

**Time Management in the KZN Department of Education Infrastructure
Projects**

by

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PREFACE

The research contained in this dissertation was completed by the candidate while based in the Discipline of Construction Management, School of Engineering of the College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Howard College, South Africa.

The contents of this work have not been submitted in any form to another university and, except where the work of others is acknowledged in the text, the results reported are due to investigations by the candidate.

Signed: **Dr N Harinarain**

Date:

DECLARATION: PLAGIARISM

I, Siphesihle N. Mabaso, declare that:

(i) the research reported in this dissertation, except where otherwise indicated or acknowledged, is my original work;

(ii) this dissertation has not been submitted in full or in part for any degree or examination to any other university;

(iii) this dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons;

(iv) this dissertation does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

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(v) where I have used material for which publications followed, I have indicated in detail my role in the work;

(vi) this dissertation is primarily a collection of material, prepared by myself, published as journal articles or presented as a poster and oral presentations at conferences. In some cases, additional material has been included;

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ABSTRACT

Social infrastructure has the capacity to escalate the growth of the economy and improves the lives of the residents in a social context and certifies that the fundamental infrastructure is well exploited. Growth in the economy and improvements in the social standing of the community may be pivotal in dealing with the factors in the South African economy that pose a great challenge, which may include among others, unemployment and human capital shortages in infrastructure delivery.

Literature has shown that governments around the world as well as locally invest in infrastructure delivery and this helps to provide the people with access to all the tools to meet their needs and to promote social welfare. The challenges faced by South Africa with regards to infrastructure delivery are not mainly because there is no funding available, at times it is because the sector departments do not have adequately skilled personnel and other resources to deliver infrastructure. The main provincial infrastructure departments include health, education, public works, and roads and transport.

In accordance with the medium-term strategic framework and the National Development Plan, the South African government has prioritised expenditure on social and economic infrastructure. There is also a continuing drive to fund programmes and policies aimed at improving the standard at which the money allocated for infrastructure is spent and the capability of government to design and deliver major infrastructure developments. It is therefore imperative to research ways in which existing social infrastructure can be developed without wasting financial resources, because substantial financial investment has gone into the development of social infrastructure, hence the focus on project time management.

This study purposes to examine the effectiveness of time management tools and techniques used by the KZN Department of Education on school construction projects and to make recommendations of how these can be enhanced to support projects towards completing on time. Explanatory sequential mixed method was used, and it involved collecting quantitative data from the Infrastructure Reporting Model (IRM) as well as the project and programme management team so that an in-depth analysis of the data can be done. A desktop study of 20 projects completed in 2016 and 2017, which are new schools and upgrades and additions projects were utilised to determine the effectiveness of time management tools and techniques. A questionnaire was also compiled, circulated to the project and programme management team,

and analysed using quantitative methods. A total of 100 questionnaires were distributed and 69 were received back and could be used for the study. Therefore the response rate is at 69%

This was followed by 5 qualitative interviews directed at programme managers and project managers within the KZN Department of Education and the Implementing Agents. The time frames of completed projects were analysed and possible improvements to the existing tools and technique highlighted. It is important to investigate the effectiveness of time management tools because the construction of schools is social infrastructure and the South African Government has invested substantial financial resources in order to provide quality education facilities. Data was obtained from the KZN Department of Education, because it is one of the departments that reports project information on the IRM and it is one of the departments with the largest infrastructure budget allocations in the province.

The study found that there are a number of time management tools and techniques that are available in the construction industry, which the department could make use of in the implementation of their construction projects. These tools and techniques are detailed in the literature review. The study further found that 95% of the projects in the desk top study sample suffer from time delays and do not complete on time. The findings of the questionnaire analysis further confirmed that a majority of projects suffered from time delays by way of a 100% agreement by the respondents to the fact. It was further found that there are time management tools and techniques implemented in the department however there is room for improvement in the implementation in order to ensure that the projects complete on time. This is substantiated by 72 % of respondents who agreed that time management tools and techniques were implemented in the department. Interviews with members of the professional team also found evidence that time management tools and techniques although they were in place, they were not adequately implemented. Other findings from the interviews were that there were no incentives in place for contractors or implementing agents when they completed projects early or on time.

KEYWORDS:

Time management, Social infrastructure, Infrastructure spending, Time overruns

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LIST OF ACRONYMS

Item	Description
IDMS	Infrastructure Delivery Management System
IRM	Infrastructure Reporting System
NTRSA	National Treasury of South Africa
CIDB	Construction Industry Development Board
KZN DoE	KwaZulu Natal Provincial Department of Education
IDMToolkit	Infrastructure Delivery Management Toolkit
DBSA	Development Bank of South Africa
ECA	Economic Commission for Africa
ESCAP	Economic and Social Commission for Asia and the Pacific

CHAPTER 1: INTRODUCTION

1.1. Introduction

In the introductory chapter the idea of time management tools and techniques implemented in the public sector in line with the Infrastructure Delivery Management (IDM) Toolkit and the IRM is detailed. The importance of investment in infrastructure development and delivery in South Africa is also introduced and discussed. Implementing time management tools and techniques with the intention of ensuring the successful delivery of the project programme in the construction phase is briefly overviewed. Furthermore, this chapter highlights the rationale for the research, the research questions, the objectives of the study and the research methodology utilised.

1.2. Rationale for the research

It is important to investigate the effectiveness of time management tools and techniques in the construction of schools because schools are social infrastructure and the South African Government has invested substantial financial resources in order to provide quality social infrastructure facilities to the citizens (Wood, 2013). The South African government has put mechanisms in place to assist in fast tracking the delivery of both social and economic infrastructure. This has been achieved by putting financial, physical and human resources in construction projects, which are the backbone of physical infrastructure delivery, so that the citizenry gets the best opportunities to thrive in a conducive environment (National Treasury Republic of South Africa (NTRSA), 2016).

However it is not only the financial, physical and human resources which are needed for effective and efficient infrastructure delivery; there is also the important component of policy development to support the construction projects. These policies need to be put in place in order to guide the way that things are done in the construction industry as well as the public sector (Development Bank of South Africa (DBSA), 2012). The government has also developed such policies and put them in place so as to streamline the industry and work towards improving service delivery. Some of these initiatives that have been put in place, include the planning commission, the national development plan and the infrastructure delivery management system, which is supported by a relevant legislative framework (NTRSA, 2017).

There is existing literature from Estache & Garsous (2012) and Threfall (2010) which supports the notion that positive infrastructure delivery and development has the ability to promote a

community to reduce unemployment and grow the economy. A growing economy means that more and more households have access to disposable income.

There are however, challenges that exist in the public sector and the private sector which lead to infrastructure not being delivered as quickly as it should be. These challenges also lead to some infrastructure construction projects, especially in the public sector, not being completed to an acceptable standard of quality (Economic and Social Commission for Asia and the Pacific (ESCAP), 2006:5). These challenges do not only occur because there is no money or enough funding for infrastructure construction projects, but because there is poor initiation, planning, implementation, monitoring and reporting ,close out and commissioning of public sector infrastructure construction projects (Simo–Kengne, 2016). The poor management of the construction project management cycle by the public sector institutions leads to projects being completed, above budget. It also leads to projects being completed later than the scheduled time or not completed at all; the quality of the workmanship and the materials used on these projects are also compromised. These quality issues, budget issues and time issues may then lead to scope changes and variation orders on the construction projects (NTRSA, 2016).

This study is focused on time management because it is a critical factor which affects the success of any construction project. If a project does not complete on time it has the potential to negatively affect the budget of the project as well as the quality of the final product that is produced (Kerzner, 2003). There are provincial infrastructure departments in the public sector that have the obligation of project funding, management control and commissioning within the given time frames, within the allocated and budgeted funds. These departments must ensure that the strategic and service delivery objectives are met, and this is not an easy task as it affects the lives of ordinary people. Therefore public sector departments who fund social infrastructure need to make sure that this intricate assignment is undertaken by experienced project managers and that they are well resourced in order to continuously measure improvement, evaluate plans, and take remedial actions when required to do so (Nepal, 2014).

Time management can or may be defined as the act or process of planning and keeping active oversight over the amount of time spent on specific activities, especially to increase effectiveness, efficiency or productivity (Osipova, 2008). Time management is important in any construction project because without proper time management, a number of problems may occur such as extension of time requests, variation orders or time overruns which may end up resulting in project delays (PMI, 2017).

It is therefore evident that the South African government regards infrastructure delivery as one of its greatest concerns, as it impacts on the economy of the country and is used as a tool to ensure that lives of all citizens are improved. It is also evident that there are time management challenges that impact on infrastructure project delivery. It is therefore important to investigate and analyse the prevailing time management tools and techniques with the aim to establish how these can be enhanced to support projects towards completing on time.

1.3. Problem statement

The South African government invests substantially in infrastructure delivery and development and there are time management related challenges which hinder the proper delivery of public sector infrastructure projects, therefore there is a need to investigate the effectiveness of existing time management tools and techniques towards reducing time delays.

1.4. Research questions

1. What are the time management tools and techniques in the IDMToolkit?
2. How are the time management tools and techniques implemented by the KwaZulu – Natal (KZN) Department of Education assisting in reducing time delays?
3. How can existing time management tools and techniques be enhanced to support projects towards completing on time and to reduce time overruns.

1.5. Study objectives

The objectives of the study are as follows:

- To conduct a literature review analysis of the Infrastructure Delivery Management Toolkit in order to gain an understanding of its time management tools and techniques.
- To conduct a desktop study of completed projects from KZN Department of Education and an analysis of the project time frames in order to determine the effectiveness of the time management tools and techniques in reducing time delays.
- To identify how the time management tools and techniques can be enhanced to better support projects towards completing on time.

1.6. Research methodology

This study addressed the effectiveness of time management tools and techniques in public sector infrastructure construction projects. An explanatory mixed methods design was used, and it involved collecting qualitative data after a quantitative phase in order to explain or follow up on the quantitative data in more depth. In the first quantitative phase of the study, a desktop study of projects completed using the IDM Toolkit and questionnaires were utilised, to determine the effectiveness of time management techniques. Instrument data was collected from the KZN Department of Education and the IRM, because it is one of the departments that use the IDM Toolkit to implement projects. The questionnaires were circulated to programme and project managers and other project team members within the department and the implementing agent organisations. The second qualitative phase was conducted by interviews with various managers at the KZN Department of Education, in order to determine their opinions on the implementation of time management tools and techniques on departmental infrastructure construction projects. This investigation purposed to assist to determine the effectiveness of the time management tools and techniques already in existence in the IDM Toolkit and possible improvements to the existing tools and techniques. The mixed methodological approach was also used in highlighting possible ways to implement these time management tools and techniques in the context of the public sector in order to decrease time and duration of projects.

1.7. Significance of the study

According to Wood (2013) infrastructure is to be of benefit to future generations and contribute positively to the potential of a country, only if it is sustainable. And Infrastructure in South Africa can and should be viewed as an investment into economic growth, and therefore, it is not only the short term provision of infrastructure that holds weight, but it is the planning and designing which will take full account of its own impact and its operational needs and use. Therefore it is important to study infrastructure delivery as well as improvement mechanisms that are put in place. The implication of conducting this research is that it will increase knowledge of infrastructure delivery mechanisms. This research will also inform policy making in public sector infrastructure delivery. This study is therefore important for the public sector infrastructure delivery because it will also contribute towards various legislations that impact on infrastructure delivery.

1.8 Assumptions

In this study it was assumed that the project information contained within the IRM is correct and updated accordingly. It is also assumed that the KZN Department of Education has appointed suitably qualified and experienced human resources and implementing agents who will take part in the study. It was further assumed that the participants in the study will be truthful in their responses.

1.9. Limitations of the study

The research was limited to KwaZulu-Natal Department of Education projects. The projects were further limited through systematic data sampling, to new schools and upgrades and additions projects. Upgrades and additions projects are those where an additional classroom, learning space, lavatory or administration block is added to an existing school. The research was further limited to projects at final completion and practical completion stage in the year 2016 and 2017. The project information and details of the time frames were obtained from the IRM. The IRM is the provincial infrastructure database which contains financial and non-financial information of projects implemented by the various provincial sector departments. The interviews and questionnaires were limited to officials directly responsible for project management within the KwaZulu-Natal Department of Education.

1.10. Ethical considerations

It is important to ensure that ethical clearance is obtained, prior conducting a study because it will ensure that the outcomes or results of the study are of benefit to all the stakeholders in the study (Seidman, 2013). Ethical clearance also ensures that the study is conducted in an ethical, voluntary and safe manner and that all private and confidential information is kept safe and all relevant approvals are obtained (Kothari, 2015). Prior written permission was obtained from the Head of Department at the KwaZulu-Natal Treasury to access the IRM which is the project data base for the province and prior written permission was obtained the Head of Provincial Department of Education to conduct interviews with programme managers and implementing agents. It was explained to all the participants that their participation is voluntary and that all information shared during the interviews and obtained from the IRM will be treated confidentially. Ethical clearance was obtained from UKZN and the ethical clearance number is HSS/0743/018M as attached in annexure A.

1.11. Outline of dissertation

Chapter 1: Introduction

This chapter introduced the research and provided the background and problem of the study, the research problem statement, the research objectives, rationale, the research methodology, limitations, assumptions, ethical considerations and limitations.

Chapter 2: Literature review

The second chapter entails a critical review of the literature. Firstly the importance of investment in infrastructure is analysed. This literature analysis entails a global and a local perspective under the headings of economic importance of infrastructure as well as social importance of infrastructure. A review of literature regarding the IDMToolkit is also conducted and finally time management tools and techniques are reviewed in literature.

Chapter 3: Research methodology

This chapter presents the research methodology proposed in order to achieve the research aims and objectives. This chapter explains the research process and approaches followed, including the research methodology used. The relationship between the research methods, objectives, data collection and sampling methodology are highlighted. In addition, the data analysis techniques that were used are discussed and finally the credibility, reliability and validity of the research findings are presented.

Chapter 4: Desktop study

This chapter presents a desktop study on active projects in final or practical completion stage of construction. These projects are in the custody of KwaZulu Natal Department of Education, in the years 2016 and 2017. The projects are using the IDM Toolkit principles. These projects are kept on the IRM which is the official infrastructure reporting template and database as determined by National Treasury. Data analysis was done using Microsoft Excel 2013

Chapter 5: Data analysis

This chapter comprises the analysis, presentation and interpretation of the findings resulting from the questionnaires and interviews conducted as part of the study. The explanatory narrative and summary statistical tables are used in the analysis.

Chapter 6: Findings and recommendations

This chapter of the research draws conclusions from the findings identified and presented in the quantitative data analysis and the qualitative data analysis chapters and relates them to the research objectives.

1.12. Chapter summary

This chapter provided an introduction to the research topic of the effectiveness of time management tools and techniques in public sector infrastructure construction projects. The focus of the chapter was on detailing the rationale for the research, presenting the problem statement and the research questions, the study objectives the research methodology, the limitations of the study, the ethical considerations and the assumptions made. Finally an outline of the dissertation was done. The following chapter will consists of a detailed literature review.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter provides a review of relevant literature and previous studies on the research theme of infrastructure delivery and time management such as the importance of investment in infrastructure, the importance of infrastructure in South Africa, the infrastructure delivery management toolkit (IDMToolkit) and time management in infrastructure development.

2.2. The Importance of Investment in Infrastructure

2.2.1. Economic Importance

Many countries in the world rank infrastructure as one of their greatest apprehensions with infrastructure development as one of the highest international challenge of the time in which we live (Threlfall, 2010). There is a vital and mounting demand for infrastructure to deal with serious global issues such as the changing climate, the need for sustainable places to source energy on a continuous basis, water and food shortages, growing mass urbanisation and economic and social growth (English, 2015). Improvements in infrastructure add to economic growth and the reduction of poverty by increasing the effectiveness as well as the connectivity of both international and domestic economies (Development Bank of South Africa (DBSA), 2012).

There exists a considerable volume of literature which highlights the importance of physical infrastructure as a determinant of economic growth, such as Aschaur (1990), Threlfall (2010), Peterson & Annez (2007), Burke (2000), English (2015) and Kumar (2001), therefore emphasizing that infrastructure development leads to positive economic growth.

Infrastructure development contributes positively to reducing unemployment and promoting the economic growth of a region (Estache & Garsous, 2012). The direct jobs created by infrastructure investments (e.g. the construction of transport infrastructures) are only the tip of the iceberg (English, 2015). There are many jobs that may be created through the augmented request for the raw materials needed for the production of the goods and service in the cement, asphalt, steel and timber industries.

There are also employment opportunities directly associated with growth and these include the employment opportunities created by the farmers who rely on the roads infrastructure to

deliver their products. Other industries also have the ability to benefit by cutting costs and avoiding power outages. Improved infrastructure further ensures that delivering products is made easier and more productive by integrating the transport infrastructure thus the workers also improve productivity. (Estache& Garsous, 2012).

The mainstay of a well-functioning city is its urban infrastructure such as a cities network of roads, the supply of electricity, water supply and the removal of waste, which allows residents and firms to work productively under high-density conditions (Peterson & Annez, 2007).

Therefore it is important that the choices made in the type and scale of infrastructure introduced in a city is chosen carefully as it may have huge consequences for environmental sustainability in a particular area (DBSA, 2012). Hence environmental sustainability and long term impact on the environment is also a substantial consideration in infrastructure investment. (Peterson & Annez, 2007).

The accessibility of good core infrastructure could also improve the investment climate for foreign direct investment (FDI), in a particular country, by financially backing the cost of total investment by foreign investors and thus raising the rate of return (Kumar, 2001).

Multinational enterprises (MNEs) may consider the quality of infrastructure available to be especially important while deciding on the location and efficiency of their businesses (Peterson & Annez, 2007). In other words, the quality of physical infrastructure could be an important consideration for MNEs in their locational choices for FDI in general and for efficiency-seeking production in particular (Kumar, 2001).

The development of good quality infrastructure is seen as being serious and impacting the future economic attractiveness of a country. It is also critical for accommodating growing populations in urbanising cities and countries (DBSA 2012). Infrastructure is one of the supports of economic change (Kumar, 2001). Sustainable economic growth frequently occurs in an situation where there is meaningful infrastructure development, and there is proof that it reduces disparity in the world (Economic Commission for Africa (ECA) 2013).

Evaluation studies conducted by the Engineering Council of South Africa (ECSA) have also provided evidence of the huge impact that road improvements can have on local communities. For instance, rural road impact studies in Guinea showed that areas where roads had been improved doubled their production and their sales almost quadrupled over a period of 5 years, while the production and sales of nearby areas that had not been improved remained the same.

The study further expounds that areas where the roads had been improved experienced between 50% and 25% reduction in travel time and transport cost respectively, while travel time and transport cost stagnated in unimproved areas.

The results of a study conducted in Ethiopia, found that the lives of the community had been improved drastically in a space of one and a half years of a road construction project being completed, in such a way that the local farmers increased their production per hectare by double for many crops with some crops even tripling their production value and this exceeded all the outlooks of the farmers who are dependent on the road for their exchange (DBSA, 2012).

2.2.2. Social Importance

Ensuring basic quality of local transport infrastructure and services is important for the achievement of primary school completion by all children of school going age and in order to promote gender equality at all levels of education (Kumar, 2001). Easier, cheaper and safer physical movement is often a significant element among measures to improve attendance at primary and secondary schools for children and teachers (ECA, 2013). Besides easing pupil's and teachers' access to the school, transport improvements can also contribute to reducing the amount of time that household members, including children, have to devote to collecting water, fuel and food, which is usually a principal reason for non-enrolment in school (Threlfall, 2010). Improvements of local roads, footpaths and other infrastructure tends to have particularly noteworthy effects on school attendance in areas where little infrastructure had previously been built (ECA, 2013).

This substantiates the need for infrastructure development in the global village within which human beings exist. Any community's social development requires better roads and railways, power plants and wind farms to meet the sustainable energy needs, for schools and hospitals (DBSA, 2006). Failure to invest in infrastructure development means failure to grow and develop the social and economic fabric of society, which everyone has a stake in (Threlfall, 2010).

The world in which we live currently is integrated and the economies of countries are interrelated and linked. Therefore the various regions of the world can easily integrate and create employment opportunities for each other and for other developing countries (DBSA, 2006). Infrastructure development also advances access to sustainable work opportunities for

communities in rural areas, but it does not end there, it also increases the earning potential and productivity of households (Fujita, 2012).

Therefore, access to good infrastructure provision encourages communities to develop, and enhances quality of life through improved efficiency and supportable economic growth, hence the countries of the world need to constantly invest in the development of both social and economic infrastructure. Having discussed the importance of infrastructure generally; the importance of infrastructure will be discussed in the South African context.

2.3. The Importance of Infrastructure in South Africa

2.3.1. Economic importance

Historical imbalances policies and practices have left South Africa with the key challenges of reducing infrastructure excesses in a period where there is no money in the national fiscus and the government needs to put measures in place to ensure that they increase revenue collection, reduced borrowing and spending (DBSA, 2006). The civic community has always played a pivotal role in the provision of infrastructure funding and this will continue, however the extent of the infrastructure development requirements is such that it can only be addressed effectively if the full participation of the public and private sector is attained (Peterson & Annez, 2007).

South Africa has one of the largest economies in Africa and is one of the most developed in sub-Saharan Africa (ECA, 2013). It is also a member of the BRICS countries, an association of five major emerging market economies, South Africa is known as a key developing market along with the other members of the group who are Brazil, Russia, India and China, according to (Price Waterhouse Coopers (PWC), 2013).

The South African Government adopted a National Infrastructure Plan in 2012. With the plan, the government meant to alter the country's economic landscape while concurrently creating noteworthy numbers of sustainable new jobs, and solidifying the delivery of basic services (PWC, 2013). The plan also strengthens the integration of African economies (Wood, 2013).

The South African Government, over a period of three years from the financial year 2013/2014, invested R827 billion in erecting new and upgrading current infrastructures (Wood, 2013). These funds were meant to improve access by South Africans to healthcare facilities, schools, water, sanitation, housing and electrification (English, 2015). On the other hand, investment in

the construction of ports, roads, railway systems, electricity plants, hospitals, schools and dams intended to contribute to quicker economic growth (PWC, 2013).

It is thus assumed that because of the essential part of infrastructure in driving a new growth path, together with the acknowledgement that there are gaps in state capacity for infrastructure delivery, the South African Government has created several organizations to support state capacity for infrastructure delivery (DBSA, 2012), namely:

- The Department of Performance Monitoring and Evaluation in the Presidency, which is tasked with enabling service delivery agreements for all infrastructure departments and checking their application;
- The National Planning Commission, which is situated in the Presidency, and is tasked with developing a long-term vision and strategic plan for South Africa, together with counselling Cabinet on important issues that affect everyone and impact on South Africa's long-term development. Infrastructure is one of the important issues dealt with by the commission;
- The Presidential Infrastructure Coordination Commission which is supervised by the President of South Africa and coordinates the execution of strategic infrastructure projects that kindle social and economic growth;
- The Presidential Review Committee on State-owned Enterprises (SOEs) that purposes to align SOEs with the government's developmental agenda, including that of infrastructure delivery and development (DBSA, 2006).

These organisations performance a critical role in driving infrastructure delivery in South Africa (DBSA, 2012). Therefore, the South African Government has invested substantially in social and economic infrastructure delivery.

Increasing investment in basic infrastructure should expand economic growth and social development (DBSA, 2006:15). Chong, Hentschel & Saavendra (2007:344) comment that when a community has access to a complete set of basic infrastructure services, the wellbeing result is greater when likened to communities where some components of infrastructure services are missing or not insufficient. Metwally, Saad & Ihada (2007:61) add that the basic infrastructure also lays the foundation for effective social infrastructure delivery such as schools, hospitals and police stations.

2.3.2. Social Importance

Social infrastructure in itself also has the ability to increase the economic growth and social development of a nation's citizens and ensures that the basic infrastructure is better utilised (Economic and Social Commission for Asia and the Pacific (ESCAP), 2006:5). Economic growth and social development in turn can play an important role in addressing long term growth challenges in South Africa, including double digit unemployment and the poor quality of human capital (Simo–Kengne, 2016).

Government invests in infrastructure, such as healthcare facilities, schools, housing and roads, in order to provide citizens with access to services and to promote social wellbeing (National Treasury Republic of South Africa (NTRSA), 2016:198). South Africa's infrastructure challenges are not mainly the result of a lack of finance but are caused by institutional miscarriages and a lack of appropriate capacity within departments (Simo–Kengne, 2016). The key provincial infrastructure departments include health, education, public works, and roads and transport, this study focuses on the education sector (NTRSA, 2016:198).

In line with the medium-term strategic framework and the National Development Plan, the South African government has prioritised spending on social and economic infrastructure such as schools, health facilities, roads and transport, energy, and water and sanitation (Simo–Kengne, 2016). It also continues to fund programmes and policies to improve the quality of infrastructure spending and the capacity of government to plan and implement capital projects (NTRSA, 2017:147).

2.3.3. Government Policy Interventions in Infrastructure

In order to support infrastructure development; the government has to put certain legislation in place and ensures that policy decisions are in favour of infrastructure development (Chong *et al.*, (2007).

According to Peterson & Annez (2007), a policy decision with greater impact is a policy decision about how future national assistance to the municipal infrastructure sector will be divided between capital grants and operating assistance as municipal infrastructure is critical to service delivery. Expense and cost is created by the policy of universal, free basic services and the operating and maintenance (O&M) cost of the newly built infrastructure, given that the overwhelming majority of new service recipients (in some smaller municipalities, almost 100 per cent) will not pay anything for service provision (Metwally *et al.*, 2007).

A shift in the overall grant structure to cover a greater part of O&M costs, especially in small municipalities, and to cover a lesser share of capital costs, especially in metros and larger municipalities, would also necessitate greater use of debt financing to meet investment coverage targets and would prolong the life of the fixed asset (Peterson & Annez, 2007).

In order to ensure that all spheres of the South African government have access to infrastructure, the government has ensured that various life cycle costing mechanisms and long term planning strategies are put in place. A case in point is stated by the DBSA (2012) that project preparation which ignores asset life cycle and longer-term strategies (e.g. localisation of input production) undermines sustainability and longevity. Inadequate operations and maintenance of infrastructure results in faster degeneration of assets and sacrifices job creation opportunities (English, 2015).

Some frameworks, strategies and initiatives have been proposed over the years for increasing, for example, broadband penetration in South Africa (Fujita, 2012). However, many of these have floundered because of the critical gap between infrastructure roll-out on the one hand, and access to skills and resources needed to make use of this infrastructure, on the other hand (DBSA, 2012).

Infrastructure delivery and expansion require a policy framework to guide resource allocation across and within sectors, and to ensure that such allocations, and the sequencing of the expansion of infrastructure, are aligned with the broader growth and development path (ECA, 2013). While this is currently not in place, the National Planning Commission (NPC) and the Presidential Infrastructure Coordinating Commission (PICC) have initiated a process to fill this vacuum (DBSA, 2012).

It is therefore evident that the South African Government regards infrastructure delivery as one of its greatest concerns, as it impacts on the economy of the country and is used as a tool to improve the lives of the citizens. There are also a number of governance structures and policy decisions that have been put in place by government in order to foster increased investment in infrastructure (Construction Industry Development Board (CIDB), 2010). One of these policy decisions is the introduction of the infrastructure delivery management toolkit which is discussed in some detail in the next section.

2.4. The Infrastructure Delivery Management Toolkit (IDM Toolkit)

2.4.1. Background of IDM Toolkit

The National Treasury of the Republic of South Africa (NTRSA), commissioned a study in 2001 aimed at reviewing provincial service delivery systems. The review identified various deficiencies and recommended that a framework be developed to guide the management of infrastructure delivery in the country (NTRSA, 2016). A further recommendation was that provincial departments should be helped to develop their capacity to manage and sustain infrastructure delivery (ECA, 2013). The government responded positively to the recommendations by creating the Infrastructure Delivery Improvement Programme (IDIP) in the year 2002 (CIDB, 2010). The implementation approach created a partnership between the NTRSA, The National Department of Public Works, Education and Health respectively, as well as DBSA and the Construction Industry Development Board (CIDB) (DBSA, 2012).

The partnership between these stakeholders, and the work undertaken in the year 2004, resulted in the development of what is referred to as the Infrastructure Delivery Management Toolkit, hereafter referred to as IDM Toolkit (PWC, 2013).

According to the NTRSA (2012), the IDM Toolkit was established in order to create a system that will capacitate those managers within the public sector who are not infrastructure specialists but are responsible for infrastructure delivery within the department. The IDM Toolkit helps to identify and facilitate a process of managing infrastructure delivery which is linked with relevant policies, legislation and mandates and it also focuses on project and programme planning implementation, monitoring and reporting and close out. (NTRSA, 2012).

2.4.2. Purpose of IDM Toolkit

According to the CIDB (2010), the following are some of the infrastructure delivery challenges that are meant to be addressed by the IDM Toolkit with regards to infrastructure delivery:

- Ad hoc projects or projects not on the departmental infrastructure plans,
- Silo approach to implementation of projects by public sector departments,
- Public sector departments not having accurate fixed asset registers,
- Public sector departments not having people with the relevant skills for the infrastructure delivery value chain,
- Public sector departments not having processes or policies in place,

- Public sector departments having limited understanding of Government Immovable Asset Management Act (GIAMA),
- Public sector departments having no procurement strategies in place for infrastructure delivery,
- Public sector departments not having programme management plans in place,
- Public sector departments having poor monitoring and reporting procedures in place,
- Public sector departments having no reporting procedures in place (CIDB, 2010).

It is certain that infrastructure is important hence the essential role of infrastructure in motivating for a new growth path, along with the recognition that there are gaps in state capacity for infrastructure delivery, the South African Government has created tools to strengthen state capacity for infrastructure delivery and the IDM Toolkit is one of these tools (DBSA, 2012).

Effective development planning structures that are aligned with growth targets need to be combined on different levels such as across sectors, space, spheres of responsibility as well as levels of government and timeframes (Osipova, 2008). Despite South Africa's long history of planning, a disunity and a mentality of working in silos continue to prevail in public sector infrastructure delivery (CIDB, 2010).

The IDM Toolkit not only aims to improve the way in which planning is done within the infrastructure sectors, but also to bring together all plans across sectors that will return more effective outcomes (PWC, 2013).

2.4.3. Development of IDM Toolkit

According to the CIDB (2010) the development of the IDM Toolkit was implemented in three phases as follows:

- Phase 1: Pilot

The first phase, initiated in July 2004, was a pilot programme to develop the methodologies and tools needed to build and support infrastructure management capacity in three selected provincial departments: Education, Health, and Roads and Transport. The pilot phase informed the design of phase 2.

- Phase 2: Developing tools and practices

The second phase, began in June 2006, and built on the lessons learned and practices developed in the first phase. A programmatic approach and management system were developed for the full rollout of the programme, which was implemented in the provincial departments of Health, Education and Public Works (CIDB, 2010).

As part of phase 2, the IDM Toolkit was developed to map out best practice delivery processes. This became the backbone on which improvement initiatives were developed in participating departments (CIDB, 2010).

The IDM Toolkit was in turn supported by a range of methodologies, including the Risk Management System, a Change Enablement Methodology, and a Knowledge Management Framework (PWC, 2013).

In 2009, an independent review concluded that phase 2 of the IDM Toolkit had improved provincial capacity to plan and manage infrastructure but that provinces still needed support to institutionalise infrastructure delivery practices and build sustainable capacity (CIDB, 2010).

It was determined by NTRSA, (2012), that the key challenge facing departments was the ability to ensure knowledge and skills transfer and in order to create sustainability, there needed to be a shift from dependence on technical assistants to a position where departmental staff assumed responsibility for the IDM Toolkit systems and tools.

It was further found by (NTRSA, 2012), that a particular impediment had been the lack of adequate organisational arrangements and of people to whom skills could be transferred. It became clear that a special organisational development approach was needed to address this problem. As a result, a process was initiated to design a Human Resource Capacitation Framework (DBSA, 2012).

This phase of the development of the IDM Toolkit also established provincial infrastructure management coordinating structures, led by provincial treasuries in collaboration with the provincial departments of Education, Health and Public Works within which this phase was being implemented (PWC, 2013). These structures coordinated and monitored infrastructure delivery activities in the provinces and supported the implementation of best practice approaches. Phase 2 of the development process was formally closed in March 2010 (NTRSA, 2012).

- Phase 3: Developing the infrastructure delivery management system

Based on the recommendations of the independent review of phase 2, the third phase of the development of the IDM Toolkit began in April 2010. The objective of this phase was to embed the methodologies of phase 2 and to design the appropriate human resource capacitation strategy to implement them (NTRSA, 2012).

In the latter part of phase 2, through the CIDB, review work began on the IDM Toolkit; the aim was to bring it in line with best practices while making it more accessible to departments (CIDB, 2010).

The revised IDM Toolkit was released on a web-based platform in October 2010 and became the basis for the development of a structured Infrastructure Delivery Management System (IDMS), which is a standardised approach to infrastructure planning, procurement and management for the public sector (CIDB, 2010). The IDMS in turn allowed the Human Resource Capacitation Framework to define the appropriate capacity requirements for provincial departments of Education, Health and Public Works in line with the relevant delivery processes (PWC, 2013).

According to (NTRSA, 2012), the IDMS focussed on the ability of infrastructure units within departments to perform tasks, produce outputs, define and solve problems and make informed decisions. It addressed four dimensions: institutions, people, and organisational behaviour and human resources systems. To assist with institutionalising the ‘people’ dimension of the framework, through the Division of Revenue Act (DORA) funding was provided to provincial Health and Education departments so that they could employ the necessary managerial, financial and technical personnel. According to the (NTRSA, 2012), the key focus areas of the human resource capacitation framework are:

- Development of appropriate organisational structures aligned to legal mandates;
- Identification of IDMS functions to be performed within organisations based on approved provincial IDMS frameworks;
- Identification of occupations required;
- Development of IDMS job descriptions;
- Competence standards;
- Qualification/professional registration and skills audits.

It is evident therefore that the South African Government has invested substantial resources in developing the IDMS and the IDM Toolkit towards assisting with infrastructure delivery.

2.5. Time Management in Infrastructure Development

2.5.1. What is time management?

Time Management is the function required to maintain appropriate allocation of time to the overall conduct of the project through the successive stages of its natural life-cycle, (i.e. concept, development, execution, and finishing) by means of the processes of time planning, time estimating, time scheduling, and schedule control (Osipova, 2008).

According to Nepal (2014:1), time management is the act or process of planning and exercising conscious control over the amount of time spent on specific activities, especially to increase effectiveness, efficiency or productivity. Time management in projects involves processes required to accomplish timely completion of projects (PMI, 2017).

Burke, (2000) states that time management is the process required to ensure that the project phases are performed on time; it consists of activity definition, activity sequencing, duration estimating, establishing the calendar, schedule development and time control.

While Gido, Clements & Baker (2018) define time management as a process of defining specific activities and arranging them in a sequence of dependent relationships to create a network plan.

Project time management includes the necessary processes to finish a project on time, which includes activity definition, activity schedule, duration estimating, schedule development and schedule control. (Passenheim, 2009)

2.5.2. Significance of time management

In the construction industry, the goal of project control is to ensure that projects finish within the allocated time, within the budget that has been set by the project sponsor and achieves all other project goals set by stakeholders. It is an intricate commission undertaken by project managers in the world of work, that includes constantly gaging progress, assessing plans, and taking remedial actions when necessary (Burger, 2013).

Successful project management insures the completion of projects on time, within budget, and to the project specifications. The undertaking of a study in time management tools is significant in order to determine how time is managed in the construction industry. So that the project team

can get a clear understanding of time management and they are able to prevent project delays early (Osipova, 2008).

Effective time management for a construction project is important in managing risk of delays on the project (Chin, Rahim & Hanid, 2015). Effective time management is vitally important for construction projects therefore the Chartered Institute of Building (CIOB) has identified time management as one of the critical factors to consider when looking at the success of a project (Chin, et. al., 2015).

Time management is important in any construction project because without proper time management, many problems will occur such as extension of time claims and time overruns (Burger, 2013). Some of the researchers describe time overruns as delays while others describe the time overruns as a result of the construction delay, no matter how they are described, time overruns are the most common problem in the construction industry worldwide (Memon, Rahman, Ismail & Zainun, 2014).

Time management is one of the answers to proper project management as flaws in time management will cause delays in project completion. Hence, time in construction projects necessitates control from the commencement of the construction process until the project is handed over to the client at completion. (Memon, et. al., 2014).

Therefore, keeping a project on track during its life cycle can support in reducing costs by removing the chance for a missed deadline and there are many scheduling and management software packages to help effective scheduling and time management in the construction industry (Memon, et. al., 2014). Project time management processes have been established to be an efficient method, which would help owners and contractors in developing countries in advancing their management competences and enable them to efficiently complete construction projects and achieve development objectives (Nabil & Enshassi, 2016).

Time management is therefore critical when it comes to delivery of infrastructure projects because of the high demand, low resources and short and medium terms that government operates under.

2.5.3. Time delays

2.5.3.1. Causes of time delays

With the high number of time delays occurring in construction projects, it is likely that a significant number of projects would not be considered successful with reference to time cost and quality (Garbharran, Govender & Msani 2012). It is essential to investigate causes of time delays while taking into account possible contributing factors with regards to cost and delays because these areas are interrelated (Burke, 2014). Figure 2.1 suggests that time delays not only influence the time aspect of the project, but other areas as well such as scope, quality, and cost (Landman, 2014).

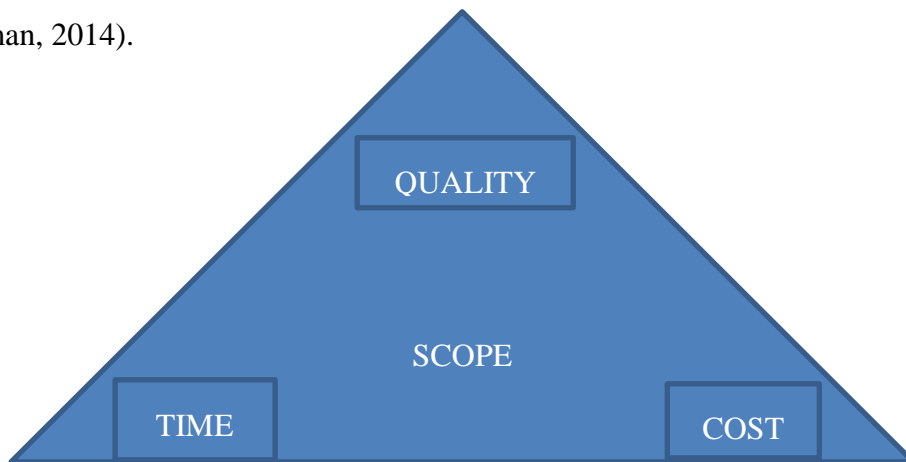


Figure 2.1: Interrelationship between time, cost, scope and quality. Source: Adapted from Landman (2014).

In Figure 2.1 it is shown that changes to the time aspect, according to its interrelations with cost, quality and scope, might have a ripple effect on some, if not all of the other areas (Garbharran *et al.*, 2012). As a result of time delays, costs might increase according to the degree of the delay and the same could be said with regards to the quality of work, as it might be of a higher standard with more time allowed, as opposed to as when a delay occurs and there is less time to complete the work (Landman, 2014).

The occurrence of time delays therefore demands further exploration regarding its causes and contributing factors as it not only influences the time aspect of projects, but other areas as well such as quality, scope and cost component of a project (Landman, 2014).

It is difficult to determine what the biggest contributing factor to time delays is, because the contributing factors and conditions are unique to specific projects and not to all projects (Baloyi & Bekker, 2011). This is due to different studies having found varying evidence with regards the contribution of the different factors. However, Baloyi & Bekker (2011) conducted a study

in South Africa and found the following 10 factors which result in delays on infrastructure delivery and development projects:

- Incomplete drawings
- Design changes
- Lack of proper decision making by the client
- Delays in the issuing of site instructions
- A shortage of skilled labour
- Poor planning and scheduling
- Labour disputes and strikes
- Variation orders by the client during construction
- Poor communication among the team
- Delays in work approvals.

2.5.3.2. Rational for time delays investigation

Although it is common knowledge in the construction industry that time and cost are two major concerns globally in any construction project (Landman, 2014). Literature indicates that there are numerous claims and disputes which arise specifically as a result from time delays (Baloyi & Bekker, 2011).

As delays are more the norm than the exception (Baloyi & Bekker, 2011), delay analysis is becoming more and more important in the construction industry. With cost impacts usually accompanying delays, it is not only important that analysis is done, but also that it is accurate in order to minimise risks and maximise the potential for project success (Landman, 2014).

Another important aspect of delay analysis is that it makes it possible to monitor the progress of a project and to prepare for the different costs involved if the project does fall behind schedule therefore by analysing the time aspect of the project it is possible to better plan for costs regarding the total project and to some extent and avoid some of those costs stemming from delays (Yates & Epstein, 2006: 168).

The relevance of project time management can be seen as a pertinent indicator that could be used to measure contractors' effectiveness and competence to succeed on the conclusion of a project and to evaluate contractors' performance (Landman, 2014).

Time management techniques assist in addressing issues of deprived management of time, type of procurement methods, participation of stakeholders in meetings, poor sequencing of construction works, lack of application of software and poor site records keeping. (Kazaz, *et al.*, 2011). These matters if not dealt with, can lead to interruptions often resulting in time overruns, cost overruns, quarrels, litigation, and complete abandonment of projects (Chin, *et. al.*, 2015).

With regards to the inhibition of project delays, the PMBOK Guide allocates one of the ten Knowledge Areas to Project Time Management, which includes the procedures required to achieve timely completion of the project (PMI, 2017). This knowledge area includes processes such as activity definition, activity sequencing, activity resource estimating, activity duration estimating, schedule development, and schedule control (Chin *et al.*, 2015).

2.5.3.3. Remedies for time delay

Delays in time on construction projects occur quite often, and more time is spent in an attempt to resolve the issues arising from delays than it is worth (Yates & Epstein, 2006:176). In order to decrease the amount of time lost, Yates and Epstein (2006:176) suggest that certain preventative measures be taken including;

- Preconstruction activities should be done better in the planning phases;
- Monitoring of construction processes should be improved
- When a delay has occurred there should be post delay consultation done.

There are steps that can be taken to minimise and prevent time delays and these include the following; effective determination of the contract completion date, the use of critical path method scheduling, proper documentation of delays and inclusion of alternative dispute resolutions in the contract (Yates & Epstein, 2006: 176). When a time delay occurs it is because the predetermined time of completion is no longer possible (Ibironke, Oladinrin, Ademiyi & Eboreime, 2013). The date of completion is determined in the contract data, which both the contractor and the client agree to when entering into the contract (Chin, *et. al.*, 2015). Yates and Epstein (2006: 177) suggest that a reasonable contract completion date will serve to eliminate many delay claims. Therefore a reasonable completion date must be agreed to by both the contractor and client and when the project start date is realistic it will contribute to the reduction of time delays on the project (Chin, *et. al.*, 2015).

2.5.4. Time management techniques

There are various techniques which are implemented in order to activate the key processes of time management (Burke, 2014). PMBOK identifies the following six steps as key processes for project time management (PMI 2017), namely:

2.5.4.1. Activity definition is a way of defining and identifying the specific schedule activities that must be done by the project team in order to produce the various project deliverables and targets.

Activity definition techniques may include but are not limited to the following:

- Decomposition, is a technique used for separating and subdividing the project scope and project deliverables into smaller components that one is able to manage.
- Rolling wave planning, is a planning technique that is sometimes known as progressive elaboration which means work activities that are closer are done in detail while work activities that are further out are not done in as much detail.
- Expert Judgement, is a technique in which the team members and other experts in the field play a significant role in that they provide the information and define the activities to be done and they make use of their experience and expertise (Burger, 2013)

2.5.4.2. Activity sequencing is the process of identifying and documenting all the various activities that need to be done and scheduling them in a logical sequence taking into consideration the relationships between the activities and how they affect each other.

Activity sequencing techniques include but are not limited to the following:

- Precedence Diagramming Method (PDM) which is also sometimes known as Activity on Node (AON) technique. This is a technique which is often used for documenting the activity sequences, and where each activity in the sequence is represented by a specific node.
- Arrow Diagramming Method (ADM) which is sometimes known as Activity on Arrow (AOA) technique, is a technique for documenting an activity sequence, in this case each activity is represented as an arrow and the nodes or points are the conditions or statuses of the deliverables which have been reached by the activities.

- Schedule Network Template is a technique for activity sequencing often used as area specific template, this is a way of sequencing activities that uses a standard template and does not deviate from it.
- Dependency Determination is a technique that deals with the relationship between activities and groups these categories and relationships according to how they are linked to each other and how they relate to each other.
- Applying leads and lags is a technique that allow the project manager to accelerate or delay a project or activities within a project accordingly in order to fit the requirements of the project (Heagney, 2012).

2.5.4.3. Activity resource estimating is the process of approximating the type and quantities of resources of all kinds including but not limited to people, goods, and raw materials required to perform a particular activity or to finalise a project.

Activity resource estimating techniques include but are not limited to the following:

- Expert Judgement is a technique where a specialist in a particular field will use their knowledge skills, experience and history to determine which materials, how much of it and what skills as well as how many of them are required to finish and activity or project.
- Alternatives analysis is a technique that tries to find other solutions to a prevailing problem because innovation and thinking which is outside of the box is encouraged. This is when options and alternatives are weighed against each other and the advantages and disadvantages highlights in order to find the best solution to the problem.
- Publishing estimating data is a technique where information about production rates is published for comment from industry stakeholders and this is normally done in order to get the view of the industry or to test research data against a particular market.
- Bottom-up estimating is the technique, where the activity is disintegrated into smaller bits, which can be estimated or calculated using basic calculations and historical data can be referred to (Shehu & Akintoye, 2009).

Kersner (2003), reasons that time management is vital in the planning of construction works because activity periods and sequence plans not being done properly is due to plans and statements not being followed through properly.

2.5.4.4. Activity duration estimating is the process of estimating how long a particular activity within a project will take and the correct time to be allocated to it.

Activity duration estimating techniques include the following:

- Expert judgement is a technique used to determine how long an activity might take by referring to industry leaders who in turn refer to historical data, previous experience and current research in order to give an informed estimate of the duration of an activity.
- Analogous estimating is a technique for estimating by comparing the actual units with other units of the same size, shape and duration that are already in existence.
- Parametric estimating is a technique that calculates the duration of an activity by standard mathematical formulas, this is taking into consideration that the estimates are purely on formulas therefore outside factors are not taken into consideration
- Three-point estimating is a method which estimates the duration of an activity by taking into consideration, the current status of the activity, the best case scenario of the project as well as the worst case scenario of the project hence it is referred to as the three-point estimating method.
- Reserve analysis is the process of calculating a reserve or a buffer into an estimate. This is done by ensuring that the time lines are not too tight and allow for any unexpected changes that might occur and negatively affect the project activities (Shehu & Akintoye, 2009).

The view of Chin, *et. al.* (2015), on schedule development is that in explaining or monitoring schedules, there should be straight, date-related status updates in line with the work truly done to the left of the line and the work to be done to the right of it and the schedule be sequential. If this was done correctly it would show the effect upon timing of the remaining planned activities of the progress estimated to have been achieved to date. The out of sequence works should take priority over planned sequential and logical work (Burke, 2014).

2.5.4.5. Schedule development is the process of examining activity sequences, durations, resource requirements, and schedule constraints in order to create the project schedule of all activities to be done on a project.

Schedule development techniques include but are not limited to the following:

- Schedule network analysis is a technique of calculating the early and late start and finish dates by using a system and generating project schedule network diagrams and inserting those estimated durations in the system for analysis.
- Critical Path Method is a way to determine the path in the network that does not have a float. Most of the time critical paths have either a zero or negative total float which means there is no lag time, and schedule activities on a critical path are called critical activities because if they don't happen the project will fail.
- Schedule compression refers to techniques to shorten the critical path without changing the scope this is done by removing activities that are not critical and making the critical path shorter.
 - The meaning of *crashing* is that the resources on an activity are changed in order to shorten the duration and this sometimes means the costs will increase.
 - The meaning of *Fast tracking* is that activities that should be done in sequence are done in parallel so that the project can finish earlier.
- The What-if scenario analysis technique is used to determine results by conducting an analysis of all possible combinations of optimistic, and pessimistic estimating in order to look at all the options.
- Resource levelling is a technique used to determine which resources are required where on the activities. Therefore at certain stages or levels it might be necessary to hurry or slow some activities by increasing or decreasing the resources.
- Applying calendars like project calendars or resource calendars can be used to allocate resources to activities and thus ensure that the project is a success (Heagney, 2012).

The single most important task of construction project management is project progress monitoring and control. Every team member must know how the project is continuing, where they are currently in contrast to plans at the beginning of the project, whether deadlines are met and if budgets are safely quantified and monitored (Chin, et. al., 2015). The importance of

progress reports in time management and keeping records on paper or electronically is also highlighted as essential by Kersner (2003).

2.5.4.6. Schedule control is the process of controlling changes to the project schedule while taking into consideration the status of the project

Schedule control techniques are those that include but are not limited to the following:

- Progress reporting regarding the actual start and finishing dates and the remaining durations for unfinished schedule activities allows the project manager to depict the status of the whole project. It is imperative that one has a decisive scale and a set of clear reporting rules which allow for a comparison of estimated and actual progress figures. One of those ways for progress measurement is known as Earned Value Technique.
- Performance measurement is the technique for explaining the differences between the plan and reality on the bases of the schedule base line and the progress reporting figures. Distinctive techniques that may be used are Schedule Variance and the Schedule Performance Index.
- Project management software often is able to support reporting and allows to comparison between the estimates and actual work done.
- Variance analysis is the action of matching target schedule dates with the actually reported dates and the predictions based upon the reports. The result of such an analysis are also recommended remedial actions.
- Schedule comparison bar charts use two graphs for each activity: one shows the actual state the other the planned state (Burger, 2013).

According to Nabil & Enshassi (2016) project time management practices have been established by industry leaders to be a proficient approach, which could assist project owners or clients, implementing agents, departments and contractors and sub-contractors in developing countries in advance their management competences and enable them to professionally complete construction projects and reach development aims.

Therefore it is essential to investigate the effectiveness of time management tools and techniques currently being implemented.

2.5.5. Time management tools

In the search for effectual project performance, time control has to be one of the most vital functions that need to be done (Kersner, 2003). It is more critical in large scale and megaprojects; where various risks and variables can be the foundation for schedule delays. Hence, there are plentiful time management tools and software packages that can be used for project planning and scheduling internationally (Memon et al, 2014). Each of the tools has different functions in providing a list of dates on which certain items are to be completed (Gido *et al.*, 2018). A concise exploration of the predominant time management tools and software packages will be undertaken.

2.5.5.1. Gantt Bar Chart

Gantt charts are modest and easy to build and hence are commonly used for scheduling and controlling in the construction industry. Furthermore, Gantt charts aid to manage the linkages between tasks and determining the resources required for each activity (McKenzie, 2012). These are used in monitoring progress of the project. The main benefits of Gantt charts are as follows:

- a) Gantt charts are useful tools for planning and scheduling projects.
- b) Gantt charts allow assessment on how long a project should take.
- c) Gantt charts determine the resources needed (Rómel et al, 2015).

2.5.5.2. Critical Path Networks/Method

Critical path method is used for network analysis and project planning in the construction industry and as a project management tool to advance scheduling and project administration tasks, this is achieved by assisting project managers to safeguard project completion dates and time frames (Johansson, 2012). Critical path method is also used to define project duration, early and late start dates float time, critical path, logical constraints and many other activity features (Attah, 2014). The main purpose of a critical path method is to build up a feasible duration plan required to perform a specific project.

2.5.5.3. Milestone Date Programming

Milestone Date Programming is when one highlights significant phases or direct deadline requirements within the overall project schedule (Attah, 2014). The milestone schedule is one of the most important documents that must be preserved and referred to throughout the project's lifecycle and is a summary level document where the project team leader can do a an analysis

and identify if any problems occur in the progress of the project, and ensure that no activity falls behind the schedule at any given point (Olawale & Sun, 2010). The milestone schedule provides a projected timeline of the project life and includes all project activities and temporary steps needed to get the project done (Kikwasi, 2012).

2.5.5.4. Program Evaluation and Review Technique (PERT)

The program evaluation and review technique (PERT) is a tool that allows for chance in activity completion times. PERT was originated by the U.S. Navy in 1958 as a tool for scheduling the development of a complete weapon system (Edum-Fotwe & McCaffer, 2001).

The main advantages of PERT are:

- a) The main use of PERT is for the projects which have not been done before in other words innovations.
- b) PERT provides a foundation from which time and cost performance can be predicted accurately.
- c) PERT delivers a valuation of the probability of reaching certain milestones by specified dates or of attaining overall project completion within a stated time period (Hendrickson, 2008).

2.5.5.5. Elementary Trend Analysis/Line of Balance (LOB)

Line-of-Balance (LOB) scheduling is a visual scheduling tool that allows the planner to explain the flow of the project explicitly (Euripides, 2008). Some of the LOB scheduling advantages are as follows:

- a) It clearly shows the amount of work taking place in a certain area at a specific time of the project.
- b) It has the ability to highlight and optimize the resources used by large number of repeated activities, executed in several zones or locations.
- c) It makes cost and time optimization analysis easier because of all the information available for each activity in the project (Euripides, 2008).

2.5.5.6. Precedence Network Diagram

The essential concept for precedence diagramming was introduced by a professor from Stanford University, John W. Fondahl in 1961 and is widely used in the construction industry (Ghahramanzadeh, 2013). According to Cheung, Suen and Cheung (2004), precedence diagrams are simpler to draw and adjust and additional activities can be introduced without changing node reference numbers. Therefore there is less risk of making logical errors with

precedence diagrams, since each activity is linked to others by an affiliation.

2.5.5.7. Simulation

In construction planning, simulation is used for examining all the risk and possible events related with the planning of infrastructure construction projects (Yimam, 2011). Earth moving, aggregate production, tunnel construction, are a few of the applications of risk analysis of construction operations using discrete event simulation that can be identified (Gajewska & Ropel, 2011).

2.5.6. Computer Software for Time Management

Keeping a project on track throughout its life cycle is a way of saving money on a project and keeping it within budget by excluding the unplanned activities and reducing the chance of deadlines not being met (Gajewska & Ropel, 2011). There are numerous scheduling and management software packages to aid effective scheduling and time management in construction industry as a few are described below:

2.5.6.1. Primavera Project Planner

Primavera is sometimes discussed as one of the technology leaders in project portfolio management as it has the ability to manage all kind of project whether large or short duration event critical project because it was designed to handle large-scale, intricate and multifaceted projects (Shmitz, 2012). The computer programme is capable of establishing resources such as labour, material and equipment needed by a construction company for managing complex and cohesive projects (Yimam, 2011).

The chief profits of Primavera Project Planner comprise that it can handle the smaller to medium size of the project, and produces various reports needed to document the project progress, while also being able to give a real time comparison on where the project is at ,compared to the targets in the business plan (Memon et al, 2014).

2.5.6.2. Microsoft Project

According to Gido *et al.* (2018) Microsoft project was intended to support the project manager in developing a plan, transferring or allocating resources to tasks following project progress, managing the budget and analysing workloads. The computer programme has several different versions where it allows the user to comprehend and control project schedules and finances, to

connect and present project information, and to organize work and persons to make sure that projects are completed on time (Rómel et al, 2015). It also affords functionality for the end user to create accounts that communicate the status and progress of the project (McKenzie, 2012).

2.5.6.3. Asta Power Project

This program was established for project planning and is a professional project management software, and it benefits to deliver construction projects of all types and sizes, on time and within budget (Johansson, 2012). Industry leaders have stated that Asta Power Project has the same appearance and feel as the Microsoft office application and that the project actions are directly drawn onto the bar chart by using mouse or typed in the spreadsheet by hand which makes it user friendly (Attah, 2014). Therefore the computer programme is good planning software because it can produce professional looking project duration plans quickly and easily and it can help to win tenders and impress clients.

2.5.6.4. Microsoft Excel

Microsoft Excel is one of the project management software that may be used in time management of construction projects. An Excel document is named a Workbook and a workbook always has at least one Worksheet which has a grid where one can store and calculate data (Olawale & Sun, 2010). Microsoft Excel is a valuable tool for scientific and statistical analysis with large data sets because the statistical formulas and graphing helps researchers to perform various types of analysis (PMI, 2017).

2.5.6.5. Project Commander

Regarding Project Commander, Kikwasi (2012) states that it is a planning tool created by industry experts in project management and actively recognised by contractors all over the world. Kikwasi (2012) further states that it covers all aspects of project management from producing simple plans through to fully adjustable professional outputs.

This software is said to be ideal for all those who are involved in project and resource planning, activity scheduling or departmental time control (Santos, 2018). An advantage of Project Commander is that it is comparatively easy to use and is also a cost effective planning solution which has the competence to exchange information with Microsoft Project (Emuze, 2011).

2.5.6.6. Deltek Open Plan

Deltek open plan is also well known software for project planning and scheduling and this

software also offers the authority and suppleness to serve the changing needs of the construction business, human resources and project managers (O’loughlin, 2015). Deltek Open Plan delivers multi-project analysis, critical path planning, and refined resource management (Santos, 2018). Therefore there are more than a few advantages to using Deltek Open Plan in project planning and scheduling such as it supports enterprise-level program management, recovers project planning, influences system and processes, and is able to manage resources.

2.5.6.7. Co Construct

This programme is a web-based and mobile project software for custom builders, remodelers and design-build firms, intended to help organise a construction team, communicate with clients and trade partners, and control the disorder of custom building (O’loughlin, 2015). The varieties function of the software package is designed to makes change orders easy to complete and it has a calendar feature that supports and coordinates schedules and makes sure deadlines are met (Urrea, 2017). It also has a comments section in this programme, which enables users to inform everyone involved in the project, in real time concerning updates.

2.5.6.8. Genie Belt

This programme is an online construction project management software which was planned and created by construction industry professionals who have become exasperated in having to tackle the same problems in every project, and with the help of modern technology, cloud computing, and mobile apps, the software is enabling its users to quickly and efficiently collaborate to regain control of their projects, save time and costs, and bring satisfaction to its customers (O’loughlin, 2015).

2.5.6.9. Procore

This programme is a cloud-based Construction Project Management software designed precisely for the construction industry by Procore Technologies. It is intended to use the newest web technologies to offer a simple but protected cloud-based application and as such it can manage numerous projects, invite limitless collaborators, and lets users monitor project progress across devices. It is full of features including a change order system and a drawing management tool which contractors can use (Courtemanche, 2018).

2.5.6.10. Workflow Max

This programme is a cloud-based work flow and activity management software and it is an

endways project management solution that has gears for leads, quotes, timesheets, job management, and invoicing (Santos, 2018). It is perfect for architects, building and construction professionals, surveyors and engineers, among others. It is an inclusive workflow and project management toolkit (Urrea, 2017).

2.5.6.11. Build Tools

This programme is a web-based construction management display place that manages communication, project schedule, budget, tasks, and documents and more; it is ideal for custom builders and remodelers, particularly built for managing custom projects and is available to any web-connected device, and as a result, scheduling conflicts are routinely brought to the builders' attention (O'loughlin, 2015).

2.6. Chapter summary

This chapter provided an in-depth review of the literature studied for this research. The chapter was made of four sub-sections and discussed the research topic, building a strong foundation to assist in the understanding of the important issues related to the research.

The first sub-section discussed the importance of investment in infrastructure, which was then followed by the second sub-section which brought to light the importance of infrastructure in South Africa. Subsection three discussed the Infrastructure Delivery Management Toolkit and sub-section four followed entailing a detailed analysis of time management tools and techniques in infrastructure delivery. The following chapter discusses the research methodology.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents the research methodology proposed in order to achieve the research aims and objectives. This chapter explains the research process and approaches followed, including the research methodology used. The relationship between the research methods, objectives, data collection and sampling methodology are highlighted. In addition, the data analysis techniques that were used are discussed and finally the credibility, reliability and validity of the research findings are presented.

3.2. The quantitative approach

The quantitative approach is limited to what can be measured objectively and exists autonomously of the feelings and opinions of individuals (Wolman, Jain, Marsden, Bell, Skinner, 2005). The approach can be experimental, quasi-experimental or non-experimental research (Wolman *et al.*, 2005). Quantitative data includes close-ended information such as that found to measure attitudes (e.g., rating scales), behaviours (e.g., observation checklists), and performance instruments (Kothari &Garg, 2015). The analysis of this type of data consists of statistically analysing scores collected on instruments (e.g., questionnaires) or checklists to answer research questions or to test hypotheses (Creswell, 2016). In this study questionnaires were used as part of the quantitative approach and a desktop study was also used in order to measure the effectiveness of time management tools and techniques used in public sector construction projects.

3.3. The qualitative approach

The qualitative approach is concerned with investigating the reasons for human behaviours and aims at discovering the underlying motives and desires (Saldana, 2009).

According to Creswell (2016) the main characteristics of qualitative data are, namely:

- That the interview takes place in a natural setting where the researcher studies the participants' experiences in a secure and comfortable environment;
- That the researcher collects data themselves through examining historical data and observing behaviours or interviewing participants;
- The researcher must build patterns, categories and themes from the responses of the participants.

- The researcher may focus on learning the meanings of facts and figures from the participants' perspective of the problem;
- Emergent design- the process of a qualitative study cannot be tightly prescribed as it can be changed based on the findings on the field during data collection. The main purpose of qualitative data is to learn about the problem;
- The researcher can think about their role in the study and their personal background and how their role can shape interpretation of the responses from the participants;
- The use of personal historical stories and experiences to address a complex problems.

Qualitative data consists of open-ended information that the researcher usually gathers through interviews, focus groups and observations (Kumar, 2014). The analysis of the qualitative data (words, text or behaviours) typically follows the path of aggregating it into categories of information and presenting the diversity of ideas gathered during data collection (Guest, 2012). In this study the researcher as key instrument was used, where the researcher interviewed the participants.

3.4. Mixed research method

Mixed methods research is a methodology for conducting research that involves collecting, analysing and integrating quantitative (e.g., experiments, surveys and data bases) and qualitative (e.g., focus groups, interviews) research (Onwuegbuzie, Johnson, 2013). This approach to research is used when integration provides a better understanding of the research problem than either of the methods alone (Maree, 2016).

Mixed methods research is a method for conducting research that involves collecting, analysing, and integrating quantitative and qualitative research in a single study or a longitudinal programme of inquiry (Creswell, 2016).

The purpose of this form of research is that both qualitative and quantitative research, in combination, provide a better understanding of a research problem or issue than either research approach alone (Creswell, 2016).

Ultimately, mixed methods research is about increased knowledge and validity (Creswell, 2016). The mixed methods design should be of such quality as to achieve beyond reasonable doubt that the findings of the study are valid (Onwuegbuzie, Johnson 2013). By mixing both quantitative and qualitative research and data, the researcher gains in breadth and

depth of understanding and support, while offsetting the weaknesses inherent to using each approach by itself (Maree, 2016). Mixed methods research was implemented in this study.

3.5. The research approach adopted

Research approach is the overall plan for conducting the research, it outlines the process and tools to be followed in order to conduct the research and presents findings (Hofstee, 2013). In other words, the research design enunciates what data is required, what methods are going to be used to collect and analyse this data, and how all of this is going to answer the research question (Kumar, 2014).

According to Hofstee (2013) the data, methods, and the way in which these will be configured in the research project, need to be the most effective in producing the answers to the research question while taking into account the practicalities and constraints of the study.

An explanatory sequential mixed methods design was used for this study. The intent of this kind of design method was to use qualitative findings to help clarify and explain certain quantitative results (Creswell & Plano Clark, 2011). Mixed methods research is both a method and methodology for conducting research that involves collecting, analyzing, and integrating quantitative and qualitative research in a single study (Creswell, 2016).

An explanatory sequential mixed methods design is when quantitative research is undertaken and findings are documented, and thereafter qualitative research is undertaken with the intention to reinforce or clarify the quantitative results (Creswell, 2016). For the first quantitative phase of the study, a desktop study was used on active projects, by the KwaZulu-Natal Department of Education, active in the years 2016 and 2017, using the Infrastructure Delivery Management (IDM) Toolkit. Upgrades and additions and new school projects at final and practical completion stages of construction were analysed in detail using graphs and tables to depict time delays or time overruns. These projects were implemented by various implementing agents. A questionnaire was also circulated to members of the technical team involved in KwaZulu-Natal Department of Education infrastructure projects and Statistical Package for the Social Sciences (SPSS) was used in the analysis of the data and to present the findings. For the second qualitative phase of the research, programme managers from the KwaZulu-Natal Department of Education and the implementing agents, were interviewed on their knowledge and experience in implementation of time management tools and techniques on KwaZulu-Natal Department of Education projects and their response documented coded and analysed.

3.6. Research instruments

There are predominantly 6 data collection methods which are used namely:

- Interviews
- Questionnaires and Surveys
- Observations
- Focus Groups
- Ethnographies, Oral History, and Case Studies
- Documents and Records (Creswell, 2016).

In this study structured interviews, questionnaires, documents and records were used.

3.7. Desktop research

3.7.1. Desktop research approach

Desktop research is also known as secondary research and, there are two types of research activities conducted in this approach namely, primary and secondary research (Greehoot, Follmer & Dawsett, 2012). Desktop research is not about collecting data, but the role of the researcher is to review previous research findings to gain a broad understanding of the field being researched (Greehoot, Follmer & Dawsett, 2012). It is the analysis of data or information that was either gathered by someone else or for some other purpose than the one currently being considered, or often a combination of the two (Hoffmann, 2017).

Desktop study is research that has previously been collected and can be retrieved by researchers (Johnston, 2014). The term is the opposite of primary data, which is data collected straight from its cradle (Greehoot, Follmer & Dawsett, 2012). Secondary data may be used to upturn the sample size of research studies and may also be chosen for the effectiveness and speediness that comes with using an already existing supply.

3.7.2. Motivation for desktop research

Desktop study data analysis can be very cost effective if it is carried out with care and diligence, it can provide a reliable way of gaining a comprehensive understanding of research questions (Windle, 2010).

Desktop study is also supportive in designing follow up primary research and can provide a starting point with which to compare your primary data collection results. Therefore, it is always wise to begin any research activity with an analysis of the secondary data (Johnston, 2014).

Before carrying out a field visit, developing a model, running a usability test, or starting on any project which is user centred, it makes sense to see what people have done in the past that relates to the research topic (Johnston, 2014). Although it's unlikely that anyone has carried out the exact research activity which is planned, someone has almost certainly tried to answer related questions (Greehoot, Follmer & Dawsett, 2012). Therefore reviewing existing data by carrying out desktop study research is the quickest and cheapest way to understand the research area.

According to Windle (2010), carrying out desktop study research is a critical first step, for at least three reasons:

- If one does know what has been done before in the field, one will not know when something new is discovered.
- Face-to-face with stakeholders is always important however a desktop study ensures that there is proper preparation for the contact sessions with stakeholders.
- Failing to do preparatory research is disrespectful of participants' time. It is therefore crucial to conduct desktop studies in order to get acquainted with the subject matter prior to meeting with stakeholders or participants.

A desktop study was conducted using the Infrastructure Reporting Model (IRM) data base and 20 projects were analysed for effective time management tools and techniques in the public sector construction projects which is discussed further in chapter 4.

3.7.3. Advantages of desktop research

- Desktop research is time saving because it is not a detailed study and sometimes relies on already existing information or data (Hoffman, 2017).
- Desktop research is cost saving because it requires less physical, human and financial resources than a detailed study (Greehoot, Follmer & Dawsett, 2012)
- The findings of a desktop study may be used to conduct further research on the area of investigation and provide opportunities for improvements (Johnston, 2014).
- Desktop studies can be conducted for both large and small sample groups depending on the type of study being conducted (Bezzina, 2015)

3.7.4. Disadvantages of a desktop study

- The secondary data used in the desktop study may be incorrect or inaccurate therefore relevant validity and reliability tests need to be conducted prior to implementation of the desktop study (Hoffman, 2017).
- The desktop studies may be superficial and not cover the research population in sufficient detail to provide reliable valid results (Johnston, 2014).
- Information in the area of research may not be available in the way the researcher needs it or the information may be too limited to use in conducting the desktop study (Bezzina, 2015).

3.8. Methods of data collection

- Primary data

The primary data is when the researcher collects and keeps data by direct and detached observation or quantifying of occurrences in the real world and uninterrupted by any in-between translator (Wolman *et al.*, 2005). The primary data is original in character as the data is collected fresh from the participants (Creswell, 2016). For the purpose of this study data was collected directly from programme managers who are directly responsible for upgrades and additions as well as new projects in the KwaZulu-Natal Department of Education using questionnaires and interviews.

- Secondary data

Secondary data discusses the data that is freely available composed by someone or an organisation, it can be either published or unpublished (Kothari & Garg, 2015). The literature review can also be referred to as secondary data as it forms the basis for all research as it is articulated by accumulating a review of research findings from a number of sources but not limited to books, journal, scholarly and government articles (Wolman *et al.*, 2005).

For purposes of this study, a secondary data sample of active construction projects undertaken and completed between 2016 and 2017 by the KZN Department of Education were the main source of data collection. Upgrades and additions and new school projects at final and practical completion stages of construction were analysed using tables to depict time delays or time overruns. The data is stored in the KwaZulu-Natal Provincial Treasury IRM.

3.8.1. Qualitative data collection

Data collection is a principal activity in the research process (Saunders & Bezzina, 2015). Data is usually collected from different sources, using different methods to achieve certain objectives (Kothari & Garg, 2015). This process increases the reliability and validity by verifying findings of data from one source with other sources. Triangulation refers to the use of different data collection methods within one study in order to ensure that the data is providing related, concise and accurate information (Saunders & Bezzina, 2015). This strategy reduces the risk and bias associated with using specific methods. Choosing a technique or methods to gather data was based on the type of information that was sought in order to achieve the research objectives, from whom, and under what conditions. Each method, tool or technique has its unique strengths and weaknesses, opportunities and pressures (Creswell, 2016).

In this study, the focus was on managers within the infrastructure unit at the KwaZulu-Natal Department of Education. Structured interview schedule was compiled and comprised of predetermined questions in a particular order (Kothari & Garg, 2015).

3.8.2. Interviews

The interview seeks to describe the meanings of central themes in the world of the subjects (Creswell, 2016). The main task in interviewing is to understand the meaning of what the interviewees say (Kumar, 2014). Interviews may be used to discover the views, experiences, beliefs and motivations of individual participants (Maree, 2016). Therefore this study makes use of structured interviews from programme managers and implementing agents to gain information on time management tools and techniques.

According to Seidman (2013) it is important to be tactful and sensitive in approach when conducting an interview. Listening is another important factor to consider as this is both the hardest as well as the most important skill in interviewing (Maree, 2016). The listening skills required in an interview require more focus and attention to detail than what is typical in normal conversation (Seidman, 2013). Therefore, it is often helpful for interviewers to take notes while the participant responds to questions or to tape-record the interviews themselves so as to be able to more accurately transcribe them later (Kumar, 2014). In this study the researcher was taking notes during the interviews.

3.8.3. Advantages and disadvantages of interviews

When considering what type of qualitative research method to use, qualitative interviewing has many advantages (Seidman, 2013). One of the greatest advantage of qualitative interviewing is the depth of detail that can be obtained from the interviewee (Leavy, 2014). Interviewing participants can paint a picture of what happened in a specific event, clarify their perspective of such event, as well as give other social cues (Leavy, 2014). Social cues, such as voice, intonation, body language of the interviewee can give the interviewer substantial additional information that can be added to the verbal answer of the interviewee on a question (Leavey, 2014). The level of detailed description, whether it be verbal or nonverbal, can show otherwise hidden interrelatedness between emotions, people and objects (Turner, 2010).

In addition, qualitative interviewing has a unique advantage in that the researcher can tailor the questions they ask to the respondent in order to get rich, full stories and the information they need for their research project (Seidman, 2013). They can make it clear to the interviewees when they need more examples or explanations (Leavy, 2014).

Researchers can also gain insight into people's interior experiences, specifically how people perceive and how they interpreted their perceptions and how events affected their thoughts and feelings (Turner, 2010). In this, researchers can understand the process of an event instead of what just happened.

Another advantage of qualitative interviewing is that researchers can write clearer reports to their readers, giving them a fuller understanding of the experiences of the respondents and a greater chance to identify with the respondents (Leavy, 2014).

According to Turner (2010), qualitative interviewing is not a perfect method for all types of research and it does have its disadvantages. Firstly, there can be complications with the planning of the interview because recruiting people for interviews hard, due to the typically personal nature of the interview. Planning where and when to meet the interviewee can be difficult because participants can cancel or change the meeting place at the last minute.

During the actual interview, a possible weakness is missing some information (Kothari and Garg, 2015). This can arise from the immense multitasking that the interviewer must do because the interviewer must make the interviewee feel comfortable, they must keep as much eye contact as possible, write down as much as they can, and think of follow up questions (Leavy, 2014).

After the interview, the process of coding has to be done and it comes with its own set of disadvantages. According to Kothari & Garg (2015), coding can be extremely time consuming and his process typically requires multiple people, which can also become expensive.

3.8.4. Interview design

There are various forms of interview design that can be developed to obtain thick, rich data utilising a qualitative investigational perspective (Creswell, 2016). Some of these interview design are as follows:

- informal conversational interview,
- general interview guide approach, and
- standardised open-ended interview.

When designing the interview questions some considerations were made such as that the standardised open-ended interview was extremely structured in terms of the wording of the questions, therefore the questions were chosen carefully. Participants were asked identical questions, but the questions were worded so that responses were open-ended (Creswell & Plano Clark). This open-endedness allowed the participants to contribute as much detailed information as they desired and it also allowed the researcher to ask probing questions as a means of follow-up.

The interview method of collecting data involves verbal questions and responses which are aimed at ascertaining the underlying reasons people perceive the world in a particular way (Kothari & Garg, 2015). This can be done through telephonic or personal interviews and can be structured, unstructured or semi-structured.

In this study, purposive sampling was used in that it was focused on managers within the infrastructure unit at the KwaZulu-Natal Department of Education. The interviews were aimed at confirming and gaining an in depth understanding of the findings of the desktop analysis of the project data base and the perceptions of respondents towards time management in public sector project management.

Structure and rational for the interview schedule

The interview schedule was structured with questions that were predetermined and had flow to them. The interview schedule was set out in this way in order to ensure that the interviewees are able to see beforehand what the interview is about and are comfortable. The interview schedule was structured in such a way that it covered four main areas of interest. **The first area** was the biographic information including gender in order to determine the gender balance of the interviewees and their qualifications and experience to answer the questions.

The second area of focus was that of time management tools and techniques. This was designed to be in line with the focus of the entire study. **The third focus area** of the interview schedule was on the IDMToolkit and the IRM. This was done in order to ensure that there is symmetry between the questionnaire and the interview questions. The interviewees had to also demonstrate their comprehension of the IRM and the IDM Toolkit in order for them to discuss the time management tools and techniques contained therein.

The fourth and final focus area of this interview schedule was to determine from the interviewees their views and opinions on areas that needed to be improved. Part of the interview schedule also aimed to get their expert opinions on how project time frames are set, and what would constitute a realistic time frame for an upgrades and additions project among others. The interview schedule is attached as Annexure B.

3.8.5. Quantitative data collection

Quantitative data was collected using survey questionnaires (Zainal, 2010). Questionnaires can be depended on because it is easy to distribute them. They can be distributed by email, post, or hand delivered and collected from participants, they also inexpensive and provide a respondent with suitable and sufficient time to give well thought out answers (Kothari & Garg, 2015). For the purposes of this study, the Likert scale was used to produce hierarchies of preferences (Wolman *et al.*, 2005).

Closed-end questions provide responses which are restricted in terms of how questions are answered as they require a selection of one of the possible alternative answer among the options given (Kothari & Garg, 2015).

3.8.6. Questionnaires

The greatest use of questionnaires is made by the survey strategy (Bryman & Bell, 2015). There are various definitions of the term “questionnaire” and some authors such as Onwuegbuzie and Burke Johnson (2013) reserve it exclusively for surveys where the person answering the question actually records their own answers. Others such as Maree (2016) and Saldana (2009) use it as a more general term to include interviews that are administered either face to face or by telephone. A more expanded definition of a questionnaire is exhibited by Leedy & Ormrod (2015) as a set of written questions for respondents to complete themselves and it is a data-gathering device that provokes from a respondent the answers or reactions to pre-arranged printed questions presented in a specific order.

The questionnaire is one of the most widely used survey data collection techniques (Saldana, 2009). This is due to the fact that each respondent is asked to respond to the same set of questions, and thus it provides an efficient way of collecting responses from a large sample (Wisdom & Creswell, 2013). However care must be taken when conducting a questionnaire, as the researcher needs to ensure that it will collect the exact data that is required to answer the research question and achieve the desired objectives. This is of supreme importance as the researcher is unlikely to be able to go back to respondents and collect additional data using another questionnaire (Maree, 2016).

3.8.7. Strengths and limitations of questionnaires

Creswell (2016) notes that the method of collecting data by mailing the questionnaires to respondents is most extensively employed in various research surveys. The advantages of this are:

- This method is cost effective regardless of the size or location of the sample population;
- The participants get the opportunity to answer questions honestly and confidentially
- Respondents can take their time to answer the questions in the comfort of their own environment.
- Respondents who are busy or far away can be sent the questionnaire by other means such as post and email as well as other online platforms.
- This method can reach a large sample population and therefore this can confirm the reliability and dependability of the results.

The disadvantages of this system are also highlighted by Creswell (2016) as follows:

- Sometimes the response rate is low and can affect negatively the validity of the results.
- This method is dependent on the willing participation of the respondents
- It can sometimes be difficult to conduct follow ups on the questionnaires once they are sent.
- This method entirely depends on the responses received, if no response is received no data analysis can be conducted.
- There is also a chance that the respondents might not answer important questions.
- It sometimes difficult to determine the quality of answer that will be received.
- This method may be the slowest because the questionnaires must be sent out and the participants given time to complete the answers and return the questionnaires.

3.8.8. The questionnaire design

When preparing the questionnaire for this research, there were a variety of influencing factors related to the research question and objectives that had to be considered. In particular, these were brought to light by Saunders & Bezzina (2015) as the following:

- The type of participants that will be part of the study must be clearly defined;
- The mode that will be used to distribute the questionnaires must be effective to reach the right participants;
- It is important that the answers are not negatively influenced in any way;
- It is important to calculate the size of the sample population and to also think about how many are likely to respond.
- It is also important to ask the right questions in order to get the right answers;
- It is also important to take into consideration the number of respondents in order not to overwhelm the participants.

In this research the types of questions included in the questionnaire were:

- Closed-ended questions because the respondent had to think carefully and compare the available responses before selecting a response. This was implemented to source higher quality responses.
- Scaled questions were also used where the respondents had to indicate their level of agreement towards statements, and how specific actions influenced them or the level of importance they allocate to a specific statement.

When designing the questionnaire, it was crucial to consider the order of questions and length of the questionnaire. Bryman & Bell (2015) note that it is advisable to start with general questions before proceeding into specific topics. Thereafter, the questions should be grouped into themes and must follow a logical pattern. Saunders & Bezzina (2015) further highlight that the questionnaire should be a reasonable length, brief and concise in order to avoid the possibility of unreliable data stemming from fatigued respondents.

In this research the researcher used a questionnaire survey instrument which comprised of close ended questions.

Structure of the questionnaire

The questionnaire consisted of a demographic information section where the participants were asked to provide information regarding their gender, their role on the project management team, and their years of experience in the current position as well as to confirm if they were involved in KZN Department of Education project. These questions were asked in order to determine that the participants were adequately experienced and equipped to answer questions about time

management. The issue of gender representation in the construction industry is also an important issue which needs to be highlighted hence the inclusion of the question around gender. The questionnaire was then structured in four parts with agreement Likert scale questions. The respondents were asked to respond to questions on a scale of 1 to 5 where 1 is Strongly disagree, 2 is Disagree, 3 is neutral, 4 is Agree and 5 is Strongly agree.

Part 1

Part 1 of the questionnaire was focused on gathering information about the implementation of time management activities and the knowledge of the project management team about these activities. Therefore the focus of part 1 was on consistency of implementation of time management activities, documentation of time management activities, monitoring of time management activities and finally reviewing of these time management activities for lessons learned.

Part 2 and 4

The second part of the questionnaire was focused on gathering information about the IDMToolkit and the IRM. The purpose of finding out about the toolkit was to determine if the systems which have been put in place to support public sector infrastructure delivery are actually fulfilling that purpose. Some of these tools and systems the IDMToolkit and the IRM. In part 4 of the questionnaire the respondents were also given the opportunity to make suggestions of how the current prevailing time management tools and techniques can be improved. This was done in order to determine any possible areas of improvement and future research and also to give the participants an opportunity to raise other relevant issues and suggestions.

Part 3

Part 3 of the questionnaire was designed to measure the effectiveness of the existing time management tools and techniques implemented within the department. Therefore the questions were structured in order to determine if the participants in the study agree or do not agree with measures such as “the majority of projects complete on time” and “the majority of projects suffer from time overruns”. The Questionnaire schedule is attached as Annexure C.

3.9. Sampling

The population is a group of possible members whom the researcher uses to make conclusions on based on the results of the study (Wolman *et al.*, 2005). Sampling as well as laborious classification and coding are very important if the researcher wants to achieve a good level of impartiality, dependability and accuracy in a study (Zainal, 2010). Strictness generally is a

processes of quality control that must be done in order to ensure the quality of the final research product is of the correct standard (Yin, 2014). When sampling it is important to consider three broad aspects, namely, what the sample is made of, the level at which the sample includes the entire population, and size of sample as they have serious implications on validity (Kumar, 2014).

3.9.1. Non-probability sampling

Non-probability sampling is sometimes used in qualitative research where the researcher's main focus is to get an exhaustive understanding of the area being researched (Wisdom & Creswell, (2013). Purposive sampling is non-probability sampling and is mainly used in qualitative research studies where the researcher sometimes selects individuals, groups of individuals, institutions for a detailed purpose in responding to a research question (Johnson & Christensen, 2017). Kothari & Garg (2015) concluded that the idea behind qualitative research is to decisively select participants, site or documents that will aid the researcher to understand the problem and answer the research questions. Other types of non-probability sampling include quota sampling, convenience sampling, and snowball sampling.

3.9.2. Probability sampling

Sampling allows the one conducting the research to save time and funds as it is not always possible to study the entire population in one study because it would take too long (Zainal, 2010). A basic principle of probability sampling is that a sample should be representative of the entire population from which it is selected if all members of the population have equal chances of being selected in the sample (Kumar, 2014). Probability samples purposes to achieve accurate representation of the entire population and are chiefly used on quantitative focused studies selecting a large number of components (Wolman *et al.*, 2005). This can be achieved by random selection (Zainal, 2010). Wisdom & Creswell (2013) assert that one of the advantages of probability sampling is that it eliminates the likelihood of being prejudiced and the researcher comprehends the limits placed on his ability to generalise. Unless there are limits set in the sample, it would not be easy to judge the how much of the population is represented by the sample. (Wolman *et al.*, 2005).

3.9.3. Systematic sampling

Systematic sampling is used on a very large population of unknown features. Systematic sampling processes include the selection of units in a sequence on a list according to a prearranged system (Wisdom & Creswell, 2013). The systematic sampling method by category was used for this study. New or Replacement assets as well as Upgrades and additions projects were selected for this study. A purposive sampling approach was adopted in this study to identify the various projects to be included in the sample. For the questionnaire survey systematic sampling was also used in that built environment staff responsible for project and programme management in the KZN Department of Education and in the Implementing Agent organisations were targeted and the questionnaires were distributed to them.

3.10. Data analysis

3.10.1. Quantitative data analysis

“Data analysis by means of statistical techniques helps us to investigate variables as well as their effect, relationship and patterns of involvement within our world” (Wolman *et al.*, 2005). Wisdom & Creswell (2013) highlighted the prominence of knowing which tests need to be done, as well as when these tests need to be done and finally when and how to perform the tests as well as to interpret the results properly. The researcher should check questionnaire to determine if there are any unclear answers, inconsistencies or multiple responses to a single item (Maree, 2016).

Descriptive statistics measure the central tendency the dispersion was adopted. Data was be captured, analysed through calculations and subsequently interpreted making use of SPSS.

3.10.2. Qualitative data analysis

Creswell (2016) indicates that the there are three main analysis strategies for qualitative data namely:

- The data must be prepared organised and analysed properly
- The data must be reduced to codes and these codes must be easy to interpreted;
- The data must then be prepared and presented in figures that are easy to explain.

In this study the data from the interviews was collected and organised into themes by highlighting the different themes found in the interview notes. The findings were then coded using thematic coding and presented in detail in the chapter on findings.

3.10.3. Thematic content analysis

Thematic analysis is used in qualitative research and focuses on examining themes within data and the method emphasises the organisation and rich descriptions of the data sets (Gibbs, 2007). Thematic analysis is not just about counting phrases or words in a text but it is also about identifying unspoken and obvious ideas within the data. It is also about developing themes within the raw data by recognising important instants in the data and encoding it prior to analysis (Saldana, 2009). The interpretation of the codes should include likening theme frequencies and, identifying theme co-occurrences, and vividly displaying interactions between different themes. Thematic analysis has a tendency to be a very useful method in capturing the particulars of connotation within a data set (Guest, 2012).

3.10.4. Coding practice

Data coding is a process to analyse and make sense of data by assigning tags or assigning numbers to all questions in the questionnaire (Wolman *et al.*, 2005). According to Gibbs (2007) there are questions that need to be considered when coding data for qualitative analysis and they are as follows:

- What people are doing and how they are to achieve their targets through what they are doing.
- What tools do people use to achieve what they need to achieve?
- Do members of the team understand what they need to do and talk about it?
- Have the people made any assumptions?
- From my own observations, what do I see going on here?
- What process did I use to choose the participants?

In this study the questions were asked when the interview schedule was being prepared and they were an integral part of the schedule preparation process. These questions were asked right through all sequences of the coding process and the data analysis in this study.

Coding can be done manually or with a software program. If a researcher is coding manually then highlighters, coloured pens or post-it notes may be used to take notes on the text that is

being analysed (Saldana, 2009). In this study manual coding was done where different colour highlighters were used to highlight responses around specific themes. Thematic content analysis was used in this study. There were four major themes that were captured in the interviews namely:

- time management tools and techniques,
- the IDM Toolkit,
- the IRM, and
- areas of improvement

3.11. Ethical considerations

Prior written permission was obtained from the Head of Department at the KwaZulu-Natal Treasury to access the IRM which is the project data base for the province and prior written permission was obtained from the Head of Provincial Department of Education to conduct interviews with programme managers and implementing agents. It was explained to all the participants that their participation is voluntary and that all information shared during the interviews and obtained from the IRM will be treated confidentially. Ethical clearance was obtained from UKZN and the ethical clearance number is HSS/0743/018M.

3.12. Reliability

Reliability is a way in which the quality of the measurement procedure that is used to collect data for a particular study is assessed so that the results of the study may be considered valid (Gibbs, 2007). It may also be defined as the level at which a given test would give consistent results if it was conducted by a different researcher in the same way under similar standard conditions (Saldana, 2009). The types of reliability measures that are recognised namely:

- test-retest reliability which measures reliability over an extended period of time,
- parallel-forms reliability which measures the reliability of two tests done in the same way using the same data,
- internal consistency which measures reliability across items of a similar nature, and
- interrater reliability which measures reliability across different researchers who are in the same field (Wisdom & Creswell, 2013).

3.12.1. Reliability of desktop study

Desktop studies making use of secondary data generally are considered reliable because the data was collected previously, and comes from actual project files or historical data (Maree, 2016). The data for the desktop study was obtained from the KZN Department of Education project files and the KZN Provincial Treasury official infrastructure reporting tool therefore the data may be considered as reliable.

3.12.2. Reliability of questionnaires

The internal consistency reliability measure was implemented in the questionnaires analysis portion of the study, making use of Statistical Package for Social Science (SPSS). The reliability test from SPSS that was use is the Cronbach's alfa.

3.12.3. Reliability of interviews

Individual interviews were conducted with suitably qualified and experienced individuals in the field of infrastructure programme and project management. An interview schedule was compiled and shared with the participants for their comments and for the purposes of ensuring participant validation.

3.13. Validity

Validity is a measure of the level at which a specific scientific test actually measures what it is intended to measure (Hofstee, 2013). Validity has to do with how correct or credible a description, conclusion, explanation or other statement of fact is (Guest, 2012). There are different types of validity and they are as follows:

- face validity which is when one looks at the appearance of a measurement method and if it looks like it is measuring the correct construct,
- content validity is the level at which the measurement method goes into detail concerning the construct under investigation,
- triangulation validity is the level of consistency of the results of a measurement method when it is compared with other instruments or methods measuring the same thing,
- criterion validity which is the level at which respondents that would be generally expected to have similar scores actually have similar scores, and
- discriminant validity which is the level at which the measurement method is different from other measurement methods that it should be different from.

3.13.1. Validity of desktop study

The desktop study consists of 20 actual school construction projects which have been complete. The projects are located in various localities within KwaZulu-Natal province. There are actual project files for these project therefore the data may be regarded as valid.

3.13.2. Validity of questionnaires

The validity test for the questionnaires portion of the study was done using content and criterion validity of SPSS. The validity test that was done is factor analysis and it consists of communalities, total variance explained and component matrix.

3.13.3. Validity of interviews

Triangulation validity test was used to test the validity of the interview portion of the study. Therefore in this study the findings from the desktop study and the questionnaire analysis were used to validate the finding from the interviews.

3.14. Summary

This chapter sketched the research strategy, design as well as the methods exploited in this research including the instruments used for the study. This chapter also explores how the relevant data was put together, analysed and presented. The next chapter presents the findings of the desktop study data base analysis.

CHAPTER 4: DESKTOP STUDY DATA ANALYSIS

4.1. Introduction

This chapter presents the source and analysis of data collected in the desktop study. Data analysis was done using Microsoft Excel 2013 and the data is presented using tables and charts.

4.2. Source of data

A desktop study is used on active projects in final or practical completion stage of construction. These projects are in the custody of KwaZulu Natal Department of Education, in the years 2016 and 2017. The projects are using the IDM Toolkit principles. These projects are kept on the Infrastructure Reporting Model (IRM) which is the official infrastructure reporting template and database as determined by National Treasury.

4.2.1. KwaZulu-Natal Department of Education infrastructure

The Department carries a large property portfolio (DBSA, 2012). The KwaZulu Natal Department of Education has approximately 5 923 public educational institutions (5 850 Ordinary and 73 Special Schools) functioning (NTRSA, 2017). The public ordinary schools accommodate ± 2.84 million learners. There are $\pm 20\ 000$ learners in public schools for Learners with Special Education Needs (LSEN) which equates to less than 0.1% of the total learner enrolment in the province (DBSA, 2012). Apart from the teaching and learning spaces and ancillary facilities dedicated to school based education service delivery, the department has non-school administrative offices which complement the aforementioned portfolio base. All these institutions are staffed by $\pm 109\ 000$ employees ($\pm 90\ 000$ educators and $\pm 19\ 000$ non-educators) (DBSA, 2012).

The KwaZulu Natal Department of Education public school infrastructure portfolio is characterised by extremes. There are schools that can be compared with the best schools in the world whilst many schools can be considered to be minimalistic (NTRSA, 2017). This imbalance and inequality is what the Government is trying to address.

Over the past 20 years, the KwaZulu Natal Department of Education has always focused on the poorer schools by applying appropriate interventions through various programmes (DBSA, 2012). The Regulations Relating to the Minimum Norms and Standards for Public School Infrastructure, published in November 2013, has provided focused impetus to the

abovementioned programmes (NTRSA, 2017) . Critical to these regulations are the minimum space norms and standards (educational, administrative and support) and sports fields that are required at schools and the timeframes for the provision thereof.

It is imperative to discuss the current infrastructure delivery structure of the department in order to determine how the department is currently dealing with the multiple challenges it faces in infrastructure delivery. Therefore a diagram depicting the current structure for infrastructure delivery is represented in Figure 4.1.

4.2.1.1. Current infrastructure delivery structure of the department

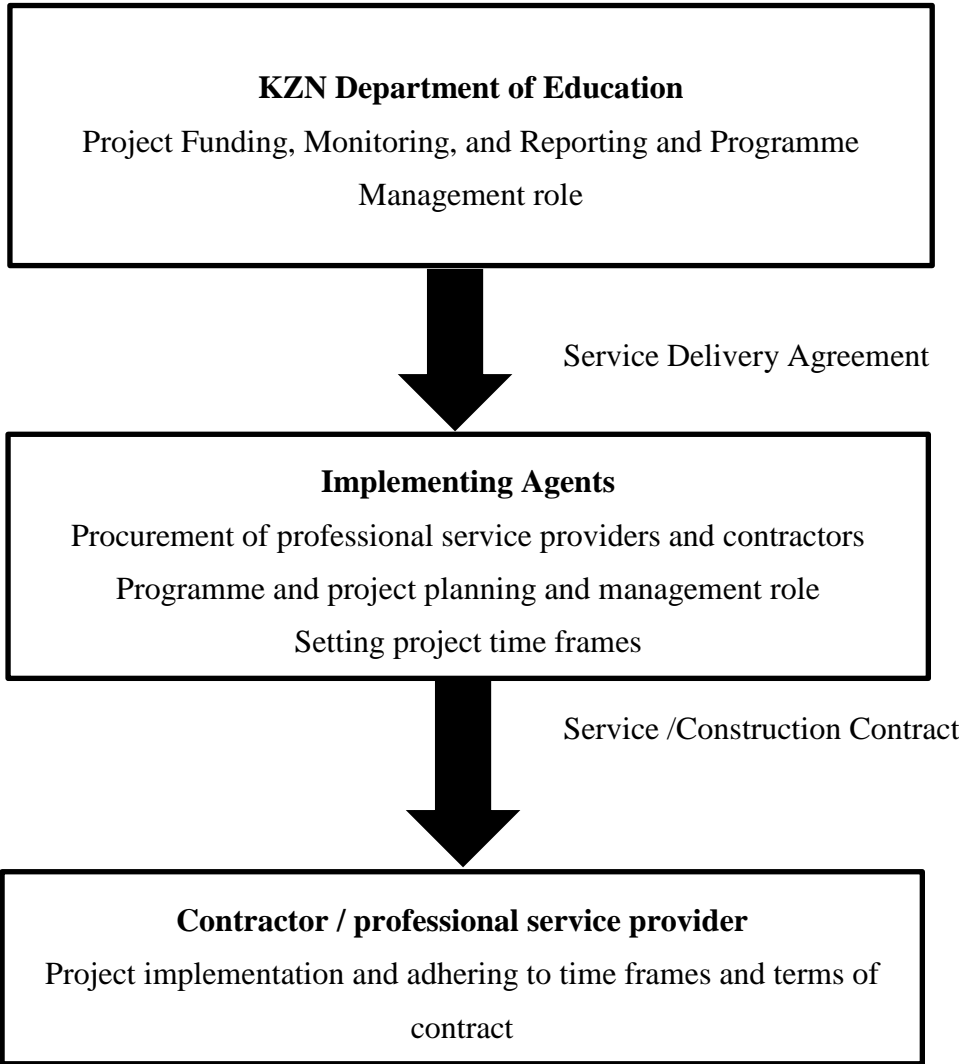


Figure 4.1: The current infrastructure delivery structure of the department

Figure 4.1 shows that the KZN Department of Education currently implements own infrastructure programmes through the use of a number of Implementing Agents, which include the KZN Department of Public Works.

The KZN Department of Education therefore contracts the Implementing Agents who in turn procure consultants and also appoint contractors. These contractors and consultants will then be responsible for project time management.

The responsibility for enforcing the contract conditions is the responsibility of the implementing agents for delayed or problematic projects.

The KZN Department of Education allocates budgets to each Implementing Agent based on the capacity of that Implementing Agent to spend the budget in a given financial year.

Unfortunately, the challenge of space deficiencies is compounded by the poor physical condition of many of our schools (DBSA, 2012). Therefore a data base or reporting tool called the IRM was created by National Treasury in order to keep a record of where and how the provincial departments are spending their infrastructure budgets. The IRM will now be discussed in detail.

4.2.2. Infrastructure Reporting Model (IRM)

The Infrastructure Reporting Model (IRM) is a project monitoring and reporting tool which looks at projects from a project level (NTRSA, 2017). It is a web based system and the model is utilised by provincial departments to report spending and performance progress on infrastructure projects (Baloyi & Beker, 2011). There is an IRM user manual intended for the users in the provincial departments who capture all infrastructure projects (Burger, 2013). The user manual contains the terminology used in the model in order to provide for a full understanding of the model and there is a legislative requirement in the Division of Revenue Act (DoRA) that requires provinces to provide reports on collective expenditure on infrastructure based on the agreed reporting format which is the IRM and has been prescribed in terms of section 13 (1) (e) of the DoRA (NTRSA, 2017).

Each provincial department has the accountability to report progress on infrastructure projects to its relevant Provincial Treasury and the relevant National Sector Department (DBSA, 2012). Both the Provincial Treasury and the National Sector Departments monitor progress on reported projects and verify data quality (ESCAP, 2006). If the quality of the data captured on the IRM is poor, the relevant Provincial Treasury and the relevant National Sector Department may request the respective provincial departments to make the necessary corrections (Burger, 2013).

Poor data quality may result in the withholding of infrastructure funds due to the provincial department as per the DoRA.

The flow of the data from provincial departments to National Treasury is shown in Figure 4.2 below:

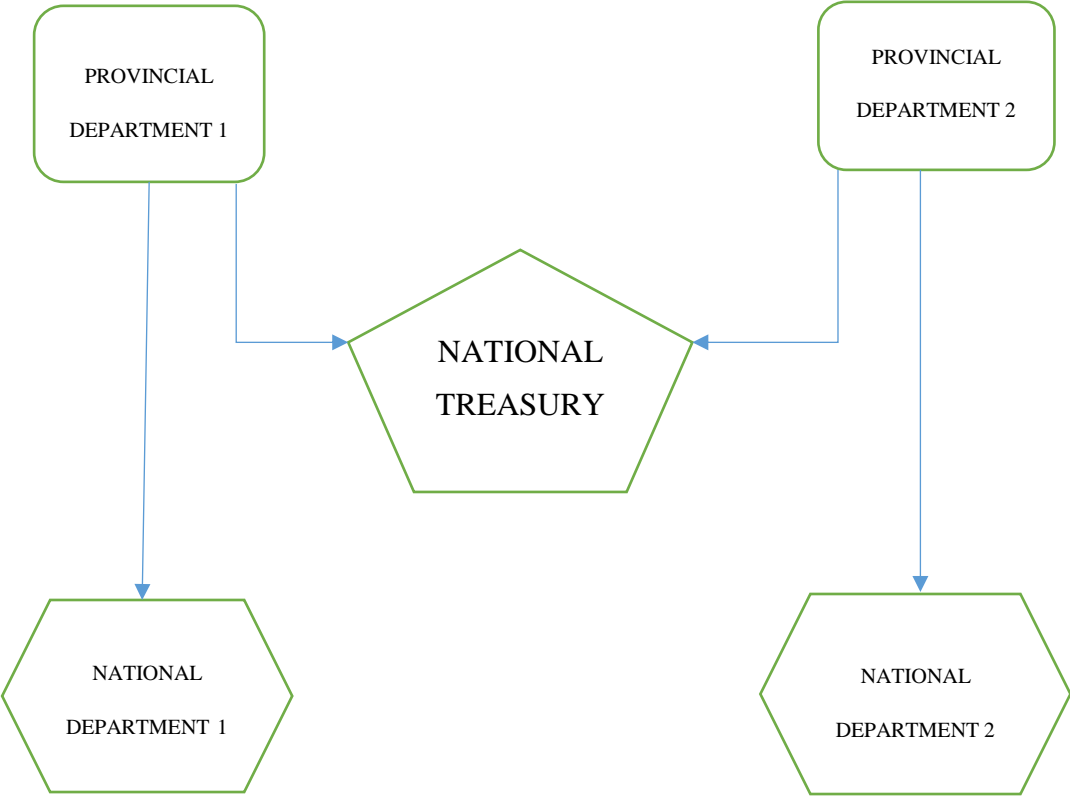


Figure 4.2: Flow of data (Source: South African National Treasury (NTRSA, 2017: 12))

The provincial department’s responsibility regarding the IRM is to record all ongoing projects and capture all new infrastructure projects at the beginning of each financial year to create a planning IRM with projected expenditure for the financial year (DBSA, 2012). Progress and expenditure on projects should be updated every month and signed-off monthly report should be submitted to the Provincial Treasury and the respective National sector department as per the flow of data in Figure 4.2 (NTRSA, 2017).

National Treasury consolidates the provincial reports into one national infrastructure report and the data is scrutinized by National Treasury to iron out any inconsistencies (DBSA, 2012). National Treasury will report to Parliament, Cabinet and to other stakeholders on request. The data that is reported on the IRM is also used to conduct infrastructure site visits. A report is then written to the Minister of Finance containing site visit findings and the recommendations thereof (NTRSA, 2017).

4.2.3. Systematic data sampling

A systematic process of data sampling was undertaken for this study (Kumar, 2014). Projects which completed in the years 2016 and 2017, which means projects that had a project status of final completion or practical completion in the said years, were analysed. The projects which are the focus of the study are those which are upgrades, additions and new projects. Also projects with no completion dates were not considered in the sample. The data was categorised by district municipality, number of projects, project status and project cost. The information is presented in graphs and tables. Total projects per district municipality in the province are captured in Table 4.1 in order to give a complete picture of the province.

Table 4.1: Total projects by District Municipality

TOTAL PROJECTS BY DISTRICT MUNICIPALITY		
District Municipality	Number of Projects	Projects Cost per district R
Amajuba	98	566 526 349
Ethekwini:	166	1 694 719 497
Harry Gwala	147	1 437 970 378
Ilembe	162	486 781 641
King Cetshwayo	162	1 304 338 129
Ugu	127	668 383 659
uMgungundlovu	183	1 379 098 773
Umkhanyakude	190	1 020 250 107
Umzinyathi	249	855 871 746
Uthukela	179	800 916 378
Province Wide	41	778 631 000
Zululand	366	1 332 530 129
Total	2070	12 326 017 786

There are 10 districts in KwaZulu –Natal and 1 Metro. The Metro is eThekweni as per Table 4.1. The table shows the total number of projects per district, as well as the costs of the projects per district. This total number of projects is made up of new schools and upgrades and additions of existing schools only. There are 366 projects within the Zululand District at a total cost of

R 1.33 billion and it is closely followed by the Umzinyathi district with 249 projects at a total project cost of R 856 million. The Metro has 166 projects at a total project cost of R 1.69 billion. On the lower end of the scale there are 41 projects that are distributed province wide at a total project cost of R 779 million. Amajuba district has 98 projects at a total project cost of R 566 million. This picture shows that there is a high demand for school infrastructure in the province as there is no district without projects and the district with the lowest number of projects is 98 projects.

Figure 4.3 shows upgrades and additions projects which have been split per district municipality.

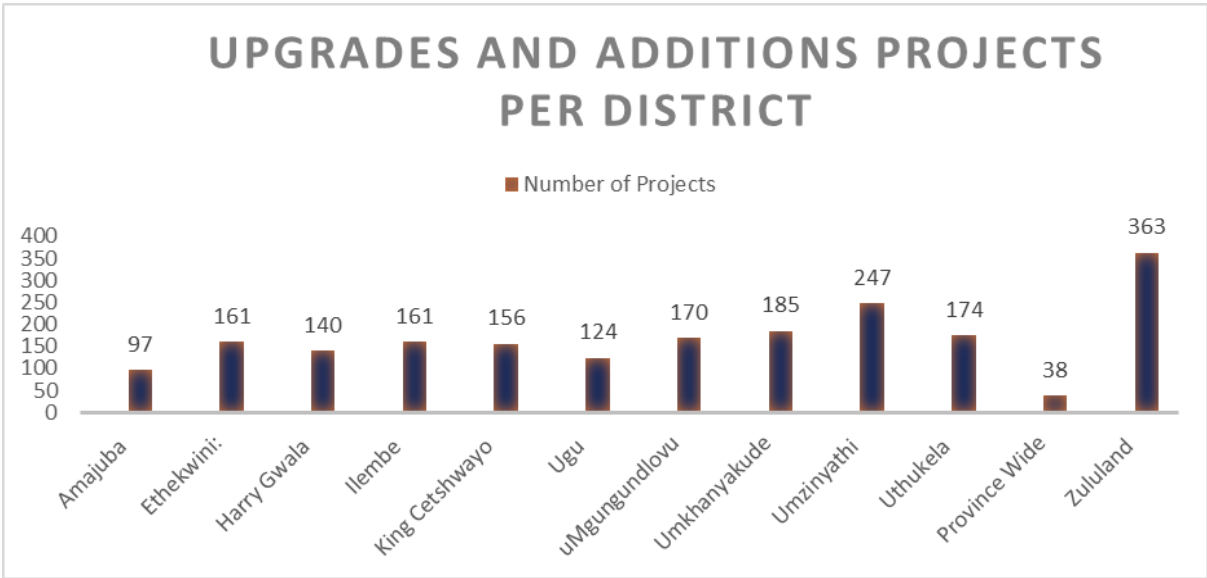


Figure 4.4: Upgrades and additions projects per district

When one focuses in on the upgrades and additions as per Figure 4.3, the total number of projects is 2016 of which the bulk is located in the Zululand district with 363 projects. Umzinyathi district has 247 projects and Umkhanyakude district has 185 projects. On the lower end of the scale, the district with the smallest number of projects is Amajuba with 97 projects.

Figure 4.4 focuses on depicting the number of new school projects distributed in the province and categorised by district municipality.

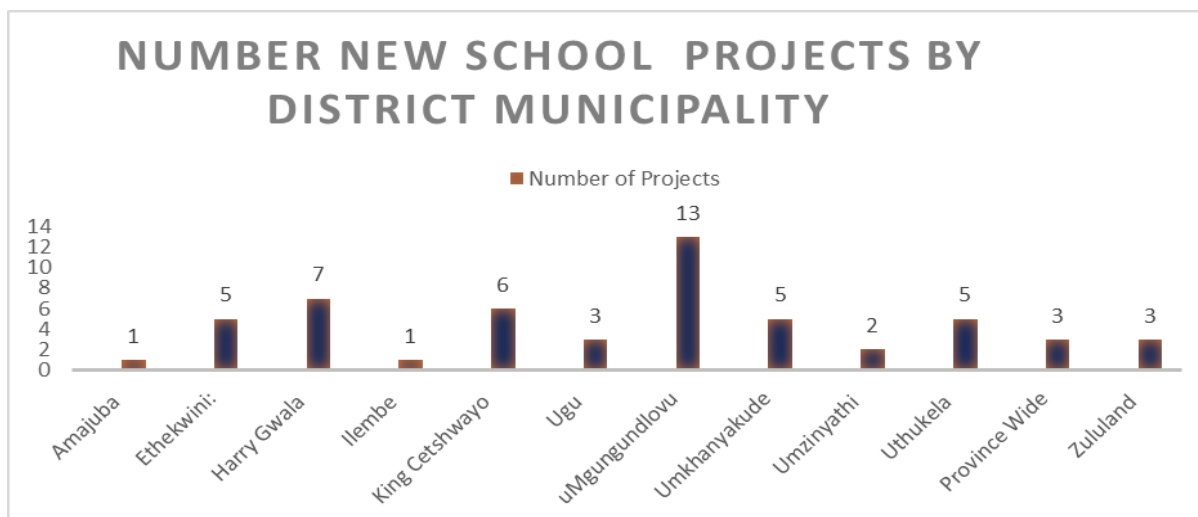


Figure 4.7: Number of new school projects by district municipality

When one focuses in on new projects in the province, as per Figure 4.4, the total number of projects is 54 of which the bulk is located in uMgungundlovu district with 13 projects. Harry Gwala district has 7 projects and King Cetshwayo district has 6 projects. On the lower end of the scale, the districts with the smallest number of projects are Ilembe and Amajuba districts with 1 project each.

Table 4.2 presents the number of projects per project status. This is aimed at showing how many projects are at final completion and practical completion stage.

Table 4.3: Number of projects by status

Project Status	No. Projects
Not Captured	0
Project Initiation	173
Pre - Feasibility	4
Feasibility	130
Design	206
Tender	765
Site Handed - Over to Contractor	5
Construction 1% - 25%	157
Construction 26% - 50%	70
Construction 51% - 75%	67
Construction 76% - 99%	187
Practical Completion (100%)	259
Final Completion	1
On Hold	0
Terminated	5
Other - Compensation of Employees	0
Other - Packaged Ongoing Project	41
TOTAL	2070

Table 4.2 above provides a comparison of the project statuses, the number of projects and the cost of the projects per nature of investment. This study focuses, the detailed analysis that will follow, on the 259 projects at practical completion with an estimated total cost of R 2.76 billion and 1 project at final completion with an estimated cost of R 13 million.

4.3. Desktop data analysis

The KZN Provincial Treasury in KwaZulu-Natal and the KZN Department of Education were requested in writing to the Heads of the two departments to grant permission for access to the Infrastructure Reporting Model (IRM) and to project files and to conduct interviews with officials. The Heads of the two departments granted permission in writing for data collection from the system for interviews to be conducted and questionnaires circulated and collected. This information was collected through different sources, namely data from the electronic system, official reports and archival records and project files. Both Departments were willing to share the information but there was a concern about confidentiality, therefore, the project names and other sensitive information are not disclosed.

The data was exported from the IRM to the Excel spread sheet for and reproduced in order to be analysed effectively.

The purpose of the case study is to analyse the consistencies and discrepancies between the project duration time estimates prepared at the beginning of the project and the actual project duration at the end of the project. However only 1 project has a status of final completion out of the sample of 2070 projects. Therefore projects at practical completion were also considered and the number of projects increased to 260 projects. There are 219 projects with no project end date captured on the IRM, therefore these projects had to be excluded as part of the study. The detailed analysis will be restricted to projects that reached practical completions in the year 2016 and 2017 and this criteria yielded 20 projects ready for analysis.

4.4. Data analysis and interpretation

The data analysis is done in order to answer the research question of how effective are the time management tools and techniques implemented by the KwaZulu-Natal Department of Education in reducing time overruns?

Effectiveness of the time management tools and techniques is measured by the adherence to project time frames. The data analysis focuses firstly on the variance between the actual and estimated project completion. Secondly the variance between estimated construction start dates

and actual construction start dates and finally the variance between estimated construction end dates and actual construction end dates. Table 4.3 shows the variance between actual and estimated project completion dates. The variance highlights whether the projects completed earlier, later or exactly as estimated.

4.4.1. Variance between the actual and estimated project completion

Table 4.4: Variance between the actual and estimated project completion

	Project Start Date	Actual Project Completion Date	Estimated Project completion Date	Variance between Estimate and Actual Project Completion
Project 1	10-Mar-11	26-Nov-17	19-Feb-17	9 months late
Project 2	15-Feb-12	18-Nov-17	23-Aug-17	3 months late
Project 3	08-Feb-13	31-Aug-17	31-Aug-17	0
Project 4	03-Jan-11	26-Nov-17	03-Sep-17	2 months late
Project 5	10-Apr-12	31-Aug-17	31-Aug-16	12 months late
Project 6	06-May-14	20-Dec-17	16-Nov-15	13 months late
Project 7	09-Nov-12	20-Dec-17	28-Nov-14	37 months late
Project 8	06-Jun-16	10-Oct-17	13-Jun-16	16 months late
Project 9	06-Jun-16	10-Oct-17	16-Jun-16	16 months late
Project 10	06-Nov-12	30-Nov-17	31-Aug-16	15 months late
Project 11	22-Feb-13	10-Nov-17	10-Aug-17	3 months late
Project 12	10-Apr-12	29-Dec-17	31-Aug-16	16 months late
Project 13	20-Mar-11	30-Nov-17	01-Sep-17	2 months late
Project 14	11-Oct-10	11-Dec-17	12-Nov-14	37 months late
Project 15	12-Feb-14	14-Nov-17	30-May-14	42 months late
Project 16	08-Feb-11	09-Nov-17	02-Sep-17	2 months late
Project 17	01-Feb-12	20-Nov-17	01-Sep-17	2 months late
Project 18	06-Jun-16	10-Oct-17	17-Jun-16	16 months late
Project 19	06-Jun-16	10-Oct-17	13-Jun-16	16 months late
Project 20	17-Feb-12	30-Nov-19	31-Aug-17	26 months late

Table 4.3 reflects a variance between actual project completion dates and estimated project completion. It is evident in Table 2 that 95% of the projects in the table completed later than the estimated completion time. 5% of the projects in the table completed on time in line with

the estimates. There are no projects that completed earlier than scheduled. On average the projects are completing 14 months behind schedule.

Table 4.4 shows a summary of the projects that were used in the desktop study and highlights what type of infrastructure project it is, the duration of the project and the scope of the project.

Table 4.5: Summary of desktop study projects

	Type of Project	Original Estimated duration	Actual Duration	Variance	Scope of project
Project 1	Upgrades and additions	71 Months	80 Months	9 Months	The scope of the project consisted of 3 additional grade R classrooms, 6 learner toilets, a play area and a wire fence.
Project 2	Upgrades and additions	65 Months	68 Months	3 Months	The scope of the project consists of 3 additional grade R classrooms, 6 learner toilets, a play area and a wire fence.
Project 3	Upgrades and additions	54 Months	54 Months	0 Months	The project scope of the project consisted of 6 HOD's offices, 1 staff kitchenette, 2 staff toilets, and 1 strong room.
Project 4	Upgrades and additions	80 Months	82 Months	2 Months	The project scope consists of 1 staff kitchenette, 1 computer room, 2 multipurpose classrooms, 1 media centre and 1 school library, a tuck shop, 1 storage area and 8 learner's toilets.
Project 5	Upgrades and additions	52 Months	64 Months	12 Months	The project scope consists of 1 grade R classroom, 4 learners' toilets and wire fence and gate.
Project 6	Upgrades and additions	18 Months	31 Months	13 Months	The project scope consists of 2 additional computer rooms and renovations and refurbishments which include, masonry, carpentry and joinery, floor covering, waterproofing, roof covering, ironmongery, plastering, tiling and electrification
Project 7	Upgrades and additions	25 Months	62 Months	37 Months	The project scope consists of 8 learner toilets.
Project 8	Upgrades and additions	0 Months	16 Months	16 Months	The project scope consists of 2 grade R classrooms, 4 learners' toilets, razor wire fence and gate.
Project 9	Upgrades and additions	0 Months	16 Months	16 Months	The project scope consists 5 alternative sanitation facilities provided at the school.
Project 10	Upgrades and additions	45 Months	60 Months	15 Months	The project scope consists of 1 principal's office, 1 deputy principal's office, 3 storage rooms, 1 staff kitchenette, 3 staff toilets and 1 strong room and 1 science laboratory.
Project 11	Upgrades and additions	54 Months	57 Months	3 Months	The project scope consists of 1 grade R classroom 4 learners' toilets, wire fence and gate.
Project 12	Upgrades and additions	53 Months	69 Months	16 Months	The project scope consists of 1 grade R classroom, 4 learners' toilets, wire fence and gate.
Project 13	Upgrades and additions	79 Months	81 Months	2 Months	The project scope consists of 1 principals' office, 1 staff kitchenette and 1 strong room.
Project 14	Upgrades and additions	49 Months	86 Months	37 Months	The project scope consists of 3 storage areas, 6 HOD's offices, 1 staff kitchenette, 4 staff toilets, 1 strong room, 12 classrooms, 1 computer room, 3 multipurpose classrooms, 1 school library, and 10 learners' toilets.

Project 15	Upgrades and additions	4 Months	46 Months	42 Months	The project scope consists of 8 learners toilets.
Project 16	Upgrades and additions	80 Months	82 Months	2 Months	The project scope consists of 1 staff toilet
Project 17	Upgrades and additions	68 Months	70 Months	2 Months	The project scope consisted of renovations and refurbishments such as paintwork, waterproofing, roof covering, ceilings and partitions, ironmongery, metal work, plastering, tiling and electrification.
Project 18	Upgrades and additions	0 Months	16 Months	16 Months	The project scope has not been captured on the IRM
Project 19	New or replacement	0 Months	16 Months	16 Months	The project scope consisted of 1 Principal's office, 1 Deputy principal's office, 1 administration office, 1 reception area, 1 storage area, 1 staff kitchenette, 5 staff toilets, 2 grade R classrooms, a food garden, 1 tuck shop, 1 multipurpose hall, walkways, learners toilets, assembly area.
Project 20	Upgrades and additions	66 Months	92 Months	26 Months	The project scope consisted of 1 principals' office, 1 deputy principals' office, 1 administration office, 1 reception area, 1 storage area, 1 printing room, 1 staff room, 4 HOD offices, 1 staff kitchenette, 6 staff toilets, 1 storeroom, 1 classroom, 1 multipurpose classroom, 1 school library, and 1 storage area.

In Table 4.4 it can be seen that the 20 projects that formed part of the desk top study consisted of upgrades and additions projects with a specific duration. It is depicted in the table that a majority of the projects completed later than scheduled. The table also provides a summary of the scope of each project therefore it can be seen what the new school projects consist of and what upgrades and additions consist of.

Table 4.5 consists of figures containing a variance between the actual and estimated construction start dates. This speaks to the planning phase of the projects and the effectiveness of the time management tools and techniques implemented in this phase.

4.4.2. Variance between the actual and estimated construction start dates

Table 4.6: Variance between the actual and estimated construction start dates

	Estimated Construction Start Date	Actual Construction Start Date	Variance Between Construction Start Dates
Project 1	18 May 2011	19 June 2011	1 month late
Project 2	08 March 2012	18 June 2012	3 months late
Project 3	10 February 2013	28 February 2013	0
Project 4	18 January 2011	09 May 2011	4 months late
Project 5	10 April 2013	10 April 2013	0
Project 6	05 June 2014	01 August 2015	13 months late

Project 7	04 November 2013	04 November 2013	0
Project 8	08 June 2016	10 June 2016	0
Project 9	10 June 2016	13 June 2016	0
Project 10	06 October 2013	30 November 2013	1 month late
Project 11	15 March 2013	18 May 2013	2 months late
Project 12	10 April 2013	10 April 2013	0
Project 13	14 March 2012	14 March 2012	0
Project 14	12 November 2012	11 December 2013	13 months late
Project 15	12 March 2014	12 May 2014	2 months late
Project 16	19 March 2011	10 September 2011	6 months late
Project 17	01 February 2015	01 March 2016	13 months late
Project 18	10 June 2016	13 June 2016	0
Project 19	08 June 2016	10 June 2016	0
Project 20	11 February 2013	11 February 2013	0

Table 4.5 reflects a variance between actual construction start dates and estimated construction start dates. It is evident in Table 3 that 50% of the projects in the table started construction later than the estimated construction start time. 50% of the projects in the table started on time in line with the estimates. There are no projects that started earlier than scheduled. There are three projects that have a construction start date that is delayed by 13 months, which is 15% of the sample. From the information in Table 4.5 it is clear that the time management tools and techniques are not fully effective in the planning phase of the projects as 50% of the projects failed to start construction on time in line with the estimated construction start time.

Table 4.6 follows and shows a variance between the estimated and actual construction end dates which highlights the planning and preparation for site hand over to the client by the contractor and the project technical team.

4.4.3. Variance between the actual and estimated construction end dates

Table 4.7: Variance between the actual and estimated construction end dates

	Estimated Construction End Date	Actual Construction End date	Variance between Construction End Dates
Project 1	15 August 2017	26 November 2017	3 months late
Project 2	23 October 2017	18 November 2017	1 month late
Project 3	17 August 2016	31 August 2017	0
Project 4	03 September 2017	26 November 2017	2 months late
Project 5	29 October 2015	31 August 2017	22 months late
Project 6	12 October 2017	20 December 2017	2 months late
Project 7	28 November 2016	20 December 2017	13 months late
Project 8	05 October 2017	10 October 2017	0
Project 9	05 October 2017	10 October 2017	0
Project 10	10 September 2017	30 October 2017	1 month late
Project 11	12 October 2017	10 November 2017	1 month late
Project 12	29 December 2015	29 December 2017	24 months late
Project 13	01 September 2017	30 November 2017	2 months late
Project 14	11 December 2016	11 December 2017	12 months late
Project 15	24 October 2017	14 November 2017	1 month late
Project 16	08 November 2017	09 December 2017	1 month late
Project 17	01 November 2017	20 December 2017	0
Project 18	05 October 2017	10 October 2017	0
Project 19	05 October 2017	10 October 2017	0
Project 20	31 August 2019	30 November 2019	3 months late

Table 4.6 reflects a variance between actual construction end dates and estimated construction end dates. It is evident in Table 4 that 65% of the projects in the table ended construction later than the estimated construction end time. 35% of the projects in the table construction ended on time in line with the estimates. There are no projects that ended construction earlier than scheduled. There are no projects that ended earlier than scheduled.

4.5. Chapter summary

In this chapter a quantitative analysis of the multi-case data was done. The IRM was used as the source of data and systematic data sampling was done in order to identify and categorise the data. The process of systematic sampling included, obtaining written consent from the Department of Education and the Provincial Treasury to use the project information contained in the IRM. The data analysis was limited to projects which completed in 2016 and 2017. Projects with a status of final completion and practical completion only were considered and the data was further limited to projects categorized as upgrades and additions as well as new school projects. The systematic sampling resulted in 19 projects at practical completion and 1 project at final completion.

4.6. Summary of findings of desktop analysis

It is evident that 95% of the projects completed later than the estimated completion date. 5% of the projects completed on time in line with the estimates. There are no projects that completed earlier than scheduled. On average the projects are completing 14 months behind schedule.

When referring to actual construction start dates and estimated construction start dates, it is evident that 50% of the projects started construction later than the estimated construction start date. 50% of the projects in the table started on time in line with the estimates. There are no projects that started earlier than scheduled. There are three projects that have a construction start date that is delayed by 13 months, which is 15% of the sample.

When referring to actual construction end dates and estimated construction end dates. It is evident that 65% of the projects ended construction later than the estimated construction end date. 35% of the projects ended construction on time in line with the estimates. There are no projects that ended construction earlier than scheduled. There are no projects that ended earlier than scheduled.

When referring to documented variation orders, 5% of the projects had documented variation orders on the IRM. For the other 95% there was no documented evidence on the IRM of any variation orders even though 95% of the projects had time overruns.

With regards evidence that the projects have reached practical completion, 25% of the projects have uploaded signed practical completion certificates as evidence that the projects have

reached the said milestone. 75% of the projects do not have any practical completion certificates uploaded on the IRM even though the project status is captured as practical completion.

The IRM does not contain any reasons for delays in the comments tab. 100% of the projects do not have reasons for delays even though the IRM has an area which is allocated for the relevant official to detail the reasons for delays or to provide comments, this section is not updated.

CHAPTER 5: DATA ANALYSIS

5.1. Introduction

This chapter comprises the analysis, presentation and interpretation of the findings resulting from the questionnaires and interviews conducted as part of the study. The explanatory narrative and summary statistical tables are used in the analysis.

5.2. Source of data

This phase of the research targeted senior managers, from the KZN Department of Education and the implementing agents, who were interviewed on their knowledge and experience in implementation of time management tools and techniques on KZN Department of Education projects. A questionnaire was also circulated to various members of the project team responsible for KZN Department of Education projects.

5.2.1. Reliability

The quality of the measurement procedure that was used to collect the data for this study is measured through the Cronbach's Alpha test from SPSS version 25. There is a rule of thumb for internal consistency and this rule of thumb was documented in Table 5.1 (Gibbs, 2007).

Table 5.1: Cronbach's rule of thumb for internal consistency (Gibbs, 2007)

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$\alpha < 0.5$	Unacceptable

Table 5.1 shows that a Cronbach’s Alpha greater than 0.9 means that the quality of the measurement procedure is excellent while a Cronbach’s Alpha of less than 0.5 means that the quality of the measurement procedure is unacceptable (Saldana, 2009).

The Cronbach’s Alpha score for all the variables in this study are recorded in Table 5.2. The Cronbach’s Alpha value is greater than > 0.700 therefore showing that internal consistency and reliability is at an acceptable level.

Table 5.2: Reliability Test

Reliability Statistics All variables	
Cronbach's Alpha	N of Items
.736	45

The test for internal consistency was also done, for only those variables that are pertinent to time management, in order to measure reliability and internal consistency and to ascertain whether the Cronbach’s Alpha is at an acceptable level as per Table 5.3.

Table 5.3: Cronbach's Alpha for time management variables

Reliability Statistics Time Management Variables	Cronbach’s Alpha	N of Items
Activity Definition	.576	6
Activity Sequencing	.676	6
Resource Estimating	.776	6
Duration Estimating	.778	6
Schedule Development	.776	6
Schedule Control	.786	6

The Cronbach’s Alpha score for the time management pertinent variables are recorded in Table 5.3. Activity definition and activity sequencing have values that are smaller than 7 however the other four time management variables namely resource estimating, duration estimating, schedule development and schedule control have a value greater than 7.

5.2.2. Validity

Validity is sometimes defined as what truth is and how it shows how correct an explanation of a process is (Guest, 2012). Validity can also have the same meaning when it comes to the extent to which a test, questionnaire or other method, measures what it is actually intended to measure (Saldana, 2009). Therefore, validity has to do with whether the findings are really about what they seem to be about. The validity test was also conducted on SPSS version 25 and the validity statistics for the questionnaires have been captured under each time management variable and in detail in this chapter.

5.2.3. Relative Agreement Index

The relative agreement index was also used to list or rank the time management factors in order of priority as per the responses of the respondents. This is based on the questionnaire design which is the agreement Likert scale. This was done in order to establish what the common understanding was among the respondents with regards to the management of time on projects. The relative agreement formula by Harinarain & Othman (2007) that was used is as follows:

$$RAI = \sum W / AN$$

W = weighting given to each statement by the respondents

A = highest weight,

N= total number of sample

The relative agreement scale is categorised into three categories, namely 1, 2 and 3 where 1 show that there was consensus among the participants in the study on the high importance of a particular factor, while a rating of 2 shows that the participants agree that a particular factor has low importance within the organisation and 3 is very low. Only the weighting given by the majority of the respondents will be considered as the value for (W) in the calculation.

5.3. Analysis of questionnaires

The KZN Department of Education has an infrastructure organogram with 75 employees who are trained built environment practitioners. KZN Department of Education has entered into implementing agency agreements with three implementing agent organisations who have staff dedicated to managing KZN Department of Education projects and the total number of these staff members is 25. Therefore a total of 100 questionnaires were distributed, where 75 were sent to the KZN Department of Education and 25 were sent to the 3 implementing agent organisations. There were 100 responses received however 31 were disregarded in putting

together the data for the study because some were completed incorrectly while others were not fully completed. Therefore 69 responses were used in data analysis for the study. Fryrear (2015) suggests that a response rate of 30-40% is acceptable and Akintoye (2014) and Fitzgerald (2012) cited in Odeyinka *et al.* (2016) agree with these rates. The response rate of this study which is at 69% can be considered acceptable. Data which was gathered through the process of questionnaires was analysed using SPSS version 25.

The first section of the questionnaire sought to identify the participants in terms of their biographic information, their work related experience and technical expertise. It is the researcher’s belief that in order to obtain dependable results, only the responses from people with experience and technical expertise in the construction of school infrastructure are to be considered. The responses to the questions are summarised in the tables below.

Table 5.4 show the gender distribution of the respondents and they have been categorised into male and female gender roles.

5.3.1. Gender distribution of respondents

Table 5.4: Gender distribution of respondents

Gender Distribution			
		Frequency	Percent
Valid	male	45	65.2
	female	24	34.8
	Total	69	100.0

Table 5.4 show that 65% of the participants in the study are males and 35% of the participants are females. That means the majority of respondents are men.

Table 5.5 follows and show the role of the respondents of the projects. The respondents had to choose that role which was suitable for them on the projects.

5.3.2. The role of the respondents on the projects

Table 5.5: Role of respondents on the projects

Are you a programme manager?			
		Frequency	Percent
Valid	Programme manager	31	45.0
	Project Manager	20	29.0
	Works Inspector	10	14.5
	Engineer	5	7.2
	Architect	3	4.3
	Total	69	100.0

The questionnaire was sent to the KwaZulu-Natal Department of Education, and all the implementing agents that have service delivery agreements with the department. Table 5.5 shows that 45% of the respondents are programme managers, 29% are project managers, 15% are works inspectors, 7% are engineers, 4% are architects. There were no other disciplines who responded. Which means the majority of respondents are programme managers and project managers.

The number of years of experience of the respondents is captured in Table 5.6.

5.3.3. Years of experience of respondents

Table 5.6: Years of experience of respondents

How many years of experience in current position?		
	Frequency	Percent
1-3 years	11	15.9
4-7 years	20	29.0
8-10 years	30	43.5
11-15 years	8	11.6
Total	69	100

Table 5.6 shows that 43% of the respondents have 8-10 years of experience in their current jobs in the public sector. 29% have 4 to 7 years’ experience, 16% have 1-3 years’ experience and 12% have 11-15 years of experience. There were no respondents with more than 16-20 years of experience and no respondents with more than 20 years’ experience. Therefore the sample consists of suitably experienced individuals. A scale was used to depict the number of years in

order to make the respondents comfortable to respond without the pressure of having to disclose their exact years of experience, as some might consider this information confidential.

Table 5.7 follows and shows the summary of the respondents to questions of time management knowledge by the project management team.

5.3.4. Project management team knowledge

Participants were requested to respond on a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, to indicate if the programme management team is knowledgeable about project activity tools and techniques.

Table 5.7: Summary of responses on time management knowledge

	N	1	2	3	4	5	Mean	Std. Dev.	RAI	Rating
Knowledge of Activity definition	69 100%	-	-	10 14%	8 12%	51 74%	4.59	0.734	0.014	1
Knowledge of Activity Sequencing	69 100%	-	-	10 14%	8 12%	51 74%	4.59	0.734	0.014	1
Knowledge activity resource estimating	69 100%	-	-	10 14%	8 12%	51 74%	4.59	0.734	0.014	1
Knowledge of activity duration estimating	69 100%	-	-	10 14%	8 12%	51 74%	4.59	0.734	0.014	1
Knowledge of project schedule development	69 100%	-	-	10 14%	8 12%	51 74%	4.59	0.734	0.014	1
Knowledge of project schedule control	69 100%	-	-	10 14%	8 12%	51 74%	4.59	0.734	0.014	1

Table 5.7 summarises the responses on time management knowledge as follows:

Seventy four percent (74%) of respondents strongly agree with the statement that the programme management team is knowledgeable about time management tools and techniques on departmental construction projects. 12% of the respondents agree with that statement and 14% are uncertain on neutral. There are no respondents that disagree or strongly disagree with the statement. This shows that the respondents regard time management as important (Mean 4.59) and a relative agreement index of 0.014 which is equivalent to a rating of 1.

Table 5.8 provides a valid statistics summary on the area of how knowledgeable the project management team is about time management concepts.

Table 5.8: Valid statistics of team knowledge

Valid Statistics of Team knowledge							
		The programme management team is knowledgeable about project activity definition tools and techniques	The programme management team is knowledgeable about project activity sequencing tools and techniques	The programme management team is knowledgeable about project activity resource estimating tools and techniques	The programme management team is knowledgeable about project activity duration estimating tools and techniques	The programme management team is knowledgeable about project schedule development tools and techniques	The programme management team is knowledgeable about project schedule control tools and techniques
N	Valid	69	69	69	69	69	69
Mean		4.59	4.59	4.59	4.59	4.59	4.59
Median		5	5	5	5	5	5
Mode		5	5	5	5	5	5
Std. Deviation		0.734	0.734	0.734	0.734	0.734	0.734
Skewness		-1.485	-1.485	-1.485	-1.485	-1.485	-1.485
Std. Error of Skewness		0.289	0.289	0.289	0.289	0.289	0.289

Table 5.8 shows the valid statistics for team knowledge which highlights that the programme management team is knowledgeable about all time management tools and techniques that must be implemented through the lifecycle of the project. The responses from all the respondents produced the same results. Therefore there was no disagreement among the respondents about their knowledge and expertise.

5.3.5. Correlation Matrix

The correlation matrix for this study is not positive definite because it is only one variable or singular which according to Petras (2013) means that the variables can be represented as a linear combination of the others. The single variable under investigation is time management.

Table 5.9 follows and shows a summary of communalities for the concept of how knowledgeable the project management team is about time management activities.

Table 5.9: Communalities for team knowledge

Communalities		
	Initial	Extraction
The programme management team is knowledgeable about project activity definition tools and techniques	1.000	1.000
The programme management team is knowledgeable about project activity sequencing tools and techniques	1.000	1.000
The programme management team is knowledgeable about project schedule development tools and techniques	1.000	.959
The programme management team is knowledgeable about project activity duration estimating tools and techniques	1.000	.959
The programme management team is knowledgeable about project activity resource estimating tools and techniques	1.000	.796
The programme management team is knowledgeable about project schedule control tools and techniques	1.000	1.000

Table 5.9 show that the communalities are high which means that the components explain the variables adequately.

Table 5.10 shows the total variance explained as per the statistical analysis on team knowledge.

Table 5.10: Total Variance Explained for team knowledge

Total Variance Explained					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
1	3.797	63.290	63.290	3.797	63.290
2	1.916	31.941	95.232	1.916	31.941
3	.286	4.768	100.000		
4	9.449	1.575	100.000		
5	.000	.000	100.000		
6	-3.898	-6.496	100.000		

Table 5.10 shows that two factors have been saved which means that the six (6) original factors or variables can be reduced to two (2) underlying factors this is according to the Kaiser rule. The first component explains the variance at 63.29%, while the second component explains the variance at 31.94%. This means that there would only be a 5% loss of information if only the first two (2) components were used.

Component matrix for how knowledgeable the project management team is about time management activities is captured on Table 5.11.

Table 5.11: Component Matrix for team knowledge

Component Matrix ^a					
	Component			Component	
	1	2		1	2
The programme management team is knowledgeable about project activity definition tools and techniques	0.854	0.52	The programme management team is knowledgeable about project activity duration estimating tools and techniques	-0.747	0.633
The programme management team is knowledgeable about project activity sequencing tools and techniques	0.854	0.52	The programme management team is knowledgeable about project activity resource estimating tools and techniques	-0.702	0.551
The programme management team is knowledgeable about project schedule development tools and techniques	-0.747	0.633	The programme management team is knowledgeable about project schedule control tools and techniques	0.854	0.52

Extraction Method: Principal Component Analysis. a. 2 components extracted.

According to Table 5.11 there are moderately strong correlations between the knowledge of programme management team about project activity definition tools and techniques and the two components. The rule of thumb when it comes to component matrix analysis is that any correlations less than 0.3 or 0.4 may be regarded as insignificant. There are therefore no insignificant correlations in this data.

Table 5.12 follows and shows the responses from the participants with regards to how consistency of time management activities is implemented on the department’s projects.

5.3.6. Consistency of time management activities

Participants were requested to respond on a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, to indicate whether time management activities were consistently done on departments projects

Table 5.12: Summary of responses on consistency of time management activities

	N	1	2	3	4	5	Mean	Std. Dev.	RAI	Rating
Activity Definition consistently done	69 100%	2 3%	3 4%	8 12%	8 12%	48 70%	4.41	1.048	0.014	1
Activity Sequencing consistently done	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Resource Estimating consistently done	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Duration Estimating consistently done	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Project Schedule Development consistently done	69 100%	18 26%	20 29%	11 16%	11 16%	9 13%	2.61	1.374	0.005	2
Project Schedule Control consistently done	69 100%	49 71%	10 14%	10 14%	-	-	1.43	0.737	0.002	3

Table 5.12 summarises the responses on consistency of time management activities as follows: Seventy percent (70%) of respondents strongly agree that activity definition is consistently done on the department’s projects and 12% agree. Another 12% are uncertain or neutral while 4% disagree with the statement and 3% strongly disagree. Therefore the majority of respondents agree with the statement and it can be concluded that activity definition is consistently done. The respondents substantiate that the activity is consistently done on the department’s projects as this activity has a relative agreement index rating of 1 and a score of 0.014

Thirty six (36%) of the respondents strongly agree with the statement that activity duration, resource and sequencing estimating are consistently done on the department’s projects. 14% of the respondents agree with the statement while another 14% are uncertain or neutral about the statement. 17% of the respondents strongly disagree and 17% agree. These activities have a relative agreement index rating of 1 and a score of 0.014.

Thirteen percent (13%) of respondents strongly agree that project schedule development is consistently done on the department’s projects and 16% of the respondents agree while another 16% is uncertain or neutral. 29% of respondents disagree with the statement and 26% strongly disagree. This shows that for the majority of respondents the consensus is that project schedule development is not consistently done on the department’s projects. Therefore it is rated 2 on the relative agreement index with a score of 0.005.

Seventy one percent (71%) of respondents strongly disagree with the statement that project schedule control is consistently done on the department’s projects. 14% of respondents are uncertain or neutral on the statement and 14% of the respondents disagree with the statement. There are no respondents that strongly agree or agree with the statement. This show that there is consensus among the respondents that project schedule control is not consistently done on the department’s projects. Therefore a relative agreement rating of 3 and a score of 0.002 is given to this activity.

Table 5.13 show the valid statistics for consistency of implementation of time management activities on the department’s projects.

Table 5.13: Valid statistics for consistency

Valid Statistics for Consistency							
		Activity definition consistently done on the department’s projects	Activity sequencing is consistently done on the department’s projects	Activity resource estimating is consistently done on the department’s projects	Activity duration estimating is consistently done on the department’s projects	Project schedule development is consistently done on the department’s projects	Project schedule control is consistently done on the department’s projects
N	Valid	69	69	69	69	69	69
	Missing	1	1	1	1	1	1
Mean		4.41	3.35	3.35	3.35	2.61	1.43
Median		5	4	4	4	2	1
Mode		5	5	5	5	2	1
Std. Deviation		1.048	1.542	1.542	1.542	1.374	0.737
Skewness		-1.758	-0.288	-0.288	-0.288	0.431	1.366
Std. Error of Skewness		0.289	0.289	0.289	0.289	0.289	0.289

Table 5.13 confirms the valid statistics for consistency and reinforces the overall consensus by the respondents that schedule control is not regarded as a priory with a mean of 1.43.

Table 5.14 shows the communalities for consistency of implementation of time management activities.

Table 5.14: Communalities for consistency

Communalities		
	Initial	Extraction
Activity definition consistently done on the department’s projects	1.000	.521
Activity sequencing is consistently done on the department’s projects	1.000	.967
Activity resource estimating is consistently done on the department’s projects	1.000	.967
Activity duration estimating is consistently done on the department’s projects	1.000	.967
Project schedule development is consistently done on the department’s projects	1.000	.903
Project schedule control is consistently done on the department’s projects	1.000	.669

Table 5.14 show that the communalities are high with the exception of activity definition and project schedule control which are at 0.5 and 0.6 respectively. These two components could be improved but the rest of the components are adequately explained by the analysis. This finding do not nullify the data.

The total variance explained for how consistently time management activities are performed is showed on Table 5.15.

Table 5.15: Total variance explained for consistency

Total Variance Explained					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
	1	4.993	83.218	83.218	4.993
2	.750	12.503	95.721		
3	.203	3.384	99.105		
4	.054	.895	100.000		
5	9.061	1.510	100.000		
6	-5.612	-9.354	100.000		

According to Table 5.15 there is only one (1) component that was kept this component has a variance of 83 % which means that the components can be reduced into one (1) component with a chanced loss of 27% of the information. This means that the data is valid.

The component matrix for how consistently the time management activities are performed in the department are captured in Table 5.16

Table 5.16: Component matrix for consistency

Component Matrix^a	
	Component
	1
Activity definition consistently done on the department's projects	-0.722
Activity sequencing is consistently done on the department's projects	0.983
Activity resource estimating is consistently done on the department's projects	0.983
Activity duration estimating is consistently done on the department's projects	0.983
Project schedule development is consistently done on the department's projects	0.95
Project schedule control is consistently done on the department's projects	-0.818

The correlations in Table 5.16 are very strong between component 1 and the consistency in implementation of the time management tools and techniques with regards to activity sequencing, resourcing, estimating, schedule development and schedule control.

The responses from the participants are captured in Table 5.17 with regards to documentation of time management activities.

5.3.7. Documentation of time management activities

Participants were requested to respond on a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, to indicate whether time management activities were well documented on departments projects

Table 5.17: Summary of responses on documentation of time management activities

	N	1	2	3	4	5	Mean	Std. Dev.	RAI	Rating
Activity Definition well documented	69 100%	7 10%	6 9%	6 9%	20 29%	30 43%	3.87	1.338	0.014	1
Activity Sequencing well documented	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Resource Estimating well documented	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Duration Estimating well documented	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Project Schedule Development well documented	69 100%	30 43%	10 14%	10 14%	19 28%	-	2.26	1.279	0.002	3
Project Schedule changes well documented	69 100%	50 72%	12 17%	7 10%	-	-	1.38	0.666	0.002	3

Table 5.17 summarises the responses on documentation of time management activities as follows: Forty three percent (43%) of respondents strongly agree that activity definition is well documented on the department’s projects and 29% agree with the statement. 10% of the respondents strongly disagree with the statement while 9% disagree and 9% are uncertain or neutral.

Therefore the majority of respondents agree with the statement and it can be concluded that activity definition is well documented on projects. The participants substantiate that activity definition is well documented with responses collating to a relative agreement rating of 1.

Thirty six percent (36%) of the respondents strongly agree with the statement that activity duration, resource and sequencing estimating is well documented on the department’s projects. Fourteen percent (14%) of the respondents agree with the statement while another 14% are uncertain or neutral about the statement. 17% of the respondents strongly disagree and 17% agree. These activities are rated 1 on the relative agreement index.

Forty three percent (43%) of respondents strongly disagree with the statement that project schedule development is well documented on the department’s projects and 14% disagree while another 14% are uncertain or neutral. 28% of respondents agree with the statement while there are no respondents who strongly agree with the statement. This shows that this is not performed and the consensus among the respondents has resulted in a relative agreement index rating of 3 and a score of 0.002.

Seventy two percent (72%) of respondents strongly disagree with the statement that project schedule changes are well documented on the department’s projects. 10% of respondents are uncertain on neutral on the statement, while 17% of respondents disagree with the statement. There are no respondents that strongly agree or agree with the statement. This show that this activity is not performed on departmental construction projects and a relative agreement rating of 3 with a score of 0.002 is captured.

Table 5.18 provides the valid statistics with regards to time management activities.

Table 5.18: Valid statistics for documentation

Valid Statistics for documentation							
		Activity definition is well documented on the department's projects	Activity sequencing is well documented on the department's projects	Activity resource estimating is well documented on the department's projects	Activity duration estimating is well documented on the department's projects	Project schedule development is well documented on the department's projects	Project schedule changes are well documented on the department's projects
N	Valid	69	69	69	69	69	69
	Missing	1	1	1	1	1	1
Mean		3.87	3.35	3.35	3.35	2.26	1.38
Median		4	4	4	4	2	1
Mode		5	5	5	5	1	1
Std. Deviation		1.338	1.542	1.542	1.542	1.279	0.666
Skewness		-1.043	-0.288	-0.288	-0.288	0.316	1.543
Std. Error of Skewness		0.289	0.289	0.289	0.289	0.289	0.289

Table 5.18 reinforces the findings with a detailed valid statistics for documentation. It is evident that project schedule changes are not well documented because of the mean of 1.38 and the majority of respondents agree that activity definition is a priority with a mean of 3.87.

Communalities for documentation of time management activities are captured in Table 5.19.

Table 5.19: Communalities for documentation

Communalities for documentation		
	Initial	Extraction
Activity definition is well documented on the department's projects	1.000	.755
Activity sequencing is well documented on the department's projects	1.000	.964
Activity resource estimating is well documented on the department's projects	1.000	.964
Activity duration estimating is well documented on the department's projects	1.000	.964
Project schedule development is well documented on the department's projects	1.000	.903
Project schedule changes are well documented on the department's projects	1.000	.522

Table 5.19 show that communalities are very close to 1 which means that the extent to which the variables are explained by the components are very high with the exception of the first and the last component. This shows that the data of this component is valid.

Table 5.20 shows the total variance explained for documentation activities related to time management.

Table 5.20: Total variance explained for documentation

Total Variance Explained for documentation					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
	1	5.073	84.547	84.547	5.073
2	.589	9.812	94.359		
3	.281	4.683	99.042		
4	.057	.958	100.000		
5	-9.673	-1.612	100.000		
6	-2.722	-4.537	100.000		

The total variance explained in Table 5.20 shows that the six (6) components may be combined into the first component with an 84.5% variance. This shows that the components render that data valid.

Table 5.21 contains the component matrix for documentation activities related to time management.

Table 5.21: Component Matrix for documentation

Component Matrix^a	
	Component
	1
Activity definition is well documented on the department's projects	-0.869
Activity sequencing is well documented on the department's projects	0.982
Activity resource estimating is well documented on the department's projects	0.982
Activity duration estimating is well documented on the department's projects	0.982
Project schedule development is well documented on the department's projects	0.95
Project schedule changes are well documented on the department's projects	-0.722

According to Table 5.21 there is a very high correlation between the time management activities and component one (1) with the lowest correlation score at – 0.722.

The responses obtained from the respondents with regard to monitoring of time management activities are captured in Table 5.22.

5.3.8. Monitoring of time management activities

Participants were requested to respond on a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, to indicate whether time management activities were well monitored during the construction phase of the projects

Table 5.22: Summary of responses on monitoring of time management activities

	N	1	2	3	4	5	Mean	Std. Dev.	RAI	Rating
Activity Definition well monitored	69 100%	-	-	9 13%	10 14%	50 72%	4.59	0.714	0.014	1
Activity Sequencing well monitored	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Resource Estimating well monitored	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Duration Estimating well monitored	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Project Schedule Development well monitored	69 100%	-	19 28%	10 14%	10 14%	30 43%	3.37	1.279	0.014	1
Project Schedule changes well monitored	69 100%	21 30%	10 14%	10 14%	10 14%	18 26%	2.91	1.606	0.002	3

Table 5.22 summarises the responses on monitoring of time management activities as follows:

Seventy two percent (72%) of the respondents strongly agree that activity definition is well monitored during the construction phase of the projects, while 14% agree with the statement and 13% are neutral or uncertain. There are no respondents who disagree or strongly disagree that activity definition is well monitored during the construction phase of the projects. Therefore

the majority of respondents agree with the statement and it can be concluded that activity definition is well monitored on projects. The participants substantiate that activity definition is well monitored and this activity is rated 1 on the relative agreement index with a score of 0.014.

Thirty six percent (36%) of the respondents strongly agree with the statement that activity duration, resource and sequencing estimating is well monitored on the department's projects. 14% of the respondents agree with the statement while another 14% are uncertain or neutral about the statement. 17% of the respondents strongly disagree and 17% agree. This shows that there is strong consensus that these activities are performed on the department's projects. This is further substantiated by the rating of 1 on the relative agreement index and a score of 0.014.

Forty three percent (43%) of respondents strongly agree with the statement that the project schedule is well monitored during the construction phase of the projects and 14% of the respondents agree with the statement while 14% are uncertain or neutral and 28% of respondents disagree but none disagree strongly. This activity is rated 1 on the relative agreement index with a score of 0.014.

Twenty six percent (26%) of respondents strongly agree and 14% of respondents agree with the statement that project schedule changes are well monitored during the construction phase of the projects. Another 14% of the respondents are uncertain or neutral while 30% of respondents strongly disagree with the statement. 14% of respondents disagree with the statement. It can be seen here that the majority of respondents are in agreement that this activity is not done on the department's projects. This activity is rated 3 on the relative agreement index with a score of 0.002.

Table 5.23 contains the valid statistics for monitoring of time management tools and techniques.

Table 5.23: Valid statistics for monitoring

Valid Statistics for monitoring							
		Activity definition is well monitored during the construction phase of the projects	Activity sequencing is well monitored during the construction phase of the projects	Activity resource estimating is well monitored during the construction phase of the projects	Activity duration estimating is well monitored during the construction phase of the projects	The project schedule is well monitored during the construction phase of the projects	The project schedule changes are well monitored during the construction phase of the projects
N	Valid	69	69	69	69	69	69
	Missing	1	1	1	1	1	1
Mean		4.59	3.35	3.35	3.35	3.74	2.91
Median		5	4	4	4	4	3
Mode		5	5	5	5	5	1
Std. Deviation		0.714	1.542	1.542	1.542	1.279	1.606
Skewness		-1.467	-0.288	-0.288	-0.288	-0.316	0.08
Std. Error of Skewness		0.289	0.289	0.289	0.289	0.289	0.289

Monitoring of project schedule changes is not regarded as a priority, the mean according the Table 5.23 is 2.91, while monitoring of activity definition is a priority with a mean of 4.59. This shows that the project management team focuses more on documenting the activities of new projects rather than changes to existing projects

The communalities for monitoring of time management tools and techniques are captured in Table 5.24.

Table 5.24: Communalities for monitoring

Communalities		
	Initial	Extraction
Activity definition is well monitored during the construction phase of the projects	1	0.704
Activity sequencing is well monitored during the construction phase of the projects	1	0.982
Activity resource estimating is well monitored during the construction phase of the projects	1	0.982
Activity duration estimating is well monitored during the construction phase of the projects	1	0.982
The project schedule is well monitored during the construction phase of the projects	1	0.954
The project schedule changes are well monitored during the construction phase of the projects	1	0.945

Table 5.24 shows that the communalities are close to 1 which means that the extent or level to which the variables in this part of the study are explained by the components are very high without including the first variable.

The total variance explained for monitoring of time management tools and techniques is captured in Table 5.25.

Table 5.25: Total Variance explained for monitoring

Total Variance Explained for monitoring					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
	1	5.550	92.497	92.497	5.550
2	.344	5.728	98.224		
3	.081	1.343	99.568		
4	.026	.432	100.000		
5	-2.801	-4.669	100.000		
6	-2.148	-3.58	100.000		

Table 5.25 shows that the components could all be combined into the first component with a variance of 92%. This means that the components are so closely related that there would hardly be any data lost if the focus was on the first component only. This renders the data valid as it measures the same components accurately.

Table 5.26 show the compound matrix for monitoring with regards to all the activities related to time management on the questionnaire.

Table 5.26: Compound Matrix for monitoring

Component Matrix^a	
	Component
	1
Activity definition is well monitored during the construction phase of the projects	.839
Activity sequencing is well monitored during the construction phase of the projects	.991
Activity resource estimating is well monitored during the construction phase of the projects	.991
Activity duration estimating is well monitored during the construction phase of the projects	.991
The project schedule is well monitored during the construction phase of the projects	.977
The project schedule changes are well monitored during the construction phase of the projects	-.972

According to Table 5.26 there is a very high correlation between component 1 and the time management activities of activity definition, activity sequencing and resource estimating,

duration estimation as well as monitoring of schedule changes. Therefore the right questions were asked regarding monitoring and the questions were asked around the correct activities.

Table 5.27 shows the responses from the respondents with regards to activities reviewed for improvements and lessons learned with regards to time management.

5.3.9. Activities reviewed for improvements and lessons learned.

Participants were requested to respond on a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, to indicate whether time management activities were reviewed for improvements and lessons learned at the end of the projects.

Table 5.27: Summary of responses on activities reviewed for improvements and lessons learned

	N	1	2	3	4	5	Mean	Std. Dev.	RAI	Rating
Activity Definition reviewed for improvements and lessons learned	69 100%	-	-	9 13%	10 14%	50 72%	4.59	0.714	0.014	1
Activity Sequencing reviewed for improvements and lessons learned	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Resource Estimating reviewed for improvements and lessons learned	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Activity Duration Estimating reviewed for improvements and lessons learned	69 100%	12 17%	12 17%	10 14%	10 14%	25 36%	3.35	1.542	0.014	1
Project Schedule Development reviewed for improvements and lessons learned	69 100%	51 74%	8 12%	10 14%	-	-	1.41	0.734	0.002	3
Project Schedule changes reviewed for improvements and lessons learned	69 100%	25 36%	5 7%	10 14%	13 19%	16 23%	2.86	1.629	0.002	3

Table 5.27 summarises the responses on the review of time management tools as follows:

Seventy two percent (72%) of respondents strongly agree that activity definition is reviewed for improvements and lessons learned at the end of the projects and 14% agree with the statement 13% of respondents are uncertain or neutral and there are no respondents who disagree or strongly disagree with the statement. Therefore the majority of respondents agree with the statement and it can be concluded that activity definition is reviewed for improvements and lessons learned on projects. This activity is rated 1 in terms of how consistently this activity is performed within the organisation.

Thirty six percent (36%) of the respondents strongly agree with the statement that activity duration, resource and sequencing estimating is reviewed for improvements and lessons learned at the end of the projects. 14% of the respondents agree with the statement while another 14% are uncertain or neutral about the statement. 17% of the respondents strongly disagree and 17% agree. These activities each are rated 1 in terms of how the respondents agree that the activities are performed within the organisation.

Fourteen percent (14%) of respondents are uncertain or neutral and 12% disagree with the statement that the project schedule is reviewed for improvements and lessons learned at the end of the project. 74% of the respondents strongly disagree with the statement, which means that the majority of respondents do not believe that the project schedule is reviewed for improvements and lessons learned at the end of the project. The participants substantiate that project schedule changes are not well reviewed for improvements and is rated 3 on the relative agreement index with a score of 0.002. Twenty three percent (23%) of respondents strongly agree with the statement that project schedule changes are reviewed for improvements and lessons learned at the end of the project. 19% agree with the statement. 14% of the respondents are uncertain or neutral while 7% disagree and 36% strongly disagree with the statement. A relative agreement rating of 3 shows that the respondents believe that this activity is not performed on the department's projects.

Table 5.28 shows the valid statistics for review of time management tools and techniques by the professional team on a project.

Table 5.28: Valid statistics for review

Valid Statistics for Review							
		Activity definition is well monitored during the construction phase of the projects	Activity sequencing is well monitored during the construction phase of the projects	Activity resource estimating is well monitored during the construction phase of the projects	Activity duration estimating is well monitored during the construction phase of the projects	The project schedule is well monitored during the construction phase of the projects	The project schedule changes are well monitored during the construction phase of the projects
N	Valid	69	69	69	69	69	69
	Missing	1	1	1	1	1	1
Mean		4.59	3.35	3.35	3.35	3.74	2.91
Median		5	4	4	4	4	3
Mode		5	5	5	5	5	1
Std. Deviation		0.714	1.542	1.542	1.542	1.279	1.606
Skewness		-1.467	-0.288	-0.288	-0.288	-0.316	0.08
Std. Error of Skewness		0.289	0.289	0.289	0.289	0.289	0.289

Table 5.28 shows the valid statistics for review of time management activities for improvements and lessons learned. The activity with the highest mean is activity definition with a mean of 4.59. Schedule changes has the lowest mean at 2.91 which show that it is not a priority.

Table 5.29 shows the communalities for review of time management tools and techniques.

Table 5.29: Communalities for review

Communalities for review		
	Initial	Extraction
Activity definition is reviewed for improvements and lessons learned at the end of the projects.	1	0.737
Activity sequencing is reviewed for improvements and lessons learned at the end of the projects.	1	0.967
Activity duration estimating is reviewed for improvements and lessons learned at the end of the projects	1	0.967
The project schedule is reviewed for improvements and lessons learned at the end of the projects	1	0.641
The project schedule changes are reviewed for improvements and lessons learned at the end of the projects	1	0.921
Activity resource estimating is reviewed for improvements and lessons learned at the end of the projects	1	0.967

According to Table 5.29 the communalities are very close to 1 which shows that the components are very well explained by the data. The lowest commonality value is 0.73.

Table 5.30 show the statistical variance explained for the review of time management tools and techniques.

Table 5.30: Variance explained for review

Total Variance Explained for review					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
	1	5.200	86.663	86.663	5.200
2	.515	8.578	95.241		
3	.247	4.110	99.351		
4	.039	.649	100.000		
5	1.316	2.194	100.000		
6	-7.494	-1.249	100.000		

Table 5.30 depicts the total variance explained and shows that all the components can be collapsed into one component with a variance of 86.6% which shows the interrelatedness of all the components and how they link perfectly to one another.

Table 5.31 shows the component matrix for review of time management tools and techniques.

Table 5.31: Component matrix for review

Component Matrix^a	
	Component
	1
Activity definition is reviewed for improvements and lessons learned at the end of the projects.	0.859
Activity sequencing is reviewed for improvements and lessons learned at the end of the projects.	0.983
Activity duration estimating is reviewed for improvements and lessons learned at the end of the projects	0.983
The project schedule is reviewed for improvements and lessons learned at the end of the projects	-0.801
The project schedule changes are reviewed for improvements and lessons learned at the end of the projects	-0.959
Activity resource estimating is reviewed for improvements and lessons learned at the end of the projects	0.983

According to Table 5.31 there is a strong correlation between component 1 which is that activities relating to time management are well defined and the time management tools and techniques.

5.3.10. Awareness of what the IDMToolkit is

The responses showed that 100% of respondents stated that they are aware of the IDMToolkit. This means that the participants have been trained on the IDMToolkit has been introduced to the project management team in the department and they are aware of its purpose, functions and components.

Table 5.32 follows and shows how the respondents answered when they were asked if they use the IDM Toolkit frequently or not.

5.3.11. Frequency of use of the IDMToolkit

Table 5.32: Frequency of use of the IDMToolkit

Variable	Frequency	Percentage
Yes	60	87%
No	9	13%

Table 5.32 shows that 87% of the respondents stated that they refer to the IDMToolkit regularly in the implementation of projects while 13% of the respondents said no they do not refer to the IDMToolkit at all. The majority of respondents use the IDMToolkit frequently in their duties and on their projects, however there is a small percentage of officials who do not use the IDMToolkit.

Table 5.33 show the responses to the question of whether the IDMToolkit assists in project time management.

5.3.12. Does the IDMToolkit assist you with project time management?

Table 5.33: Does the IDMToolkit assist with project time management?

Variable	Frequency	Percentage
Yes	39	57%
No	30	43%

Table 5.33 shows that 57% of the respondents said yes the IDMToolkit assists with project time management while 43% of respondents said no the IDMToolkit does not assist with project time management. This shows that there are gaps in the IDMToolkit that need to be addressed because just under 50% of respondents hold the opinion that the IDMToolkit does not assist with project time management. Therefore areas of improvement in the IDMToolkit are worth researching further in order to determine how the system can be improved to assist the sector department with project time management.

Table 5.34 shows responses to time management implementation and consequences management as stated by the respondents.

5.3.13. Implementation and consequence management

Participants were requested to respond on a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, to indicate whether time management is a priority for the department.

Table 5.34: Summary of responses to time management implementation and consequence management

	N	1	2	3	4	5	Mean	Std. Dev.	RAI	Rating
The majority of projects suffer from time overruns	69 100%	-	-	-	29 42%	40 58%	4.58	0.497	0.014	1
There are time management tools and techniques implemented by the department	69 100%	9 13%	10 14%	-	10 14%	40 58%	3.9	1.535	0.014	1
Time management is a priority on my construction projects	69 100%	59 86%	-	-	-	10 14%	1.58	1.418	0.002	3
The majority of projects complete on time	69 100%	59 86%	10 14%	-	-	-	1.14	0.355	0.002	3
There are NO legal consequences for the project team on my projects if the projects do not complete on time	69 100%	33 48%	12 17%	4 6%	10 14%	10 14%	2.3	1.537	0.002	3
There are harsh legal consequences for the project team on my projects if the projects do not complete on time	69 100%	30 43%	10 14%	10 14%	11 16%	8 12%	2.38	1.466	0.002	3

Table 5.34 provides a summary of responses to time management implementation and consequence management as follows: Fifty eight percent (58%) of respondents strongly agree and 42% of respondents agree with the statement that the majority of projects suffer from time overruns. There are no respondents who are uncertain, disagree or strongly disagree. The relative agreement rating of 1 shows that time management is not a priority because projects do not complete on time.

Eighty six percent (86%) of respondents strongly disagree with the statement that the majority of projects complete on time and 14% of respondents disagree with the statement. There are no respondents who are neutral or uncertain, agree or strongly disagree with the statement. The relative agreement rating of 3 show that time management is not a priority because project do not complete on time.

48% of respondents strongly disagree with the statement that there are no legal consequences for the project team on projects that do not complete on time and 14% of respondents agree with the statement while 4% of respondents were neutral. This shows that the majority of respondents say that there are legal consequences for project not completing on time and this has been rated 3 on the relative agreement index with a score of 0.002.

Forty three percent (43%) of respondents strongly disagree with the statement that there are harsh legal consequences for projects that do not complete on time while only 12% agree with the statement. This shows that the majority of respondents have warranted that this activity be rated 3 because the respondents feel that the consequences for projects not completing on time are not harsh.

Table 5.35 shows the valid statistics for implementation and consequences in time management.

Table 5.35: Valid statistics for implementation and consequences

Valid Statistics for Implementation and consequences							
		There are time management tools and techniques implemented by the department	Time management is a priority on my construction projects	The majority of projects suffer from time overruns	The majority of projects complete on time	There are harsh legal consequences for the project team on my projects if the projects do not complete on time	There are NO legal consequences for the project team on my projects if the projects do not complete on time
N	Valid	69	69	69	69	69	69
	Missing	1	1	1	1	1	1
Mean		3.9	1.58	4.58	1.14	2.38	2.3
Median		5	1	5	1	2	2
Mode		5	1	5	1	1	1
Std. Deviation		1.535	1.418	0.497	0.355	1.466	1.537
Skewness		-0.98	2.062	-0.33	2.062	0.553	0.719
Std. Error of Skewness		0.289	0.289	0.289	0.289	0.289	0.289

Table 5.35 details the valid statistics for the implementation of time management tools and techniques as well as the implementation of consequences for delayed projects. The respondents felt that there are legal consequences for projects that do not complete on time with a mean of 2.3. The respondents also felt that the majority of projects implemented by the department do not complete on time with a mean of 1.14.

The findings on the communalities for implementation and consequences activities in time management tools and techniques are captured in Table 5.36.

Table 5.36: Communalities for implementation and consequences

Communalities for implementation and consequences		
	Initial	Extraction
There are time management tools and techniques implemented by the department	1.000	.885
Time management is a priority on my construction projects	1.000	.971
The majority of projects suffer from time overruns	1.000	.923
The majority of projects complete on time	1.000	.971
There are harsh legal consequences for the project team on my projects if the projects do not complete on time	1.000	.940
There are NO legal consequences for the project team on my projects if the projects do not complete on time	1.000	.931

According to Table 5.36 the communalities are high which means that the time management activities of are clearly explained by the various components.

A summary of the total variance explained for the implementation and consequences of time management tools and techniques is captured in Table 5.37.

Table 5.37: Total Variance Explained for implementation and consequences

Total Variance Explained for implementation and consequences					
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
1	4.400	73.332	73.332	4.400	73.332
2	1.221	20.351	93.683	1.221	20.351
3	.264	4.396	98.079		
4	.087	1.450	99.529		
5	.028	.471	100.000		
6	5.551	9.252	100.000		

Table 5.37 show that the 6 components can be collapsed into two (2) main components with a variance of 73% and 20% respectively which means that the other 6 components can best be explained by the two components with a chance that only 10% of the information may be lost.

A component matrix for implementation and consequences was also conducted and the results are in Table 5.3.

Table 5.38: Component Matrix for implementation and consequences

Component Matrix^a		
	Component	
	1	2
There are time management tools and techniques implemented by the department	-0.939	-0.062
Time management is a priority on my construction projects	0.828	0.533
The majority of projects suffer from time overruns	0.761	-0.586
The majority of projects complete on time	0.828	0.533
There are harsh legal consequences for the project team on my projects if the projects do not complete on time	-0.8	0.548
There are NO legal consequences for the project team on my projects if the projects do not complete on time	0.963	-0.06

Table 5.38 show that there is a strong correlation between component 1 and the segments dealing with the implementation of time management as a priority as well as the segments dealing with the legal consequences of project delays. This shows that time management is not a priority on construction projects within the department and although there are penalties for delayed projects these can sometimes not be regarded as harsh.

5.3.14. Aware of what the IRM is

One hundred (100%) of respondents stated that they are aware of the IRM. This means that the participants have been trained on the IRM has been introduced to the project management team in the department and they are aware of its purpose, functions and components.

It was further important to find out if the project respondents made use of the IRM in their day to day operations and the data is shown on Table 5.39.

5.3.15. Do you refer to the IRM often?

Table 5.39: Responses to how often the IRM is referred to

Variable	Frequency	Percentage
Yes	60	87%
No	9	13%

Table 5.39 shows that 87% of the respondents stated that they refer to the IRM regularly in the implementation of projects while 13% of the respondents said no they do not refer to the IRM at all. This means that the majority of respondents refer to the IRM regularly.

Table 5.40 shows the responses the question of the IRM assisting with project time management.

5.3.16. Does the IRM assist you with project time management?

Table 5.40: Does the IRM assist with project time management?

Variable	Frequency	Percentage
Yes	39	57%
No	30	43%

Table 5.40 shows that 57% of the respondents said yes the IRM assists with project time management while 43% of respondents said no the IRM does not assist with project time management.

5.3.17. Areas of improvement

The questionnaire had a section where the respondents were asked to answer the question: How can existing time management tools and techniques be enhanced to support projects towards completing on time and to reduce time overruns?

The suggestions given by the respondents are as follows:

- The respondents suggested that the department should invest in an information technology (IT) project management system. The KZN Department of Education investing in a project management system would assist the department to better manage project time frames and ensure the reduction of time overruns.
- The respondents also suggested that the KZN Department of Education should consider contracts managers in the human resource structure of the department. The contract manager would be responsible exclusively for monitoring project time frames, especially on multiyear projects. This appointment will also assist with ensuring that conditions of contract are implemented to the benefit of the department.
- The respondents suggested that the funding or budgets of infrastructure projects should be ring-fenced and exclusively appropriated for infrastructure. This means that the infrastructure budget cannot be used for any other purpose within the department. This will assist to ensure that projects are not delayed or stopped because there are no longer funds available. This has happened in the past within the department.
- The respondents suggested that financial incentives be created for contractors and implementing agents who complete projects early or on time.
- The respondents suggested that the department establish and maintain a register of delayed projects and annually quantify the cost of delayed projects to the department, currently no such register exists in the department and it is therefore not possible to fully quantify the cost of delays to the department.

5.4. Summary of questionnaire data analysis

Findings from the questionnaire are as follows: 72% of respondents attest that there are time management tools and techniques implemented by the department. The project management team is knowledgeable about time management techniques as 86% of respondents attest to this. However 100% of respondents agree that a majority of projects suffer from time overruns and do not often complete on time. 43% of respondents attest that the time management tools and techniques are consistently implemented on departmental projects. 42% of respondents attest that the time management techniques are well documented on departmental projects. 56% of respondents attest that the time management techniques are well monitored during the construction phase. 46% of respondents attest that time management techniques are well reviewed for lessons learned at the end of the project. 65% of respondents attest that although there are legal consequences for delayed projects, these consequences are not harsh.

5.5. Analysis of interviews

There are differing views with regards to how many interviews are enough in qualitative research. Yin, (2014) is for the view that the number of interviews conducted depends on the objectives of the research as well as the methodology used. This view is supported by Wisdom and Creswell, (2013) who state that one interview conducted can provide substantial information on the subject matter depending on what the end goal is and the availability of time and resources. Seidman, (2013) states that any number of interviews from twenty to fifty could constitute as valid number bases on the methodology, approach, time, resources available and budget available.

In this study five interviews were conducted because a mixed methods research was used and the interviews form one portion of the four part mixed methods study. The other reason for conducting interviews was to get expert opinion from industry leaders. The interviewees were selected based on their involvement on the programme and project management of KZN Department of Education Projects.

These interviews focused on finding out what time management tools and techniques are implemented on projects and understanding the reasons for time overruns based on the findings emerging from the analysis of the 20 cases. The interviews further focused on establishing the views of the public sector on the IRM and the IDMToolkit and the effectiveness of its time management tool and techniques. Five individuals were interviewed who were directly involved in all the projects. Prior to conducting the interviews, written permission was obtained from the KZN Department of Education Head of Department.

In order to maintain confidentiality the participants are referred to as Managers, and differentiated with numbers. Therefore reference is made to Manager 1, Manager 2, Manager3, Manager 4 and Manager 5. The five participants were interviewed separately however they were all asked the same questions. The questions were categorised into five broad sections and thematic content analysis was conducted under the following sections:

- Section 1 was the demographic information section dealing with questions about gender, years of experience and specific role on the projects within the department.
- Section 2 was the time management tools and techniques section where the theme of time management tools and techniques used on departmental construction projects was

dealt with. Effectiveness of these tools as well as accountability and monitoring of the various time management tools was also discussed.

- Section 3 was the IDMToolkit section where an assessment of how the IDMToolkit was assisting in project time management in order to determine its effectiveness was done.
- Section 4 was the IRM section where an assessment of how the IRM was assisting in time management was done. Questions around the accuracy and reliability of the data contained in the IRM were also asked.
- Section 5 was a section where the participants were asked to make recommendations or suggestions for areas of improvement in time management, the IDMToolkit and the IRM. Therefore thematic contentment analysis was done.

5.5.1. Details of interviewees

The interview with Manager 1 took place on the 15th August 2018. Manager 1 is a female who is not a programme manager however she provides support, advice and assistance on the institutionalisation of IDMS within the KZN Department of Education. She stated that she has 7 years of experience in the current position.

The interview with Manager 2 took place on 25th August 2018. Manager 2 is a female who is a programme manager, directly involved on the projects as she is the infrastructure grant coordinator responsible for ensuring compliance with the Education Infrastructure Grant conditions. She stated that she has 4 years' experience in her current position.

The interview with Manager 3 took place on 28th August 2018. Manager 3 is a female who is a programme manager, directly involved on the projects as she is responsible for reporting project progress as well as financial reporting and IRM management for all the Department of Education projects. She stated that she has 3 years' experience in her current position.

The interview with Manager 4 took place on 25th August 2018. Manager 4 is a male who is a programme manager, directly involved on the projects as she is responsible for 150 projects. He stated that he has 10 years' experience in her current position.

The interview with Manager 5 took place on 28th August 2018. Manager 5 is a male who is a programme manager, directly involved on the projects as she is responsible for 150 projects. He stated that he has 15 years' experience in his current position.

5.5.2. Theme 1: The use of time management tools and techniques of departmental construction projects.

The first manager to be interviewed was Manager 1 and she was asked to elaborate on what time management tools and techniques are use on departmental construction projects, she stated that there are no documented time management tools and techniques implemented in the department on construction projects. She further stated that the department should have a project charter in place as well standard operating procedures in place where the time management tools and techniques are documented. The reasons she provided for the department not having time management tools and techniques was that the department appoints implementing agents to procure, implement and manage their projects. The department therefore only processes payments and monitors progress of the infrastructure delivery programme. The implementing agents have the responsibility of putting in place the tools and techniques for ensuring overall project success. This is the same response that was provided by the other managers who were interviewed, they all agreed that there are not time management tools and techniques on departmental projects. This therefore raises a concern that time management is not adequately managed and monitored by the KZN Department of Education. The responsibility of time management on departmental projects is left to the implementing agents and the contractors as they set the time frames and only report to the department as and when required. This could possibly be the reason why such a large number of projects profiled in the desktop study were found have been delayed or not completed on time. All the managers could not accurately or with certainty list which time management tools and techniques the appointed implementing agents and contractors use, however there was general unsupported consensus that the tools and techniques are there.

5.5.3. Theme 2 effectiveness of the time management tools.

When Manager 1 was then asked to elaborate on the effectiveness of these tools as well as accountability and monitoring of the various time management tools. Manager 1 stated that there are projects that complete on time but the exact records are kept by the implementing agents as they keep the records of all delays per project. She further stated that responsibility and accountability for projects completing on time is the duty of the implementing agent in line with the Service Delivery Agreement entered into between the department and the implementing agent. She stated that in order for project time frames to be met and projects to be successful the department and implementing agents should work cooperatively.

When Manager 2 was asked the same question she stated that a majority of the projects do not complete on time due to various delays but most of these delays are approved and there are extensions of time granted. She further stated that responsibility and accountability for projects completing on time is the duty of the implementing agent in line with the Service Delivery Agreement.

Manager 3s opinion on the matter is that it is not easy to determine effectiveness since the department has been negatively affected by budget cuts, which means the department has had less money to implement projects and as such, some projects have had to be stopped. She further stated that a majority of the projects do not complete on time due to various delays but most of these delays are approved and there are extensions of time granted. She further stated that responsibility and accountability for projects completing on time is the duty of the implementing agent in line with the Service Delivery Agreement.

Manager 4 also concurred with Manager 3 that it is not easy to determine effectiveness since the department has been negatively affected by budget cuts, The budget cuts happened in the year 2015/ 2016 but because of the multiyear nature of their projects, it affected the outer years as well. He further stated that there are some projects that do not complete on time due to various delays but most of these delays are approved and there are extensions of time granted. There are also remedial actions that are taken against contractors that are not performing in line with the JBCC contract.

Manager 5 believed that it could be easy to determine effectiveness if the department was closely monitoring its projects and holding the implementing agents accountable for time delays. Manager 5 believes that the government has put in relevant legislation and practice notes to hold implementing agents and contractors accountable for time delays, however these are not implemented within the department and hence they are regarded as ineffective. He also made reference to the multiyear nature of the projects which poses a challenge because government focuses on budget and expenditure in the current financial year and not on multiyear projects. He further stated that there are some projects that do not complete on time due to various delays but most of these delays are approved and there are extensions of time granted. He also agreed with Manager 4 that there are remedial actions that are taken against contractors that are not performing in line with the JBCC contract and that responsibility and accountability for projects completing on time is the duty of the implementing agent in line with the Service Delivery Agreement entered into between the parties.

Therefore it can be concluded on this theme that the time management tools and techniques are not fully effective either because they are not closely monitored or they are not put in place. This is because all the managers interviewed and the desktop study shows that the majority of projects do suffer from time delays. The multi-year nature of construction projects and the funding constraints experienced by the department in the year 2015/2016 alluded to by Manager 4, has also negatively affected the effectiveness of time management of departmental projects.

5.5.4. Theme 3: The effectiveness of the IDMToolkit in assisting with time management of projects.

Manager 1 was then asked to elaborate on how the IDMToolkit was assisting in project time management in order to determine its effectiveness. She stated that the department was aware of the IDMToolkit and referred to it regularly for various functions in the infrastructure delivery value chain, including time management. She state that the IDMToolkit advocates a gate system which states that documented proof must be provided when a project moves from one milestone to the next in the project lifecycle. If this system is implemented properly it can assist in reducing project time overruns. She further stated that the IDMToolkit is currently being reviewed and it is not sector specific therefore it has limited impact when it comes to assisting with reducing project time overruns. This is the same view that is held by all the other managers who were interviewed. However when it comes to the effectiveness of the system, Manager 2 was of the view that the IDMToolkit does not assist with project duration estimation however it does assist with project duration monitoring through its gate and stage system. She further stated that it does not have any mechanisms to assist with reducing time overruns. This is the same view held by Manager 3 who stated that she stated that she also believes that the IDMToolkit does not assist with project duration estimation and it also does not assist with project duration monitoring but she stressed that this is her opinion. She further stated that the IDMToolkit does not have any mechanisms to assist with reducing time overruns.

Managers 4 and 5 hold a different view that the IDMToolkit does assist with project duration estimation and it also does assist with project duration monitoring and he further stated that the IDMToolkit does have any mechanisms to assist with reducing time overruns which are the gates in the gate system which require that information be uploaded for any milestone that has been reached in the project implementation process, according to Manager 4 all that is missing

is the proper adoption and implementation of the system within the department and the implementing agents.

It can therefore be concluded that there are varying views with regards to the effectiveness of the IDMToolkit in assisting with time management.

5.5.5. Theme 4 the effectiveness of the IRM in assisting with time management of projects.

When Manager 1 was asked about how the IRM was assisting in time management. She stated that the department is aware of the IRM and referred to it regularly for reporting project progress, both financial and non-financial information. She stated that the IRM does not assist with project time management because the time frames are inaccurate and are not updated as regularly as they should be. She stated that the department focused on ensuring that the financial information, project budget and expenditure are captured accurately, and not so much on the non-financial information such as project statuses, project location and time frames.

When Manager 2 was asked the same question stated that the IRM does not assist with project duration estimation, however that it assists with project duration monitoring and reducing time overruns. This is because it allows a space for estimated dates to be captured against a project as well as actual dates. She however raised a concern that the IRM is not updated regularly and that it could be more accurate.

The view of Manager 3 on the issue that the IRM assists with project duration estimation, however that it is dependent on the accuracy of the time frames captured by those responsible for capturing information on the system. She stated that the information captured on the system is sometimes not accurate which then compromises the credibility of the data. She further stated that the system assists with project duration monitoring and reducing time overruns. This is because it allows a space for estimated dates to be captured against a project as well as actual dates. She however raised a concern that the IRM is not updated regularly and that it could be more accurate.

Managers 4 and 5 agreed with the others however they had their own different reasons which were that Programme Managers are too busy with other duties to capture project information accurately because of the large number of projects. They feel that the system for reporting and updating time frames on the IRM should be streamlined in order to better assist with project duration monitoring and reducing time overruns. This is because it allows a space for estimated dates to be captured against a project as well as actual dates.

5.5.6. Theme 5: Recommendations for areas of improvement

The Managers were then asked to provide recommendations or suggestions for areas of improvement in time management, the IDMToolkit and the IRM. Manager 1 suggested that estimated time frames or project durations should be documented in the same way the cost norms for schools have been documented by the National Treasury and National Department of Basic Education. She also suggested that in order to improve project time management a project charter should be drafted and implemented by the department. She also stated that the department should clearly document its standard operating procedures, because some activities are done but there is sometimes no guiding policy document for the function. She also stated that budget cuts in the infrastructure programme in the year 2016 had a profoundly negative impact on projects. Projects were delayed due to non-payment and late payment of implementing agents and contractors. Finally Manager 1 suggested that cooperation between the implementing agents and the department will lead to overall project success.

Manager 2 suggested that the IRM be updated regularly and accurately. She suggested that the IDMToolkit gate system be fully implemented in the department and supporting documents for each stage deliverable be kept and uploaded on the IRM. She suggested that contracts managers be appointed in the department to ensure that project time frames are kept. She suggested that a financial incentive system be developed for IAs who complete their projects on time or before time and also a demerit system for projects that complete late.

Manager 3 suggested that the department invest in an IT system as currently there is no system in place which will ensure that project management, finance and property management are integrated, which will make reporting progress on all levels easier. She said that the IRM is there but it is not a Department of Education system and therefore administering it and customising it to the needs of the department is not easy.

Manager 4 suggested that increasing the budget allocation to the department will assist them to complete projects on time because they will be able to pay contractors on time. He also stated that tightening the conditions of contract that implementing agents operate under will also assist in ensuring that they perform better. He further suggested that the department should focus closer on communication between all project stakeholders and meeting their needs in order to ensure project success and thereby seeing projects complete on time.

Manager 5 that the departmental reporting structure be followed and the resources be used efficiently. He further suggested that scope changes and extensions of time information be updated regularly and accurately. He also stated that monitoring the conditions of contract that

implementing agents operate under will also assist in ensuring that they perform better. He further suggested that the department should focus closer on communication between all project stakeholders and meeting their needs in order to ensure project success and thereby seeing projects complete on time.

5.6. Summary of interview findings

Findings from the interviews are as follows: The participants attest that there are time management tools and techniques implemented by the department however there is room for improvement since actual construction is outsourced to various implementing agents and documentation of the time management activities is not done by the department. There are varying views with regards to the effectiveness of the IDMToolkit in assisting with time management. Some participants agree that the IDMToolkit assists with time management others feel that it is lacking. The general consensus however is that the IDMToolkit can be fully effective if it can be adopted completely by the sector department and be accurately utilised. On the theme of the IRM, there was general consensus that the tools is used by the department for infrastructure reporting purposes. There was disagreement however on the issue of effectiveness as some participants felt that is was not accurate and that the focus is on financial information and not project progress or time management.

The project management team is knowledgeable about time management techniques as the participants agree to this, however due to various factors such as, budget constraints and human capacity issues the majority of projects suffer time overruns and do not often complete on time. The participants agree that the major challenge the department experiences with regard to time management, is due to the large number of projects that the department has. The lack of an IT project management system in the department was also highlighted as a constraint.

5.7. Chapter summary

A total of 100 questionnaires were distributed, 69 completed questionnaires were the base for computing the results because they were received and completed correctly. The questionnaire was divided into demographic questions, questions about time management tools and techniques and questions about the IRM as well as the IDMToolkit. The respondents were also requested to make recommendations for improvement of the time management tools and techniques in the public sector.

The structured interviews were conducted with 5 Managers in the KZN Department of Education who are involved in infrastructure delivery. The interviews focused on finding out what time management tools and techniques are implemented on projects and understanding the reasons for time overruns.

Findings from the interviews and the questionnaires are that the participants confirm that there are time management tools and techniques implemented by the department; however there is room for improvement since actual construction is outsourced to various implementing agents. The participants agree that the project management team is knowledgeable about time management techniques, however due to various factors such as, budget constraints and human capacity issues the majority of projects suffer time overruns and do not often complete on time.

CHAPTER 6: FINDINGS AND RECOMMENDATIONS

6.1. Introduction

This chapter of the research draws conclusions from the findings identified and presented in the quantitative data analysis and the qualitative data analysis chapters and relates them to the research questions.

6.2. Summary of literature review

The literature review focused on the importance of infrastructure investment in the general global context as well as on the importance of infrastructure investment in the South African context. The literature was reviewed from a social importance and an economic importance perspective. The findings of the review were that infrastructure investment is regarded as critical to the economic and social development of the world. This view is substantiated by Kumar (2001); ECA (2013); DBSA (2012) and Estache & Garsous (2012) who hold the view that investing in economic and social infrastructure helps to promote economic growth, alleviate poverty and improve the wellbeing of communities. There is also literature available such as Simo-Kengne (2016); DBSA (2006); CIDB (2010) and English (2015) which shows that the South African government has invested substantial resources in infrastructure delivery and that the government has also put in place a supportive legislative framework to promote the construction of sustainable infrastructure including the development and maintenance of the IDMToolkit. It is therefore true and proper that the South African Government invests substantially in infrastructure delivery and monitors value for money.

The literature review also focused on time management tools and techniques which are prevalent in the construction industry. It was found that there are many time management tools and techniques available in the construction industry which are aimed at assisting projects to complete within the set time frames. These time management tools and techniques assist project managers to initiate, plan, implement, monitor and evaluate, close out and commission projects. It was found that the prevailing time management tools and techniques were developed to assist project managers to complete projects on time. If projects are completed on time they will be cost effective and the project funder may realise value for money. These tools and techniques should be increasingly used in public sector infrastructure delivery.

6.3. Summary of methodology

The methodology that was used in the study was an explanatory sequential mixed methods research with a desk top analysis of 20 completed projects. A total of 100 questionnaires were distributed, and 69 collected and analysed. Five individual interviews were conducted with relevant professionals and a desktop analysis of completed projects was done.

6.4. Findings on the research questions

6.4.1. The first research question was as follows: What are the time management tools and techniques in the IDM Toolkit?

The review of literature from NTRSA (2017) and CIDB () revealed that the IDM Toolkit was developed to provide a system for enhancing the capacity of infrastructure delivery managers within the public sector, who are responsible for managing the planning and implementation of infrastructure related projects. Further analysis of the IDM Toolkit revealed that it identifies and facilitates the management of infrastructure delivery policies linked to the strategic mandate of organs of state, infrastructure and maintenance planning and budgeting. The IRM which was used as a source of data for the 20 project desktop analysis is a critical component of the IDMToolkit and it allows for capturing of estimated project start and end dates. The IRM also allows for the capturing of actual project start and end dates.

A detailed analysis of the IDM Toolkit revealed that it contains the following time management tools:

- Gantt Bar Chart
- Critical Path Method
- Precedence Diagramming
- Milestone Date Programming

The following time management techniques are contained in the IDMToolkit:

- Activity definition techniques
- Activity sequencing techniques

There seems to be a lack in the IDMToolkit when it comes to activity resource estimating techniques as well as schedule development.

The Infrastructure Reporting Model (IRM) is a project level monitoring and reporting tool. It is a web based system. The model is used by provincial departments to report expenditure and performance progress on infrastructure projects. There is an IRM user manual intended for the

users in the provincial departments who capture all infrastructure projects. The user manual contains the terminology used in the model in order to provide for a full understanding of the model.

6.4.2. The second research question was as follows: How the time management tools and techniques implemented by the KwaZulu-Natal Department of Education assisting in reducing project delays?

6.4.2.1. Desktop study findings

It was evident from the analysis of multiple cases on the IRM that 95% of the projects completed later than the estimated completion date. 5% of the projects completed on time in line with the estimates. There were no projects that completed earlier than scheduled. On average the projects are completing 14 months behind schedule.

When referring to actual construction start dates and estimated construction start dates, it was evident that 50% of the projects started construction later than the estimated construction start date. 50% of the projects in the table started on time in line with the estimates. There were no projects that started earlier than scheduled. There are three projects that have a construction start date that is delayed by 13 months, which is 15% of the sample.

When referring to actual construction end dates and estimated construction end dates. It was evident that 65% of the projects ended construction later than the estimated construction end date. 35% of the projects ended construction on time in line with the estimates. There were no projects that ended construction earlier than scheduled. There are no projects that ended earlier than scheduled.

When referring to documented variation orders, 5% of the projects had documented variation orders on the IRM. For the other 95% there was no documented evidence on the IRM of any variation orders even though 95% of the projects had time overruns.

With regards evidence that the projects had reached practical completion, 25% of the projects had uploaded signed practical completion certificates as evidence that the projects had reached the said milestone. 75% of the projects did not have any practical completion certificates uploaded on the IRM even though the project status was captured as practical completion.

The IRM did not contain any reasons for delays in the comments tab. 100% of the projects did not have reasons for delays even though the IRM had an area which was allocated for the relevant official to capture the reasons for delays or to provide comments.

6.4.2.2. Questionnaire analysis findings

Findings from the questionnaire analysis were as follows: 72% of respondents attest that there are time management tools and techniques implemented by the department. The project management team is knowledgeable about time management techniques as 86% of respondents attest to this. However 100% of respondents agreed that a majority of projects suffer from time overruns and do not often complete on time. 43% of respondents confirmed that the time management tools and techniques are consistently implemented on departmental projects. 42% of respondents attest that the time management techniques are well documented on departmental projects. 56% of respondents attest that the time management techniques are well monitored during the construction phase. 46% of respondents agreed that time management techniques are well reviewed for lessons learned at the end of the project. 65% of respondents attest that although there are legal consequences for delayed projects, these consequences are not harsh.

6.4.2.3. Interview analysis findings

The participants in the interviews concurred with the findings of the questionnaire analysis attest that there are time management tools and techniques implemented by the department however they further stated that there is room for improvement since actual construction is outsourced to various implementing agents. There are varying views with regards to the effectiveness of the IDMToolkit in assisting with time management. Some participants agree that the IDMToolkit assists with time management others feel that it is lacking. The general consensus however is that the IDMToolkit can be fully effective if it can be adopted completely by the sector department and be accurately utilised

On the theme of the IRM, there was general consensus that the tools is used by the department for infrastructure reporting purposes. There was disagreement however on the issue of effectiveness as some participants felt that is was not accurate and that the focus is on financial information and not project progress or time management.

The project management team is knowledgeable about time management techniques as the participants agreed to this, however due to various factors such as, budget constraints and human capacity issues the majority of projects suffer time overruns and do not often complete on time. The participants agreed that the major challenge the department experienced with regard to time management, was due to the large number of projects that the department has. The lack of an IT project management system in the department was also highlighted as a

constraint because without a project management IT system it would be challenge to implement time management tools and techniques that are IT based.

6.4.3. The third research question was as follows: How can existing time management tools and techniques be enhanced to support projects towards completing on time and to reduce time overruns.

The respondents suggested that in the department should invest in an IT project management system. The KZN Department of Education investing in a project management system would assist the department to better manage project time frames and ensure the reduction of time overruns.

The respondents also suggested that the KZN Department of Education should consider contracts managers in the human resource structure of the department. The contract manager would be responsible exclusively for monitoring project time frames, especially on multiyear projects. This appointment will also assist with ensuring that conditions of contract are implemented to the benefit of the department.

The respondents suggested that the funding or budgets of infrastructure projects should be ring-fenced and exclusively appropriated for infrastructure. This means that the infrastructure budget cannot be used for any other purpose within the department. This will assist to ensure that projects are not delayed or stopped because there are no longer funds available. This has happened in the past within the department.

The respondents suggested that financial incentives be created for contractors and implementing agents who complete projects early or on time. The respondents suggested that the department establish and maintain a register of delayed projects and annually quantify the cost of delayed projects to the department, currently no such register exists in the department and it is therefore not possible to fully quantify the cost of delays to the department.

6.5. Implications of the study

The research contributes to the study of public sector infrastructure delivery and time management. The research has implications for public sector policy, practice, theory, and subsequent research. There is a need in the public sector to improve the implementation of time management tools and techniques on construction projects. There is a further need to realise value for money on public sector construction projects and to provide an incentive system for service providers to complete projects early or on time.

6.5.1. Recommendations for improvements in the service delivery structure

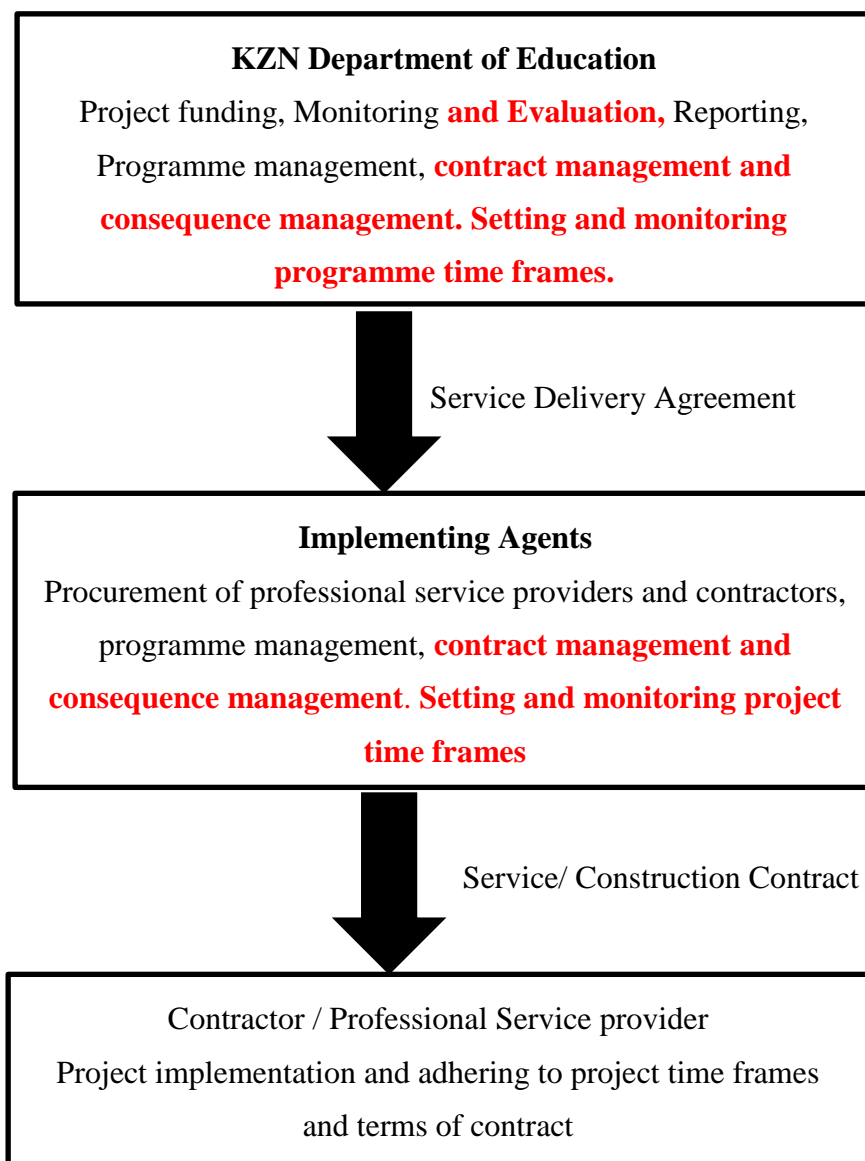


Figure 6.2: proposed revised infrastructure delivery model

6.5.1.1. Characteristics of revised infrastructure delivery model

- The KZN Department of Education needs to enhance its mandate by ensuring that internally within the department there are adequately qualified and experienced people to support the department with evaluation of programme and project progress as captured in Figure 6.1. To ensure that there are people who are responsible and accountable for contract management and monitoring the performance of the implementing agents against set targets as well consequence management for poor or good performance. To ensure that the programme time frames are set and monitored using the right time management tools and techniques. The service delivery agreements are in place, the conditions of the agreements just need to be implemented with vigour.
- When the department focuses capacitating itself to focus on monitoring programme progress it will also be forced to not just focus on budget expenditure in a particular financial year, but also value for money on the investment in infrastructure.
- The implementing agents in their procurement of service providers and contractors must also ensure that they have adequately qualified individuals within their organisations, to perform contract management and consequence management, because the desktop analysis, the interviews and the questionnaires findings revealed that there is no contract management taking place and also that consequence management is inadequate.
- The implementing agents should also procure and use the available time management tools and techniques as literature has revealed that there are many time management tools available in the market for planning, implementation and monitoring of project progress. The service and construction contracts are in place and need to be implemented with vigour, and monitored closely in order to ensure that projects complete on time and to the agreed quality.

6.6. Recommendations for future research

- Factors influencing the lack of time management of infrastructure projects within the KZN Department of Education.
- The extent of the negative impact of the time delays on the total project cost of delayed infrastructure projects.
- An investigation of a workable time management framework for the public sector infrastructure projects.

6.7. Summary

A detailed literature review was conducted and substantiated the importance of infrastructure investment in the world economy as well as in the South African context. The literature review further detailed government interventions to support and promote infrastructure investment in South Africa. The study then investigated the effectiveness of time management tools and techniques with a specific focus on KZN Department of Education infrastructure projects. An explanatory sequential mixed methods design was undertaken and findings were documented.

This chapter summarised the main findings of this research project. The main objective of the study was to investigate the use of time management tools and techniques within KZN Department of Education infrastructure projects. Explanatory sequential mixed methods were used and a detailed literature review was conducted.

The study found that there are a number of tools used by the construction industry to manage the time factor on construction projects. The study further found that there are a number of techniques for time management predominantly used on construction projects.

The study also found that a majority of projects in the KZN Department of Education suffer from time overruns and do not complete on time. The findings of the study indicate that the public sector should take an active role in time management from the planning stage, through the construction stage until the project has been completed.

The study further found that there are time management tools and techniques implemented by the department; however that there is room for improvement since actual construction is outsourced to various implementing agents. The participants agree that the project management team is knowledgeable about time management techniques, however due to various factors such as, budget constraints and human capacity issues the majority of projects suffer time overruns and do not often complete on time. It was also found that there are no incentives in place for the project team to ensure that the projects complete on time and there are also no harsh penalties for project that do not complete on time.

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APPENDIX A: ETHICAL CLEARANCE LETTER

APPENDIX B: INTERVIEW SCHEDULE TEMPLATE

APPENDIX C: QUESTIONNAIRE TEMPLATE