Projects (RES) followed, comprised of 18.2% respondents'. Rated next, is 11.4% respondents involved in Pump Station (PS) projects, followed by respondents constituting 9.1% who are involved in Water Treatment Works (WTW), along with another 9.1% respondents engaged in Waste Water Treatment Works (WWTW). The least number of respondents is 4.5% who are involved in Dam constructions (DAM). The results indicate that the majority of respondents were involved in a variety of projects, hence are versatile and bring an abundance of experience to answering the questions covered in the questionnaire, satisfactorily.

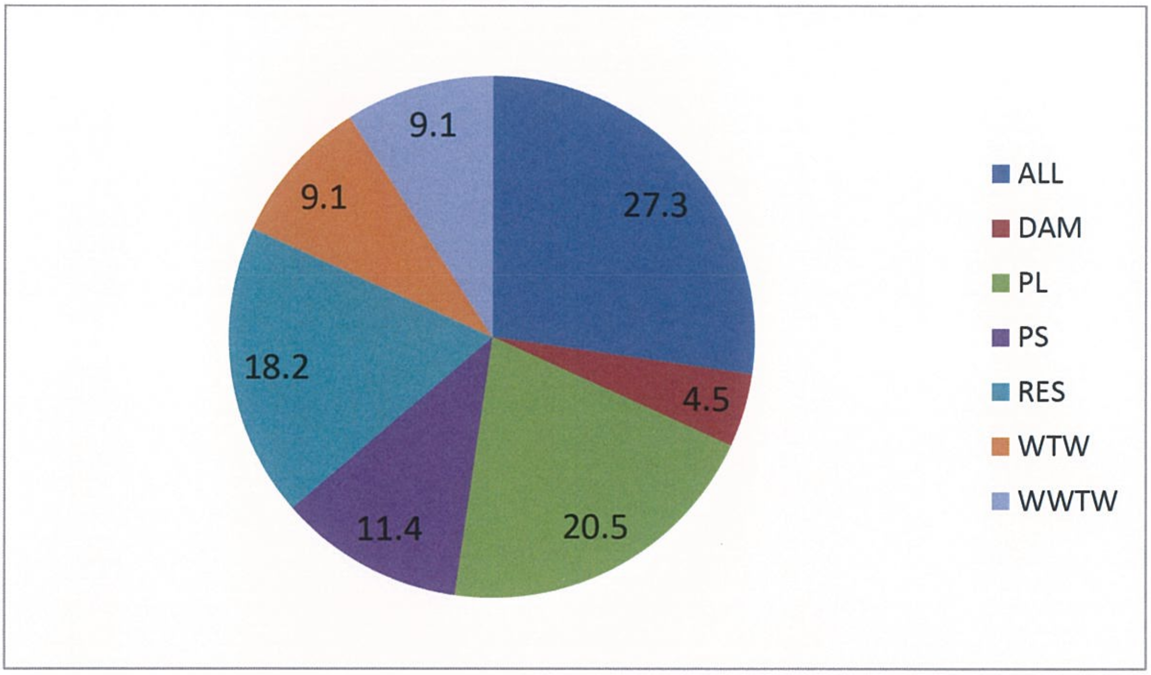


Figure 5.7: The types of projects respondents were involved in.

5.3 Main questionnaire

The main questionnaire is sub divided into two sections. The first section addresses project values, actual project value relative to original budget, project delays experienced and the type of projects relative to the above. The second section analyses the main questions.

5.3.1 Section 1

5.3.1.1 Project values

Respondents were asked to identify one completed project that they were involved in and to indicate the project value range. Figure 5.8 indicates that most respondents'

(27.3%) project values ranged from R51 – R100 million, followed by 25.0% of the respondents' project values varying between R11 – R50 million. Similarly, respondents with project values between R101 – R500 million were 25.0%, respectively. The least amount of respondents' (22.7%) project values were greater than R500 million.

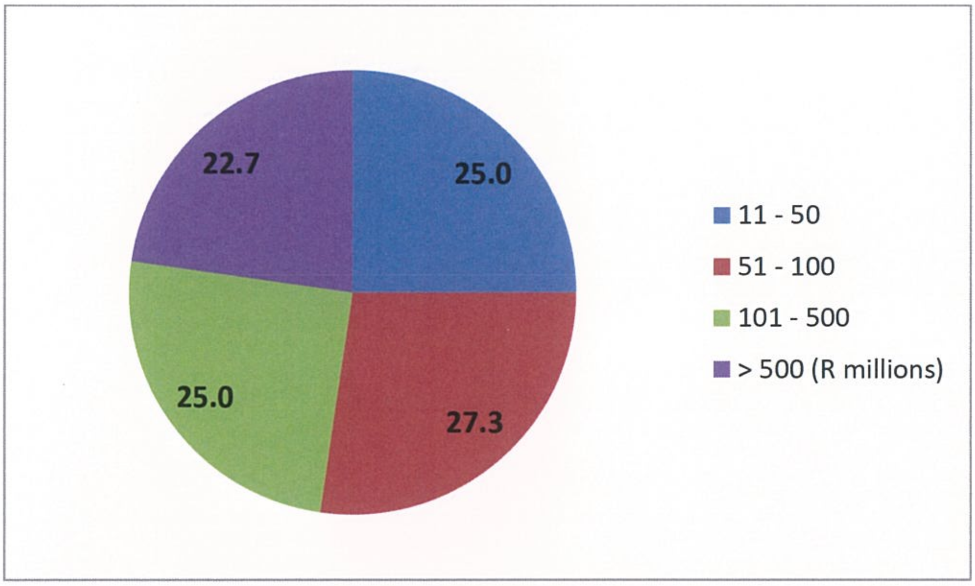


Figure 5.8: Indication of final project values of respondents selected projects

5.3.1.2 Actual project value relative to original budget

Figure 5.9 shows the actual project value in relation to the original budget. Most respondents (34.1%) revealed that the deviation between the final project value and the original budget is ranging from 16% – 30%, followed by 18.2% respondents that were between 31% - 45%. Rating next, are 22.7% respondents indicating a deviation of 46% - 60%, followed by 20.5% respondents specifying a deviation of 61% - 75%. The least number of respondents (4.5%) mentioned a deviation of over 75%.

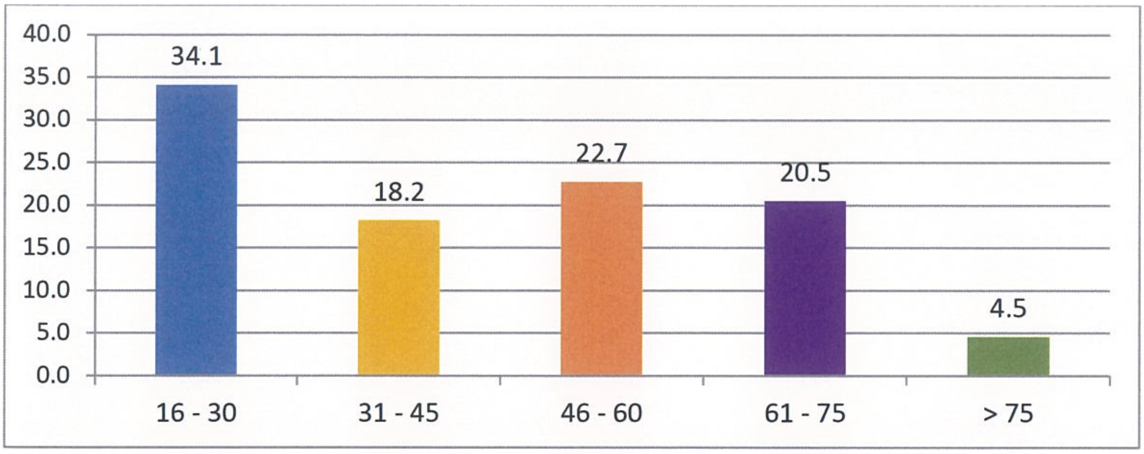


Figure 5.9: Percentage deviation between final project value and original budget.

5.3.1.3 Project delays experienced

Figure 5.10 represents the project delays experienced. It indicates that the greatest percentage of respondents (29.5%) revealed that the relative project was delayed by 6 – 10 months, followed by 27.3% of respondents who indicated a delay between 16 – 20 months. Thirdly, 20.5% of respondents stated that the delay was between 11 – 15 months. Following that, 13.6% of respondents mentioned a delay of 21 – 25 months, and the least percentage of respondents (9.1%) stated that the project was delayed by more than 25 months.

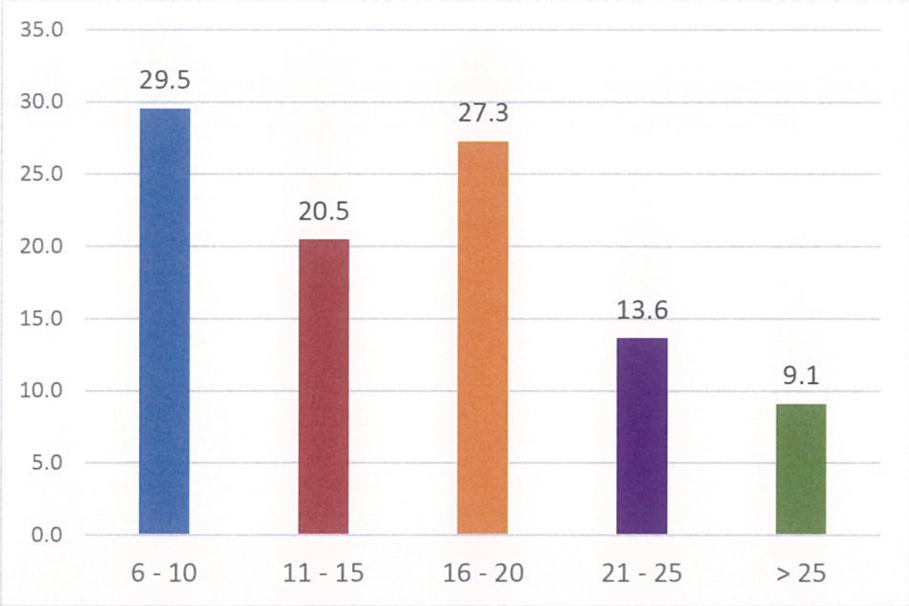


Figure 5.10: Delays experienced between the actual completion date to that of the planned completion date.

5.3.1.4 Type of project

Figure 5.11 indicates the type of project that the respondents were referring to in relation to all of the above questions put to them. Respondents involved in Pipe Line (PL) projects predominate in the sample by 29.5%, followed by 20.5% respondents that are involved in Reservoir (RES) projects along with 20.5% respondents that are involved in Bulk Waste Water Supply Schemes (SCH). Subsequently, respondents constituting 15.9% are engaged in Pump Stations (PS). Rated next, are 6.8% respondents that work in the Water Treatment Works (WTW), followed by 4.5% of respondents that are involved in the Waste Water Treatment Works (WWTW). The least respondents constituting of 2.3% indicated their involvement in Dam construction (DAM).

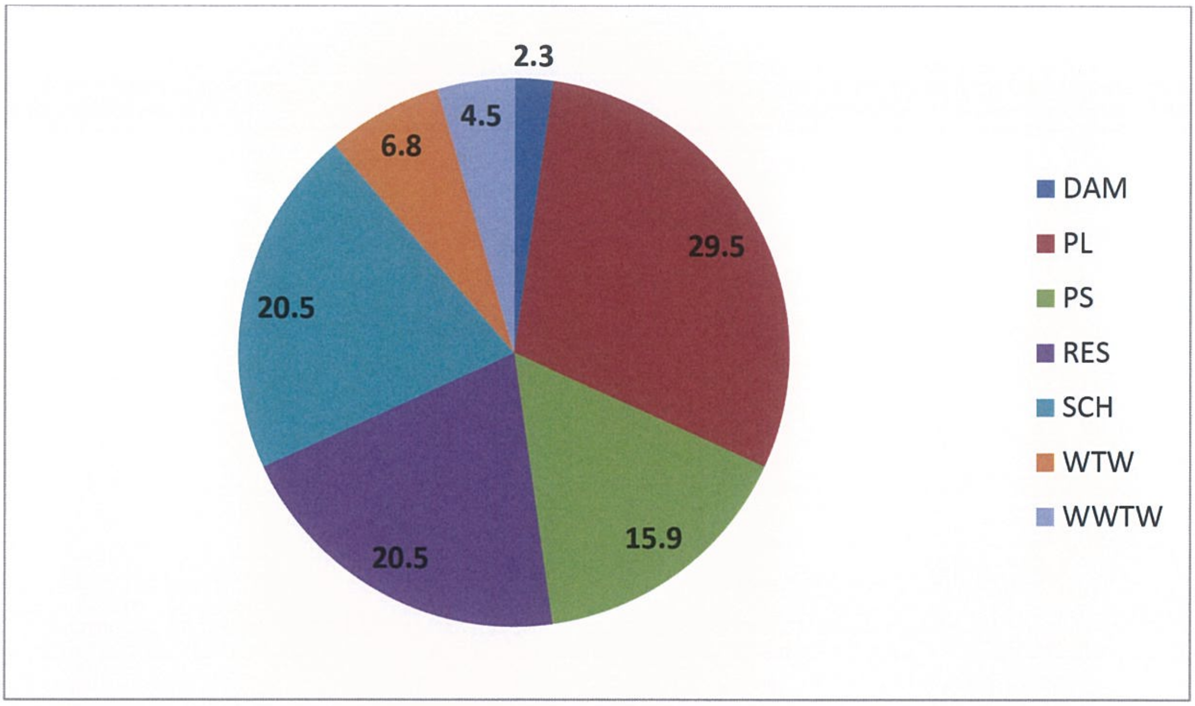


Figure 5.11: Respondents indication to project type.

5.3.2 Section 2 – Analysis of main questions

Questionnaires were employed in the collection of data. A five-point Likert scale, using "Unsure" and "Does not" options, was utilised to gauge the observations of employees within Umgeni Water in KwaZulu-Natal. Tables 5.7 to 5.15 show the observations of respondents relative to the project delivery challenges, causes and impacts in terms of percentage responses to a scale of 1 to 5, and a MS ranging between 1.00 and 5.00. MSs were calculated for each statement to allow an understanding of the percentages relative to each point on the response scale. Given that there are five points on the scale, and that 5 – 1 = 4, the ranges were defined by dividing 4 by 5 which equates to 0.8. Therefore, the ranges and their classifications are:

> 4.20 ≤ 5.00 between a near major to major / major influence;

> 3.40 ≤ 4.20 between moderate influence to a near major / near major influence;

> 2.60 ≤ 3.40 between a near minor to moderate influence / moderate influence;

> 1.80 ≤ 2.60 between a minor to near minor influence / near minor influence, and

> 1.00 ≤ 1.08 between a minor to near minor influence.

5.3.3 Reliability tests

The outcomes of the item analysis used to establish the reliability of the summated scores calculated for the factor categories are reported in this section. The Item analysis was concluded for the fifty-two statements in the questionnaire that were summated into scores for the nine factor categories. For each factor Cronbach's coefficient α was calculated and a factor analysis specifying a one factor model was conducted.

5.3.3.1 Cronbach's coefficient α test

Tests for the internal reliability of the factors in each category were conducted by determining their Cronbach's coefficient α value as demonstrated in Table 5.3.

Table 5.3: Cronbach's coefficient α value for all factor categories

Factor categories	No. of Items	Cronbach's Alpha
Project Delivery Challenges encountered at Umgeni Water	7	0.614
Factors which influence participation and contribution by the client	7	0.584
Factors influencing planning and designing	4	0.579
Factors influencing risk management	4	0.915
Factors influencing estimating	6	0.570
Factors which contribute to communication problems	6	0.461
Factors influencing quality	6	0.730
Factors which influence the implementation of a good project management approach	5	0.468
Impact of factors on project delivery at Umgeni Water	7	0.746

Cronbach's α value for all factor categories were > 0.5, with the exemption of two, which is regarded as adequate proof of internal consistency. It should be noted that Cronbach's α values of 0.50 to 0.70 are acceptable.

5.3.3.2 Results of factor analysis

Factors in each category were tested for correlation using factor analysis. The matrix tables are followed by a summary table that shows the results of KMO and Bartlett's Test. The Kaiser-Meyer-Olkin Measure of sampling adequacy should be greater than 0.5 and the Bartlett's Test of Sphericity should be less than 0.05. In all cases, the conditions are fulfilled, allowing for the factor analysis procedure. Factor analysis is conducted solely for the Likert scale items. Certain components are divided into smaller components, which are demonstrated below in the rotated component matrix.

Table 5.4: Summary of factor analysis conducted for categories

Factor Analysis	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	Bartlett's Test of Sphericity		
		Approx. Chi-Square	df	Sig.
Project Delivery Challenges encountered at Umgeni Water	0.526	22.273	15	0.051
Factors which influence participation and contribution by the client	0.516	29.471	15	0.014
Factors influencing planning and designing	0.500	0.000	1	0.099
Factors influencing risk management	0.755	117.338	6	0.000
Factors influencing estimating	0.423	6.982	6	0.032
Factors which contribute to communication problems	0.539	5.136	6	0.053
Factors influencing quality	0.725	92.201	15	0.000
Factors which influence the implementation of a good project management approach	0.447	5.365	3	0.069
Impact of factors on project delivery at Umgeni Water	0.560	110.898	21	0.000

Table 5.4 indicates that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy has seven values greater than 0.500 and therefore the conditions are satisfied for factor analysis. Furthermore, the Bartlette's Test of Sphericity indicated that sig. were greater than 0.05 and therefore did not satisfy conditions for factor analysis.

Table 5.5: Rotated Component Matrix for project delivery challenges encountered at Umgeni Water

Rotated Component Matrix[a]			
Factor	**Component**		
	1	**2**	**3**
Inadequate participation and contribution by the client during the project	0.083	0.057	0.943
Insufficient planning and designing done during the project	0.023	0.875	-0.127
Project risks that are poorly identified, assessed, mitigated and controlled during the project	0.661	-0.099	-0.304
Unsatisfactory cost estimating resulting in errors and oversights	0.567	0.081	0.090
Oversight of critical quality factors during the project	0.831	0.001	0.200
Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	0.001	0.801	0.243
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 4 iterations.			

The following tables fall under Table 5.5: Causes influencing project delivery challenges at Umgeni Water, which have been divided into seven sub-headings as follows:

Table 5.5 (a): Component Matrix for factors which influence participation and contribution by the client

Component Matrix[a]		
Factors	Component	
	1	2
Client misunderstanding of design drawings and specifications	0.718	0.232
Client lack of awareness regarding project processes	0.348	0.791
Weak authoritative decision making by the client	0.558	0.529
Lack of decision making by the client in a pressure situation	0.790	0.133
Clients absence towards contribution of ideas	0.481	0.280
Clients inability to brief the project team regarding the projects short and long term aims and objectives	0.334	0.472
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 5.5 (b): Component Matrix for factors influencing planning and designing

Component Matrix[a]	
Factors	Component
	1
Insufficient time given to plan and design the works	0.708
Skill shortage of designers in the consulting sector	0.708
Extraction Method: Principal Component Analysis.	
a.1 components extracted.	

Table 5.5 (c): Component Matrix for factors influencing risk management

Component Matrix[a]	
Factors	Component
	1
Unable to identify risks that has an effect on the project	0.924
Inadequate assessment of risks and realising its associated consequences	0.860
Inability to mitigate risks that have previously been identified	0.896
Unsatisfactory risk controlling strategies endorsed to control and monitor risks	0.893
Extraction Method: Principal Component Analysis.	

Table 5.5 (d): Component Matrix for factors influencing estimating

Component Matrix[a]		
Factors	Component	
	1	2
Inaccurate estimating towards project duration and contract period	0.716	-0.028
Error in judgement by overlooking risks that have a direct impact on costs	0.364	0.618
Lack of historical data	-0.103	0.832
Incorrect estimating techniques	0.837	-0.143
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 5.5 (e): Component Matrix for factors which contribute to communication problems

Component Matrix[a]			
Factors	Component		
	1	2	3
Communicating inaccurate information	0.782	-0.152	0.396
Misunderstanding the communication	0.051	0.826	-0.443
Overlooking the urgency of the communication and not keeping to communication timelines	0.791	0.064	-0.400
Circulation of incomplete communication	0.041	0.630	0.717
Extraction Method: Principal Component Analysis.			
a. 3 components extracted.			

Table 5.5 (f): Component Matrix for factors influencing quality

Component Matrix[a]		
Factors	Component	
	1	2
Poor quality of design work by consultants	0.780	-0.351
Weak quality of skills by the project manager	0.788	0.048
Using inferior quality of construction materials	0.802	0.240
Poor quality of workmanship performance	0.846	-0.234
Implementing a weak quality management system	0.672	0.485
Poor quality management methodologies used in processing quality planning, quality assurance and quality control	-0.107	0.790
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 5.5 (g): Component Matrix for factors which influence the implementation of a good project management approach

Component Matrix[a]		
Factors	Component	
	1	2
Lack of coordination capabilities by the project manager	0.805	0.283
Inexperience of the project manager	0.812	-0.252
Incompetence of the project manager	-0.024	0.956
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 5.6: Rotated Component Matrix for impact of factors on project delivery at Umgeni Water

Rotated Component Matrix[a]		
Factors	**Component**	
	1	**2**
Inadequate participation and contribution by the client during the project	0.081	0.837
Insufficient planning and designing done during the project	0.033	0.891
Project risks that are poorly identified, assessed, mitigated and controlled during the project	0.894	0.023
Unsatisfactory cost estimating resulting in errors and oversights	0.583	0.379
Communication problems within the project	0.591	0.139
Oversight of critical quality factors during the project	0.863	-0.015
Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	0.182	0.777
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Factor analysis is an arithmetical method whose key objective is data reduction, typically used in survey research, when a researcher requires characterising questions with a minor number of hypothetical factors. With reference to tables 5.5, 5.5(a) to 5.5(g) and 5.6 above:

The principle component analysis was used as the extraction method, and the rotation method was Varimax with Kaiser Normalization. This is an orthogonal rotation technique that reduces the number of variables that have a great impact on each factor, which indicates the elucidation of the factors.

- Factor loading shows inter-connections between variables.

- Items of questions that loaded correspondingly suggest measurement within a similar factor. An analysis of the subject of items loading at or above 0.5 (and utilising the highest loading in cases where items cross-loaded at greater than this value) measured along the various components.

The statements that made up some questions, such as factors influencing Risk Management loaded exactly along a single component. This suggests that the statements that constituted these sections perfectly measured what it set out to measure.

Notably, the variables that constituted other questions, such as Project Delivery Challenges, loaded along more than 1 component (sub-themes), which denotes that respondents recognised different trends within the section. Furthermore, the section comprises of colour coded splits, where Code 1 is yellow, Code 2 is green and Code 3 is blue.

5.4 Main Questionnaire Analysis

5.4.1 Project delivery challenges encountered during the Project Life Cycle at Umgeni Water

Table 5.7: Project delivery challenges encountered at Umgeni Water

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor............................Major							
			1	2	3	4	5			
Insufficient planning and designing done during the project	0.0	0.0	6.8	4.5	20.5	47.7	20.5	3.7	1.1	1
Communication problems within the project	0.0	0.0	6.8	11.4	31.8	34.1	15.9	3.4	1.1	2
Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	0.0	0.0	2.3	20.5	27.3	38.6	11.4	3.4	1.0	3
Inadequate participation and contribution by the client during the project	0.0	0.0	13.6	9.1	25.0	38.6	13.6	3.3	1.2	4
Project risks that are poorly identified, assessed, mitigated and controlled during the project	0.0	0.0	9.1	45.5	29.5	9.1	6.8	2.6	1.0	5
Unsatisfactory cost estimating resulting in errors and oversights	0.0	0.0	20.5	40.9	25.0	11.4	2.3	2.3	1.0	6
Oversight of critical quality factors during the project	0.0	0.0	29.5	31.8	27.3	6.8	4.5	2.3	1.1	7

Table 5.7 presents the respondents rating of project delivery challenges encountered during the project life cycle at Umgeni Water during infrastructure development. Notably, all factors in the category have MSs> 2.3 ≤ 3.7, which indicates that the factors have between a near minor to moderate / moderate influence.

The factor with the most significant influence is Insufficient planning and designing done during the project (MS = 3.7). This is as a result of inadequate effort out-laid at the front end of the project and insufficient time given to plan and design the works.

The second most significant factor in this category is communication problems within the project (MS = 3.4). This is due to overlooking the urgency of the communication and not keeping to communication timelines, including circulation of incomplete communication.

The third most significant factor in this category is inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach (MS = 3.4). The main reasons for this dilemma are the inexperience, weak leadership attributes, lack of coordination and incompetence of the Project Manager.

Inadequate participation and contribution by the client during the project (MS = 3.3) is the fourth most significant factor in this category due to weak authoritative decision making by the client and lack of decision making by the client in a pressurised situation, to name a few.

Project risks that are poorly identified, assessed, mitigated and controlled during the project (MS = 2.6) are the fifth most significant in this category, due to inadequate assessment of risks and realising its associated consequences, together with unsatisfactory risk controlling strategies endorsed to control and monitor risks.

Lastly, the least two significant factors in this category are unsatisfactory cost estimating resulting in errors and oversights (MS = 2.3) and oversight of critical quality factors during the project (MS = 2.3). Evidently, this is due to lack of historical data, incomplete project scope definition, design, specifications and information, weak quality of skills by the project manager and poor quality of design work by consultants, respectively.

5.4.2 Causes of project delivery challenges at Umgeni Water

Respondents were required to rate the causing factors that influence project delivery challenges encountered at Umgeni Water. The causes of challenges were divided into seven main categories which are participation and contribution by the client, planning and designing, risk management, estimating, communication problems, quality and implementation of a good project management approach. Under each main factor there were sub-factors. The factors with the most influence in these categories have MSs> 1.7 ≤ 4.0, which indicates that the factors have between a near minor to moderate / moderate influence.

5.4.2.1 Factors which influence participation and contribution by the client

Table 5.8: Factors influencing participation and contribution by the client

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor................................Major							
			1	2	3	4	5			
Weak authoritative decision making by the client	0.0	0.0	4.5	6.8	31.8	40.9	15.9	3.6	1.0	1
Lack of decision making by the client in a pressure situation	0.0	0.0	11.4	9.1	20.5	34.1	25.0	3.5	1.3	2
Client lack of awareness regarding project processes	0.0	0.0	18.2	15.9	27.3	20.5	18.2	3.0	1.4	3
Clients inability in understanding project constraints	0.0	0.0	13.6	22.7	27.3	22.7	13.6	3.0	1.3	4
Clients absence towards Contribution of ideas	2.3	0.0	20.5	15.9	31.8	15.9	13.6	2.9	1.3	5
Clients inability to brief the project team regarding the projects short and long term aims and objectives	0.0	0.0	22.7	18.2	22.7	27.3	9.1	2.8	1.3	6
Client misunderstanding of design drawings and specifications	0.0	0.0	45.5	43.2	6.8	4.5	0.0	1.7	0.8	7

The factor that has the most significant influence under participation and contribution by the client is: Weak authoritative decision making by the client (MS = 3.6) The most probable reason for this factor arises from the notion that construction projects need quick, fast and direct decision making in order to avoid delays and clients that prolong decision making have a negative effect on project milestones.

The second most significant factor in this category is lack of decision making by the client in a pressure situation (MS = 3.5). The most possible reason for this factor stems from the idea that construction projects are executed in a highly pressurised environment and the repercussions of making the incorrect decision in a pressure situation has adverse results on the project.

The least significant factor in this category is client misunderstanding of design drawings and specifications (MS = 1.7). This could imply that clients dealing with Umgeni Water are competent in understanding drawings and specifications.

5.4.2.2 Factors influencing planning and designing

Table 5.9: Factors influencing planning and designing

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor.................................Major							
			1	2	3	4	5			
Inadequate effort out-laid at the front end of the project	0.0	0.0	4.5	6.8	11.4	40.9	36.4	4.0	1.1	1
Insufficient time given to plan and design the works	0.0	2.3	11.4	4.5	22.7	43.2	15.9	3.5	1.2	2
Selection of lowest bidder over experienced design consultants	2.3	0.0	22.7	27.3	38.6	9.1	0.0	2.3	0.9	3
Skill shortage of designers in the consulting sector	0.0	0.0	29.5	29.5	27.3	9.1	4.5	2.3	1.1	4

The factor that has the most significant influence under planning and designing is: Inadequate effort out-laid at the front end of the project (MS = 4.0). The most probable reason for this factor stems from the perception that the value-add of front-end planning at the start of a project is important because it influences project success which plays a significant role in realising schedule, cost, and targets during the construction stage.

The second most significant factor in this category is insufficient time given to plan and design the works (MS = 3.5).The most likely reason for this factor comes from the idea of rushing the design process in order to commence with construction, therefore compromising the quality of the drawings.

The least significant factor in this category is the skills shortage of designers in the consulting sector (MS = 2.3). This implies that consultants employed by Umgeni Water have the necessary resources to fulfil their mandate.

5.4.2.3 Factors influencing risk management

Table 5.10: Factors influencing risk management

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor................................Major							
			1	2	3	4	5			
Inadequate assessment of risks and realising its associated consequences	0.0	2.3	6.8	47.7	29.5	11.4	2.3	2.5	0.9	1
Unsatisfactory risk controlling strategies endorsed to control and monitor risks	2.3	0.0	9.1	50.0	22.7	9.1	6.8	2.5	1.0	1
Inability to mitigate risks that have previously been identified	0.0	2.3	15.9	47.7	20.5	9.1	4.5	2.4	1.0	3
Unable to identify risks that has an effect on the project	0.0	0.0	15.9	54.5	15.9	9.1	4.5	2.3	1.0	4

The factor that has the most significant influence under risk management is: Inadequate assessment of risks and realising its associated consequences (MS = 2.5). The most probable reason for this factor arises from the notion there are various risks associated with construction projects and that risk comes from many sources. Therefore, the project budget and schedule should be controlled, assessed and modified according to the risk assessments to achieve a successful project.

The second most significant factor in this category is unsatisfactory risk controlling strategies endorsed to control and monitor risks (MS = 2.5).The most possible reason for this factor stems from the idea that risk monitoring and controlling is determined by the risk assessment and that the influence of the risk to the project can be controlled and monitored.

The least significant factor in this category is inability to identify risks that have an effect on the project (MS = 2.3).This implies that Umgeni Water has the necessary tools to identify risks, hence being able to avoid risks.

5.4.2.4 Factors influencing estimating

Table 5.11: Factors influencing estimating

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor................................Major							
			1	2	3	4	5			
Lack of historical data	0.0	0.0	4.5	6.8	11.4	40.9	36.4	4.0	1.1	1
Incomplete project scope definition, design, specifications and information	0.0	2.3	11.4	6.8	20.5	45.5	13.6	3.4	1.2	2
Inaccurate estimating towards project duration and contract period	0.0	0.0	13.6	22.7	27.3	22.7	13.6	3.0	1.3	3
Misunderstanding the projects complexity	0.0	0.0	20.5	15.9	34.1	15.9	13.6	2.9	1.3	4
Error in judgement by overlooking risks that have a direct impact on costs	2.3	0.0	22.7	18.2	20.5	27.3	9.1	2.8	1.3	5
Incorrect estimating techniques	0.0	2.3	18.2	27.3	29.5	20.5	2.3	2.6	1.1	6

The factor that has the most significant influence on estimating is: Lack of historical data (MS = 4.0). This could be caused by the difficulty to obtain and integrate historical data into estimating techniques.

The second most significant factor in this category is incomplete project scope definition, design, specifications and information (MS = 3.4).The most likely reason for this factor comes from the idea that in any construction project the consistency of the cost estimate is defined by the level shown in the description of the scope of works. Without a completed project definition and scope the platform is set for assumptions that lead to adverse circumstances.

The least significant factor in this category is incorrect estimating techniques (MS = 2.6).This implies that Umgeni Water has the correct tools and techniques in place to drive their estimating processes.

5.4.2.5 Factors which contribute to communication problems

Table 5.12: Factors which contribute to communication problems

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor.................................Major							
			1	2	3	4	5			
Overlooking the urgency of the communication and not keeping to communication timelines	0.0	0.0	4.5	6.8	11.4	43.2	34.1	4.0	1.1	1
Circulation of incomplete communication	0.0	0.0	9.1	6.8	25.0	45.5	13.6	3.5	1.1	2
Communicating inaccurate information	0.0	0.0	13.6	9.1	20.5	31.8	25.0	3.5	1.3	3
Communication barriers that prevents the flow of good communication	0.0	0.0	13.6	25.0	25.0	22.7	13.6	3.0	1.3	4
Communication procedures following incorrect process and channels	0.0	0.0	15.9	15.9	38.6	18.2	11.4	2.9	1.2	5
Misunderstanding the communication	0.0	0.0	22.7	11.4	29.5	27.3	9.1	2.9	1.3	6

The factor that has the most significant influence under communication problems is: overlooking the urgency of the communication and not keeping to communication timelines (MS = 4.0). The most probable reason for this factor arises from the view that in the construction industry, time is measured as one of the most vital parts of the project and this also applies to communication. Hence, through adhering to correctly managed communication, timelines can improve the projects communication structures which are advantageous to the project as a whole.

The second most significant factor in this category is circulation of incomplete communication (MS = 3.5).The most possible reason for this factor stems from the concept that communication needs to cover all significant aspects with the objective to give a full picture of its purpose in order to avoid misinterpretation, misjudgement and misrepresentation.

The least significant factor in this category is misunderstanding the communication (MS = 2.9). This implies that Umgeni Water has the proper communication systems in place to combat any communication mishaps.

5.4.2.6 Factors influencing quality

Table 5.13: Factors influencing quality

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor................................Major							
			1	2	3	4	5			
Weak quality of skills by the project manager	0.0	2.3	15.9	22.7	43.2	9.1	6.8	2.7	1.1	1
Poor quality of design work by consultants	0.0	0.0	6.8	50.0	34.1	4.5	4.5	2.5	0.9	2
Implementing a weak quality management system	2.3	0.0	18.2	29.5	38.6	6.8	4.5	2.5	1.0	3
Poor quality of workmanship performance	0.0	0.0	25.0	27.3	38.6	4.5	4.5	2.4	1.1	4
Poor quality management methodologies used in processing quality planning, quality assurance and quality control	0.0	2.3	31.8	27.3	25.0	11.4	2.3	2.2	1.1	5
Using inferior quality of construction materials	0.0	0.0	52.3	11.4	25.0	11.4	0.0	2.0	1.1	6

The factor that has the most significant influence on quality is: Weak quality of skills by the project manager (MS = 2.7). The most probable reason for this factor arises from the perception that the project manager plays the most pertinent role on the project from the initial phases through to construction then project close-out. All information, risks, communication and processes are coordinated, circulated, handled and observed by the project manager. Therefore, should the project manager fail to maintain the required standard of quality, there may be devastating consequences on the project.

The second most significant factor in this category is poor quality of design work by consultants (MS = 2.5). The most likely reason for this factor comes from the concept that contractors building a specific product require the correct information from drawings and specifications to reach their objective and the quality of these drawings and specifications has an effect on the outcome of a project.

The least significant factor in this category is using inferior quality of construction materials (MS = 2.0). Hence the assumption is that Umgeni Water has the appropriate quality control systems in place.

5.4.2.7 Factors which influence the implementation of a good project management approach

Table 5.14: Factors which influence the implementation of a good project management approach

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor.................................Major							
			1	2	3	4	5			
Inexperience of the project manager	0.0	0.0	4.5	6.8	11.4	40.9	36.4	4.0	1.1	1
Weak leadership attributes of the project manager	2.3	2.3	4.5	6.8	27.3	40.9	15.9	3.6	1.0	2
Lack of coordination capabilities by the project manager	0.0	0.0	11.4	9.1	20.5	34.1	25.0	3.5	1.3	3
Incompetence of the project manager	0.0	0.0	9.1	6.8	25.0	45.5	13.6	3.5	1.1	4
Lack of commitment shown by the project manager	0.0	0.0	13.6	25.0	25.0	22.7	13.6	3.0	1.3	5

The factor that has the most significant influence under implementation of a good project management approach is: Inexperience of the project manager (MS = 4.0). The most feasible reason for this factor results from the observation that an inexperienced manager in any industry can prove costly. Additionally, inexperience inclines to bring many undesirable factors such as, poor quality of work, bad attitude, weak attendance, poor client relations, weak time management and lack of teamwork skills.

The next most significant factor in this category is weak leadership attributes of the project manager (MS = 3.6). The most likely reason for this factor comes from the concept that any lack of leadership shown by the project manager will lead to failure in reaching the project objective, thus, good leadership qualities are eminent in any project.

The least significant factor in this category is lack of commitment shown by the project manager (MS = 3.0). Hence the assumption is that Umgeni Water's project managers are dedicated and committed to their duties and responsibilities.

5.4.3 Impact of these factors on project delivery at Umgeni Water

Table 5.15: Impact of these factors on project delivery at Umgeni Water

Factor	Response (%)							Mean Score	Standard Deviation	Rank
	Unsure	Does not apply	Minor........Major							
			1	2	3	4	5			
Insufficient planning and designing done during the project	0.0	0.0	4.5	18.2	13.6	20.5	43.2	3.8	1.3	1
Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	0.0	0.0	6.8	22.7	22.7	18.2	29.5	3.4	1.3	2
Inadequate participation and contribution by the client during the project	0.0	0.0	11.4	15.9	20.5	38.6	13.6	3.3	1.2	3
Communication problems within the project	0.0	0.0	15.9	27.3	15.9	34.1	6.8	2.9	1.2	4
Unsatisfactory cost estimating resulting in errors and oversights	0.0	0.0	9.1	34.1	34.1	15.9	6.8	2.8	1.1	5
Project risks that are poorly identified, assessed, mitigated and controlled during the project	0.0	0.0	13.6	43.2	31.8	6.8	4.5	2.5	1.0	6
Oversight of critical quality factors during the project	0.0	0.0	20.5	36.4	27.3	11.4	4.5	2.4	1.1	7

Table 5.15: presents the respondents rating regarding the impact of challenges on project delivery at Umgeni Water. Notably, all factors in the category have MSs > 2.4 ≤ 3.8, which indicates that the factors have between a near minor to moderate / moderate influence.

The factor that has the greatest significant impact in the category is insufficient planning and designing done during the project (MS = 3.8). The probable reason is the emergence of discrepancies during the construction process, which could lead to multiple variation orders which is undesirable.

The second most significant factor in the category is inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach (MS = 3.4). The inexperience and incompetence of a project manager on any project could result in unsuccessful project delivery.

The third most substantial factor in the category is inadequate participation and contribution by the client during the project (MS = 3.3). Presumably, if the client is not fully involved in the project processes, gaps will arise, therefore having a negative impact on project delivery.

The least significant factor in the category is the oversight of critical quality factors during the project (MS = 2.4). The probable cause for this could be that contractors and consultants are employed to manage project quality, hence removing the responsibility from Umgeni Water.

5.5 Discussion of the findings (phase 1 questionnaire)

The findings of the study indicate that the most significant challenges facing Umgeni Water are insufficient planning and designing, which ultimately causes delays and budget over-runs during the construction stage. The findings have also been attested by van der Weijde (2008). Furthermore, Serrador (2013) concurs that pre-planning and designing is vital to the success of a project and if not carried out adequately, the negative effects emerge during the construction implementation phase. George *et al.* (2008) recommend that when sufficient planning and designing is carried out, risks are minimised during construction.

The study also presented the underlying causes at the project delivery challenges encountered at Umgeni Water. The leading causes are related to inadequate effort out-laid at the front end of the project, lack of estimating historical data, overlooking the urgency of communication and keeping to communication timelines, and inexperience of the project manager. Jaggernath (2017), Pickett and Elliot (2007), Chan *et al.* (2004) and Jagdev (2012) share the view that, the causes have a significant influence on the relative challenges that affect the successful delivery of a project.

The findings of the study also indicate that insufficient planning and designing, together with inadequate attributes and capabilities endorsed by the project manager, are the leading factors that have a huge impact on the delivery of a project. The lack of planning and designing has the most substantial impact on project delivery (Serrandor, 2013). Similarly, an inadequate project manager is catastrophic to any project and has the most significant impact on project delivery (Maxwell *et al.*, 2016).

5.6 Testing of hypotheses

To establish if the scoring trends per statement were significantly different per option, a chi square test was conducted. It can be concluded that respondents scoring similar numbers across statements can result in a null hypothesis (one statement at a time). The alternate states that there is a significant difference between the levels of major influence and minor influence.

The methods to reporting results require a statement of statistical significance. A p-value is generated from a test statistic. A significant result is indicated with "$p < 0.05$".The results for P-Values are presented in Table 5.16.

Table 5.16: Summary of P-Values conducted on the Hypotheses

Null Hypotheses	Chi-Square	df	Asymp. Sig. (P-Value)
Inadequate participation and contribution by the client during the project	10.55	4	0.032
Insufficient planning and designing done during the project	18.05	4	0.001
Project risks that are poorly identified, assessed, mitigated and controlled during the project	24.86	4	0.000
Unsatisfactory cost estimating resulting in errors and oversights	15.55	4	0.004
Communication problems within the project	10.09	4	0.039
Oversight of critical quality factors during the project	13.96	4	0.007
Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	6.23	4	0.183

A chi-squared test is a statistical hypothesis test that is valid to perform when the test statistic is chi-squared distributed under the null hypothesis which was required and significant to the study. To make a conclusion about the hypothesis with 95% confidence, the value labelled Asymp. Sig. (which is the p-value of the Chi-Square statistic) should be less than .05 (which is the alpha level associated with a 95% confidence level). P-values that are less than .05 can be concluded that the variables are not independent of each other and that there is a statistical relationship between the categorical variables.

5.7 Chapter summary

This chapter outlined the results of the quantitative data analysed in this study. These results to answer research questions and test research hypothesis were obtained by using both descriptive and inferential statistics. The information obtained from the background profile assessment of the respondents surveyed gave a good range indication of gender, age, qualification, experience and relation to Umgeni Water. Questionnaires were employed to analyse the main research questions. The outcomes of the item analysis used to establish the reliability of the scores calculated for the factor categories were reported. Tests for the internal reliability of the factors in each category were conducted by determining their Cronbach's coefficient α value. Factors in each category were tested for correlation using factor analysis. Factor analysis conditions were satisfied using Kaiser-Meyer-Olkin Measure of sampling adequacy. Component Matrix was conducted on each factor.

CHAPTER SIX: DEVELOPMENT OF A PROJECT DELIVERY MODEL

6.1 Introduction

In relation to the second objective of the study as illustrated in chapter one, the intention was to attempt to develop a project delivery model for Umgeni Water's infrastructure projects. The researcher identified three key areas which need to be co-ordinated and collaborated in order for this development; these three key areas being: data analysis findings, National Treasury's IDMS model and distinguished project life cycle methodologies currently in use in the project management environment.

6.2 Data analysis findings

The data analysis findings identified in chapter five, gave the researcher direction on the key focus areas based on organisational perception. It was established that there is a need for a project delivery model and that there are some major project delivery challenges encountered at the organisation during project planning and implementation. The researcher has taken consideration of these findings in developing the model.

6.3 National Treasury's IDMS model

As established in the literature review of chapter two, National Treasury developed a standardised, general and fit-for purpose IDMS project delivery model based on best practise project life cycle methodologies for State-Owned entities in all sectors of government. The researchers development of the study's project delivery model is in line and compliant with the standards and requirements as set out in National Treasury's IDMS model.

6.4 Project life cycle - methodologies

There are various types of project life cycles. For the purpose of this research the following project life cycle methodologies have been assessed: waterfall, incremental, agile together with project lifecycle phases.

6.4.1 Waterfall project life cycle

Bhunu (2007), states that the waterfall model was created in the 1970's. The models name depicts a picture of water flowing down. Project Smart Executive Brief (2008), explains that the waterfall method has confirmed its capability and is classified as a progressive model with visibly distinct outputs for each phase. Scheid (2015) confirms that the waterfall method has critics that claim it does not embrace change control if things go wrong. Bhunu (2007) explains the number of stages can differ and subject to project requirements and there is a distinct evolution between stages or phases. According to Bhunu (2007), the waterfall project life cycle can be associated with projects of high value and long durations.

6.4.2 Incremental project life cycle

Project Smart Executive Brief (2008), indicates the key aim of the incremental method is to develop the project life cycle in manageable increments, starting from basic requirements and gradually adding more requirements until completion. In comparison to the waterfall, the incremental method allows for change requirements. According to Bhunu (2007), the idea behind the incremental project life cycle is that of targeting to complete finished products at the end of each phase. The complete project cycle is led by a sequence of goals which are allocated to each phase. Sawant (2013) confirms that deliverables are handed over incrementally in terms of project program. Bhunu (2007) explains the incremental project life cycle can be related with projects of high value and short durations or low value and long durations and that this model required high management intervention.

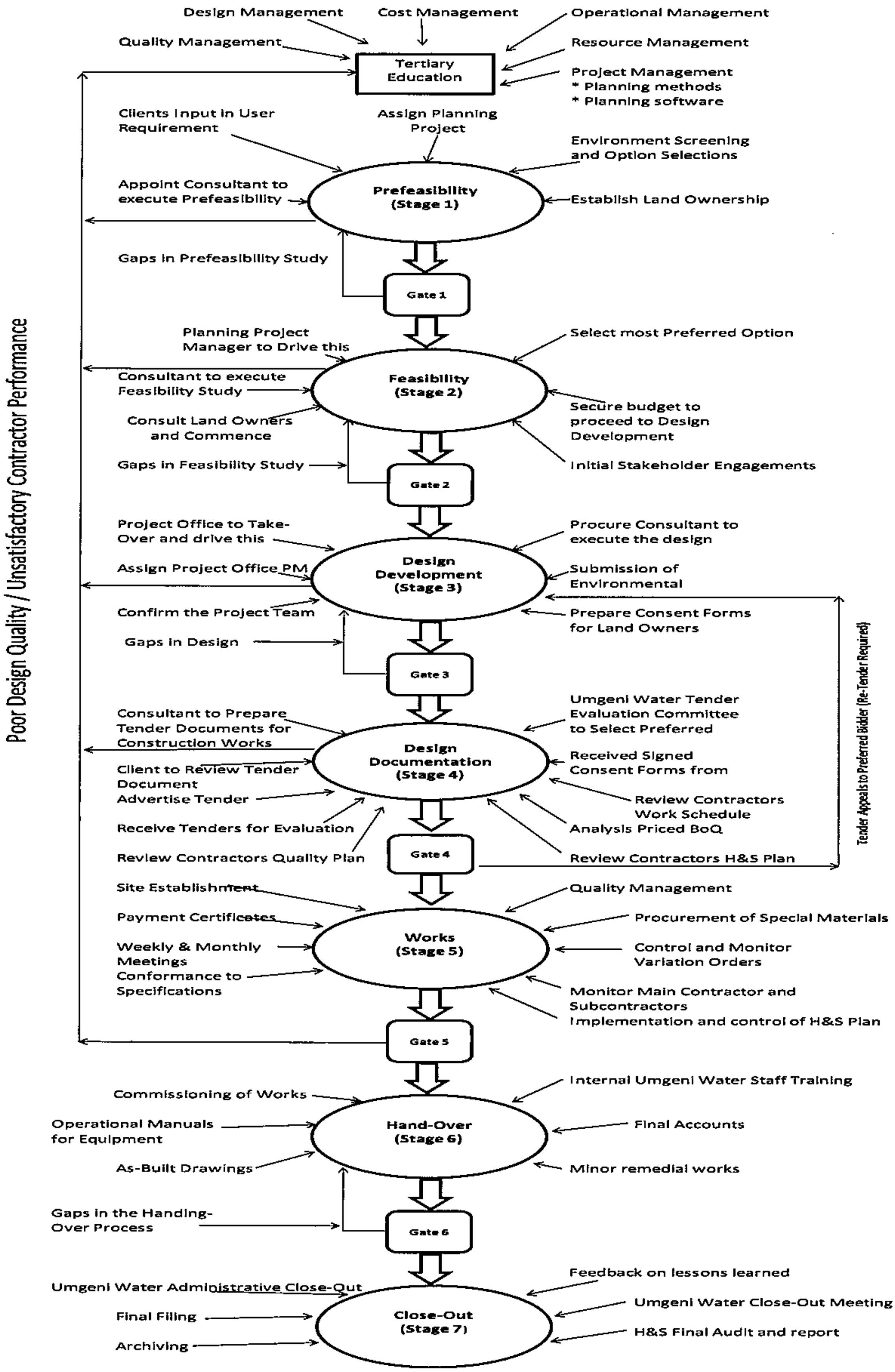
6.4.3 Agile project life cycle

Bhunu (2007) confirms that the agile method also known as the extreme programming method is just developing as a theoretically feasible life cycle. The agile method aims to reduce time in the early phases. The objective is to reach implementation as quickly as possible. Scheid (2015) further elaborates that using the agile method assists in defining the project requirements to clients and project teams, monitoring changes and communication. Project Smart Executive Brief (2008) states companies are cutting output and delivery times from months to weeks. Sawant (2013) reinforces that the agile methodology has numerous flexible and adaptive methods that are used to execute and manage the project. As stated by Bhunu (2007) the agile method can be associated with projects of low value and short durations.

6.4.4 Project life cycle – phases

PMI (2013) describes the project life cycle as a set of project phases that provide improved management control and appropriate links to the on-going operations of the performing organisation. A standard project typically has the following four major phases: initiation, planning, execution and closure (Barron *et al.*, 2009). This model is referred to as the 4 stage project life cycle. Another approach is that of the 5 stage project life cycle as defined by the PMI (2013), which includes the: initiation, planning, execution, controlling and closing phases. This model includes the: feasibility, initiation, planning, execution, closing and post-project evaluation phases.

6.5 Project delivery flowchart model



6.5.1 Components constituting the model

The model seeks to provide detailed input and output on each of the stages within a project. It will also explain activities that must be carried out in each stage.

There are seven distinct stages, which make up the model. Each of these stages are unique and standalone but collectively, they make up the entire project life cycle process. Projects are not insular or standalone, they interact with various departments within Umgeni Water from the initial concept through to completion, operating and maintenance. Projects rely on these interfaces in order to be successfully completed.

Each stage is separated by a gate. The gate (or gate review) is a form of independent due diligence to ensure that correct processes were followed during the recently completed stage and that the activities and deliverables successfully met the predefined standards and maturity levels for that stage. The gate review either indicates the start of a stage or the end of a stage. Each stage is driven by project management processes that occur in a particular order. These processes, if carried out correctly ensure positive outcomes for each stage.

A Project Manager understands the importance of team motivation and the impact it has on project results Using Maslow's theory, will look at how needs direct human behaviour and identify techniques based on the theory that can be used on projects. Apply the theory to know project team members as individuals and working to understand their specific needs through-out the project lifecycle, will help identify what actions are needed on your part to keep them motivated at different stages of the project.

The General Systems theory is particularly essential and will prove useful for its implementation into a project lifecycle in providing a framework in developing a project delivery model. A systems approach to a project allows for the breakdown of systems, within a project, into subsystems, and provides the methods and tools which will affect the system, hence considering each systems requirement to proceed.

6.5.1.1 Definition of Each Stage

- **Stage 1 – Prefeasibility**

  The Prefeasibility Study Stage considers various options for the implementation of the project, with a focus on ensuring that the most fit-for-purpose option or solution is not overlooked. Technical, environmental, desktop geotechnical and social issues are considered to exclude those alternatives with fatal flaws and to narrow down the viable options to a limited shortlist for further consideration.

  - Assign planning Project Manager;
  - Environment screening and option selections;
  - Establish land ownership;
  - Appoint consultant to execute a prefeasibility study;
  - Client's input in user requirement specification;
  - Gate review 1 – Gaps in the prefeasibility stage are detected at gate review 1 allow for re-evaluation.

- **Stage 2 – Feasibility**

  The Feasibility study takes the preferred alternatives developed under the Prefeasibility Stage, and through further study and investigation refines the engineering and costing to a point where a single accepted project or solution can be identified, having been confirmed through a set of clearly defined parameters. The purpose of the Feasibility study, aside from selecting the above solution, is to determine whether it is feasible to proceed to the Detail Design Process.

  - Select most preferred option;
  - Secure budget to proceed to design development;
  - Initial stakeholder engagement;
  - Consult land owners and commence negotiations;
  - Consult to execute feasibility study;
  - Planning Project Manager to drive the feasibility stage;
  - Gate review stage – Gaps in feasibility study detected which allows for re-evaluation.

- **Stage 3 - Design Development**

  Design Development takes the accepted concept or project and thoroughly develops initial engineering designs, specifications, performance parameters etc. to create a comprehensive description of the project and packages for tender and construction purposes, including updated cost estimates and schedules.

  - Procure consultant to execute the design;
  - Submission of environmental approvals;
  - Preparation of consent forms for land owners;
  - Confirmation of project team;
  - Assign Project Office PM (Project Manager);
  - Project Office to take over and drive stage 3;
  - Gate review 3 – Gaps in design development detected, allows for re-evaluation.

- **Stage 4 – Design Documentation**

  Once the initial design has been confirmed through the Design Development stage and its approvals process, the final detailed engineering, specifications and other information is developed, as required for tender and/or manufacture, fabrication or construction.

  - Advertise tender;
  - Consultant to prepare tender documents for construction works;
  - Receive tenders for evaluation;
  - Umgeni Water tender evaluation committee to select preferred bidder;
  - Receive signed consent forms from land owners;
  - Receive contractors work schedule;
  - Analysis of priced BoQ;
  - Review contractors' Health and Safety plan;
  - Review contractors' quality plan;
  - Client to review tender document;
  - Gate review 4 – Tender appeals to preferred bidder therefore re-tender required.

- **Stage 5 – Works**

- The Works stage covers the construction or installation of the project including testing and snagging, and is completed once the works stage is certified in accordance with the provisions of the contract being utilised.
  - Site establishment;
  - Quality management;
  - Procurement of special materials;
  - Control and monitor variation orders;
  - Implementation and control of Health and Safety Plan;
  - Gate 5 – Poor design or unsatisfactory contract performance.

- **Stage 6 – Hand-over**

  Hand-over comprises the completion of all documentation such as operating and maintenance manuals, record drawings, warranties, spares schedules, etc. that form the final record of the project. It includes pre- or cold-commissioning by the constructor prior to handover.
  - Commissioning of works;
  - Operational manuals for equipment;
  - As built drawings;
  - Internal Umgeni Water staff training;
  - Minor remedial works;
  - Gate 6 – Gaps in commissioning detected to allow for re-evaluation.

- **Stage 7 – Close-out**

  This initial stage of close-out may be required in cases where commissioning, ramp-up and acceptance/performance testing are required in order to achieve partial or interim close-out and acceptance of the facility into full operation.
  - Umgeni Water administrative close-out;
  - Final filing of project documents;
  - Archiving;
  - Health and Safety final audit and report;
  - Umgeni Water close-out meeting;
  - Feedback on lessons learned.

6.6 Validation of the Model

An assessment was piloted amongst professionals within Umgeni Water in order to authenticate the model. A total of twenty nine employees signifying strategic professions at Umgeni Water were surveyed using the validation questionnaire. These professionals are project managers, civil engineers, planning engineers, and quantity surveyors. The mean score (MS), percentage frequency and test of means difference were used in the analysis of the data. To facilitate interpretation of the MS, the MS range used during the interpretation of means of data is illustrated below.

$> 4.20 \leq 5.00$ between a near major to major / major influence;

$> 3.40 \leq 4.20$ between moderate influence to a near major / near major influence;

$> 2.60 \leq 3.40$ between a near minor to moderate influence / moderate influence;

$> 1.80 \leq 2.60$ between a minor to near minor influence / near minor influence, and

$> 1.00 \leq 1.08$ between a minor to near minor influence.

6.6.1 Data presentation and analysis

6.1.1.1Below is a presentation of Cronbach's α for validation data

Table 6.1 Cronbach's α for validation data

Interventions category	Cronbach's α
Stage 3 - Design Development	**0.946**
Stage 4 – Design Documentation	**0.946**
Stage 5 – Works	**0.929**
Stage 6 – Hand-Over	**0.926**
Stage 2 – Feasibility	**0.923**
Tertiary Education - Built Environment	**0.913**
Stage 7 – Close-out	**0.883**
Stage 1 – Prefeasibility	**0.872**

The Cronbach's α value for interventions category are all > 0.80. Based upon these, the internal consistency of the data can be deemed reliable.

6.1.2 Ranking of interventions categories

Table 6.2: Ranking of interventions categories

Project Delivery Model - Validation Questionnaire								Mean	Rank
Interventions	**U**	**DN**	**Minor........................Major**						
			1	**2**	**3**	**4**	**5**		
Stage 3 - Design Development								**3.31**	**1**
Effectively addressing gaps found in this phase	0.0	0.0	0.0	17.2	17.2	31.0	34.5	3.83	
Determine the responsible project team during the phase	0.0	0.0	3.4	17.2	20.7	48.3	10.3	3.45	
Commence preparing consent forms for land owners	0.0	0.0	17.2	17.2	13.8	17.2	34.5	3.34	
Initiate the appointment process for a consultant to execute the design	0.0	3.4	10.3	13.8	27.6	27.6	17.2	3.29	
Confirm that Project Office will take-over from Planning and drive this stage	0.0	0.0	0.0	27.6	31.0	27.6	13.8	3.28	
Appoint a responsible "Project Office" Project Manager to drive this phase	0.0	0.0	10.3	27.6	27.6	17.2	17.2	3.03	
Start the submission process for environmental approvals	0.0	0.0	3.4	27.6	48.3	10.3	10.3	2.97	
Stage 1 – Prefeasibility								**3.30**	**2**
Effectively addressing gaps found in this phase	0.0	0.0	0.0	13.8	6.9	44.8	34.5	4.00	
Adequately prompt for a responsible Planning Project Manager to drive this phase	0.0	0.0	3.4	10.3	17.2	31.0	37.9	3.90	
Take the necessary actions in reviewing environment screening and option selections	0.0	0.0	10.3	17.2	27.6	17.2	27.6	3.34	
Establishing land ownership within the project boundaries	0.0	0.0	17.2	13.8	27.6	31.0	10.3	3.03	

Initiate the appointment process for a consultant to execute the prefeasibility study	0.0	3.4	13.8	27.6	31.0	10.3	13.8	2.82	
Adequately establish client's input in user-requirement specification	0.0	0.0	20.7	27.6	24.1	13.8	13.8	2.72	
Stage 2 – Feasibility								**2.99**	
Effectively addressing gaps found in this phase	0.0	0.0	3.4	3.4	27.6	34.5	31.0	3.86	
Take into account the selection of the most preferred option	0.0	0.0	17.2	13.8	27.6	31.0	10.3	3.03	
Giving directive as to when initial stakeholder engagements are to be established	0.0	0.0	17.2	13.8	31.0	27.6	10.3	3.00	
Initiate the appointment process for a consultant to execute the feasibility study	0.0	0.0	3.4	27.6	48.3	10.3	10.3	2.97	3
Prompt the process in securing budget to proceed to design development	0.0	0.0	10.3	41.4	27.6	10.3	10.3	2.69	
Confirm that the Planning Project Manager is still driving this phase	0.0	0.0	20.7	27.6	27.6	10.3	13.8	2.69	
Effecting the process in consulting land owners and commence negotiations	0.0	0.0	27.6	17.2	27.6	17.2	10.3	2.66	
Stage 4 – Design Documentation								**2.97**	
Effectively addressing gaps found in this phase	0.0	0.0	0.0	6.9	31.0	34.5	27.6	3.83	
Supporting the tender advertising process	0.0	0.0	10.3	10.3	31.0	27.6	20.7	3.38	
Trigger the process for the consultant to prepare tender documents for construction works	3.4	0.0	10.3	17.2	31.0	17.2	20.7	3.21	
Reviewing contractors' Work Schedule	0.0	10.34	6.9	24.1	31.0	10.3	17.2	3.08	4
Reviewing and evaluating tender document	0.0	0.0	10.3	34.5	20.7	20.7	13.8	2.93	
Checking for signed consent forms from land owners	0.0	0.0	0.0	37.9	37.9	20.7	3.4	2.90	
Confirm the involvement of Umgeni Water tender evaluation committee to select preferred bidder	10.3	0.0	17.2	24.1	17.2	17.2	13.8	2.85	
Analysing the selected contractors' priced BoQ	0.0	0.0	17.2	20.7	27.6	31.0	3.4	2.83	

Reviewing contractors' Health and Safety plan	0.0	3.4	24.1	17.2	27.6	17.2	10.3	2.71	
Allowing the client to review tender document	0.0	0.0	17.2	37.9	20.7	13.8	10.3	2.62	
Reviewing contractors' Quality Plan	0.0	3.4	27.6	31.0	17.2	17.2	3.4	2.36	
Stage 6 – Hand-over								**2.95**	
Effectively addressing gaps found in this phase	0.0	0.0	3.4	6.9	24.1	44.8	20.7	3.72	
Reviewing and receiving contractors' as built drawings	0.0	0.0	10.3	27.6	24.1	20.7	17.2	3.07	
Responsibility of operational manuals for equipment	0.0	0.0	10.3	34.5	20.7	20.7	13.8	2.93	**5**
Training for Umgeni Water staff	0.0	0.0	10.3	41.4	17.2	17.2	13.8	2.83	
Search for minor remedial works	0.0	0.0	17.2	37.9	20.7	13.8	10.3	2.62	
Testing all aspects that needs to be commissioned	0.0	0.0	13.8	34.5	37.9	10.3	3.4	2.55	
Stage 7 – Close-out								**2.83**	
Confirm that Umgeni Water requires an administrative close-out	0.0	0.0	0.0	17.2	34.5	34.5	13.8	3.45	
Confirm that final filing of project documents will be required	0.0	3.4	3.4	31.0	27.6	13.8	20.7	3.18	
Reviewing of Health and Safety final audit	0.0	0.0	17.2	13.8	31.0	27.6	10.3	3.00	**6**
Verifying that project data archiving must be carried out	0.0	0.0	17.2	27.6	24.1	17.2	13.8	2.83	
Initiate the need on feedback for lessons learned during the project	0.0	0.0	13.8	34.5	37.9	10.3	3.4	2.55	
Confirm that a final close-out meeting at Umgeni Water will be required	0.0	0.0	48.3	17.2	20.7	13.8	0.0	2.00	
Stage 5 – Works								**2.82**	
Effectively addressing gaps found in this phase	0.0	0.0	0.0	17.2	20.7	37.9	24.1	3.69	
Reviewing procurement for special materials	0.0	0.0	10.3	34.5	17.2	20.7	17.2	3.00	
Monitoring contractors' Health and Safety Plan	0.0	0.0	17.2	27.6	24.1	20.7	10.3	2.79	**7**
Contractor and consultant checking quality requirements	0.0	0.0	10.3	37.9	31.0	10.3	10.3	2.72	
Starting the control and monitoring of variation orders during this phase	0.0	0.0	24.1	34.5	17.2	13.8	10.3	2.52	

Confirming if the contractors site establishment is in accordance with the planned layout	0.0	0.0	31.0	34.5	20.7	10.3	3.4	2.21	
Tertiary Education - Built Environment								**2.75**	8
Quality management competencies relative to each discipline	3.4	0.0	13.8	13.8	31.0	34.5	3.4	3.00	
Cost management competencies	3.4	0.0	17.2	20.7	31.0	13.8	13.8	2.86	
Project management competencies	0.0	0.0	13.8	27.6	34.5	13.8	10.3	2.79	
Resource management competencies	3.4	0.0	13.8	41.4	10.3	20.7	10.3	2.71	
Design management competencies	0.0	0.0	27.6	17.2	27.6	17.2	10.3	2.66	
Operational management competencies relative to each discipline	0.0	3.4	31.0	13.8	27.6	20.7	3.4	2.50	

The most significant interventions to reduce or mitigate project delivery challenges at Umgeni Water are those interventions suggested at Stage 3 (Design Documentation). At this stage all the interventions have MSs > 2.90.

Stage 1 (Prefeasibility) of interventions is second in ranking, followed by Stage 2 (Feasibility), Stage 4 (Design Documentation), Stage 6 (Hand-Over), Stage 7 (Close-Out), Stage 5 (Works), and Tertiary Education - Built Environment.

It can be deduced that the top four ranked interventions are within the planning and designing stages of the project cycle which is in support with the findings from our main questionnaire. Within the top four ranked interventions, the findings reveal that respondents considered the gate review process to address gaps within each of these phases very significant.

Table 6.3: Ranking of mean scores according to interventions categories

Interventions category	Mean score	Ranking
Stage 3 - Design Development	**3.31**	**1**
Stage 1 – Prefeasibility	**3.30**	**2**
Stage 2 – Feasibility	**2.99**	**3**
Stage 4 – Design Documentation	**2.97**	**4**
Stage 6 – Hand-over	**2.95**	**5**
Stage 7 – Close-out	**2.83**	**6**
Stage 5 – Works	**2.82**	**7**
Tertiary Education - Built Environment	**2.75**	**8**

All of the above interventions MS's range between 2.75 and 3.31, hence all the interventions can be concluded to have between a near minor to moderate influence / moderate influence.

6.7 Chapter Summary

The above chapter identified that the literature review, data analysis together with standard project life cycle methodologies were used and made up the conceptual strategy for the proposed flowchart. The model pursues to offer thorough input and output on each of the stages within a project. It also detailed activities that are to be completed at each stage. There are seven stages making up the models life cycle. Each stage standalones but jointly, they make up the entire project. A stage is separated by a gate. The gate (or gate review) is a procedure to ensure that correct practices were undertaken during the recently completed stage and that stage has successfully met the predefined standards. The gate review either indicates the start of a stage or the end of a stage. The model was also validated by questionnaires and data analysis. An assessment was piloted amongst professionals within Umgeni Water in order to substantiate the model. Twenty nine employees were surveyed using a validation questionnaire. These employees are project managers, civil engineers, planning engineers, and quantity surveyors. The mean score (MS), percentage frequency and test of means difference were used in the analysis of the data. It was realised that the top four ranked interventions are within the planning and designing stages of the project and within the top four ranked interventions, the findings disclose that respondents thought that the gate review process to address gaps within each of these phases very significant.

CHAPTER SEVEN: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The chapter presents the conclusions and the recommendations of the research. Conclusions relative to the questionnaire will be elucidated as well as conclusions relative to the validation of the flowchart model will be explained. Recommendations of the study will be sectioned into two, which will encompass: Recommendations from questionnaires and recommendations from the validation of the flowchart. Additionally, the study includes recommendations for further studies that still need to be investigated.

7.2 Summary of findings

- Insufficient planning and designing done during the project is caused by inadequate effort applied at the beginning of the project, insufficient time allocated for planning and designing, preference of the lowest bidder over experienced design consultants, and the shortage of skills in relation to designers in the consulting sector. These factors can negatively impact the project budget, time and quality;

- Communication problems within the project are caused by overlooking the urgency of communication and not keeping to the timelines, distribution of incomplete communication, communication of incorrect information, prevention of the flow of sound communication, miscommunication and misunderstanding. These aspects can hinder project progression;

- Inadequate participation and contribution by the client during the project is influenced by poor authoritative decision making, unable to make decisions when required, lack of knowledge of project processes, inability to foresee project constraints, absence of ingenuity, the incompetence to define the short and long term project objectives to the team, and the inexperience to interpret design drawings and specifications. Therefore, if the client is incapable of assisting the project team, in relation to the above-mentioned factors, the systematic flow of operations will be negatively affected;

- Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach is caused by inexperience, weak leadership qualities, lack of coordination, incompetence and not enough of commitment. Thus, if the Project Manager is the reflection of the above-mentioned shortfalls, the project will suffer negative impacts at every phase within the project life cycle and ultimately not achieving project objectives;

- Project risks that are poorly identified, assessed, mitigated and controlled during the project are driven by failing to adequately assess risks, poor risk control, unable to mitigate and identify risks. Risks that are not identified in the early stages of a project will impact the construction phase, ultimately affecting the budget and the project programme. Furthermore, the above mentioned risk factors also need to be applied during the construction phase in order to avoid additional delays and expenses;

- Unsatisfactory cost estimating resulting in errors and oversights is due to the shortage of historical data, insufficient project information, miscalculation of project and contract durations, misinterpretation of project complexities, overlooking crucial risks, and poor estimating techniques. The above-mentioned factors can result in cost overruns and delays to a project;

- Oversight of critical quality factors during the project is caused by the weak project manager, poor designing by consultants, applying an ineffective quality management system, poor workmanship, and inefficient use of quality management methodologies. Therefore, by overlooking quality, holistically, the result can be the redoing of activities in order to satisfy the required standards, hence impacting on the time and budget of a project.

7.3 Conclusions relative to the hypothesis

7.3.1 First hypothesis

Inadequate participation and contribution by the client does significantly influence project delivery. Majority of the factors associated with this project delivery challenge show that they do not support the hypothesis. It can be assumed that respondents are of the opinion that the influencing factors identified in the study are not relative within Umgeni Water.

7.3.2 Second hypothesis

Insufficient planning and designing done during the project does significantly influence project delivery. Significantly, all factors that refer to this problem significantly support the hypothesis. Based upon the fact that planning and designing is a complex, integrate and time consuming activity and if executed inefficiently, problems are expected during construction.

7.3.3 Third hypothesis

Project risks that are poorly identified, assessed, mitigated and controlled during the project do significantly influence project delivery. Notably, all factors related to this challenge significantly support the hypothesis. Based upon the fact that risk management assists in the identification, assessment, mitigation and controlling of risks that are bound to have undesirable consequences on project delivery.

7.3.4 Fourth hypothesis

Unsatisfactory cost estimating resulting in errors and oversights does significantly influence project delivery. Half of the factors related with this project delivery challenge show that they do not support the hypothesis. It can be deduced that respondents are of the opinion that cost estimating responsibilities rest with the consultants and they should be held accountable.

7.3.5 Fifth hypothesis

Communication problems within the project do significantly influence project delivery. Half of the factors linked with this project delivery challenge specify that they do not support the hypothesis. It can be reasoned that Umgeni Water already has a good working project communication system in place and respondents are not aware of problematic communication situations.

7.3.6 Sixth hypothesis

Oversight of critical quality factors during the project does significantly influence project delivery. It is significant to specify that all factors that describe this problem significantly support the hypothesis. Quality, time and cost make up the project constraints. Based upon this, respondents are aware that failing in quality has impacts on cost and time, hence on project delivery.

7.3.7 Seventh hypothesis

Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach does not significantly influence project delivery. Majority of the factors associated with this project delivery challenge suggest that they do not support the hypothesis. It can be presumed that respondents are of the opinion that the obligation of implementing a good project management approach is the responsibility of all project stakeholders and not just the accountability of the project manager.

7.4 Conclusions relative to validation of the model

The intention of conducting the research was to provide solutions to the challenges that were identified. Hence, the second objective for the study was to develop a project delivery model for Umgeni Water to implement when executing their water infrastructure projects. Chapter 6 was uniquely dedicated to identifying those gaps and providing the solution for Umgeni Water. Those gaps have been filled with the proposed flowchart model.

The most important category of interventions is that of the Stage 3 - Design Development. The interventions at Stage 3 have an average MS of 3.24.

The MS of 3.24 falls within the range > 2.60 ≤ 3.40. Respondents can be thought to be of the view that the interventions relative to this category have between a near minor to moderate influence / moderate influence on project delivery. It also suggests that respondents are of the view that the interventions at Stage 3 could reduce problems in project delivery.

Based on the average MSs of interventions categories, it can be established that respondents considered all interventions proposed at each stage of the model to have between a near minor to moderate influence / moderate influence on minimising project delivery challenges.

A project is a sequence of events that are reliant and dependent on its predecessors, therefore it can be established that the proposed inputs at the various stages within the flowchart model are essential for reaching project objectives and to minimise challenges encountered during project delivery.

7.5 Recommendations

The recommendations stemming from this research are separated into two, namely recommendations arising from the questionnaire and the validation of the flowchart conclusions.

7.5.1 Recommendations from questionnaire

The following interventions should be given adequate attention to mitigate the impact of these project delivery challenges at Umgeni Water:

- To mitigate insufficient planning and designing done during the project, the project team must ensure that ample effort is applied at the beginning of the project, sufficient time must be allocated to successfully complete the planning and designing process and consultants must be selected on their experience rather than low bidding.

- To mitigate communication problems within the project, the project team must ensure that communication urgency and timelines are not overlooked, avoid distributing incomplete communication and ensure that correct information exists in the communication.

- To mitigate inadequate participation and contribution by the client during the project, the client must show strong authoritative decision making abilities, make decisions when required and be able to understand project processes.

- To mitigate inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach, the project team must ensure that experienced project managers are appointed, project managers must have strong leadership qualities and project managers must have coordinate capabilities.

- To mitigate project risks that are poorly identified, assessed, mitigated and controlled, the project team must ensure that risks are sufficiently identified, adequately assessed, properly mitigated and ultimately controlled.

- To mitigate unsatisfactory cost estimating resulting in errors and oversights, the project team must ensure that adequate historical data is made available, sufficient project information is defined and to confirm that the correct calculations are applied to project and contract durations.

- To mitigate oversight of critical quality factors during the project, the project team must ensure that the responsible project managers are of high quality, consultant producers above average quality designs and implement a good quality management system.

7.5.2 Recommendations from the validation of the model

Implementation of a workable project delivery model is what determines project success. When project delivery models are sufficiently used and properly managed from start to completion, the project is guaranteed to be completed facing minimal challenges along its path.

The below modules or courses are suggested to be included at higher level education institutes for all disciplines in the built environment. They are:

- Quality management
- Cost management
- Project management
- Resource management
- Design management
- Operational management

The execution of Stage 1 - Prefeasibility phase Stage is suggested: Recommendation for criteria during prefeasibility are:

- Adequately prompt for a responsible Planning Project Manager to drive this phase
- Take the necessary actions in reviewing environment screening and option selections
- Establishing land ownership within the project boundaries
- Initiate the appointment process for a consultant to execute the prefeasibility study
- Adequately establish client's input in user-requirement specification
- Effectively addressing gaps found in this phase

At Stage 2 - Feasibility, attention should be given to:

- Take into account the selection of the most preferred option
- Prompt the process in securing budget to proceed to design development
- Giving directive as to when initial stakeholder engagements are to be established
- Effecting the process in consulting land owners and commence negotiations
- Initiate the appointment process for a consultant to execute the feasibility study
- Confirm that the Planning Project Manager is still driving this phase
- Effectively addressing gaps found in this phase

At Stage 3 – Design Documentation, consideration of the following interventions should be considered:

- Initiate the appointment process for a consultant to execute the design
- Start the submission process for environmental approvals
- Commence preparing consent forms for land owners
- Determine the responsible project team during the phase
- Appoint a responsible "Project Office" Project Manager to drive this phase
- Confirm that Project Office is take-over from Planning and drive this stage
- Effectively addressing gaps found in this phase

7.5.3 Recommendations for further studies

The below studies are suggested:

- Pipeline projects in the South African Water Sector – Causes of delays
- A quantitative study of the influences of delay on projects that are executed by State Owned Enterprises, and
- Research relative to influences to delivery of projects by consultants in the water sector industry.

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04 December 2018

Dear Madam / Sir

Influences on project delivery at Umgeni Water

The survey is part of a research aimed at meeting the requirements for M-Tech (Master of Built Environment) at the Durban University of Technology, carried out to:

- Determine the impact of project delivery challenges at Umgeni Water;
- Develop key performance indicators, and
- Develop a model to minimise or mitigate project delivery challenges.

Kindly complete the accompanying questionnaire and note that your anonymity is assured. Solutions to delays experienced on construction projects will be evolved from your response. We would be grateful if you would endeavor to complete the questionnaire and return it by 04th February 2019:

Department of Construction Management and Quantity Surveying
Durban University of Technology
PO Box 1334
Durban
4000

Or per facsimile to: (033) 341 1167

Att: Mr AD Naidoo

Should you have any queries please do not hesitate to contact Mr AD Naidoo at 072 022 5138 or per e-mail: ashok.naidoo@umgeni.co.za

Thanking you in anticipation of your response.

Mr Ashok Naidoo
M-Tech (Student)

Dr Ayodeji Olatunji Aiyetan, PDH (Construction Management)
Department of Construction Management and Quantity Surveying
Durban University of Technology

Questionnaire

Section 1: Demographic Data

A: Personal Data

1- Please fill in your name

____

2- Indicate your gender

M	F

3- Please indicate your age group

20 - 29	30 - 45	46 - above

4- Please indicate your highest level of education

Matric certificate	
Diploma - 1 Year	
National Diploma- 3 years	
B-Tech/Bachelor's Degree - 4 Years	
Honours Degree	
Masters Degree	
Doctoral Degree	
Other	

5- Please indicate years of experience

0 - 5 years		21 - 25 years	
6 - 10 years		26 - 30 years	
11 - 15 years		31 - 35 years	
16 - 20 years		> 36 years	

B: Organisational Data

1- What position do you hold at Umgeni Water?

____

2- In which division of Umgeni Water do you work?

____

3- In what department does that fall under?

____

4- How long have you been employed at Umgeni Water?

____

5- Do you play any role during the "project life cycle" of Umgeni Water's infrastructure projects? Either directly or indirectly

____

6- Please indicate which type and category of projects you are involved in.

All		All	
Pipelines		Augmentation	
Pump stations		Development	
Water Treatment Works		Expansion	
Waste Water Treatment Works		Rehabilitation	
Dams		Upgrade	
Reservoirs		Other	

Section 2: Main Questionnaire

1- Name one construction project that you were involved in at Umgeni Water, which is now complete.

____

2- What was the final project value?

Less than 10 (million)	
11 to 50 (million)	
51 to 100 (million)	
101 to 500 (million)	
Greater than 501 (million)	

3- Kindly indicate what was the percentage deviation between the final project value and original budget.

0% - 15%		46% - 60%	
16% - 30%		61% - 75%	
31% - 45%		> 75%	

4- Please indicate how much delay was experienced between the original planned completion date to the actual completion date

0 - 5 Mths		16 - 20 Mths	
6 - 10 Mths		21 - 25 Mths	
11 - 15 Mths		> 26 Mths	

5- Please indicate what type of project it falls under.

Pumpstation	
Pipeline	
Reservoir	
WTW	
WWTW	
Dam	
Scheme - Many	

6- On a scale 1 (minor) to 5 (major), rate these project delivery challenges encountered during the Project Life Cycle at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)

	Project Delivery Challenges	U	DN	Minor...Major				
				1	2	3	4	5
6.1	Inadequate participation and contribution by the client during the project	U	DN	1	2	3	4	5
6.2	Insufficient planning and designing done during the project	U	DN	1	2	3	4	5
6.3	Project risks that are poorly identified, assessed, mitigated and controlled during the project	U	DN	1	2	3	4	5
6.4	Unsatisfactory cost estimating resulting in errors and oversights	U	DN	1	2	3	4	5
6.5	Communication problems within the project	U	DN	1	2	3	4	5
6.6	Oversight of critical quality factors during the project	U	DN	1	2	3	4	5
6.7	Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	U	DN	1	2	3	4	5

7- On a scale 1 (minor) to 5 (major), rate these factors which influence participation and contribution by the client during the project at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)

	Influencing Factors	U	DN	Minor...Major				
				1	2	3	4	5
7.1	Client misunderstanding of design drawings and specifications	U	DN	1	2	3	4	5
7.2	Client lack of awareness regarding project processes	U	DN	1	2	3	4	5
7.3	Weak authoritative decision making by the client	U	DN	1	2	3	4	5
7.4	Lack of decision making by the client in a pressure situation	U	DN	1	2	3	4	5
7.5	Clients absence towards Contribution of ideas	U	DN	1	2	3	4	5
7.6	Clients inability in understanding project constraints	U	DN	1	2	3	4	5
7.7	Clients inability to brief the project team regarding the projects short and long term aims and objectives	U	DN	1	2	3	4	5

8- On a scale 1 (minor) to 5 (major), rate these factors as they influence planning and designing during the entire project life cycle at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)

	Influencing Factors	U	DN	Minor...Major				
				1	2	3	4	5
8.1	Inadequate effort out-laid at the front end of the project	U	DN	1	2	3	4	5
8.2	Insufficient time given to plan and design the works	U	DN	1	2	3	4	5
8.3	Selection of lowest bidder over experienced design consultants	U	DN	1	2	3	4	5
8.4	Skill shortage of designers in the consulting sector	U	DN	1	2	3	4	5

9- On a scale 1 (minor) to 5 (major), rate the influence of these risk management factors on project delivery at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)

	Influencing Factors	U	DN	Minor............Major				
				1	2	3	4	5
9.1	Unable to identify risks that has an affect on the project	U	DN	1	2	3	4	5
9.2	Inadequate assessment of risks and realising its associated consequences	U	DN	1	2	3	4	5
9.3	Inability to mitigate risks that have previously been identified	U	DN	1	2	3	4	5
9.4	Unsatisfactory risk controlling strategies endorsed to control and monitor risks	U	DN	1	2	3	4	5

10- On a scale 1 (minor) to 5 (major), rate these factors which influence estimating during the project at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)

	Influencing Factors	U	DN	Minor............Major				
				1	2	3	4	5
10.1	Misunderstanding the projects complexity	U	DN	1	2	3	4	5
10.2	Inaccurate estimating towards project duration and contract period	U	DN	1	2	3	4	5
10.3	Error in judgement by overlooking risks that have a direct impact on costs	U	DN	1	2	3	4	5
10.4	Lack of historical data	U	DN	1	2	3	4	5
10.5	Incomplete project scope definition, design, specifications and information	U	DN	1	2	3	4	5
10.6	Incorrect estimating techniques	U	DN	1	2	3	4	5

11- On a scale 1 (minor) to 5 (major), rate these factors which contribute to communication problems during the project life cycle at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)

	Influencing Factors	U	DN	Minor............Major				
				1	2	3	4	5
11.1	Communicating inaccurate information	U	DN	1	2	3	4	5
11.2	Communication procedures following incorrect process and channels	U	DN	1	2	3	4	5
11.3	Communication barriers that prevents the flow of good communication	U	DN	1	2	3	4	5
11.4	Misunderstanding the communication	U	DN	1	2	3	4	5
11.5	Overlooking the urgency of the communication and not keeping to communication timelines	U	DN	1	2	3	4	5
11.6	Circulation of incomplete communication	U	DN	1	2	3	4	5

12- **On a scale 1 (minor) to 5 (major), rate the influence of these quality factors during project delivery at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)**

	Influencing Factors	U	DN	Minor............Major				
				1	2	3	4	5
12.1	Poor quality of design work by consultants	U	DN	1	2	3	4	5
12.2	Weak quality of skills by the project manager	U	DN	1	2	3	4	5
12.3	Using inferior quality of construction materials	U	DN	1	2	3	4	5
12.4	Poor quality of workmanship performance	U	DN	1	2	3	4	5
12.5	Implementing a weak quality management system	U	DN	1	2	3	4	5
12.6	Poor quality management methodologies used in processing quality planning, quality assurance and quality control	U	DN	1	2	3	4	5

13- **On a scale 1 (minor) to 5 (major), rate these factors which influence the implementation of a good project management approach at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)**

	Influencing Factors	U	DN	Minor............Major				
				1	2	3	4	5
13.1	Weak leadership attributes of the project manager	U	DN	1	2	3	4	5
13.2	Lack of coordination capabilities by the project manager	U	DN	1	2	3	4	5
13.3	Inexperience of the project manager	U	DN	1	2	3	4	5
13.4	Incompetence of the project manager	U	DN	1	2	3	4	5
13.5	Lack of commitment shown by the project manager	U	DN	1	2	3	4	5

14- **On a scale 1 (minor) to 5 (major), rate the impact of these factors on project delivery at Umgeni Water. (Please note the 'unsure' (U) and 'Does not' (DN) options)**

	Impact on Project Delivery	U	DN	Minor............Major				
				1	2	3	4	5
14.1	Inadequate participation and contribution by the client during the project	U	DN	1	2	3	4	5
14.2	Insufficient planning and designing done during the project	U	DN	1	2	3	4	5
14.3	Project risks that are poorly identified, assessed, mitigated and controlled during the project	U	DN	1	2	3	4	5
14.4	Unsatisfactory cost estimating resulting in errors and oversights	U	DN	1	2	3	4	5
14.5	Communication problems within the project	U	DN	1	2	3	4	5
14.6	Oversight of critical quality factors during the project	U	DN	1	2	3	4	5
14.7	Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	U	DN	1	2	3	4	5

DUT DURBAN UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF CONSTRUCTION MANAGEMENT AND QUANTITY SURVEYING
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01 May 2019

Dear Madam / Sir

Validation of Project Delivery Time Model

The attached 'model' is the culmination of research into influences on project delivery time performance.

This model has been developed with the view that, adhering to the details at each stage of the project delivery, the time taken to deliver projects will not be extended.

A three page questionnaire to validate the above assertion is included below the model presented below.

A survey of convenience has been adopted in the sampling and selection of respondents. Therefore, your response to the questionnaire will be greatly valued.

We would be grateful if you would endeavour to complete the questionnaire, and return it by 09th May 2019 to:

Department of Construction Management and Quantity Surveying
DUT
PO Box 1334
Durban
4000

Or per facsimile to: (033) 341 1167

Att: Mr AD Naidoo

Should you have any queries please do not hesitate to contact Mr AD Naidoo at 072 022 5138 or per e-mail: ashok.naidoo@umgeni.co.za

Thanking you in anticipation of your response.

Mr Ashok Naidoo
M-Tech (Student)

Dr Ayodeji Olatunji Aiyetan, PDH (Construction Management)
Department of Construction Management and Quantity Surveying
Durban University of Technology

On a scale 1 (Minor) to 5 (Major), rate the extent to which the following prefeasibility, feasibility, design development, design documentation, works, hand-over and close-out interventions influence in eliminating delays on the delivery of Umgeni Water projects.

	Project Delivery Model - Validation Questionnaire							
	Interventions	**U**	**DN**	**Minor...Major**				
				1	**2**	**3**	**4**	**5**
1	**Stage 1 – Prefeasibility**							
1.1	Adequately prompt for a responsible Planning Project Manager to drive this phase							
1.2	Take the necessary actions in reviewing environment screening and option selections							
1.3	Establishing land ownership within the project boundaries							
1.4	Initiate the appointment process for a consultant to execute the prefeasibility study							
1.5	Adequately establish client's input in user-requirement specification							
1.6	Effectively addressing gaps found in this phase							
2	**Stage 2 – Feasibility**							
2.1	Take into account the selection of the most preferred option							
2.2	Prompt the process in securing budget to proceed to design development							
2.3	Giving directive as to when initial stakeholder engagements are to be established							
2.4	Effecting the process in consulting land owners and commence negotiations							
2.5	Initiate the appointment process for a consultant to execute the feasibility study							
2.6	Confirm that the Planning Project Manager is still driving this phase							
2.7	Effectively addressing gaps found in this phase							
3	**Stage 3 - Design Development**							
3.1	Initiate the appointment process for a consultant to execute the design							
3.2	Start the submission process for environmental approvals							
3.3	Commence preparing consent forms for land owners							
3.4	Determine the responsible project team during the phase							

3.5	Appoint a responsible "Project Office" Project Manager to drive this phase							
3.6	Confirm that Project Office will take-over from Planning and drive this stage							
3.7	Effectively addressing gaps found in this phase							
4	**Stage 4 – Design Documentation**							
4.1	Supporting the tender advertising process							
4.2	Trigger the process for the consultant to prepare tender documents for construction works							
4.3	Reviewing and evaluating tender document							
4.4	Confirm the involvement of Umgeni Water tender evaluation committee to select preferred bidder							
4.5	Checking for signed consent forms from land owners							
4.6	Reviewing contractors' Work Schedule							
4.7	Analysing the selected contractors' priced BoQ							
4.8	Reviewing contractors' Health and Safety plan							
4.9	Reviewing contractors' Quality Plan							
4.10	Allowing the client to review tender document							
4.11	Effectively addressing gaps found in this phase							
5	**Stage 5 – Works**							
5.1	Confirming if the contractors site establishment is in accordance with the planned layout							
5.2	Contractor and consultant checking quality requirements							
5.3	Reviewing procurement for special materials							
5.4	Starting the control and monitoring of variation orders during this phase							
5.5	Monitoring contractors' Health and Safety Plan							
5.6	Effectively addressing gaps found in this phase							
6	**Stage 6 – Hand-over**							
6.1	Testing all aspects that needs to be commissioned							
6.2	Resposibility of operational manuals for equipment							
6.3	Reviewing and receiving contractors' as built drawings;							
6.4	Training for Umgeni Water staff							

6.5	Search for minor remedial works							
6.6	Effectively addressing gaps found in this phase							
7	**Stage 7 – Close-out**							
7.1	Confirm that Umgeni Water requires an administrative close-out							
7.2	Confirm that final filing of project documents will be required							
7.3	Verifying that project data archiving must be carried out							
7.4	Reviewing of Health and Safety final audit							
7.5	Confirm that a final close-out meeting at Umgeni Water will be required							
7.6	Initiate the need on feedback for lessons learned during the project							
8	**Tertiary Education - Built Environment**							
8.1	Operational management competencies relative to each discipline							
8.2	Quality management competencies relative to each discipline							
8.3	Design management competencies							
8.4	Cost management competencies							
8.5	Resource management competencies							
8.6	Project management competencies							

CIDB Postgraduate Conference

Positioning the construction industry in the fourth industrial revolution

28 - 30 July 2019, Johannesburg, South Africa

ACCEPTANCE LETTER

Aiyetan, Ayodeji Olatunji
Naidoo Ashok

21th May 2019

Dear Authors,
We are pleased to inform you that your paper(s) has been accepted for Oral presentation at the 11th Construction Industry Development Board (CIDB) Postgraduate Research Conference to be held at the University of Johannesburg, South Africa, from 28th to 30th of July 2019.

Paper No: 0100
Paper Title: An Assessment of the Challenges in the Delivery of Umgeni Water Project in South Africa

Kindly note that the acceptance of your paper was based on a rigorous double blinded peer-review conducted by the conference assigned reviewers from the scientific committee. Inclusion of the paper in the conference proceeding is subject to registration of at least one of the authors per paper, and a signed Springer consent to publish agreement form submitted along with the corrected papers by the posted deadline.

Thank you for your participation and we look forward to seeing you in Johannesburg, South Africa.

Sincerely,

[redacted]

Professor Clinton Aigbavboa,
Conference Chairperson
Vice Dean, Postgraduate Studies,
Research and Innovation,
Faculty of Engineering and the Built Environment,
University of Johannesburg

Contact Email
Cidb2019@gmail.com

An Assessment of the Challenges in the Delivery of Umgeni Water Project in South Africa

Aiyetan, Ayodeji Olatunji[1] and Naidoo Ashok

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Abstract. Implementing a suitable plan, design and management strategy is critical to the success of a project. Project delivery challenges encountered within the built-environment is a global phenomenon. Factors causing project delivery challenges in construction projects differ between countries, due to various fundamental reasons. The aim of the study is to assess lack of performance and its effects on project delivery for construction infrastructure projects with reference to Umgeni Water. The study was conducted at Umgeni Water, Pietermaritzburg in Kwazulu-Natal. Respondents for the study were Project Managers, Civil Engineers, Planning Engineers, Quantity Surveyors, Servitude Administrators and Environmental Project Managers. A non-probability sampling technique was employed in the selection of samples. A total of twenty three questionnaires were analysed for the study, Descriptive statistic was employed for the analysis. Findings revealed that insufficient planning and designing, and a weak project management approach endorsed and implemented by the project manager influence project success at Umgeni Water. This implies the need for the study to pursue strategies that will improve project and service delivery at Umgeni Water. Recommendations include that attention should be given to implementing a workable project delivery plan and management approach that will result in a better understanding and successful delivery of a project.

Keywords: Challenges · Design · Project delivery · management approach

1 Introduction

Understanding the project delivery challenges and its associated influences are very important to achieve project success. [1] explains approaches endorsed and undertaken at different stages of the project may exert positive or negative influences on the project. Positive influences are such that it assists the project to reach its desired outcome and within the initial estimated time, cost and quality, while negative influences are such that will affect initial plans and exceed anticipated successful project delivery parameters. Strategic planning and management, which can be referred to as Process

Model are expected to assist project managers including all stakeholders throughout the project life cycle. [2] defines a project life cycle as a set of sequential phases that a project goes through from its beginning to its completion. [3] states that having an effective project delivery model increases the stakes of implementing and completing a successful project. [4] describes a project delivery model as a methodology within a framework. This means that a project delivery model must follow a certain process within the boundaries of an established setting. [3] states the quality and workability of the project delivery model affects the parameters. These could result in inadequate participation and contribution by the client, insufficient planning and designing, project risks, estimating errors, communication problems, project quality, and challenges, which hinder the implementation of a good project management approach. Therefore, this study aims at identifying leading challenges together with their associated influences and impact relative to the delivery of the project.

2 Literature Review

2.1 South African Water Infrastructure Projects

[5] reported that prior to 1994, water supply obligation was split with no singular government department accountable for its management. This caused inconsistent levels of service delivery within South Africa. After 1994, the government saw the critical need for new policies for the county, which included changes in the water sector. The department of water and sanitation is currently the third largest contributor to public sector infrastructure expenditure, with an estimated value of R132.1 billion between the period 2012/13 to 2018/19 [6]. This contribution by the department provides an indication of water infrastructures importance.

2.2 Project delivery challenges and influencing factors

2.2.1 Inadequate participation and contribution by the client during the project

[7] state that clients have to be more interactive with the project team and should be hands-on relating to contribution and participation. According to [8], these factors could be measured as client understanding of design drawings and specifications, awareness of the project processes, authoritative decision making, decisions made in a pressure situation, contribution of ideas, capabilities of understanding project constraints and productiveness of briefings to the project team.

[9] opined that client participation have high impact on project delivery, which in many cases may determine the project's success or failure; and that the clients' involvement during the project life cycle provides the fundamental link to the project.

2.2.2 Insufficient planning and designing done during the project

[10] investigates the effects of placing enough effort and cost into the early planning and design phases of capital expenditure projects in order to try to eliminate as many problems as possible when executing the project, labelling this process as front end loading (FEL). Factor that influence this are: the amount of time given to plan and

design the works, procurement processes that favours the cheapest rather than experienced consultants and skill shortage experienced by consulting firms.

2.2.3 Proect risks that are poorly identified, assessed, mitigated and controlled during the project execution stage

[2] defined the objectives of risk management as: to increase the probability and effect of positive events and decrease the probability and influence of negative events during the project. According to [11], risk management analysis should be performed in order to give the project manager significant, acceptable and valuable information on which future decisions will be based on. The findings by [12] suggest that there is a direct relationship associated with achieving project success and good risk management; and that the impact of not properly identifying, assessing, mitigating and controlling risk often results in project delays and cost overruns.

2.2.4 Unsatisfactory cost estimating resulting in errors and oversights

[13] conclude that the initial cost estimates fail in considering all costs. Generally, costs are managed during the execution phase of a project and costs are not sufficiently managed during the planning, and design phases, when 80% of project costs are committed. [14] identify some of the main factors that measure cost estimating and cost control; Conditions of contract, market requirements, type of project and its complexity, project duration and contract period, error in judgement, lack of historical data, incomplete project information and estimating techniques.

2.2.5 Communication problems within the project

It can be identified from [15] certain measurable components within communication in the construction industry. They are accuracy, procedures, barriers, understanding, timelines and completeness.

[16] explain that poor communication has grave consequences and effects in the construction environment, such as time overruns, cost overruns, disagreements, and finally project failure.

2.2.6 Oversight of critical quality factors during the project

[17], explain that project quality is often side-lined and insufficient attention paid on quality because project teams are more focused on the time and cost factors. [18] list some items that need to be addressed in order to improve on quality which positively affects the success of a project, these items are; designs, project management, materials, workmanship, quality management systems and methodologies.

2.2.7 Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach

[19] validate that being a manager that leads is an important aspect in managing projects and performing at a high level as a leader is a vital manager's obligation to ensure the effort of people are aimed towards the same objective. [20] reinforces the perception that managers and leaders mould the environment and efficiency of the work surroundings. [21] classify the causes that are challenging the successful imple-

mentation of a good project management approach as; lack of leadership, failure to coordinate, inexperience, incompetence and lack of commitment.

2.3 Factors Impacting on the delivery of Umgeni Water project

There are many factors that can impact either negatively or positively on a project. These include: [22] insufficient planning and designing, [23] that reflecting incorrect costs at the beginning of a project has serious effects on the project, [19] poor project management adversely affects three fundamental aspects of a project, which are, cost, time and quality. [24] risks have the most influence during the construction phase if not managed correctly, client's level of participation and contribution on project delivery has enormous influence on the project, [17]state re-work is a product from poor quality both in designs and on the construction site. Further, he explain that redoing work due to poor quality is extremely costly and adversely impact on project time, and [15] identify that incomplete, inaccurate or misunderstood and these communication problems have a knock on effect on time, cost and quality

3 Research Methodology

The focus of the study was to identify and assess challenges and its associated impact on project delivery in Pietermaritzburg, South Africa. The sampling frame consisted of Project Managers (10), Civil Engineers (5), Planning Engineers (3), Quantity Surveyors (2), Servitude Administrators (2) and Environmental Project Manager (1).

The sample size formula used: $n = \frac{N}{1+N(e)2}$

n = required sample size, N= the applicable population size, and e = precision or e-value

The study adopted a case study research approach; therefore, a non-probability sampling approach was employed due to limitation in number within the sample frame, namely, a selective method of sampling. The research instrument for this study was a questionnaire survey. These were administered through e-mail and were received through the same means. A total of twenty-three (23) questionnaires representing 88.8% response rate achievement recorded on questionnaire administration. Differential statistics statistical tool was used for data analysis. The sample frame consist of Project Managers, Civil Engineers, Planning Engineers, Quantity Surveyors, Servitude Administrators and Environmental Project Manager. Regarding the qualification of respondents, bachelors' degrees predominate. Most of the respondents have working experience above six years and have handled large project more than six. Based on these, the data obtained can be deem reliable. The Cronbach alpha values were > .70, which is satisfactory.

3.1 Data Presentation and Analysis

This section presents the data obtained of the study and the analysis.

Table 1: Project delivery challenges encountered during the Project Life Cycle at Umgeni Water

S/No	Factors	Mean score	Standard deviation	Rank
1	Insufficient planning and designing done during the project	3.5	1.2	1
2	Inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach	3.3	1.3	2
3	Unsatisfactory cost estimating resulting in errors and oversights	3.2	1.0	3
4	Inadequate participation and contribution by the client during the project	3.1	1.3	4
5	Communication problems within the project	3.1	1.2	5
6	Oversight of critical quality factors during the project	2.8	1.3	6
7	Project risks that are poorly identified, assessed, mitigated and controlled during the project	2.8	1.4	7

Table 1 presents the respondents' rating of the influence of project delivery challenges encountered during the Project Life Cycle at Umgeni Water. It is notable that all factors in the category have MSs > 2.60 ≤ 3.50, which indicates that the factors have between a near minor to moderate/moderate influence on project delivery at Umgeni Water.

The factor with the most significant influence is insufficient planning and designing done during design stage of the project (MS=3.5). It is evident that when a project is not properly thought out, planned and designed, these short-falls are felt during the construction phase noticeably affecting time, cost and quality.

Following this factor is inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach (MS=3.3). A project manager is an individual who is appointed to steer the project team that is accountable for accomplishing the project purposes and has the necessary abilities to apply understanding, capabilities and tools to project activities in meeting project objectives. It could be catastrophic to a project, should a project manager be incompetent, inexperienced or lack leadership skills.

The least significant factor is project risks that are poorly identified, assessed, mitigated and controlled during the project (MS=2.8). Project risk is a specialised field of expertise and requires knowledge with experience to execute successfully. It is normally assessed and controlled by consultants and contractors, therefore this may be the reason why the factor is the least influential.

Impact on project delivery

Table 2: Influencing factors impacting on project delivery at Umgeni Water

S/No	Impact	Mean score	Standard Deviation	Rank
1	Planning and designing	3.1	1.1	1
2	Influence cost estimating	3.0	1.3	2
3	Implementation of a good project management approach	3.0	1.2	3
4	Level of risk management	2.9	1.2	4
5	Level of participation and contribution by the client	2.8	1.3	5
6	On quality of product	2.8	1.2	6
7	Quality of project communication	2.8	1.2	7

Table 2 presents the respondents rating regarding influencing factors that impact on project delivery at Umgeni Water. All factors in this category have MSs > 2.80 ≤ 3.10, which indicates that these factors have between a near minor to moderate / moderate influence on infrastructure project delivery at Umgeni Water.

The most significant influencing factor impacting on project delivery at Umgeni Water is planning and designing (MS=3.1). The probable reason for this is that respondents are fully aware of time constraints given to properly plan and design including not putting enough emphasis into front-end loading at the beginning of a project.

The second most significant influencing factor is cost estimating (MS=3.0). The most likely reason for this is that respondents realise at Umgeni Water estimates are generally calculated based on incomplete project scope definition, designs, specifications and information.

The third most significant influencing factor is implementation of a good project management approach (MS=3.0). The most possible reason for this is that respondents are conscious that Umgeni Water employs young inexperienced project managers to undertake complex projects. These project managers tend to have weak leadership skills and lack coordination capabilities.

The least significant factor in this category is project communication (MS=2.8). The most probable reason for this could be that Umgeni Water has effective communication procedures in place that addresses matters around project communication.

3.2 Discussion

Findings from the data analysed through mean score ranking indicates that insufficient planning and designing done during the project is the most influential project delivery challenge at Umgeni Water, which is consistent with [10], conclusion that the lack of effort invested at the beginning of the project is the most significant problem that hinders project delivery. The second most influential project delivery challenge is inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach. This is supported by [20], who argue that employing a weak project manager to steer a project to its successful completion is very unlikely to occur. [20] further explain that the most substantial challenge that obstructs project delivery is incompetent and inexperienced project managers. Unsatisfactory cost estimating resulting in errors and oversights is the third ranked influence, which is in alignment with [25], deduction that commencing and continuing with incorrect cost estimates can be the single most crippling factor to a project.

The findings do not back the view of prior researchers, who found, inadequate participation and contribution by the client during the project, communication problems within the project, oversight of critical quality factors during the project and project risk management as very significant problems that have a major influence on project delivery. [5]; [16]; [26], and [11]. These results may be due to the fact that Umgeni

Water has good client relations, established project communication systems, and adequate quality and risk management procedures in place.

According to [27], water infrastructure is still one of South Africa's most important requirements and 20% of South Africans live without clean drinkable water. Regrettably [28] reported that in South Africa the delivery of large scale water infrastructure projects decreased by 30% from 2015 to 2016. It is becoming increasingly apparent that currently and in the future, water infrastructure project implementation will be at the forefront of the construction industry, which will require, the need for sound project implementation strategies and models to achieve successful project delivery.

4. Conclusions and Recommendations

4.1 Conclusion

Based on the analysis of data, the following conclusions are reached:

Insufficient planning and designing done during the project and inadequate attributes and capabilities endorsed by the project manager that hinder the implementation of a good project management approach are the most significant project delivery challenge at Umgeni Water. Unsatisfactory cost estimating resulting in errors and oversights is observed as challenge in the delivery of Umgeni water.

4.2 Recommendations

The following are recommendation to mitigate these project delivery challenges at Umgeni Water:

The project team should endorse a front-end loading approach when implementing projects and sufficient time must be given to the planning and designing team to execute their work successfully in order to mitigate insufficient planning and designing issues experience on the project

Regular checks and updates must be done to determine if the cost estimates and time periods are still valid and applicable. Umgeni Waters estimating there is adequate project scope defined to start the estimating process to guide against adverse influence on cost estimating

The organisations project stakeholders must hold regular meetings to assist the project manager. Relative to the evaluation of the progress and settling issues of concern to ensure smooth progression of the project. This will positively influencing the implementation of a good project management approach

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25 January 2019

IREC Reference Number: **REC 138/17**

Mr A D Naidoo
26 Bonanza Road
Bellevue
Pietermaritzburg
3201

Dear Mr Naidoo

DEVELOPMENT OF A PROJECT DELIVERY MODEL FOR UMGENI WATER: INFRASTRUCTURE PROJECTS

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely,

[redacted]

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2019 -01- 25
INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
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