

https://dspace.org/

Construction progress reporting methods and project outcomes

Ngomana, Ntsako

2018

https://hdl.handle.net/10539/27296

Ngomana, Ntsako (2018) Construction progress reporting methods and project outcomes, University of the Witwatersrand, Johannesburg, https://hdl.handle.net/10539/27296

Downloaded from a DSpace repository. https://dspace.org/



Construction progress reporting Methods and project outcomes.

SUPERVISOR: Dr A.O.U. Ozumba

BUQS7009
NTSAKO NGOMANA
0703367T

DECLARATION

I declare that this report is my own unaided work. It is being submitted in partial fulfilment of the degree of Master in Project Management to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination to any other university.

Ntsako Ngomana ……

……. day of ……2018

ACKNOWLEDGEMENTS

To God, for His continuous mercy upon my life

My family: my mom, dad and my siblings, Ntwanano and Nyiko, for never giving up on me and trusting that I got this!! Thank you for not allowing me to wallow in defeat, always rooting for me and pushing me to keep going. I thank GOD for you! To my bosses at Gothic Construction (Pty) Ltd, thank you for sponsoring me, for believing in my dreams and for being patient with me since I started this journey. This especially goes to my mentor, Mr Anton Botha – always thankful for your support and patience, I really do appreciate it!

Johan Botha – Thank you!!

To the lovelies – thank you for coming into my life and staying – your positivity is contagious. I love you guys dearly!

To Thandeka, Yolanda and Qoli – Thank you for being there, I love and appreciate you.

Loom 8 – Sbonge imotivheshi!!!

To all those that came into my life, supported me and cheered for me, I see you, I appreciate you. I hope God will continue to bless you for all that you have done for me.

My colleagues, all the people that took part in this research, thank you and GOD bless you! Cuzen Talla, thank you my love, my God continue to bless you for me!

Lastly, to my supervisor, Dr Ozumba, thank you, you never gave up on my capability. Thank you for your advice and for your understanding. Thank you for encouraging me, always and for seeing my potential more than I did most of the time!! May God bless you and keep you – we need more people like you!

ABSTRACT

The construction industry is commonly known for project delays and cost overruns in various parts of the world. Developing countries such as South Africa have experienced their fair share of these negative outcomes as outlined in existing literature. The causative factors identified, which relate to poor construction project management, include poor project control and poor progress monitoring and reporting by building contractors. This research was aimed at determining and evaluating the effectiveness of current progress monitoring and reporting methods and their linkage with undesirable project outcomes. The research methodological approach was essentially phenomenological, using a review of relevant literature, which was complemented with a phased field investigation. The field investigation used a mix of both quantitative and qualitative data. Semi-structured interviews were conducted for qualitative data and a survey by questionnaire was used for quantitative data collection. The data was collected from professionals working in the greater Johannesburg area, and hence, the findings could be interpreted to only affect construction projects in Johannesburg; while limiting the generalizability to the Construction industry in South Africa. Therefore, in regulating the impact of the limitation, the sources from which data was collected, intentionally consisted of experienced professionals who have worked on different types of projects of varying complexities. Results from the 80 questionnaire surveys and 15 interviews suggest the existence of appreciable gaps in the accuracy, or quality, in the monitoring and reporting of construction projects progress. Furthermore, the findings revealed that construction inexperience, the lack in project information and the poor allocation of project resources, were perceived to be the most influential factors of undesirable project outcomes. Therefore, the results from this study can be used as a guideline for construction stakeholders to ascertain the importance of implementing adequate progress monitoring and reporting systems to improve poor project outcomes. Building contractors can also use the findings from this study to evaluate their current projects and check the most influential causes of negative outcomes, and how these can be remedied.

Table of Contents

DECLARATION *1*

ACKNOWLEDGEMENTS ..... *ii*

ABSTRACT ..... *iii*

LIST OF FIGURES ..... *v*

LIST OF TABLES ..... *vi*

ABBREVIATIONS ..... *vii*

CHAPTER 1 ..... *1*

1. INTRODUCTION TO THE RESEARCH PROBLEM **1**

1.1. Background to Research **1**

1.2. Research Problem 4

1.3. Research Question 4

1.4. Aim of Research 4

1.5. Research Objectives 4

1.6. Research Scope 4

1.7. Summary of research methodology used for the study 5

1.8. Rationale for the study 5

CHAPTER 2 ..... *7*

2. LITERATURE REVIEW *7*

2.1. CONSTRUCTION PROJECT MANAGEMENT 7

2.1.1. Construction time delays 11

2.1.2. Construction project cost overruns 14

2.1.3. Construction quality management 17

2.2. CONSTRUCTION PROJECT CONTROL 19

2.3. CONSTRUCTION PROJECT PROGRESS MONITORING 23

2.4. CONSTRUCTION PROJECT PROGRESS REPORTING 26

2.4.1. Construction project progress reporting and its accuracy 28

2.4.2. Current construction progress reporting methods 28

2.5. THE SOUTH AFRICAN CONTEXT 34

2.6. Summary to review of relevant literature. 41

CHAPTER 3 ..... *44*

3. RESEARCH DESIGN AND METHODOLOGY **44**

3.1. RESEARCH DESIGN 44

3.1.1. Research Philosophy 44

3.1.2. Research Approach 45

3.1.3. Research Methods 47

3.1.3.1. Qualitative Research 47

3.1.3.2. Quantitative Research 48

3.2. RESEARCH STRATEGY 50

3.2.1. Survey method followed 51
3.2.2. Interviews 53
3.3. DATA SOURCES 54
3.4. POPULATION AND SAMPLING 55
3.4.1. Population 56
3.4.2. Sampling 56
3.4.3. Sampling Technique 57
3.5. APPROACH TO DATA ANALYSIS 58
3.6. Ethical Considerations 60

CHAPTER 4 62

4. ANALYSIS OF DATA 62
4.1. GENERAL CHARACTERISTICS OF RESPONDENTS 62
4.1.1. General Characteristics of Respondents from questionnaire survey 62
4.1.2 General characteristics of respondents from interviews 64
4.2. RESULTS FROM ANALYSIS 64
4.3 FINDINGS AND DISCUSSIONS 74

CHAPTER 5 76

5. CONCLUSIONS AND RECOMMENDATIONS 76
5.1 ADDRESSING THE OBJECTIVES AND AIM 76
5.2. IMPLICATIONS OF FINDINGS 78
5.3. RECOMMENDATIONS FOR FUTURE RESEARCH 78
5.4 ADDRESSING LIMITATIONS 79
5.5 CONCLUDING REMARKS 79

REFERENCES 80

APPENDICES 89

LIST OF FIGURES

Figure 3. 1 Inductive research format 46
Figure 3. 2 Sequential exploratory strategy 47

Figure 4. 1 Extract of Data Analysis in ATLAS.ti 8 66
Figure 4. 2 Atlas.ti 8 Word cloud - Decoding data 66

LIST OF TABLES

Table 2. 1 Construction Project Management Methods 10
Table 2. 2 Causes of delays on construction projects 12
Table 2.4 Causes of Construction Cost Overruns 16

Table 3. 1 Summary of existing literature reviewed 49

Table 4. 1 General characteristics of respondent selection 63
Table 4. 2 Respondent selection in experience 63
Table 4. 3 Respondent experience in years 63
Table 4. 4 Poor construction project management vs Construction delays ..... **Error! Bookmark not defined.**
Table 4. 5 Construction project management vs Construction delays (RII) 69
Table 4. 6 Construction project management vs Budget Constraints ..... **Error! Bookmark not defined.**
Table 4. 7 Construction project management vs Budget Constraints (RII) 70
Table 4. 8 Construction project management vs Poor project quality .... **Error! Bookmark not defined.**
Table 4. 9 Construction project management vs Poor project quality (RII) 71
Table 4. 10 General characteristics of interviewees ..... **Error! Bookmark not defined.**
Table 4. 11 Interviewee construction experience (years) ..... **Error! Bookmark not defined.**
Table 4. 12 Qualitative Data Analysis Relationships on progress monitoring ..... **Error! Bookmark not defined.**

ABBREVIATIONS

BIM	Building Information Management
CCS	Construction Computer Software
CPD	Construction Project Status Dashboard
CPM	Critical Path Model
CPS	Critical Path Segments Technique
DCM	Digitalizing Construction Monitoring
EVA	Earned Value Analysis
EVM	Earned Value Management
ICT	Information and Communication Technologies
PERT	Programme Evaluation and Review Technique
PMBOK	Project Management Body of Knowledge
RII	Relative Importance I

CHAPTER 1

1. INTRODUCTION TO THE RESEARCH PROBLEM

1.1. Background to Research

The construction industry has been described as a vehicle for the achievement of tangible developments (Enshassi *et al*, 2010). This industry constitutes professionals from different backgrounds who meet to undertake temporary projects to fulfil set requirements (Winch, 2010). Building contractors occupy a central position in these temporary undertakings; where success is dependent on how effectively building contractors manage, monitor and control projects (Agapiou *et al*, 1997; Vegad *et al*, 2014). However, even with the appreciable amount of time spent managing and controlling projects, delays and cost overruns are still experienced (Ling and Ang, 2013; Amoatey *et al*, 2014; Asiedu *et al*, 2017).

Traditionally, building contractors carry out the work of constructing facilities that are designed by the clients' representatives which consist of engineers, architects and other designers (Ling and Chong, 2005). Building contractors play a role in the development, coordination, management and control of projects (Dykstra, 2011). Such are visible in the arrangement and allocation of resources such as management, labour, plant and materials to ensure project execution to specification and completion to set parameters (Clough *et al*, 2005).

In order to achieve desired effectiveness, building contractors develop different practices to enhance the management and control of projects from inception to completion (Winch, 2010). One such practice is progress reporting, which is mainly reliant on the constant awareness of project status at any point in time of the projects being undertaken (Nzekwe *et al*, 2015). This awareness is measured by the recognition of variations and scope changes, determining how these impacts the timely completion of projects and accurately reporting on these impacts to project stakeholders timely (Lamptey and Fayek, 2012). As such, the regular knowledge of the actual project status simplifies the project management practice of progress reporting for building contractors. However, existing research suggests that the nature of reporting is neither effective nor accurate, and the reporting is also not within the

time constraints that will allow effective mitigation of potential project risks (Han and Golparvar-Fard, 2015).

Construction progress reports lack the precision and consistency required for projects of varying complexities, and prevents project stakeholders from making informed decisions on projects (Lamptey and Fayek, 2012). As such, inaccurate progress reporting prevents building contractors from implementing effective management and control practices for project success (Dhawale and Tuljapurkar, 2015).

Based on the traditional view, construction projects are expected to be completed on time, within budget and to the quality expectations desired (Dykstra, 2013). Intrinsically, construction progress monitoring and reporting are considered key elements for improving project performance and achieving the desired results (Ling and Ang, 2013). However, current practices of progress monitoring and reporting have not reduced the probability of the negative outcomes of delays, cost overruns and poor-quality results (Aliverdi, Naeni and Salehipour, 2013; De Marco and Narbaev, 2013; Nguyen and Chileshe, 2015). The poor levels of progress monitoring and reporting have negatively impacted aspects of planning and project execution to achieve desired project results (Nzekwe et al, 2015). As a result, projects continue to experience negative outcomes of delays and cost overruns, as well as poor quality outcomes (Munns and Bjeirmi, 1996; Nzekwe, Oladejo and Emoh, 2015). Consequently, authors such as Hazir (2015), query the occurrence of time and cost overruns and poor quality of work, in the presence of progress monitoring and reporting systems. The queries are influenced by how negative project outcomes are negatively affecting the reputation of building contractors, bringing into question their ability to perform (Mubarak, 2010).

Progress monitoring and reporting on construction projects is currently mainly visual, prone-to-error, infrequent, and time consuming (Alizadehsalehi and Yitmen, 2016). The inadequacy of progress monitoring and reporting implies that progress reports are ineffective to improving management and control efforts which are aimed at achieving project success (Jugdev *et al*, 2015). A major reason advanced is the unwillingness of building contractors to adopt new methods of monitoring and reporting of project progress (Jallow *et al*, 2014). Soman et al (2017) stated that only about 2% of the effort invested in construction projects is dedicated to monitoring and recording progress information. Such

efforts are also based on manual processes which have proven to be slow, ineffective and inaccurate.

Mthethwa (2018) found that construction industries in developed countries tend to have stronger systems implemented to limit the occurrence of time delays and cost overruns. Project performance in terms of time and cost is closely monitored, and the success of projects can be easily compared between actual cost and the level of objectives achieved (Baloyi and Bekker, 2011). The construction industries of developing economies, however, have weaker systems implemented and, therefore, tend to have significant time and cost overruns (Mthethwa, 2018). The traditional objective of project management to coordinate multi-layered construction tasks in order to successfully procure and deliver projects on time and within budget is rarely achieved (Gbahabo and Ajuwan, 2017). South Africa is considered one such developing country, where the construction industry has not been able to elude the negative project outcomes that lead to project failure (Nkiwane *et al*, 2016; Gbahabo and Ajuwan, 2017).

According to Mulenga *et al* (2014), even though project management and control is evident on South African projects, the objectives of time, cost and quality are still not achieved. Tengan and Aigbavboa (2016) also noted that the poor performance of South African projects is as a result of the weak link between poor planning, management and control efforts, which are partly caused by poor progress reporting. Adugna (2015) noted that building contractors are still producing inaccurate progress reports that negatively affect construction project management decisions. Building contractors in the South African construction industry have been faulted for the unwillingness to adopt new methods and practices for progress monitoring and reporting (Mukuka *et al*, 2014). The inadequacy of progress monitoring and reporting is still evident in the unsuccessful efforts displayed by building contractors to complete projects on time, within budget and to the desired quality results (Nkiwane *et al*, 2016).

On the basis of the assertions discussed above, there is a need for improvement in this area, which should be based on a clear understanding of current practice. Therefore, there is a need to understand the nature and occurrence of construction progress reporting methods employed on construction projects in South Africa. Inevitably, it is important to understand the threat to adoption of more effective and accurate methods of progress reporting.

Therefore, this research will investigate the nature and occurrence of ineffective and inadequate progress reporting as it occurs on projects in South Africa. With this, the research will find ways of improving the current inefficiencies of progress monitoring and reporting to achieve project success. Consequently, the research problem can therefore be stated below:

1.2. Research Problem

There is an inadequacy in the adoption of modern progress monitoring and reporting systems during the construction phase, by building construction companies; causing time and cost overruns and poor quality of work.

1.3. Research Question

How adequate in terms of accuracy and efficiency are the currently implemented project progress monitoring and reporting systems by building construction companies?

1.4. Aim of Research

The aim of this research is to determine the nature and effectiveness of the current project progress monitoring and reporting systems currently implemented in construction projects in South Africa.

1.5. Research Objectives

i. To determine the current occurrence of inadequate project monitoring and progress reporting systems in construction projects within South Africa.
ii. To find out how poor progress reporting systems relate to the negative outcomes of delays, cost overruns and poor-quality results in the South African context.
iii. To explore the possible mitigating factors to improving identified shortcomings in progress monitoring and reporting systems for construction projects.

1.6. Research Scope

The research context is South Africa. The study focused on the efficiency of currently implemented monitoring and reporting systems by building contracting firms operating in and around the greater Johannesburg area of the Gauteng Province. The research seeks the opinions of professionals such as construction managers, project managers, foremen, site agents, quantity surveyors, architects, engineers and other designers that are involved in the construction process.

1.7. Summary of research methodology used for the study

In conducting the investigation, a pragmatic philosophical view with the inductive approach was adopted for the study. Essentially, the research is explorative utilizing both quantitative and qualitative data sets. Data were gathered using a structured questionnaire and semi-structured interviews (Saunders, Lewis and Thornhill, 2012). The research sampling was purposive in nature because utilising maximum variation sampling to support the selected methods of data collection as well as ensuring that the most diverse characteristics are attached from the data sources visited.

1.8. Rationale for the study

Construction projects are time constrained and have many expectations, particularly on the quality of the undertaking and the budget allowed for. The varying expectations from construction projects have been researched and discussed by many researchers, including Toor and Ogunlana, 2009; Shehu and Akintoye, 2010; Aigbavboa, Mukuka and Thwala, 2014; Mahamid, 2014 and Yang *et al*, 2015. Even with the various concerns raised and the possible solutions that have been proposed, building construction companies still fail to complete and handover projects with the desired outcomes. Researchers such as Aliverdi *et al* 2013; Rolstadas *et al*, 2014; Olawale and Sun 2015; Yang *et al*, 2015 outlined progress monitoring and reporting as some of the factors that have an implication on the outcome of projects. Therefore, the fundamental reason for this research is to ascertain the nature and effectiveness of progress monitoring and reporting systems currently implemented in construction projects in South Africa.

Building contractors in the construction industry in South Africa are still unable to complete and handover projects timely or to the desired quality. One of the attributed reasons is the inaccuracy and inconsistency of the progress reports currently being produced by building contractors, which induce negative project outcomes. Therefore, research is needed to ascertain modern project monitoring and reporting systems that can improve the ineffectiveness and inaccuracy of progress reporting and ultimately improve project outcomes. The challenges attributable to the accuracy of progress reporting systems are broad, but generally relate to the traditional outcomes of time delays, cost overruns and poor-quality outcomes in the general construction industry.

=9. Structure of the report

Chapter 2 – Literature review

This chapter reviews literature on construction project control, management, monitoring and progress reporting by researchers and scholars within the built environment. The aim here is to establish what is already known on the relevant areas of this topic from extant literature.

Chapter 3 – Research design

This chapter outlines the research design, strategies and methods that were followed to collect and analyse data and report findings. It outlines details of the methodological dimensions of the research and describes the survey and interview approaches, and the population and sample.

Chapter 4 – Data analysis

This chapter presents analyses of the data collected through the questionnaire survey and interviews. It also presents the results, findings and discussions.

Chapter 5 – Conclusions and recommendations for future study

This chapter presents a summary and overview of the research. The chapter also highlights the conclusions from the data collected in chapter 4 and provides recommendations for possible future studies into poor progress reporting in construction projects and the association with negative outcomes of time delays, cost overruns and poor-quality outcomes using the South African construction industry as a context, to extrapolate to the global context.

CHAPTER 2

2. LITERATURE REVIEW

This chapter aims to review the current views and debates regarding management and control, as well as progress monitoring and reporting as they occur on construction projects. The review seeks to derive an understanding of the effectiveness of current methods implemented towards monitoring and reporting on project progress. This is aimed at guiding this research in determining whether there is a need to implement other methods of progress monitoring and reporting to improve effectiveness. This review will also pursue an understanding of the relationship between the current state of progress monitoring and reporting, with the negative outcomes of delays, cost overruns and quality defects. In achieving this, the review will be guided by the following framework:

Section 2.1 is dedicated to construction project management in order to introduce the overall phenomena that is reviewed in this chapter. The next Section 2.2 is dedicated to a critical discussion of project control and its contribution to both project failure and to successful completion of projects. This is followed in Section 2.3 that deals with an exploration of progress monitoring on projects and how this contributes to both project failure and to the successful completion of projects. In bringing the research discussed in the prior sections within the scope of the research, Section 2.4 discusses the nature and existence of progress reporting on construction projects. Finally, Section 2.5 is an overview control monitoring and progress reporting as it occurs in the South African construction industry.

2.1. CONSTRUCTION PROJECT MANAGEMENT

According to Mavi and Standing (2018), there is an extensive number of factors that influence the success and failure of projects. Dermirkesen and Ozorhon (2017), outlined that project performance relies on different dimensions of project management. As such, Muller and Jugdev (2012) outlined that the success of construction projects is dependent on the implementation of construction project management. However, Heravi and Ilbeigi (2012) argued that construction project management and the success of projects are not directly linked, as the key project management objectives of time, cost and quality are not the only

factors that measure project success. Nonetheless, it is important to understand, especially for this research, why the aforementioned project management objectives are not effectively managed to prevent project failure. Burger (2013) defined project management as a controlled methodology to effectively manage projects from inception to completion. This, according to the Project Management Institute (PMI, 2013), involves the use of different processes including planning, organising, controlling and coordination of projects.

The objectives of project management include ensuring that projects are completed on time, within budget and to the performance standards expected by the client (Jalal and Koosha, 2014). Likewise, the purpose of project management involves describing the requirement of work; establishing the extent of work to be carried out; allocating the required resources; planning for the execution of the works; monitoring the progress of the works and adjusting any deviations from the original plans (Davis, 2014). However, the successful completion of projects is not dependent on construction project management alone (Radujkovic and Sjekavica, 2017). Munns and Bjeirmi (1992), earlier found that the objectives and controls of time, cost and progress are considered to be project management objectives and should not be misperceived with the measurement of project success. Likewise, Koskela, Ballard and Howell (2002), previously found that projects can be over budget, not be completed at the stipulated time or quality, but still be completed successfully. Therefore, even though project success and project management share similarities, they are not the same and the one is not the only determinant of the other (Aneesha and Haridharan, 2017). Researchers such as Davis (2014) and Beleiu *et al* (2017), demonstrated that the approaches to construction project success have since evolved from focussing only on the operational level of projects, to incorporating a stakeholder-focussed approach. This is because researchers raised concerns and questions about the insufficiency of the objectives of time, cost and quality as the only measurements of project success (Han *et al*, 2012). Davis (2014), listed 9 themes that describe the additional objectives and criteria for construction project success to be: cooperation and communication; timing; identifying and agreeing objectives; stakeholder satisfaction; acceptance and use of final products; cost and budget aspects; competencies of the project manager and strategic benefits of the projects. The focus of this research however, is on the efficiency of currently implemented progress monitoring and reporting systems in projects and how these systems relate to the

negative outcomes of time delays, cost overruns and poor-quality outcomes, leading to project failure. While researchers continue to show the different aspects of project success, it is seen that project success is a complex concept consisting of many different dimensions (Silva, Warnakulasuri and Arachchige, 2016). Therefore, it is important to understand for this research, the impact of poor progress monitoring and reporting on the overall success of construction projects. It is also important to highlight, for this research, the relevance of the project management to the successful completion of projects. As such, the objectives of project management depend on the achievement of strategic organizational objectives, which according to Sigh (2017), have to be SMART (Smart, Measurable, Assignable, Realistic and Time related). Therefore, it is imperative that building contractors employ management methods and techniques that will steer projects towards the anticipated level of success (Rahman *et al*, 2013). While project management tools and techniques aid building contractors to do their jobs, management methods offer strategies to ensure that project procedures are duly followed to ensure desirable outcomes are achieved (Jugdev *et al*, 2015).

Construction projects vary in size and complexity and this necessitates differing levels of competence to achieve desired results. The different competencies are to ensure that project constraints such as scope, budget, schedule, resources, quality and risks are balanced out (PMI, 2013). Therefore, the implementation of management tools and techniques, alongside the competence of building contractors should improve project outcomes (Nguyen and Chileshe, 2015). However, this is not the case as construction projects still fail where project management objectives of time, cost and quality are not met (Nzekwe *et al*, 2015). Nguyen and Chileshe (2015) pointed out that construction projects still fail due to poor project management, control, progress monitoring and reporting.

In an effort to improve project management on construction projects, Jalal and Koosha (2014) suggested that project management methodologies, tools and techniques be standardised per project, from inception to completion. Joslin and Muller (2016), however, argued that project management methodologies, tools and techniques cannot be easily standardized to suit projects because they can change, based on their effectiveness in the respective projects.

According to Merrium-Webster (2013), project management methods refer to systematic procedures, techniques or modes of enquiry employed to aid with the effective running of projects. These management methods, tools and techniques are grouped as presented in Table 2.1 based on Jugdev *et al* (2013):

Table 2. 1 Construction Project Management Methods

Method type	**Description (Examples)**
Project Management methods	These are outlined in the PMBOK, PRINCE, PRINCE 2, SSADM
Project Management software	Microsoft Project, Primavera, Excel and CCS
Project Management tools	Gantt Charts; Work Breakdown Structure (WBS); Critical Path Method (CPM); Program Evaluation and Review Technique (PERT); Strengths; Weaknesses; Opportunities and Threats (SWOT)
Decision-Making tools (DM)	Cost Benefit analysis, Decision analysis and Sensitivity analysis.
Risk Assessment tools	Probability analysis, Life-cycle cost analysis and Reliability Analysis
Information and Communication Technology (ICT) support tools	Integrated groupware (email, collaborative tools, shared access to web portals), video conferencing, virtual environments, and voice over protocol.

According to Jugdev *et al* (2013), there are still methods and tools that are under-utilised but have the potential of improving project success. The authors further stated that current methods and tools lack the capacity to improve project success as they have been frequently used and have reached their full potential. However, existing literature has not provided new methods, tools and techniques to improve progress monitoring and reporting towards project success. It is therefore arguable that building contractors still track project progress through the current methods, tools and techniques that are considered not effective and, therefore, hinder the successful completion of projects (De Marco and Narbaev, 2013).

The frequent use of outdated progress monitoring and reporting methods, tools and techniques to successfully manage projects has increased the occurrence of negative outcomes of time delays, cost overruns and quality defects, leading to project failure (Nzekwe *et al*, 2015; Albert *et al*, 2017). Marzouk and El-Rasas (2012) had previously stated that the aforementioned negative outcomes have continued to adversely impact and affect construction projects and were considered most damaging to the successful completion of projects. Consequently, it is important to understand the relationship between current project management methods, tools and techniques, and the negative outcomes that encompass construction projects (Mavi and Standing, 2018). It is also important for this research, to understand the relationship, if any, between currently implemented systems of progress monitoring and reporting, and the negative outcomes of time delays, cost overruns and poor-quality outcomes. As such, the following sections summarise this relationship, while underlining the importance of improving the current efficiency levels of progress monitoring and reporting systems to attain favourable project outcomes.

2.1.1. Construction time delays

Construction projects encompass a large number of factors, they differ in size, duration and objectives, with the success predictions strongly based on time durations, cost parameters set out, achieving contract specifications and stakeholder satisfaction (McCord *et al*, 2012). Therefore, the study of poor project performance leading to time delays is not uncommon in the construction sector globally (Lei and Skitmore, 2004).

There are many ways to define construction time delays, all of which refer to none or delayed completion (McCord *et al*, 2015). Aziz (2013) defined construction time delays as non-completion of projects within the specified period agreed on contracts. Cristoba (2014) provided a more formal definition by stating that construction time delays are acts or events that extend the time required to perform tasks under constraint. Khoshgoftar *et al* (2014) indicated that delays form part of most projects and as a result, it has become difficult for projects to be completed on time, even with the use of different management methods, tools and techniques. This is after Del Pico (2013), indicated that management, monitoring and control methods employed on construction projects were not being carried out effectively and this enforced the impact of time delays. However, according to Enshassi *et al* (2009) and Memon *et al* (2014), time delays could be minimised by the employment of

realistic strategies for project control, progress monitoring and reporting, good practices and careful judgement with the projects undertaken.

According to Khoshgoftar *et al* (2010), the construction process is divided into three phases: conception, project design, and project construction. Most delays are experienced during the construction phase, where uncertain project specific variables such as finance, the lack of information as well as design and scope changes occur (McCord *et al*, 2015). Gardezi *et al* (2014) noted that the existence of time delays is evident in poorly managed projects, where planned project activities are not effectively monitored or accurately reported on. Albert *et al* (2017) emphasised the relevance of understanding project specific requirements, to ensure that sufficient and effective management, monitoring and progress reporting methods are employed.

The causes of construction delays have been thoroughly studied by researchers including Assaf *et al* (1995), Ayodeji and Odeyinka (2006), Simbasivan and Soon (2007), Al-Kharashi and Skitmore (2009), Haseeb *et al* (2011), Doloi *et al* (2012), Durdyev *et al* (2017), and their findings share similarities. The causes are grouped and summarised in the following Table 2.2:

Table 2. 2 Causes of delays on construction projects

Grouping	**Description**
Materials	Shortages of materials e.g. (Marzouk and El-Rasas, 2014; Aziz, Asmaa and Abdel-Hakam, 2016; Gebrehewit and Luo, 2017)
Equipment	Any delay cause related to failure, shortage and delivery of any equipment e.g. (Gardezi, Manarvi and Gardezi, 2014; Niazi and Painting, 2017)
Financing	Contractor's financing requirements vs progress payments by clients e.g. (Ayodeji and Odeyinka, 2006; McCord *et al*, 2015)
Environmental	Different climatic conditions e.g. (Assaf and Al-Heiji, 2006; Senouci, Ismail and Eldin, 2006)

Grouping	Description
Scheduling and Controlling	Poor planning, management, monitoring and control practices in project programme scheduling e.g. (Sambasivan and Soon, 2007; Hamzah *et al*, 2011; Arditi, Nayak and Damci, 2017)
Shortages in industry infrastructure	Includes the supply of resources required for the construction of planned projects e.g. (Sweis *et al,* 2008; Doloi *et al*, 2012)
Client and consultant related	Includes minimal urgency in decision-making, the introduction of necessary variations on projects, cash flow problems, and changes in project scope and difficulties in obtaining work permits. E.g. (Aziz, 2013; Gardezi, Manarvi and Gardezi, 2014; McCord *et al*, 2015)
Contractor Inadequacy Related	Includes poor site management and supervision, material management problems, planning and scheduling problems, poor site labour management, inadequate human resource skill and experience, poor coordination and communication problems e.g. (Simbasivan and Soon, 2007; Marzouk and El-Rasas, 2014).

As shown in Table 2.2, there are many causes of construction delays and these include scheduling and controlling causes, as well as contractor inadequacy related causes, which identify with the progress monitoring and reporting aspects that are being researched in this report (Assaf and Al-Heiji, 2006; Simbasivan and Soon, 2007; Marzouk and El-Rasas, 2014).

Time delays are considered the biggest factors of project failure, as they directly impact the cost and quality aspects of projects (Chiu and Lai, 2017). Other effects of time delays include financial waste and cost overruns, inherent disputes, arbitration and litigation, as well as project abandonment (McCord *et al*, 2015). Therefore, as stated by Toor and Ogunlana (2008), improving the level of management, control, monitoring and progress reporting on construction projects is vital for project success to be achieved.

The PMI (2013) outlined processes that could aid in the management of the time requirements set on different projects to ensure successful completion. These processes include establishing policies and procedures for executing management; monitoring and control of construction progress; analysing project activity sequences; durations and resource requirements; and frequently reporting on those activities; as well as monitoring the progress of project activities to ensure that time deadlines are met. However, even with these current processes in place, many projects are still not being completed on time and within budget currently. The amount of rework occurring has affected overall project quality (Nzekwe *et al*, 2015; Zarai *et al* 2017).

It is, therefore, important to establish other methods of management control, progress monitoring and reporting that can be implemented to improve current outcomes of project, which have been largely failure.

2.1.2. Construction project cost overruns

The aim of any building construction firm is to make a profit at the end of each project undertaken (Zarei *et al*, 2017). In achieving this, building contractors are expected to effectively manage, monitor and control projects to complete them on time, within budget and to the quality requirements set out (Polat *et al*, 2014). The poor project management outcome of cost overruns has also negatively impacted the successful completion of projects (Nazi and Painting, 2017).

Shehu *et al* (2014) defined cost overruns as the difference between the initial agreed contract amount and the final account amount or cost. Al-Hazim *et al* (2017) supported this by defining cost overruns as budget overruns that include unforeseen additional costs incurred due to the underestimation of the anticipated budget of construction projects. Mahamid and Dmaidi (2013) found that construction projects are dependent on many changing and unexpected variables that emanate from sources such as the performance of construction parties, financial problems, managerial issues, resource unavailability and other external conditions. Due to these and other factors, the existence of cost overruns is eminent in most construction projects and this affects project outcomes (Mahamid, 2014).

Many projects fail due to poor cost monitoring and control as cost performance remains one of the more influential measures of successful construction projects (Memon *et al*,

2014; Ahiaga-Dagbui *et al*, 2014). Mahamid (2014) expressed that most construction projects experience cost overruns more often than not and that has negatively impacted project outcomes. It is, therefore, important to establish management methods, tools and techniques that will aid in monitoring and controlling cost performance on construction projects (Jayaraman, 2015).

The causes of construction cost overruns have been comprehensively studied by different authors (e.g., Kaming *et al* (1997); Doloi (2013); Mahamid (2014); Rahman *et al* (2014); Shehu *et al* (2014); Polat *et al* (2014); Jayaraman (2015); Adam *et al*, (2015); Al-Hazim *et al*, (2017); Durdyev *et al* (2017), among others). The findings from these studies share similarities which have been summarised into the categories presented in the following Table 2.3 based on Adam *et al* (2015):

Table 2.3 Categories of factors causing cost overruns and time delays

Causes (Groupings)	**Description (Examples)**
Communication	Poor communication between contractors and clients
Financial	Inflation, delayed payments to contractors and poor financial planning
Management	Poor construction project management, inadequate managerial skills, poor progress monitoring and control, client variation orders, lack of project information, rework and poor labour planning and management.
Material	Material shortages and poor plant management
Organizational Structures	Poor management structures and poor process procedures

Projects	Longer project durations than originally planned for and high levels of project complexities
Weather	Harsh weather conditions and unforeseen working conditions

Building contractors have consistently failed to successfully complete appointed projects within budget and McConville (2015) highlighted some of the causes of this negative consequence on the following Table 2.4:

Table 2.3 Causes of Construction Cost Overruns

No	Cause of cost overrun
1	Oversights and errors in capturing the full intent, complexity and scope of work on a construction project by the estimating team
2	Slip-ups in determining the appropriate productivity values that will be achieved on a construction project when considering factors like client safety requirements, congested work areas and extreme weather conditions
3	Employing inexperienced project team members that overlook the complexities of specific projects undertaken at a time.
4	Working with unrealistic construction programmes that are ordained by clients, where major delays, design changes and construction errors are not taken into consideration.
5	Compiling construction project estimates where the basis and timing of these estimates does not allow for a fully developed scope of works and is subject to interminable modifications and changes
6	The lack of overall construction programme integration, too little detailing, planning, monitoring and control methods on construction activities.
7	Poor communication and coordination between different project team members and the failure to have frequent reports on factors like cost, completed work percentages and roadblocks that need to be overcome.

8	Not enough contingencies contained in the body of submitted construction cost estimates.

The causes of cost overruns on the aforementioned table affect all stakeholders involved in projects. The impact can be seen through outcomes such as poor returns on investments for clients, poor contractor margins, and the inability for clients to invest in new projects (Park and Papapoulou, 2012; Polat *et al*, 2014). There is, therefore, a need to employ management methods, tools and techniques that can improve the impact of cost overruns (Doloi, 2013). Consequently, project management attributes of managing, controlling and monitoring of cost performance on projects are significant to ensuring project success (Jayaraman, 2015).

The PMI (2013) provides suggestions to better manage project costs and these include developing approximations for budgetary requirements to complete projects, monitoring project progress to constantly update costs, and manage changes to main budget.

It is, therefore, imperative to establish suitable methods of project management and control, as well as progress monitoring and reporting, that can be implemented to improve cost performance and project failure (Del Pico, 2013).

2.1.3. Construction quality management

Dermirkesen and Ozorhun (2017) listed the objectives of project management performance to be time, cost, quality, safety and client satisfaction. While the success of construction projects is largely dependent on timely completion and positive cost performance (Ying and Yip, 2010), this review also considers project quality as another important factor that determines the success of projects (Arditi and Gunaydin, 1997).

Construction projects are complex in nature and require effective management, control and consistent monitoring to complete activities errorless on the first attempt (Al-Hazim *et al*, 2017). As it is the expectation for building contractors to achieve and maintain client quality requirements on projects, the aforementioned objectives of management are considered significant in achieving desired quality outcomes (Orangi *et al*, 2011).

Building contractors previously considered the success of projects to only be dependent on time, cost and quality outcomes (Farooqui *et al*, 2010). However, most construction projects

concentrate on the time and cost aspects, leaving out quality (Acikara *et al*, 2017). This has resulted in the definition of project quality being ambiguous and inconsistent (Basu, 2014). The International Organisation for Standardisation (ISO 9000:2000), defines quality as "the totality of the features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs." Chen and Luo (2014) observed that project quality is the ability for buildings to persuade and serve the purpose for which they were constructed. Basu (2014), however, defined project quality as the consistent conformance to client expectations on successfully completed projects.

Researchers such as Arditi and Gunaydin (1997), Rad and Khosrowshani (1998) and Golob *et al*, (2013) found that the attributes of project quality include for it to be pleasing to the eye fit for purpose free from imperfection on completion and containing satisfactory durability. According to Ying and Yip (2010), positive project quality results are largely dependent on the employment of effective management, control and monitoring methods, tool and techniques. These methods, tools and techniques, according to the PMI (2013), should be implemented at the design and planning stages of projects, where the project configuration, material specifications and functional performances are decided.

The implementation of effective management, control and quality monitoring methods, tools and techniques are significant for achieving project quality, but have not been consistently practiced on projects; hence, the poor-quality outcomes (Safa *et al*, 2015). According to Battikha (2002), construction projects are subject to high levels of uncertainty, where changes are expected on most of the projects undertaken. These, coupled with unforeseen circumstances, incorrect designs and re-evaluation of design decisions during the construction phase all impact project quality performance (Al-Tmeemy *et al*, 2012).

Yang and Yip (2010) reiterated the importance of managing, controlling and monitoring project quality performance at any point of the construction phase. Memon *et al* (2014), however, noted that building contractors are not implementing quality management, control and monitoring methods effectively; hence, the increased levels of re-work on projects. The impact of poor project quality outcomes negatively affects building contractors and clients (Walker and Keniger, 2002). This is seen through negative impacts such as penalties, cost and time overruns due to re-work, which can lead to loss of productivity for building contractors, structural failure, functional underperformance and

additional maintenance costs (Battikha, 2002; Walker and Keniger, 2002; Tam and Le, 2007; Orangi *et al*, 2011; Golob *et al*, 2013).

Based on the summary presented above on quality performance in construction projects, it is important to establish effective quality management, controlling and monitoring methods, tools and techniques that will assist in the successful completion of projects. As such, the following sections summarize the progress monitoring and reporting aspects of project control and how these can assist with the successful completion of projects, while considering the aspects of time, cost and quality.

2.2. CONSTRUCTION PROJECT CONTROL

The existence of control on construction projects suggests that there is consideration for planning, management and monitoring (Nzekwe *et al*, 2015). It is therefore necessary to understand the relationship between control, management and monitoring of construction projects, in order to ascertain their role in the successful completion of construction projects (Rezania *et al*, 2016). The nature of this relationship will provide clarity on the linkage of these factors with time delays, cost overruns and poor-quality outcomes on projects.

According to Rezania *et al* (2016), project control is considered a fundamental process of project management and is well-known as an important factor of project success. Olawale and Sun (2010) and Mubarak (2010) defined project control as a complex duty involving continual measurement of progress, evaluating base plans, checking project sequence and undertaking corrective actions when required to ensure project success. Wang *et al* (2017), defined project control as a classification of activities in projects and entails scope management and consideration for cost management, cash flows and performance management scheduling. Del Pico (2013) summarised the factors of project control to include:

- *The creation of plans against which the performance towards set goals can be measured;*
- *The measurement of progress towards the goals regularly;*
- *The regular evaluation of causes of substantial differences from the original plans; and*

- *Taking corrective action, based on the evaluations to bring projects back in line with the goals originally set.*

Building contractors have found it manageable to employ planning tools in order to ascertain the desired levels of control on construction projects (Rolstadas *et al*, 2014). Project management methods such as Gantt charts, Programme Evaluation and Review Technique (PERT) and Critical Path Model (CPM); along with tools such as Microsoft Projects, Asta Power Project and Primavera, have all been instrumental in ensuring effective project control is carried out (Olawale and Sun, 2010). Building contractors are expected to employ management resources with the capacity to efficiently utilise appointed control methods and tools productively towards completion (Memon *et al*, 2014). However, the use of current control methods and tools has been unable to prevent project failure through time delays, cost overruns and quality defects (Jugdev *et al*, 2013). The implementation of modern useful methods, tools and techniques of project control is therefore important to the successful undertaking and management of projects (Eriksson *et al*, 2017).

Construction projects are complicated and involve different stages that characterise different processes (Haponava and Al-Jibouri, 2008; Sanchez *et al*, 2017; Ansah and Sorooshian, 2017). Likewise, construction projects are undertaken to achieve certain goals and objectives (Del Pico, 2013). Existing literature indicates that project management is most important in ensuring that project specific goals and objectives are met (Yang *et al,* 2015; Gustavsson, 2015). Consequently, Kivila et al (2017), outlines project control as essential to the execution phase of projects; thus, making it predominant in achieving project management goals and objectives. Thus, more emphasis should be placed on control management practices and standards to improve the probability of projects being completed on time, within budget and to the desired quality (Rezania *et al*, 2016).

In addition, building contractors should also concentrate on employee awareness, development and competencies relevant to project control requirements and expectations (Spalek, 2014). It is equally important for employees to be knowledgeable in project undertaking to ensure the employment of relevant control management methods, tools and techniques for project success (Albrecht and Spang, 2014).

Lycett *et al* (2003) suggested the implementation of Information and Communication Technologies (ICT) to improve the levels of management and control effected on construction projects. Shehu and Akintoye (2009), indicated that ICT can align factors such as scope changes, variation orders, late information positively to project outcomes without increasing negative outcomes of time delays and cost overruns. Gustavsson and Gohary (2012) supported this by noting that the impact of ICT can be translated through timely completion of projects, on budget and to the desired quality. Likewise, Sirisomboonsuk *et al* (2017), averred that ICT enable building contractors to effectively control project responsibilities and accountabilities through tracking and monitoring project performance.

However, the implementation of ICT has not drastically improved the current negative outcomes on construction projects (…). Even with the acknowledgement of the benefits of ICT, construction projects still fail to meet management objectives of time, cost and quality (Gustavsson and Gohary, 2012). Building contractors are still largely regarded as unable to deliver projects to the agreed success indicators (Gabula, 2012).

Sirisombooknsuk et al (2017) found that the improvement of project performance by focussing on project-based management and control has not improved project outcomes. Project complexities and uncertainties in monitoring and reporting have made it difficult to implement reliable management and control methods suitable to increase project performance (Turner *et al*, 2016). Improving the efficiency of project management and control attempts to improve project outcomes such as time and cost reduction to achieve success (Spalek, 2014).

Achieving effective management and control requires consideration of risks, project templates from which to measure progress, and practical strategies for dealing with factors that may hinder project performance (CIOB, 2011). Wang et al (2017) recognised the significance of understanding project requirements from the design, procurements and construction phases, in order to employ management and control methods that will meet the needs of complex projects.

Project control presents the control and coordination of construction activities through the use of control methods and tools to ensure that projects are completed on time, within budget and to the desired quality (Ansah and Jorooshian, 2017). Similarly, project

management displays the management and coordination of resources throughout the life of projects by the use of current methods of management to accomplish scheduled objectives of time, cost and quality (Kozlovska *et al*, 2016). Project controlling comprises project monitoring and reporting, among others, and it is important to understand the relationship of these factors with negative outcomes of time delays, cost overruns and quality defects (Wang *et al*, 2017).

Table 2.5 presents a summary of the factors of project control, grouped into the three construction project management factors of cost, time and quality (Ling and Ang, 2013).

Table 2.5. Factors of project control

Groupings	**Factors of project control**
Measures to control cost	- Accuracy of measurement systems - The use of technology - All project team members expected to understand all cost controlling principles. - Project managers to understand their roles and responsibilities. - Frequency of evaluation and reporting
Measures to control time	- The quality of project schedule planning - Adequacy of project information - The adequacy of float time - The quality of techniques to support risk identification - Sufficiency of project coordination - Quality of supplier selection
Measures to control quality	- Quality of quality inspection records - Quality of quality management

Groupings	Factors of project control
	- Quality of dedicated information systems - Project team contribution to record systems - Teams level of understanding of the quality control process - Adequacy of time spent on the actual quality management requirements on construction projects. - Emphasis placed on creating solutions for all the known project quality issues

2.3. CONSTRUCTION PROJECT PROGRESS MONITORING

According to De Marco and Narbaev (2013), the primary purpose for managing construction projects is to ensure that they are completed on time and within budget, while conforming to the established requirements and set specifications. The previous section outlined the significance of controlling project activities to ensure project management goals and objectives are achieved as supported by Rezania *et al* (2016). This section considers project monitoring as another factor which contributes to the achievement of project management objectives (De Marco and Narbaev, 2013).

The implementation of effective project management requires timely and accurate reports on project progress (Rebolj *et al*, 2017). Progress monitoring is considered significant to achieving the progress reporting effectiveness desired on construction projects (Alizadehsalehi and Yitmen, 2016). Therefore, in order to ensure the highest project performance, progress and productivity are to be intensely monitored from project inception to completion (Soman *et al*, 2017).

The PMI (2013) defines progress monitoring as “an aspect of project management performed throughout the project that includes collecting, measuring and distributing

performance information and assessing measurements and trends to effect process improvements." De Marco and Narbaev (2013) went on to define progress monitoring as a frequent act that measures project performance as projects progress. Tengan and Aigbavboa (2017) define progress monitoring as a constant process which project stakeholders use to obtain regular feedback on progress made towards achieving project goals and objectives.

According to Al-Jibouri (2003), project monitoring can be summarised into the following:

- *Making a plan;*
- *Implementing the plan;*
- *Monitoring actual output and recording it; and*
- *Reporting actual and planned parameters and their variations.*

Monitoring specifically outlines performance deviations when they occur and referring to tracking progress on the construction of building elements and monitoring the quality of work being executed (Yang *et al*, 2015). Tools such as the construction programme, PERT and WBS have been widely used to monitor project performance (Olawale and Sun, 2010; De Marco and Narbaev, 2013; Memon *et al*, 2014). The use of these tools, has, however, grown ineffective over the years, as projects still fail to achieve the expected successes (Jugdev *et al*, 2013). This can be attributable to the growth and increasing complexity of construction projects, as well as the level of management appointed to monitor project progress (Banihashemi *et al*, 2017).

Continuous monitoring provides necessary feedback on the performance of projects and identifies areas that may require attention (PMI, 2013). It is, therefore, arguable that consistent progress monitoring allows building contractors to generate useful progress reports that can be presented to other project stakeholders.

However, even with the listed benefits of progress monitoring, projects are not achieving the desired goals and objectives (Son and Kim, 2010). Progress monitoring in most construction projects is considered poor, hindering successful completion (Omar and Nehdi, 2016). Building contractors are not delivering according to the contractual requirements as set out in the initial planning stages of projects (Koosha, 2014). The poor undertaking and delivery of projects has often led to project failure (Chen and Wang, 2017). In essence,

projects are not being managed effectively, thus indicating that effective progress control and monitoring through currently implemented construction project management, are not being explicitly exercised (Rebolj *et al*, 2017).

The poor management, control and monitoring of progress on projects has negatively impacted the general perception of building contractor capabilities in successfully undertaking projects (Mubarak, 2010). The general perception is that building contractors are unable to fulfil contractual requirements by completing projects on time, within budget and to the desired quality (Dhawale and Tuljapurkar, 2015). Projects are not being managed efficiently, progress is not being controlled or monitored accurately and this affects project outcomes (Getuli *et al*, 2016). Existing literature has outlined increasing levels of poor management and inexperience in the undertaking of construction projects, as the leading impacts of negative project outcomes (De Marco and Narbaev, 2013). Building contractors lack the experience required to undertake projects of differing complexities and this affects how projects are undertaken (Behnam *et al*, 2016). The expectation surrounding project outputs is that human resources appointed to manage projects should possess the ability to plan, organize, schedule, implement, manage, monitor, control and track the progress on appointed projects (Farooqui *et al*, 2010).

It is, therefore, necessary to understand different projects and their requirements to employ relevant progress monitoring methods to attain project success (Wang *et al*, 2016). Without the basic skill requirements, it becomes difficult for management resources to effectively monitor and control project progress successfully (Del Pico, 2013). Stakeholder knowledge and expertise is acknowledged as one of the important attributes of understanding project requirements and expectations (Dhawale and Tuljapurkar, 2013).

Having experience in different types of projects assists with employing relevant management methods, tools and techniques to ensure project success (Omar and Nehdi, 2016). Similarly, with progress control and monitoring methods, project knowledge and experience allow building contractors to handle different challenges on projects effectively to achieve project success (Getuli *et al*, 2016). Current progress monitoring methods, tools and techniques are not effective as building contractors still fail to complete projects within the management goals and objectives of time, cost and quality (Tengan and Aigbavboa, 2017).

Existing literature outlines the existence of progress monitoring methods, which have over time become inadequate in monitoring and controlling different aspects of project requirements (Shebob *et al*, 2012). This is because, according to (Behnam *et al*, 2016), current methods, tools and techniques of progress monitoring are unable to handle growing and ever-changing complexities that come with current projects. The overall impact of the aforementioned inadequacy is project failure, with negative outcomes such as time delays, cost overruns and poor-quality outcomes (Cristoba, 2014).

It is, therefore, necessary to establish new methods of progress monitoring to complement the current growth and direction of the construction industry (Shrestha and Jeong, 2017). The methods, tools and techniques of old have been instrumental in ensuring that project progress is effectively monitored (Aneesha and Haridharan, 2017). However, the growth and complexity of newer projects is coercing the construction industry to move onto newer methods, tools and techniques that can keep up with the accuracy levels of progress monitoring and control, while ensuring successful completion and handover of projects (Jugdev *et al*, 2013).

2.4. CONSTRUCTION PROJECT PROGRESS REPORTING

The previous sections depicted the relationship between construction project management, project control and progress monitoring. Existing literature portrays the dependency of project success on the effective implementation of project management, monitoring and control (Lin *et al*, 2012). Understanding how the above-mentioned elements complement each other to attain project success is important in any project undertaking (Eriksson *et al*, 2017). One other element that complements project management is progress reporting, which provides construction stakeholders with the needed ammunition to effectively monitor and control project progress (Hegazy *et al*, 2014). Thus, progress reporting is arguably part of progress monitoring and control, where monitoring and control are the input while reporting is the output.

In construction terms, progress reporting and the manner with which construction projects are controlled and monitored can almost be intricately linked (Han and Golparvar-Fard, 2015). Described by Omar and Nehdi (2016), as “the most vital aspect of project control and monitoring,” project progress reporting is simply a process of reporting on the actual work

done on site versus what was initially planned at the conception stages of construction projects.

Other researchers have presented more formal definitions of progress reporting. For instance, El-Omari and Moselhi (2011) describe progress reporting as a process that is commonly developed as a means to compare the collected actual data related to work done on site as compared to what was planned.

A definition provided by Alizadehsalehi and Yitmen (2016), posits that project progress reporting is a vital process of "providing project progress information in an accurate and timely manner to ensure that discrepancies between actual and planned progress at a particular time are recorded accordingly." Progress reporting assists with decision-making on crucial corrective actions by senior management (Hegazy *et al*, 2014). Omar and Nehdi (2016) found that progress reporting aids in ensuring that sufficient and effective control and monitoring are exercised on current projects to guarantee that project-specific objectives are met timely.

Finally, Golparvar-Fard *et al* (2009) defined monitoring as "collecting, recording and reporting information concerning any or all aspects of project performance which highlights the presence of progress discrepancies and facilitates decision-makers to take corrective actions in a timely manner." This definition alludes to a positive link between monitoring and reporting, where the success of projects is balanced with how projects are monitored and reported on through a systematic and comprehensive approach (Han and Golparvar-Fard, 2015).

The definitions outlined above accentuate the link between construction project progress reporting with monitoring, control and management of projects (Yang *et al*, 2015). Therefore, while the success of construction projects is highly recognizable through the efficiency of project control the success of these projects also hinges on how the actual progress of projects is reported on (Tang *et al*, 2014).

Thus, an understanding of the current levels of accuracy of progress reporting is required to determine the level of improvements required within construction projects.

2.4.1. Construction project progress reporting and its accuracy

The need to deliver projects on time, within budget and to the desired quality is most crucial and cannot be over emphasized (Tengan and Aigbavboa, 2017). Therefore, the transparency in project management, especially progress monitoring and control, is important to achieving management objectives and goals (Dimitrov and Golparvar-Fard, 2014). The accuracy of progress reporting is most critical to achieving set construction goals and objectives (Wang *et al*, 2016).

Accurate progress reporting is considered an intricate part of successful project management as the desired outputs from progress monitoring and control are widely dependent on detailed progress reports (Roh *et al*, 2011). Progress reports provide project stakeholders with the information needed to determine performance deviations and control actions that can avoid or minimise deviations (Han and Golparvar-Fard, 2015). Therefore, the accuracy of progress reports improves the dependency of successful project management on progress monitoring and control methods implemented for project success (Omar and Nehdi, 2016).

Conversely, progress reports are currently not being done accurately and do not provide the much-needed benefit to achieving project success (Soman *et al*, 2017). Construction projects are still overrunning on time and cost, and the quality of completed projects is not as desired (Brito and Ferreira, 2015). The methods, tools and techniques used to control, monitor and accurately report on project progress have not yielded the desired results (Kropp *et al*, 2017). It is vital to establish the efficiency of current methods, tools and techniques for progress reporting, to determine the possible need to introduce newer methods that will increase the probability of project success.

2.4.2. Current construction progress reporting methods

Progress reports usually take the form of periodic printed reports (prepared mostly for site meetings on a fortnightly or monthly basis) (Memon *et al*, 2007). The reports examine the present against the planned status of projects, by considering factors such as budgets, constructability issues, quality issues and variation and scope changes and communicating these accordingly (Golparvar-Fard *et al*, 2009). In essence, there are many methods, tools

and techniques expressed in literature for preparing progress reports (Brito and Ferreira, 2015). However, these methods are either considered inaccurate or expensive and cannot yield the anticipated results (Kropp *et al*, 2017).

The most widely used tools for progress control, monitoring and reporting is the construction programme, along with Gantt charts and precedence networks (Le *et al*, 2013). Building contractors consider the construction programme as a formidable communication tool that is useful in providing a visual and graphical medium of actual progress on site (Tang *et al*, 2014). Building contractors support progress reports by using pictures that give a depiction of what happens on projects (Lamptey and Fayek, 2012).

Nevertheless, existing literature shows that construction programmes do not show an as-built report of how projects are actually being constructed and what the actual physical process is at a particular point of the project (Carmichael and Murray, 2006). The time taken to prepare, review, approve and submit progress reports does not reflect the actual progress, as progress reports are not conducted as frequently as required (Gershon, 2013). According to (Roh *et al*, 2011), most of the complications encountered in projects cannot be proficiently expressed by literal or stated descriptions alone. The poor reporting of complications experienced in projects does not prevent building contractors from repeating the same mistakes in future projects (Czarnigowska, 2011).

Due to the poor levels of progress reporting in projects, there has been an increase in the number of studies conducted to find practical alternatives to improve progress reporting (Lamptey and Fayek, 2012; Getuli *et al*, 2016; Omar and Nehdi, 2016; Behnam *et al*, 2016; Shrestha and Jeong, 2017). The following Table 2.6 outlines some of the possible methods, tools and techniques to improving progress reporting:

Table 2.6 Progress Monitoring and reporting Methods and Tools

Method	Description	Disadvantages	Source
Earned Value Management and Analysis (EVM)	Proves the earned value of completed work and compares it with actual cost and planned cost to determine project performance and forecasts future trends	- Has a subjective way of assessing project progress, which may lead to false reporting - Difficult to analyse EVM indicators, especially where the variations to the cost base - No clear accountability for contractual penalties when time delays are experienced	(khamidi *et al*, 2012; Czarnigowska *et al*, 2011; Gershon, 2013; Dhawale and Tuljapurkar, 2015; Baumann *et al*, 2014)
Construction Commodity tracking	Tracking the actual progress of construction activities such as excavations, construction of brick walls, and placed concrete to determine potential problems in the initial plans – uses the planned performance Index (PPI) as an extension of EVM to measure project progress	- Problems arising on projects cannot be easily deciphered once they have not been tracked from a macro level - Highly dependent on commodity curves and these must constantly be updated with variations, otherwise desired results cannot be yielded. - Tracking projects from a macro level prevents project stakeholders from recording details associated with the overall project progress.	(Brienza and Hildreth, 2007)

Method	Description	Disadvantages	Source
Construction Project Status Dashboard (CPD)	Used by management to clarify and assign accountability for the critical key objectives, key indicators and project tasks needed to steer projects in the right direction	- Requires a separate team of experts dedicated to controlling the CPD, which is not always feasible on projects.	(Lamptey and Fayek, 2015)
Digitalizing Construction Monitoring System (DCM)	ICT used to monitor projects and update project progress by integrating engineering drawings with AutoCAD drawings to create progress reports faster	- Expensive material cost - Time consuming to install the automatic system - Requires field observation	(Memon *et al*, 2006; Raut *et al*, 2013; Gwanggyosan-ro *et al*, 2014)
S-Curve	Used to predict project durations and determine current construction progress	- Is not guaranteed to produce similar results for the same projects and this may lead to false reporting - Historical information gathered from old projects may not be useful to current projects due to the differing levels of complexities	(Lin *et al*, 2012)
Critical Path Segments Technique (CPS)	An improvement to the traditional CPM to further improve project control techniques,	- Segmenting activity durations adds for too much information on the	Hegazy et al, 2012

Method	Description	Disadvantages	Source
	provide detailed progress events for projects of differing complexities, by linking schedule reporting, corrective actions optimization and forensic analysis of schedules	CPM and this may become difficult to translate - Separate time segments may cause unnecessary splits in activities. This could lead to an over allocation of resources	
Laser Scanning	Used for 3D object recognition by incorporating BIM to track project progress		Kropp *et al*, 2017
4D BIM Models (Photography-based techniques)	Facilitate the process of designing and constructing more integrated quality projects through its ability to control and monitor progress effectively	- Not enough qualified professionals to use tools - Very expensive to adopt and maintain - Building contractors are very conservative about adopting tools due to unfamiliarity to the benefits of progress monitoring	Brito and Ferreira, 2015

Gershon (2013) found that even though there are different methods, tools and techniques available for implementation, building contractors are still reluctant to undertake these methods. However, in overcoming the reluctance to change, Gershon (2013) further outlined the following factors that building contractors should take into consideration:

- **The significance of on-site progress monitoring** – It is important for building contractors to come up with newer methods that will improve the level of progress monitoring and reporting to achieve project deliverables.
- **Training** – The reluctance to implement newer methods of project management is often heightened by poor understanding and knowledge of the benefits that come with the newer advanced methods of project management, monitoring and control. Therefore, training is a requirement for building contractors to be able to utilise more advanced methods, tools and techniques.
- **Efficient Project Management** – the development of an efficient project management plan gives due consideration for efficient project control, monitoring and reporting to achieve project success. Therefore, understanding project requirements enforces the knowledge of which methods, tools and techniques will yield desired outcomes on appointed projects.

Therefore, the adoption of more effective progress reporting methods is crucial to improving the accuracy and efficiency of progress reports as well as the advancement of progress monitoring and control (Brown, 2015).

The following section looks into the current levels of progress reporting in construction projects in South Africa and the relationship with the construction project management objectives of time, cost and quality.

2.5. THE SOUTH AFRICAN CONTEXT

The construction industry in South Africa plays a vital role in the country's economy and is also considered substantial to economic growth (Windapo and Catell, 2013). It is considered to contribute positively to the socio-economic development on the construction industry in South Africa (Brown, 2015). The contribution is seen through the creation of employment, the development and transfer of technology, as well as improving the quality of life for the users of its products (Pinfold and Ayodeji, 2016).

Nevertheless, the construction industry in South Africa has not been able to avoid challenges faced by other developing countries in terms of delivering projects at the stipulated time and within the allocated budgets (Mukuka *et al*, 2014). The complex nature of the construction industry in South Africa necessitates immense capital outlays and tight money; thereby, inducing the challenge of sustaining programmed time and budgeted cost (Adugna, 2015). Conversely, construction projects continually experience cost overruns and time delays; thereby, negatively affecting the economic and political aspects within South Africa (Smallwood and Shakantu, 2011).

The National Development Plan (NDP, 2012) highlights construction as one of the key areas earmarked with potential for growth in South Africa. Brown (2015) noted that the expected growth should be an incentive for building contractors to assess the effectiveness of their management and control methods in order to prompt necessary changes. South African construction projects are complex and need to be undertaken within the limitations of time, budget and quality constraints (Brown, 2015). As such, effective project management, control and monitoring are considered important to the success of projects (Nkiwane *et al*, 2016).

However, Shunmugam and Rwelamila (2014) found that poor management, control and progress monitoring and reporting have increased the occurrence of poor project outcomes within the construction industry in South Africa. Arguably, building contractors have continuously approached projects of differing complexities ill-equipped, leading to project failure as projects continue to experience negative outcomes of time delays, cost overruns and poor-quality outcomes (Chihuri and Pretorius, 2010). The increased frequency of projects failing within the construction industry in South Africa has prompted criticism

aimed at building contractor's incapability to deliver projects as required (Adugna, 2015). It is therefore important to establish the reasons behind the poor management, control and monitoring of projects within the construction industry in South Africa.

Gabula (2012) outlined the importance of adopting and implementing effective project management towards the successful undertaking and completion of projects. Similarly, Nkiwane *et al* (2016) noted the significance of effectively controlling and monitoring projects to attain set goals and objectives on projects. However, Pinfold and Ayodeji (2016) pointed out that current construction project management practices and methods are becoming ineffective in tackling projects with increasing complexities. The authors further noted that construction companies in South Africa have shown a reluctance to adopting and implementing new practices and methods to improve project outcomes. Further research is needed to establish reasons why current methods and best practices of project management and control, including progress monitoring and reporting, are becoming ineffective on current projects.

Existing research shows the introduction of technologies that can be considered incentives for change, but building contractors have not shown the willingness to deviate from traditional ways of managing projects (Venkatachalam, 2014). The unwillingness to change in order to improve outcomes has affected contractor and client relationships over time.

There are methods, tools and techniques of project management and control that have already been introduced to the South African construction industry (Burger, 2013). Construction companies have adopted and implemented some of the methods, tools and techniques. Conversely, building contractors within the South African construction industry still fail to meet project management objectives of time, cost and quality (Chihuri and Pretorius, 2010).

The following table shows some of the different methods, tools and techniques that are currently utilized by building contractors within the South African construction industry to manage, monitor, control and report on projects (Howes, 2009; Burger, 2013).

Table 2. 7 Available Progress Monitoring and Reporting Tools

Methods	Description	Advantages	Disadvantages
Bar Charts/Gantt Charts	Most common and most used technique used by building contractors	- Simple format - Easy to understand - Well-known and visual	- Not suitable to predict or accommodate uncertainty - Does not accommodate the critical path or float for activities - Not suitable for complex projects
Line of balance programmes	Indicates the number of units versus time and then shows balancing of resources/trades	- Shows trades + sequence of work - Indicates number of teams required for activities + lead times - Organises repetitive work - Very visual + easy to control + indicates unproductive sequences	- Activities are summarised - Lacks the necessary details
Networks: PERT/CPM Planning	An automated system that integrates	- Shows activity relationships and dependencies - Indicates the critical path	- Very complex to use - Utilises a large amount of data to prepare

Methods	Description	Advantages	Disadvantages
	construction information shared by different stakeholders	- Outlines different probabilities to achieve the end result - Able to handle and effect variation orders - Accommodates a large number of activities	- Not very user friendly - Expensive and time-consuming to update
Microsoft Project	Used by building contractors to logically plan the construction process + it provides a logical process of events from inception to completion of project for project managers	- Breaks down large projects into smaller activities – making it easier to plan durations + assign resources + link similar activities - Accurately determines start + completion dates - Easier to prepare work breakdown structure - Outlines critical processes - Estimated cost of projects + cash flow can be determined - Performance of projects can be accurately measured.	- Requires user to input data + operate software in order to obtain desired results - Requires specific human knowledge to operate - Time consuming to maintain and keep up to date.

Methods	Description	Advantages	Disadvantages
		- Identifies + remedies possible delays	
Microsoft Excel	Also considered an important application used by building contractors to capture + calculate project information	- Useful for calculating project budgets - Can be used for preparations of monthly interim certificates + estimates + preparations of BOQ's - Trends + predictions can be applied to determine a project's actual performance	- Requires human input to operate - Time consuming to update
Candy Build Smart	Construction accounting system that integrates costing + project accounting to effect construction management	- Manages all sources of project cost such as material procurement + labour + subcontractors + plant overheads - Allows for estimating + critical path planning + forecasting + cash flow modelling + reconciliation	- Requires human resources that are proficient in it, otherwise difficult to use - Relatively expensive
Construction Computer Software	A modern software suite focused on	- Links money and time through the interactive link between BOQ +	- Requires human input to perform accordingly

Methods	Description	Advantages	Disadvantages
(CCS) Cost Modelling + Project Control	project control for building contractors. Includes taking off + pricing and planning projects + controlling at the construction phase through to final account stage	construction programme/schedule of work to provide accurate information for building contractors - Standardises the estimating process for building contractors - Provides continuity between estimating + post tender commercial control - Easily integrates the BOQ and the programme where items on the BOQ can be allocated to items on the programme to produce a budget forecast - Integrates quantity take-offs with estimates and valuations - Adjudicates subcontract appointments	- Expensive

Methods	Description	Advantages	Disadvantages
Primavera	Handles large scale projects of different complexities	Aids with the following: - To balance resource capacity - Plan + schedule and aids in controlling complex projects - Allocate the best resources - Monitor and visualise project performance versus planned - Conduct what-if analysis and analyse alternative project plans	- Requires experienced input - Very expensive to implement - Complex

The preceding Table 2.7 lists methods that possess the capability to assist with effective project management and control, including progress monitoring and reporting. However, the availability of these tools does not mean that all building contractors within the construction industry in South Africa have adopted and implemented them (Nkiwane, 2016). Therefore, it is important to ascertain reasons why building contractors are reluctant to the presented change. Similarly, the accuracy of progress reporting needs to be corroborated to understand how it relates to poor project outcomes of delays, cost overruns and poor-quality results in the South African context.

2.6. Summary to review of relevant literature.

The construction industry plays an important role in the national economy and economic development of any country (Akinyede, 2014). As such, the importance of the construction industry has induced its growth and contribution to economic development (Windapo and Catell, 2013). In turn, the growth of the construction industry has led to the increased complexities of construction projects along with the general expectations and requirements from clients and other project stakeholders (Behnam *et al*, 2016). Similarly, building contractors and other professionals directly linked to the construction process are expected to adapt and grow with the changes effected within the construction industry (Davis, 2014).

Existing literature (Munns and Bjeirmi, 1992; Nzekwe *et al*, 2015; Nguyen and Chileshe, 2015) identified the adoption and implementation of effective construction project management to manage, control and monitor projects of varying complexities to ensure that the objectives of time, cost and quality are always achieved. However, building contractors and other construction professionals have been slow to adopt and implement newer methods, tools and techniques of managing projects. Consequently, the construction industries of most countries continue to experience time delays, cost overruns and poor-quality outcomes.

Literature (Yup *et al*, 2017; Eriksson *et al*, 2017; Omar and Nehdi, 2016; Yang *et al*, 2016) also recognised the implementation of accurate and efficient progress reporting to ensure that valid acts of management, monitoring and control are coerced to achieve project

success. As such, building contractors are expected to report on the actual progress of projects to provide the opportunity to remedy any possible risks that could negatively impact project success. However, progress reporting is currently not accurate, valid or reliable because of the poor uptake of methods and systems that can manage the levels of complexities currently experienced on undertaken projects, and this has prompted the eminent outcomes of time delays, cost overruns and poor-quality outcomes.

The economies of developing and developed countries are impacted differently by the negative outcomes of time and cost overruns. Existing literature (Baloyi and Bekker, 2011; Mthethwa, 2018) has shown that developed countries have been able to monitor and control the impact of time and cost overruns by adopting and implementing methods that effectively manage and control project progress. Developing economies such as South Africa, have however, not been able to control or prevent the negative impacts of time delays, cost overruns and poor-quality outcomes because of the reluctance to adopt new methods and systems that can withstand the increasing levels of project complexities that are experienced in the construction industry. Accordingly, literature outlines that although management and control exist in the South African construction industry, the objectives of time, cost and quality are still not achieved. Building contractors have not been able to grow with the construction industry and adapt to the changes that have been introduced.

There are already some methods, tools and techniques that have been introduced to the South African construction industry to aid in the management and control of construction projects. However, the methods have either not been adopted or implemented, or have been overly used and have over time become ineffective and inefficient to the productive undertaking of projects. Building contractors have not maintained the consistency of preparing and producing accurate progress reports in order to increase the effectiveness of project management and control. As such, progress reporting is often not efficient, valid or reliable and this negates how effectively projects can be managed and controlled to achieve the desired results.

Therefore, it is important to establish the extent of poor progress monitoring and reporting as they occur in projects and how these factors negatively affect the efficiency of management and control and consequently lead to negative project outcomes. Similarly, it is also important to ascertain the remedying methods, tools and techniques for the impact

of poor progress monitoring and reporting, and consequently poor management and control. By understanding why, the aforementioned deficiencies occur, remedies for negative project outcomes of delays, cost overruns and poor-quality outcomes can be ascertained.

The following chapter describes the research methodology used to investigate the reasons for the different objectives of this study.

CHAPTER 3

3. RESEARCH DESIGN AND METHODOLOGY

The objective of this chapter is to describe the approach followed to gather the data to test and conclude on the research problem presented in this research report. This chapter begins by examining the choice of research design for this research report, followed by the research methodology.

3.1. RESEARCH DESIGN

The following aspects of the selected research design will be outlined in this chapter:

- The related research philosophy
- The attributable research strategy and methodology
- The chosen research instrument and sampling techniques relevant to this research.

Research design is described by Vaus (2001) as a strategy chosen to integrate the different components of a study in an articulate and logical way, to aid in effectively addressing the research problem; by collecting, measuring and analysing data. Saunders, Lewis and Thornhill (2012) simplified the definition of research design, by calling it a more generalized plan of how the research question will be answered. The research design outlines the research objectives gathered from the research question and considers factors such as the sources of data, how data will be collected and how the collected data will be analysed (….).

The purpose of this research was to determine the nature and effectiveness of the current project progress monitoring and reporting systems currently implemented in construction projects in South Africa. In achieving the aforementioned purpose, an exploratory research design was followed as it provided clarity on how to best proceed with solving the research problem:

> *There is an inadequacy in the adoption of modern progress monitoring and reporting systems during the construction phase, by building construction companies; causing time and cost overruns and poor quality of work.*

3.1.1. Research Philosophy

Research philosophies are considered to be a certainty about the manner with which data relating to a chosen phenomenon should be gathered and analysed (Saunders *et al*, 2012).

The philosophy followed in this research is the pragmatist philosophy, which is concerned with utilizing methods that appear best suited for the research problem (Giacobbi Jr, Poczwardoski and Hager, 2015). According to Goldkuhl (2012), the pragmatist philosophy relates to action and change and the relationship between knowledge and action. Similarly, the pragmatist philosophy contains the flexibility that allows for any research method, technique or procedure associated with either qualitative or quantitative research (Alzheimer and Europe, 2009). The investigation conducted followed the pragmatist philosophy following the principles highlighted by Harvey (2012):

- That knowledge, concepts and values are treated as true if these will bring change to the targeted area of research,
- That pragmatism is mainly empirical and inductive as the facts about a research phenomenon are taken from reality based on people's interest and purpose, and
- That pragmatists believe that the truth in research is modified as discoveries are made and this is relative to the time and place where the research is being conducted.

Therefore, the selection of the pragmatism philosophy for this research follows the following rationale:

The pragmatism philosophy, unlike the positivism and interpretivism philosophies, takes into consideration the reality of a situation, which is ever-changing at different points in time. Pragmatism does away with the impression of freedom to interpret experience in whichever way deemed fit, but instead encourages the linkage between real actions and real outcomes. This is the basis of this research, to recognize the reality and existence of project failure through negative factors such as time delays, cost overruns and poor project quality outcomes, and to acknowledge the impact of poor monitoring and reporting on project progress as major factors that lead to projects failing (Saunders *et al*, 2012; Giacobbi Jr *et al,* 2015).

3.1.2. Research Approach

Based on the perception that the pragmatist philosophy is both empirical and inductive, the research adopted a primary inductive approach (Saunders *et al*, 2012). This is because the

research aimed to find out how poor progress reporting systems related to the negative outcomes of delays, cost overruns and poor-quality results in the South African context.

The inductive research approach is concerned with the generation of new theories emerging from the data collected (Saunders *et al*, 2012). Goddard and Melville (2004) noted that the inductive research approach starts with observation and then theories are formulated towards the end of the research as a result of the observations. Bernard (2011) further advances that the inductive approach is based on learning from experience, where patterns, resemblances and regularities in experience are observed in order to reach the desired conclusions or to generate new theory for the underlying research being undertaken. The analogy is depicted in the following Figure 3.1:



Figure 3. 1 Inductive research format (Adapted from Saunders *et al*, 2012)

The inductive research approach is also referred to as grounded theory, which, according to Hussein, Hirst and Osuji (2014), is characterized by its structured guidelines and is considered a good fit for the pragmatic philosophical approach to research. Grounded theory is the end product of the inductive research process and it provides an explanatory framework to be used to understand the phenomenon under investigation (Saunders *et al*, 2012). Data was gathered and analysed from different building contractors and other construction stakeholders operating in and around Johannesburg to aid in identifying the current occurrence of inadequate project monitoring and progress reporting systems in construction projects within South Africa.

3.1.3. Research Methods

This research aimed to determine the nature and effectiveness of the current project progress monitoring and reporting systems currently implemented in construction projects in South Africa. In achieving the aforementioned aim, the research followed a mixed methods approach, specifically the sequential exploratory research strategy, where both the qualitative and quantitative research methods were used in sequence as depicted in Figure 3.2. The methods complemented each other in supporting the interpretations and conclusions.

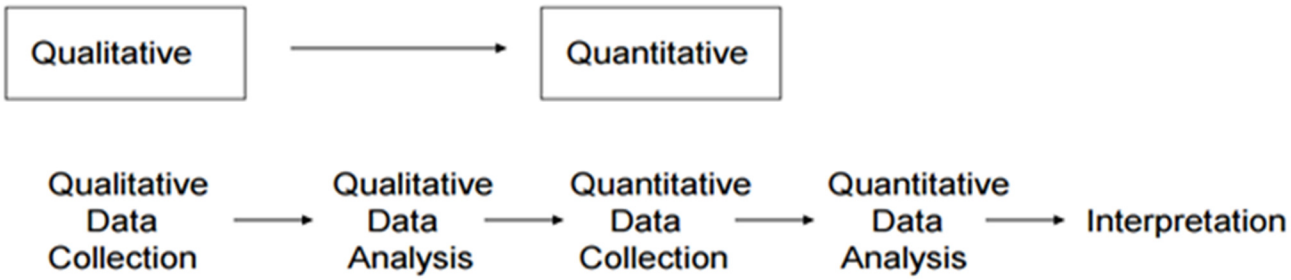


Figure 3. 2 Sequential exploratory strategy (Saunders *et al*, 2012)

3.1.3.1. Qualitative Research

Generally, qualitative research is about recording, analysing and attempting to uncover the deeper meaning and significance of human behaviour and experience, including contradictory beliefs, behaviours and emotions (Saunders *et al*, 2012). With that in mind, the research was aimed at gaining a deeper understanding of why the methods currently implemented to monitor and report on construction project progress are not effective and hinder the successful delivery of projects. This research examined the methods, tools and techniques implemented by building contractors to understand the poor performance patterns that have plagued construction companies in developing countries, particularly South Africa. This was extrapolated from first-hand experience, truthful reporting and quotations from actual conversations with building contractors and other construction professionals working within the construction industry. Therefore, in achieving this, semi-structured interviews were conducted with different construction stakeholders working in the construction industry in South Africa.

3.1.3.2. Quantitative Research

The quantitative research method is generally used to explore factors including "how much, how many, how often and to what extent?" and is regarded as a scientific way to get to the truth about a topic, to understand it to the extent that the research problem can be controlled through identifying the cause and effect relationships (Khothari, 2004). In this instance, the quantitative research method was used as a complementary method to quantify and generalize the results from the qualitative research. The quantitative method also measured the incidence of the various views and opinions of the selected sample of building contractors. The results were depicted in the form of tabulations as the findings from a quantitative method of data collection are considered conclusive in nature and are used to recommend a final course of action (Saunders *et al*, 2012). Therefore, a structured questionnaire survey method was applied to gather the data required for this investigation. In gathering the data required, the following research strategies were applied:

Review of existing literature

Existing information that was researched by other practitioners from other developing economies and relates to how effectively construction projects are monitored and how the progress on construction projects can be efficiently reported on, was analysed. The result was compared with findings from the investigation on the South African context

The selected research methods and techniques fall in line with those selected by other research practitioners who conducted research on topics that are either directly or indirectly related to the research problem stated above. The following Table 3.1 outlines some of the papers that were used:

Table 3. 1 Summary of key literature analysed, with corresponding methodologies

Topic	Author	Research Methods
Impact of pre-construction planning and project characteristics on performance in the US electrical construction industry	Meches, Hanna, Nordheim and Russell (2008)	Mixed Methods – consisting of both quantitative (questionnaire survey) and qualitative (Interviews)
Critical Planning processes in construction projects	Zwikael (2009)	Mixed design – qualitative questionnaire, followed by quantitative analysis
Cost and time control of construction projects: inhibiting factors and mitigating measures in practice	Olawale and Sun (2010)	Mixed methods – Quantitative analysis using questionnaires and qualitative analysis using semi-structured interviews
Progress monitoring of construction projects: inhibiting factors and mitigating measures in practice	Elazouri and Salem (2011)	Quantitative data analysis - Questionnaire survey
Revisiting the construction project failure factors in Vietnam	Nguyen and Chileshe (2014)	Mixed design – Including literature review, pilot interviews, questionnaire survey and statistical analysis
Understanding delays in the housing construction: evidence from Northern Ireland	McCord, Davis, Haran and Rodgers (2015)	Quantitative – Questionnaire survey
The impact of field data capturing technologies on automated construction project progress monitoring	Alizadehsalehi and Yitmen (2016)	Quantitative – Questionnaire survey
Evaluating barriers to effective implementation of project monitoring and evaluation in the Ghanaian construction industry	Tengan and Aigbavboa (2016)	Quantitative – Questionnaire survey

Semi Structured Interviews

Building contractors from different construction companies were interviewed in a fairly open framework which allowed for a focused, conversational two-way communication. The questions relating to the interview were prepared as a follow-up from the structured questionnaire that was sent out to the different construction participants and focused on the construction issues already studied, but requiring further clarity. This was beneficial because it yielded a higher response rate and allowed for the opportunity to clarify any ambiguous issues.

Structured Questionnaires

A sequence of questions that were not covered in the semi-structured interview aspect were issued to the selected sample of building contracting companies. Even though the research specifically focussed on building contractors, the questionnaires also engaged consultants and other construction stakeholders such as consultants, clients and subcontractors who are considered to add valuable input, opinions, ideas and experience to the stated research problem.

3.2. RESEARCH STRATEGY

Saunders *et al* (2012), define a research strategy as "a plan of how the researcher will go about answering his or her research question. It is the methodological link between your philosophy and subsequent choice of methods to collect and analyse data."

Since this research opted to utilize both the qualitative and quantitative research methods, a survey was conducted through the utilization of self-administered questionnaires. The questionnaire was guided by the following important considerations:

- Who the targeted audience (respondents) were;
- How the targeted audience (respondents) were identified;
- How the questionnaire survey was sent out and delivered to the different respondents
- What the expected responses to the questionnaire were, to meet research objectives

In addition to the questionnaire survey, structured interviews were conducted with the same respondents to elaborate further on the opinions, feedback and experiences provided on the survey questionnaire

3.2.1. Survey method followed

Understanding the targeted respondents was key in determining the level of intensity of the questions that were included in the questionnaire. This research targeted respondents working within the construction industry in South Africa, particularly people that are directly involved in construction projects, including building contractors (foremen, contracts managers, contractor quantity surveyors, senior management, etc.) and consultants such as project managers, architects, engineers, professional quantity surveyors and even clients. Factors of the level of education and construction experience were also considered when the questionnaire was being designed.

The questionnaire was hand-delivered to most of the respondents to grant them the opportunity to clarify any queries they may have had with the contents of the questionnaire. As such, the questions posed were explained in depth to the respondents to make it easier to answer as understandably as possible. An example of the questionnaire can be seen in Appendix C and it can be seen from the questionnaire that the anonymity of the respondents was also a valid consideration as this meant that more respondents were willing to take part in the survey knowing that anonymity is guaranteed. Fortunately, the nature of this research did not require respondents to identify themselves further than their occupation and the level of experience they have in the construction industry.

Determining what type of questions to ask was also contemplated in order to meet the objectives of this research. The most important information received from the questionnaires was feedback on the level of progress reporting currently occurring within building construction companies in South Africa.

All the aforementioned explanations called for the questions on the questionnaire to be plainly-worded, concise and unequivocal. As a result, the questionnaire, as presented in Appendix C, was broken down into:

- **Open and closed questions** – to cover construction project delay causes

- **Single and multiple response questions** – to cover construction project cost overruns on current projects; and
- **Rated responses** – to cover factors causing inadequate progress reporting

3.2.1.1 The questionnaire consisted of four sections:

- **Section A** – Which was based on the checklist method, consisted of five questions. The checklist method used in this section was to determine the respondents' profession, which area of construction the respondents work in, years of experience in the construction industry, types of projects and the number of projects worked on.
- **Section B** – Which was based on the open and closed questions, focused on the factors influencing the successful completion of projects. Six categories were presented, along with an array of closed questions, which allowed respondents to weigh their options with regards to time delays and budget constraints within construction projects.
- **Section C** – Which was based on the checklist method, consisted of two questions. The checklist method was used in this section to determine whether the respondents utilize the construction programme in their respective companies, why they use the construction programme and whether this has led to the success of their projects.
- **Section D** – Which was a combination of the checklist method as well as the Likert Scale; consisted of four questions. The first three questions were based on the checklist method and were used to determine respondent awareness of progress reporting, whether their respective companies report on project progress, how often this is done and whether the current methods implemented are considered effective. The last question in this section was based on the Likert Scale and provided three categories, which falls within the proposed range of categories when using the Likert Scale, as it involves a minimum of two categories and a maximum of eight or nine (Burger, 2013).

The questionnaires sent out were supplemented with an approved covering letter that had the university letterhead, as attached in Appendix C. The covering letter explained that the

aim of the research is to determine the effectiveness of the current project progress monitoring and reporting methods and their linkage with the negative outcomes of time delays, cost overruns and poor-quality results in the South African construction industry. The letter further stated who was undertaking the research and that it formed part of an MSc study. The letter further confirmed that the information obtained from the respondents would be considered to be highly confidential and that anonymity would be guaranteed.

3.2.1.2 Number of respondents

Due to the impression that questionnaires have a low response rate, 144 questionnaires were sent out to building contractors, architects, engineers, quantity surveyors and other designers, and only 80 usable responses were received back. Concern for possible drawbacks and misinterpretations different research instruments were used for this research. The advantage for this is that the shortfalls of the questionnaire were supplemented by the interviews set up and conducted concurrently.

3.2.2. Interviews

Fifteen interviews were conducted as a way to control the other results received from the questionnaires. The interviews were a follow-up to the questionnaires that were sent out beforehand. This was a way to allow the researcher an opportunity to clarify the responses on the questionnaires to decrease the probability of misinterpretation of the responses from the questionnaire. The fifteen interviews were conducted with highly positioned professionals such as contracts directors, senior quantity surveyors, senior contracts managers, project managers, architects, engineers, etc., that all have many years of experience within the construction industry. According to Saunders *et al* (2012), interviews can be conducted face-to-face or by using other mediums such as telephones. This research made use of both the telephone as well as face-to-face mediums. A total of nine interviews were conducted face-to-face, with the other six conducted telephonically. Burger (2013), outlined the probable guidelines that need to be considered when conducting interviews:

- The interview questions need to be identified beforehand
- The respondents' cultural backgrounds are considered before interviews are set up as this assist with anticipating their probable responses
- Cultural beliefs may influence the interviews and possible outcomes.

All of the aforementioned guidelines were considered when respondents were selected and approached to take part in the interview process.

3.2.2.1 Pre-testing

After the questionnaire was completed, the survey was pre-tested with a group of building contractors consisting of foremen, contracts managers and contracts directors. The questionnaire was purposively created so that the selected respondents would understand since this is in line with what they do on construction projects. Respondents such as foremen and contract managers were specifically selected for pre-testing to gauge the level of simplicity of the questionnaire survey. This is because foremen have a general understanding of the occurrences on the projects they are appointed on and this can be seen through their understanding of drawings, design details, etc. Therefore, the intensity of the difficulty of the questionnaire would be seen in the ability for the foremen the questions posed.

The selected individuals tested the questionnaire survey and reported back noting that the survey scale and instructions were easily understood, that the questions and statements were well-defined and unequivocal. They did, however, note that the survey was too long and time consuming, which made it laborious to get through. An alteration was made to the questionnaire that was presented as a test taking into consideration the notes made by the test group. After this, the survey was re-sent to the same test group consisting of foremen, contracts managers and contracts directors to check whether the alterations made to the questionnaire made it simpler. The test group reported back noting that the survey was short and precise which made it easier to get through. After this feedback, the survey was sent out and delivered to the various respondents that were selected as samples for the research.

Once the questionnaire was sent out and responses received, interviews were set up with the survey respondents to clarify questions that were not answered with the detail required to meet the research objectives set out.

3.3. DATA SOURCES

As mentioned in the previous section, to properly address the research question posed in this research report, a combination of both primary and secondary data was needed.

The primary data sources for this research were responses from both the self-administered questionnaire survey and the structured interviews. With respect to the research question, particularly the efficiency and accuracy of currently implemented progress monitoring and reporting systems, the interview questions referred to the accuracy and efficiency of systems currently implemented in building construction companies, as can be seen in Appendix B. Likewise, the questionnaire survey also included sections that relate to rating the accuracy and efficiency of currently implemented progress monitoring and reporting systems where the different respondents are working, as can be seen in Appendix C.

The secondary data aspect included the following sources:

- **Public Records** – that was made available by the companies and included records of company information and the listed projects that were being constructed at the time and those that had already been completed. This was to establish a trend between the managing of completed projects against those that were still undergoing. These records included cost reports for new and completed projects, construction programmes for new and completed projects, etc.
- **Minutes of project meetings and emails** – these were used as a guide to establish the frequency of progress reporting on the projects being constructed.

The information gathered from the above was generalized to suit the current occurrences on construction projects with the South African construction industry.

3.4. POPULATION AND SAMPLING

According to Saunders *et al* (2012), the use of questionnaires and interviews would require the researcher to collect a sample. They go on to state that using sampling creates an even bigger opportunity for overall accuracy of results from analysis. Mugo (2002), defines a sample as "a set of respondents (people) selected from a larger population for the purpose of a survey." Whereas sampling refers to a process of choosing people, organizations, etc., from a chosen population so that by studying a sample, the results from the survey can be simplified back to the initial population it was taken from (Williams, 2008). Due to the fact that most of the survey questionnaires were hand delivered to the chosen sample population (respondents), it made it easier to control which respondents would respond to the survey. However, for the most part, where the questionnaire was mailed to the selected

respondents, there was very little control over which of the respondents would respond to the questionnaire survey.

3.4.1. Population

The population chosen for this research consists of a wide range of professionals working for companies of various sizes, so as to provide the much-needed variety of knowledge and experience for data collection and analysis. The population was selected from building contracting companies operating within the greater Johannesburg area of Gauteng Province, in South Africa. In selecting the sample, the following factors were considered about building contractors:

- That they have the relevant experience and knowledge about the complexities that arise from projects of different sizes;
- They have a better understanding of the causes of project failure and how to best mitigate these;
- Would be able to provide more detail behind the accuracy of progress reporting and its effectiveness on current projects;
- Would be able to provide insight on the current intensities of progress monitoring and reporting and their effectiveness on the success of projects; and
- Would be able to provide clarity on the impact of negative outcomes of delays, cost overruns and poor-quality outcomes.

3.4.2. Sampling

Therefore, sample populations included contracts directors, construction managers, quantity surveyors, foremen and site agents. Consultants such project managers, architects, engineers, interior designers and clients that also form part of the larger scale of construction consultants were also approached. The consultants were approached to provide the research with the following input:

- Provide more insight on their roles and how these change as the complexities of projects change;
- Provide opinions on the reasons behind project failure and how this outcome can be improved on current projects;

- Confirm the level of accuracy of building contractor progress reporting and how this can be improved to suit project and client requirements; and
- On how to best mitigate project delays, cost overruns and poor delivery of quality on current projects and future projects to be constructed.

Similarly, the sample population selection was restricted to selecting respondents based on the level of experience and what position they hold in the companies they worked for. The research considered construction stakeholders that have had direct exposure to progress monitoring and reporting as they occur in construction projects. Similarly, respondents that have experienced the impacts of delays, cost overruns and poor-quality outcomes were also considered. This assisted in diversifying the level of data collected from different opinions within the construction industry.

3.4.3. Sampling Technique

For the purposes of this research report, a non-probability sampling technique was selected. Non-probability or non-random sampling is a group of sampling techniques that help researchers to select units from a population that they are interested in studying (Laerd Dissertation). Non-probability sampling or purposive sampling is especially useful in mixed method research as it aids in identifying and choosing information-rich cases for the most effective use of limited resources (Palinkas *et al*, 2016). Methods of non-probability or non-random sampling according to Saunders, Lewis and Thornhill (2012), include:

- Volunteer or snowball sampling – Is mainly used when it is difficult to identify members of a population, so people usually volunteer instead of being chosen;
- Quota sampling – is based on the expectation that the selected sample will represent the whole population as the variability in the sample for various quota variables is the same as that of the population;
- Purposive sampling – involves the selection of a group from the population based on the availability of information; and
- Maximum variation sampling – involves the recording of diverse variations that have surfaced from adapting to different conditions.

This research considered the maximum variation sampling strategy as it poses the following advantages:

- It involves identifying individuals or groups of individuals that are especially knowledgeable of experienced with the research study of interest.
- It endeavours to maximise the efficiency and validity of the research study through its consistency with the aims and objectives inherent in the use of the mixed method option selected for the research study.
- It can be used to identify and expand the range of differences and to describe the variability of values for different objectives set out on the research study

The sampling population for this research was carefully selected with the aim of it being representative of the South African construction industry. The representation was determined by the selection of a sample population that possess different aspects of construction knowledge and experience. The data was collected from individuals who have worked in the construction industry for a period longer than 5 years, as well as from those that have limited construction experience and have not experienced the varying levels of project complexities. Similarly, the sampling technique considered individuals that work for building contracting companies and are directly linked to the construction process; as well as individuals who are indirectly linked to the construction process such as consultants. The sample population was selected in the aforementioned manner to provide a basis for the different extremes that exist in order to ascertain the validity and reliability of the samples and sampling technique.

3.5. APPROACH TO DATA ANALYSIS

QUESTIONNAIRE SURVEY ANALYSIS

According to Saunders *et al* (2012), quantitative research is mainly associated with deductive reasoning, whereas qualitative research is affiliated with inductive reasoning. Therefore, for the purposes of this research, both forms of reasoning were identified and used to analyse data. Quantitative data was analysed through the use of numbers and because of this, the Likert 5-point scale was utilized to generate the numerical data requirements for this research. According to Dane (2008), the Likert Scale is a psychometric response scale used in questionnaires to gain respondent preference or degree of agreement with the research statement or statements. The data was analysed and

interpreted through the use of descriptive statistics and the results of the analyses are interpreted taking into consideration the research problem and question.

Descriptive statistics

According to the Web Centre for Social Research Methods, descriptive statistics are used to determine the basic features of data in a research report. They provide simple summaries about the chosen sample. Descriptive statistics are broken down into three characteristics that measure a single variable, in this case a single sub-group and these include:

- Frequency distribution;
- The central tendency; and
- The dispersion

Frequency distribution – this is used to express how many times observations of a particular variable can be expressed. This form of distribution can either be depicted in percentage tabular form or in graphic form (in the form of a bar chart or a histogram) (Web Centre for Social Research Methods). For the purposes of this research and the selected sample, the respondents' level of experience subgroup can be distributed into the lower to the highest number of years in construction, accompanied by the number of projects worked on.

Central Tendency – This is an estimate of the "centre" of a distribution of values. The central tendency is best described using the Mean, Median and Mode, with the mean occurring as the most used methods of describing central tendency (Jacobs, 2010). For the purposes of this research report, reference was made to the mean scores of project control and progress reporting. The use of the mean for this research helped to answer questions such as:

- Are construction projects currently being monitored effectively?
- Is the current level of progress reporting effective?
- What is the relationship between construction experience and knowledge, and the accuracy and efficiency of progress monitoring?

Dispersion – This refers to the spread of values around the central tendency and is usually depicted by the range and the standard deviation, with the standard deviation being the most widely used method of dispersion.

INTERVIEW DATA ANALYSIS

The analysis of qualitative data on the other hand, is not considered to be as cumbersome as that of quantitative data. Due to the consideration that, qualitative data is mostly inductive, it is analysed through qualitative content analysis for this research. Qualitative content analysis is defined as an analysis that considers both visual and verbal forms of data that is leaning towards reviewing the information contents of the data collected (Sandelwoski, 2000). Saunders *et al* (2012), edged around what they deem a generic approach to analysing qualitative data and this is what the analysis will follow:

- Categorising or coding data in order to comprehend and understand the data;
- Attaining data from contrasting sources to appropriate categories (codes) to integrate data collected;
- Developing analytical categories further to identify relationships and patterns
- Developing testable propositions; and
- Drawing and verifying conclusions.

As such, in achieving the aforementioned analysis, a computer software, ATLAS.ti 8, was used as it offers a selection of tools for completing the tasks associated with any systematic approach to unstructured data or data that cannot be implicitly analysed by formal statistical methods (Ngalande and Nkwinda, 2013). ATLAS.ti 8 helps to manage, extract, compare and explore the data from interviews which has meaning for the analysis. Similarly, the software also assists in building networks and relationships resulting in creating graphical views for the data (Foreman and Fritz, 2008).

3.6. Ethical Considerations

The ethical considerations for this research fell under four main categories and these included – informed consent, avoiding harm to participants, confidentiality and non-biased findings. This research is not for material gain and was conducted in an ethical manner,

while taking care to adhere to all elements of ethics as noted above. Informed consent was requested from all respondents beforehand, as can be seen from the Ethics Clearance Certificate in Appendix A. No harm was inflicted on the respondents and the respondents were treated with respect during all contact, whether face-to-face, on email or during telephone conversations. There were possible vulnerabilities, such as a language barrier, however, to avoid the impact, some questionnaires were hand-delivered to the respondents and the contents of the questionnaires thoroughly explained to the respondents. Appreciation for their participation was expressed to all respondents as their feedback and opinions was valuable to the research findings. None of the respondents were forced or coerced to take part in this research but instead, all respondents were granted the opportunity to decide whether they wanted to take part in the research or not. There was no bias in the data analysis instead, all the data was analysed sincerely and honestly and none of the respondents' names have been mentioned or included in the research.

CHAPTER 4

4. ANALYSIS OF DATA

The reason for this chapter is to examine the questionnaire survey and interview answers received and to present the results from the analysis conducted from these responses. In choosing the data analysis methods to be employed, due consideration was made for the research objectives outlined in chapter 1 of this research report. Another important consideration was to select analysis methods that would enable the fulfilment of the research question posed in chapter 1.

In analysing the data received from the questionnaire survey, the research study made use of the Likert Scale. This is because the Likert Scale assumes that the intensity of experience is linear, i.e. on a continuum from strongly agree to strongly disagree and carries the assumption that attitudes can be measured (McLeod, 2008). Respondents were asked to indicate their level of agreement with a given instalment by way of an ordinal scale (Dane, 2008).

4.1. GENERAL CHARACTERISTICS OF RESPONDENTS

4.1.1. General Characteristics of Respondents from questionnaire survey

The subsequent **Table 4.1** indicates the different professions of the respondents that took part in the survey. The numbers of respondents for each profession were purposely selected based on the anticipated levels of exposure to progress monitoring and reporting that each profession would have in construction projects. Similarly, the numbers of respondents for each profession were knowingly selected to diversify the knowledge being presented under each profession regarding the presented research problem and question. The overall selection of respondents was to validate the reliability of responses received.

Table 4. 1 General characteristics of respondent selection

General Characteristics of respondents	Respondents	No. of Responses
Building Contractors	Construction Managers/Directors	4
Consultants	Architects	2
	Quantity Surveyors	2
	Engineers	3
	Project Managers	4
Total		15

The selection of respondents is also expressed in **Table 4.2** below, which shows categories of the number of years the respondents fell under. The respondents were intentionally selected based on the number of years of experience in the construction industry.

Table 4. 2 Respondent selection in experience

Construction Experience	
0 - 3 years	
3 - 5 years	28.75%
5 - 10 years	27.50%
10 - 15 years	15.00%
longer	28.75%

The selection of respondents is further expressed in the following **Table 4.3,** which outlines the different categories of the number of projects the respondents have worked on during their careers in construction. These are followed by frequency indicating the number of respondents that fell within a particular category.

Table 4. 3 Respondent experience in years

Projects Worked on	
1 - 2	
3 - 4	28.75%
5 - 10	42.50%
More	28.75%

4.1.2 General characteristics of respondents from interviews

There were 15 interviews conducted for the purposes of this research. The interviews consisted of highly positioned professionals such as Project Managers, Architects, Engineers, Construction Managers/Directors and quantity surveyors that all have a vast number of years in experience within the construction industry. Table 4.10 displays the 15 interviewees' background and answers questions on their level of experience in the construction industry, while Table 4.11 depicts the number of years of working in construction.

Table 4.4 General characteristics of interviewees

General Characteristics of respondents	Respondents	No. of Responses
Building Contractors	Construction Managers/Directors	4
	Quantity Surveyors	2
Consultants	Architects	2
	Engineers	3
	Project Managers	4
Total		**15**

Table 4. 5 Interviewee construction experience (years)

Construction Experience	
0 - 3 years	
3 - 5 years	
5 - 10 years	4.00
10 - 15 years	4.00
longer	7.00

4.2. RESULTS FROM ANALYSIS

The first objective of this study achieved through the questionnaire survey was to determine the current occurrence of inadequate project monitoring and progress reporting systems in construction projects within South Africa. As such, in exploring the stated objective, the responses from sections B, C and D of the questionnaire survey were considered and analysed. The results from the analysis are presented in Table 4.6, Figure 4.1 and 4.2 respectively.

Table 4.6 Occurrence of Progress Monitoring and Reporting

Respondent grouping	Respondents	No. of Respondents	Progress reporting		Frequency of reporting		Reporting method/system type	Adequacy of implemented reporting	
			YES	NO	Fortnightly	Monthly		YES	NO
Building Contrac	Contract Managers	15	100%	0%	100%	100%	Construction programme, Gantt Charts, PERT/CPM; CCS	47%	53%
	Foremen	12	100%	0%	100%	100%	Contractor reports	42%	58%
	Site Agents	8	100%	0%	100%	100%	Contractors reports and construction programmes	50%	50%
Consultants	Architects	7	100%	0%	0%	100%	project dashboards, AutoCAD, Revit	57%	43%
	Engineers	8	100%	0%	0%	100%	Microsoft project, Microsoft excel, Microsoft word, powerpoint, Revit	38%	63%
	Quantity Surveyors	20	100%	0%	65%	100%	WinQS, CCS, Microsoft Excel, QTO, BuildingSMART	100%	0%
	Project Managers	7	100%	0%	100%	100%	Construction programme, Gantt Charts, PERT/CPM; CCS	57%	43%
	Interior Designers	3	100%	0%	0%	100%		100%	0%

represents the results from analysing the existence of progress monitoring and reporting in construction companies, its frequency and adequacy thereof. Two respondent groups were created, building contractors and consultants, to depict how each group rate the level of progress monitoring and reporting as it occurs on their respective projects. Equal percentages of respondents agreed to the existence of progress reporting, as well as the frequency of when progress reports are generated. However, the lower percentages under "adequacy of implemented reporting methods" show that both respondent group types agreed to there being a certain level of inadequacy in the implemented systems/methods of progress monitoring and reporting. The data collected pertaining to the aforementioned objective was further analysed using ATLAS.ti through qualitative content analysis, as a means to further understand the themes that were developing. Through comparison with the findings from the literature review, the following themes were adopted from the word cloud presented in Figure 4.1: Project complexities, construction inexperience, poor planning and management, poor implementation of reporting tools, poor programme use, poor communication and flow of information thereof, and reluctance to implement new methods of reporting. The words from the word cloud were then placed under the codes to

provide a weighting determined by the level of occurrence of the words. This can be seen with words such as “complexities,” “experience,” “planning,” “programme” and “reporting.”



Figure 4.1 Atlas.ti 8 Word Cloud – Decoding Data

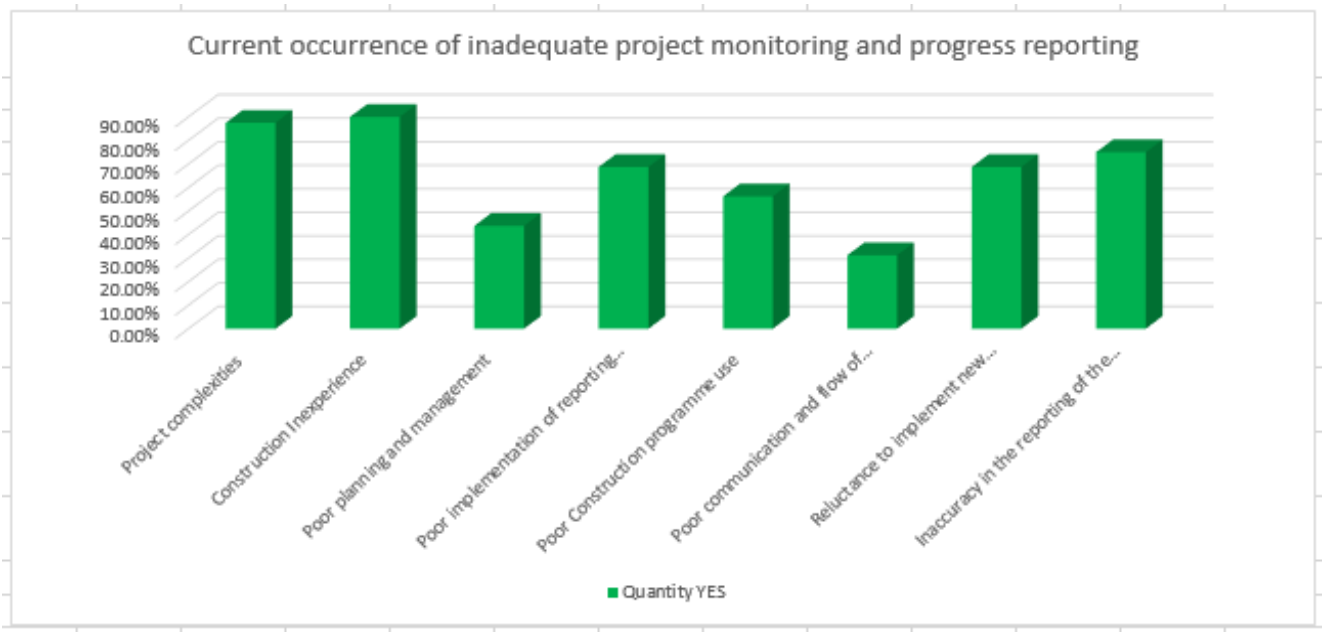


Figure 4.2 – Current Occurrence of Inadequate Project Monitoring and Progress Reporting

Figure 4.2 shows that project complexities and construction inexperience are the leading factors to the inadequacy of project monitoring and progress reporting, followed by the

poor implementation of reporting tools and poor construction programme use, among others.

The second objective of this study was to find out how poor progress reporting systems relate to the negative outcomes of delays, cost overruns and poor-quality results in the South African context. Therefore, for this objective, the data gathered from Section D of the questionnaire survey was analysed using the Likert Scale. Respondents were asked to rate the relationship between the themes created under the exploration of the first research objective for inadequate progress reporting, and negative outcomes using the 5-point Likert Scale ratings ranging from 1=Strongly Disagree (SD) to 5= Strongly Agree (SA).

To further ascertain the relative importance of the different factors of poor construction progress reporting that lead to negative outcomes, the Relative Importance Index (RII) was adopted. This is a type of relative importance analyses that aids in finding the contribution of a particular variable to the prediction of another variable, both by itself and in combination with other predictor variables (Baloyi and Bekker, 2011; Ejaz, Ali and Tahir, 2011; Muhwezi, Acai and Otim, 2014; Somiah, Poku and Aidoo, 2015). In essence, the RII is used to calculate the relative importance of independent variables, when those independent variables are correlated to each other. The questionnaire survey identified 11 factors of poor construction project progress reporting, related to the themes created under the analysis of the first research objective, that lead to negative outcomes of time delays, cost overruns and poor-quality outcomes. Consequently, the RII was used for this analysis as it best fits the purpose of this research and is depicted with the following formula:

Where:

$$\text{RII} = \frac{\sum W}{A * N}$$

W = is the sum of the weightings given to each statement by the respondents and ranges from 1-5 [Strongly Disagree (D) to Strongly Agree (SA)]

A = Highest weighting, in this case 5(Strongly Agree)

N = Total number of respondents (N=80)

As an example, for this analysis:

$$RII = \frac{W1 + W2 + W4 + W5}{A(5) \times N(80)}$$

The above formula was used to determine the RII calculated for the factors in **Tables 4.7, 4.8 and 4.9** respectively and ranges from ranges from **0.5 – 1.0** and not higher than this bracket.

The five-point scales earlier described were grouped together to show just "Agree" and "Disagree," i.e. [Strongly Disagree + Disagree (SD + D) and Agree + Strongly Agree (A + SA)], as seen in **Tables 4.7, 4.8 and 4.9.** The "Neutral (N)" responses were left out of the analysis as they neither represent the "Agree" or "Disagree" scales. Therefore, for each possible delay factor where respondents remained neutral, the total number of those neutral respondents was deducted from the total number of respondents (N=80). This was done to determine the actual relative importance of the particular factor of delay, without overstating the accuracy by using neutral responses.

The RII for each possible factor of delay in **Table 4.7** was calculated by multiplying the different weights (1 to 5) by the number of respondents that agreed with a particular weight for each possible factor of delay. This is then divided by multiplying the highest weight (A=5) by the total number of respondents that took part in the survey (N=80). The interpretation of the RII then presumes that the possible factors of delay are scored on the basis that the higher scores are consistent with increased risk and they are ranked as such (from the highest RII to the lowest). As an example of the calculation procedure explained above, the RII for the fifth possible factor of delays in **Table 4.7** is calculated below:

$$RII = \frac{(W1 \times \text{No. of Strongly Disagree}) + (W2 \times \text{No. of Disagree}) + (W4 \times \text{No. of Agreed}) + (W5 \times \text{No. of Strongly Agree})}{A(5) \times N(80)}$$

$$RII = \frac{(1 \times 0) + (2 \times 0) + (4 \times 52) + (5 \times 28)}{5 \times 80}$$

$$RII = 0.87$$

Table 4. 7 Construction project progress reporting vs Construction delays (RII)

Possible factors of time delays	Performance Indicator			
	Construction Delays			
	SD + D (1 + 2)	A + SA (4 + 5)	RII	Ranking
Inexperience – Leading to the lack of understanding of the scope of works outlined for different projects	0.00%	100.00%	0.903	1.00
Lack of project information as required on projects	0.00%	87.50%	0.877	2.00
Inadequate resourcing placed on projects	0.00%	100.00%	0.875	3.00
Poor management and reporting of potential delays	0.00%	90.00%	0.872	4.00
Poor project planning from project inception to completion	0.00%	100.00%	0.870	5.00
Poor communication and timely actioning of changes/ variations	0.00%	92.50%	0.870	6.00
Unrealistic programming at project inception	0.00%	100.00%	0.855	7.00
Poor monitoring on site, leading to potential problems being identified too late	0.00%	100.00%	0.848	8.00
Construction project milestones not set from the start of projects undertaken	0.00%	96.25%	0.826	9.00
Project team members not aligning project execution plan with their work	8.75%	70.00%	0.784	10.00
Lack of tools of tools for accurate progress reporting (i.e. CCS and Microsoft projects)	40.00%	56.75%	0.589	11.00

The second calculation example below depicts how the RII was calculated in instances where there were neutral respondents for a particular possible factor of delays:

$$RII = \frac{(W1 \times \text{No. of Strongly Disagree}) + (W2 \times \text{No. of Disagree}) + (W4 \times \text{No. of Agreed}) + (W5 \times \text{No. of Strongly Agree})}{A(5) \times N(80 - \text{No. of Neutral respondents})}$$

$$RII = \frac{(1 \times 0) + (2 \times 0) + (4 \times 46) + (5 \times 26)}{5 \times (80 - 8)}$$

$$RII = 0.872$$

The calculation methods applied for the RII in Table 4.7 were also applied for the calculation of the RII in Table 4.8 below. The possible factors of cost overruns were ranked according to their relative importance in the impact of budget constraints.

Table 4. 8 Construction progress reporting vs Budget Constraints (RII)

Possible factors of budget constraints	Performance Indicators			
	Budget Constraints			
	SD + D (1 + 2)	A + SA (4 + 5)	RII	Ranking
Inexperience - Leading to the lack of understanding of the scope of work outlined on different projects	0.00%	100.00%	0.878	1
Lack of project information as required on projects	0.00%	86.25%	0.870	2
Poor communication and timely actioning of changes/variations	0.00%	62.50%	0.868	3
Poor management and reporting of potential delays	0.00%	86.25%	0.861	4
Unrealistic programming at project inception	0.00%	100.00%	0.850	5
Poor project planning from project inception to completion	3.75%	91.25%	0.850	6
Project team members not aligning project execution plan with their work	0.00%	87.50%	0.843	7
Poor monitoring on site, leading to potential problems being identified too late	6.25%	56.25%	0.824	8
Inadequate resourcing placed on projects	21.25%	78.75%	0.743	9
Construction project milestones not set from the start of projects undertaken	43.75%	46.25%	0.633	10
Lack of tools for accurate progress reporting (i.e. CCS and Microsoft projects)	57.25%	46.25%	0.523	11

According to the aforementioned results, variables such as construction inexperience, lack of project information, poor communication and poor management and reporting of potential delays are the most influential contributors to cost overruns. Construction inexperience, as similarly derived for time delays, is the most influential contributor.

Table 4.9 illustrates all the respondents that rated the factors of inadequate progress reporting as a link to the performance indicator “Poor project quality”

The calculation methods applied for the RII in Table 4.7 and 4.8 above were also applied for the calculation of the RII in Table 4.9 below. The relative importance “ranking” categorises the factors of poor construction progress reporting according to the influence they have on the negative performance indicators of poor project quality outcomes.

Table 4. 4 Construction progress reporting vs Poor project quality (RII)

Possible causes of poor project quality outcomes	Performance Indicators			
	Poor Project Quality			
	SD + D (1 + 2)	A + SA (4 + 5)	RII	Ranking
Lack of project information as required on projects	0.00%	100.00%	0.893	1
Inexperience - Leading to the lack of understanding of the scope of work outlined on different projects	0.00%	100.00%	0.878	2
Poor monitoring on site, leading to potential problems being identified too late	0.00%	95.00%	0.871	3
Poor project planning from project inception to completion	0.00%	100.00%	0.870	4
Inadequate resourcing placed on projects	0.00%	75.00%	0.863	5
Unrealistic programming at project inception	0.00%	100.00%	0.863	6
Poor communication and timely actioning of changes/variations	0.00%	92.50%	0.857	7
Project team members not aligning project execution plans with their works	0.00%	100.00%	0.850	8
Poor management and reporting of potential delays	6.25%	72.50%	0.841	9
Construction project milestones not set from the start of projects undertaken	10.00%	75.00%	0.782	10
Lack of tools for accurate progress reporting (i.e. CCS and Microsoft projects	52.50%	46.25%	0.519	11

From the RII calculations depicted in Tables 4.7 and 4.8, factors such as construction inexperience, the lack of project information, poor communication and inadequate resourcing, as well as poor management and reporting of potential delays were found to be the leading causes of delays and cost overruns. Likewise, factors such as the lack of project information, inexperience and poor monitoring on site are the leading causes of poor-quality outcomes on projects. The analysis also revealed that although the currently implemented methods/systems for accurate progress reporting are also a factor of negative outcomes of delays, cost overruns and poor-quality outcomes, respondents considered them the least relevant by rating them 11th most relevant to the negative outcomes.

The third and final objective of this was to explore the possible mitigating factors to improving identified shortcomings in progress monitoring and reporting systems for construction projects.

Section 2.1.1 of the literature review emphasised the significance of understanding project specific requirements, to ensure that sufficient and effective management, monitoring and progress reporting methods are employed (Albert *et al*, 2017). Enshassi *et al* (2009) previously stated that negative outcomes can be minimised by the employment of realistic strategies for project control, progress monitoring and reporting, good practices and careful judgement with the projects undertaken.

Tables 4.7, 4.8 and 4.9 showed that respondents ranked inexperience as the most influential cause of delays, cost overruns and poor-quality outcomes in projects. Consequently, the understanding of project specific requirements and the ability to employ efficient levels of management, monitoring and reporting is dependent on construction experience. Likewise, the determination of realistic strategies for project control, progress monitoring and reporting, good practices and careful judgement are reliant on construction experience.

The poor inflow of project information was ranked the second most significant cause of construction delays and budget constraints. As such, the inadequacy of project information on projects negatively affects the planning, control, management, progress monitoring and reporting requirements on projects. Similarly, respondents also noted the poor allocation of resources as another significant cause of negative project outcomes. Consequently, respondents referred to some of the methods of improving identified shortcomings to progress monitoring and reporting on current projects and these include:

- **Training (Practical Experience) –** The analysis in Tables 4.7, 4.8 and 4.9 showed that construction inexperience is a factor of inadequate progress reporting that needs to be corrected to improve project outcomes. Tertiary education, though it provides an analytical way of approaching projects, is not sufficient to provide a clear-cut way of approaching projects of different complexities. There is therefore a need to properly evaluate the support structures offered by building construction companies to ensure that that practical experience is achieved to improve progress reporting and essentially, project outcomes. By this, building contractors would be able to provide the skills required to effectively undertake projects of different complexities. Similarly, the improvement of construction knowledge through training will provide

building contractors the ability to effectively manage projects by enhancing progress reporting and monitoring.

- **Improving the flow of project information –** Tables 4.7, 4.8 and 4.9 depicted rankings for the lack of project information 2nd, 2nd and 1st, deeming it another important factor that negatively impacts the success of projects. As such, the information flow on construction projects need to be remedied and improved to achieve desired project results. According to interview data, the initial plans on construction projects are usually not used throughout the projects. Instead, scope changes, variation orders, design changes, etc. coerce plans to change and this still needs to be reinforced by building contractors in the construction industry. The base plans are good references, but cannot be used to tackle growing complexities on projects. The flow of information that relates to any changes effected on projects needs to be monitored to ensure that all construction stakeholders are in position to perform their duties at any point of a project. Consequently, the constant flow of information also improves the accuracy in progress reporting, and subsequently progress monitoring. Constant updating of project plans and consistent programme updates and reports dissolve the probability of time delays, budget constraints and poor project quality outcomes. Tables 4.5 and 4.7 also show the poor allocation of resources on projects as another cause of poor project outcomes.
- **Improving the allocation of resources –** This is another factor that leads to poor project outcomes as per findings from the analysis. Therefore, the allocation of resources on projects need to be improved to make project outcomes better. The better understanding of the construction programme and its benefits can enhance its use and perfects the ability to allocate resources effectively. The ability to interpret the different complexities that come with projects and implementing the construction programme as a means to communicate these complexities can increase the chances of project success. As such, the proper allocation of resources allows building contractors to implement management and control methods that will prove beneficial to the successful completion of projects. Interview respondents also noted the importance of resource allocation changes so that updates can be conducted consistently on the construction programme.

There are also some technological methods that can be utilised by building contractors in the South African construction industry which have provided benefits to building contractors from other developing countries. These technologies are listed in literature review (Sections 2.2 and 2.5). The benefits of utilising the technologies include:

- Placing building contractors in a position to easily identify and correct negative project trends through improved decision-making and project performance.
- Providing detailed progress reporting that shows current project trends and allows for the opportunity to introduce new ways of undertaking projects for the desired completion.

The adoption of construction project management and control technologies, including those for progress monitoring and reporting within the South African construction industry, still need to be investigated. Section 2.5 of the literature review states that many building construction companies have been slow in adopting the technologies and other methods that could ease the process of progress reporting (Mulenga *et al*, 2014).

4.3 FINDINGS AND DISCUSSIONS

This section endeavours to examine and discuss the results from the data analysis in comparison to what is already known from existing literature. The results from the analysis share similarities with the findings from existing literature, particularly on the current occurrence of inadequate project monitoring and progress reporting in construction projects. The findings from the research suggest that poor progress reporting exists (Table 4.6). The current occurrence of poor progress reporting is as a result of hindering factors such as increasing project complexities, construction inexperience, poor planning and management and poor implementation and reporting, etc. (Figure 4.1). The analysis showed that construction inexperience and the increasing complexity levels of construction projects are the leading causes of poor project monitoring and progress reporting on construction projects. Existing literature reviewed showed that the increasing expectations from clients have made projects more complex, thereby inducing the need for more practical experience (Section 2.5.2; Gershon, 2013). Consequently, the poor levels of construction experience have were found to be the leading causes of negative outcomes of delays, cost overruns and poor-quality outcomes (Tables 4.7, 4.8 and 4.9). Gardezi *et al* (2014) found that the existence of time delays, cost overruns and poor-quality outcomes is evident in poorly

managed projects, where planned project activities are not effectively monitored or accurately reported on. Similarly, the analysis also revealed that poor implementation of progress reporting methods has considered another factor of poor project monitoring and progress reporting (Figure 4.1). However, respondents did not consider this to lead to delays, cost overruns or poor-quality results (Table 4.6). The finding is supported by existing literature, where building contractors consider their currently implemented tools/methods formidable communication tools that have the capacity to report on project information accurately (Tang *et al*, 2014). This can be seen as a reluctance to undertake and implement new methods of project monitoring and progress reporting. However, Literature also revealed that building contractors have adopted and implemented new methods, but projects are still not being monitored effectively or reported on accurately (Chihuri and Pretorius, 2010). This reinforces the finding that a lack in construction experience negatively impacts the outcomes of projects (Figure 4.1). As such, there is a need to remedy the level of influence that construction inexperience has on the undertaking of projects of varying complexities. There is also a need to properly evaluate the support structures offered by building construction companies to ensure that practical experience is achieved to improve progress reporting and ultimately, project outcomes.

CHAPTER 5

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of the research findings and discussions. The aim was to determine the effectiveness of the current progress monitoring and reporting methods and their linkage with the negative outcomes of time delays, cost overruns and poor-quality results in the construction industry.

The summary that follows addresses these objectives and aim set out in this study based on the findings from the research. Consecutively, the research problem will be addressed and the research question answered respectively.

5.1 ADDRESSING THE OBJECTIVES AND AIM

The outcomes for the research objectives are presented below:

The first objective was to determine the current occurrence of inadequate progress monitoring and progress reporting. Existing literature, as presented in Chapter 2, showed the inadequacy and inaccuracy of progress reports and how they negatively influence the occurrence of adequate progress monitoring. The literature review did not however, reveal the intensity of the influence that inadequate progress monitoring and reporting have on the outcomes of construction projects. Data analysis revealed that poor project monitoring and progress reporting exist within building construction companies. Analysis also revealed that inadequate progress reporting exists due to hindering factors such as construction inexperience, construction project complexities, poor planning and management and poor implementation of efficient progress reporting methods, among others. Likewise, it was also revealed that the occurrence of poor project monitoring and progress reporting lead to negative outcomes of time delays, cost overruns and poor-quality outcomes. Again, the factor of construction inexperience was found to be the bigger contributor to delays, cost overruns and poor-quality outcomes. As such, it can be deduced that the employment of adequate levels of construction experience will improve the approach to both progress monitoring and reporting, as well as the adequacy in their implementation.

The second objective was to ascertain the extent of the impact that poor progress monitoring and reporting have on achieving the management objectives of time, cost and quality. The literature review in Chapter 2 shows that the project management factors of control and progress monitoring and reporting are poorly implemented in construction

projects. Consequently, the poor implementation has led to delays, cost overruns and poor-quality outcomes.

Based on the results of this study, the nature and occurrence of inadequate project monitoring and progress reporting in South Africa includes construction inexperience, project complexities, the literature review did not however, depict the degree of influence that the poor management factors, particularly progress monitoring and reporting have on the occurrence of time delays, cost overruns and poor-quality results. Similarly, the results from both the analysis showed that the occurrence of both inadequate project monitoring and progress reporting lead to time delays, cost overruns and poor-quality outcomes. The findings showed that the occurrence of inadequate progress reporting is fuelled by construction inexperience, which is also the most influential cause of delays, cost overruns and poor-quality outcomes, according to the analysis in the previous chapter.

The third and last objective was to establish approaches of alleviating the impact of poor progress monitoring and reporting on project outcomes. As deduced from the previous objective's construction inexperience is the most influential cause of time delays, cost overruns and poor-quality outcomes, among other factors also depicted in the analysis in the previous chapter.

Accordingly, the improvement of construction inexperience, will improve the influence of project monitoring and progress reporting on current projects. As such, it is the desired level of experience that will enable building contractors to monitor projects of varying complexities in accordance with the needs of appointed projects. Similarly, the improvement of construction experience employed on projects will allow for the accurate reporting of actual progress on projects, to mitigate the outcomes of delays, cost overruns and poor-quality outcomes.

The aim of was to determine the nature and effectiveness of progress monitoring and reporting systems currently implemented in construction projects in South Africa. The analysis in Chapter 4 showed that progress monitoring and reporting exist in building construction companies in South Africa, but are still deficient due to factors such as construction inexperience and poor planning and management on projects, among others. It was also discovered that poor progress monitoring and reporting lead to negative outcomes

of time delays, cost overruns and poor-quality outcomes. However, even with these negative outcomes, construction stakeholders do not consider the lacking in implementation of newer methods or systems of progress reporting as a requirement on their projects. The general concurrence is that currently implemented systems of progress reporting are sufficient for the presentation and communication of relevant project progress information as required.

5.2. IMPLICATIONS OF FINDINGS

The results from the analysis revealed that building construction companies consider their currently implemented project monitoring and progress reporting systems effective and adequate for the recording, processing and reporting of project progress. This implies that there are other reasons, according to findings, for the inadequacy of the current occurrence of progress reporting. Apart from the findings strengthening the reasoning behind the reluctance to undertake and implement new methods and systems of progress reporting, it also implies the significance of improving construction experience in order to improve the adequacy of current reporting systems, which construction stakeholders would rather improve, than change.

Current literature does not validate the above-mentioned implications and as such, there is need to understand how construction inexperience and the other factors causing poor progress monitoring can be remedied to improve project outcomes.

5.3. RECOMMENDATIONS FOR FUTURE RESEARCH

In order to remedy the inadequacy and ineffectiveness, due consideration for the adoption and implementation of newer methods, tools and techniques should be made by building construction companies. The improvement of progress reporting subsequently improves the choice of methods, tools and techniques suitable for projects of varying complexities. Furthermore, the lack of construction experience appointed on current projects has had detrimental impacts on project outcomes. There is a need to relook the levels of experience available to undertake construction projects of different levels of complexities. Training for practical experience is required to increase the experience presented to construction projects. The improvement of experience is set to improve project outcomes by increasing

the ability to manage and control projects with different complexities, as well as improve the accuracy in reporting, and consequently the adequacy of progress monitoring

5.4 ADDRESSING LIMITATIONS

The initial chosen topic had presented a lack in prior studies in the South African context, which then affected the structure of the literature review. The data for the South African context was collected from professionals working in Johannesburg, and hence, the findings could have been interpreted to only affect construction projects in South Africa, while limiting the generalizability to the South African construction industry. Thus, in regulating the impact of the limitation, the sources from which the data was collected, intentionally included experienced professionals who have worked on different types of projects of varying complexities.

5.5 CONCLUDING REMARKS

The research was aimed at determining the nature and effectiveness of progress monitoring and reporting systems currently implemented in construction projects in South Africa. The research findings revealed that the current methods being used to report on progress are not effective and hence affect the effort placed on managing and controlling projects towards desirable outcomes. The analysis also showed that due to the poor levels of progress reporting, and consequently progress monitoring, projects are experiencing delays, cost overruns and poor-quality outcomes. Even so, building contractors still convey a persistent slow adoption to newer methods for progress reporting, and this is not helping with the increased levels of complexities projected by current projects. Likewise, the current project complexities being projected require an increased level of project experience to handle and currently, what building contractors are conveying on project is not sufficient to produce desirable outcomes. Therefore, there is a need to eliminate the reluctance to the adoption of methods that could possibly save many reputations. There is also a need to employ professionals that actually possess the capability, knowledge and experience to deal with current levels of project complexities, otherwise, it is better to invest in training practices to improve project outputs in the long run.

REFERENCES

Knott R.J. and Davis E.R. (1982). Project control – an overview. Journal of the South African institute of mining and metallurgy p.160-164.
https://www.saimm.co.za/Journal/v082n06p160.pdf

Acitara T., Kazaz A. and Ulubeyi S. (2017). Evaluations of construction project participants' attitude towards quality management in Turkey. Procedia Engineering Vol. 196 Pp.203-210

Adam A., Josephson P.B. and Lindahl G. (2017). Aggregation of factors causing cost overruns and time delays in large public construction projects: trends and implications. Engineering, Construction and Architectural Management Vol 24 Pp. 393-406

Adugna N.T. (2015), A study of causes of delay and cost overrun in office construction projects in the eThekwini Municipal Area, South Africa.
https://ir.dut.ac.za/xmlui/bitstream/handle/10321/1374/ADUGNA_2015.pdf?sequence=1&isAllowed=y

Ahiaga-Dagbui D.D. and Smith S.D. (2014). Dealing with construction cost overruns using data mining. Construction management and economics Vol. 32 Pp.682-694

Ahiaga-Dagbui D.D. and Smith S.D. (2014). Rethinking construction cost overruns: cognition, learning and estimation. *Journal of Financial Management of Property and Construction Vol.19 No.1, pp.38-54*

Aibinu A. A. and Jagboro G.O. (2002). The effects of construction delays on project delivery in the Nigerian construction industry. *International Journal of Project Management* (20*) pp.593-599*

Aibinu A.A. and Odeyinka H. A. (2006). Construction delays and their causative factors in Nigeria. *Journal of Construction Engineering and Management* (132) *pp667-677*

Aiyetan A., Smallwood J. and Shakantu W. (2011). A systems thinking approach to eliminate delays on building construction projects in South Africa
http://www.ajol.info/index.php/actas/article/viewFile/77178/67628

Akintoye A. S. and MacLeod M. J. (1997). Risk analysis and management in construction. *International Journal of Project Management* (15) *pp.31-38*

Albert M., Balve P. and Spang K. (2017). Evaluation of project success: A structured literature review. International Journal of Managing projects in business Vol. 10 Pp. 796-821

Albrecht C.J. and Spang K. (2014). Linking the benefits of project management maturity to project complexity insights from a multiple case study. International journal of managing projects in business Vol.7 Pp.285-301

Al-Hazim N., Abu Salem Z. and Ahmed H. (2017). Delay and cost overruns in infrastructure projects in Jordan. Procedia Engineering Vol. 182 Pp. 18-24

Aliverdi R., Naeni L. M. and Salehipour A. (2013). Monitoring project duration and cost in a construction project by applying statistical quality control charts. *International Journal of Project Management* (31) *pp.411-423*

Alizadehsalehi S. and Yitmen I. (2016), The Impact of Field Data Capturing Technologies on Automated Construction Project Progress Monitoring. Procedia Engineering (161) p.97-103
http://0-ac.els-cdn.com.innopac.wits.ac.za/S1877705816327126/1-s2.0-S1877705816327126-main.pdf?_tid=11fa2216-c9f5-11e6-9c58-00000aacb35e&acdnat=1482596688_57b316cfb991661c59b2eee9ccef09f9

Al-Jibouri S. (2003). Monitoring systems and their effectiveness for project control in construction. *International Journal of Project Management (21) pp.145-154*

AlNasseri H. and Aulin R. (2015). Assessing understanding of planning and scheduling theory and practice on construction projects. *Engineering Management Journal Vol.27 No.2, pp.58-72*

Al-Tmeemy S. M. H., Rahman H. A. and Harun Z. (2012). Contractor's perception of the use of costs of quality system in Malaysian construction industry projects. *International Journal of Project Management* (30) *pp.27-838*

Amoatey C.T., Amenyaw Y.A., Adaku E and Famiyeh S. (2014), Analysing delay causes effects in Ghanaian state housing construction projects. International Journal of Managing Projects in Business Vol 8 No. 1 Pp.198-214
Ansah R.H. and Sorooshian (2017). Effect of lean tools to control external environment risk of construction projects. Sustainable cities and society Vol. 32 Pp.348-356
Arcila S., 2012, 'Avoiding cost overruns in construction progress in the United Kingdom,' MSc thesis. The University of Warwick
Arcuri F.J. (2007). A development of performance metrics for forecasting schedule slippage. https://theses.lib.vt.edu/theses/available/etd-05022007-170555/unrestricted/FrankJArcuriThesisDocument.pdf
Asiedu R.O., Adaku E. and Owusu-Manu D.G. (2017) beyond the causes: Rethinking mitigating measures to avert cost and time overruns in construction projects. Construction Innovation Vol. 17 Pp.363-380
Assaf S.A. and Al-Hejji S. (2006). Causes of delay in large construction projects. *International Journal of Project Management (24), pp.349-357*
Aziz R.F. (2013). Ranking of delays in construction projects after Egyptian revolution. *Alexandria Engineering Journal* (52) p*p.387-406*
Basu R. (2014). Managing quality in projects: An empirical study. International Journal of project management Vol. 32 Pp.178-187
Battikha M.G. (2002). QUALICON: Computer-based system for construction quality management. Journal of Construction engineering and management Vol. 128 Pp.164-173
Blyth K. and Lewis J. (2004). Developing a framework for a standardized works programme for building projects. *Construction Innovation (4) pp.193-210.*
Brienza Jr R.M. and Hildreth J.C. (2007), Tracking project commodities for project control. http://www.virginiadot.org/business/resources/const/0709_commodity_tracking.pdf
Brito D.M. and Ferreira E.AM. (2015). Strategies for representation and analysis of 4D modelling applied to construction project management. Procedia Economics and Finance Vol 21 Pp.374-382
Brown J.S. (2015). A SCM approach to project management in the South African construction industry
Burger M. (2013). Project management in the built environment: The need for industry specific knowledge.
http://scholar.ufs.ac.za:8080/xmlui/bitstream/handle/11660/1457/BurgerM.pdf?sequence=1

Chan A.P.C. (2001). Framework for measuring the success of construction projects. Report 2001-003-C-01 http://eprints.qut.edu.au/26531/1/2001-003-C-01_Framework_for_Measuring_Success.pdf
Chan D.W.M. and Kumaraswamy M.M. (1997). A comparative study of causes of time overruns in Hong Kong construction projects*. International Journal of Project Management Vol.15 No.1, pp.55-63*
Cheleka M., Abeyasinghe L., Greenwood D. L. and Johansen D. E. (2001). An efficient way of scheduling construction projects with resource constraints. *International Journal of Project Management* (19) *pp.29-45*
Chen Y. and Kamara J.M. (2008), Using mobile computing for construction site information management*. Engineering, Construction and Architecutural Management* (1) *pp. 7-20*
Chihuri S. and Pretorius L. (2010). Managing risk for success in a South African engineering and construction project environment. South African Journal of Industrial Engineering Nov 2010 Vol 21(2): 63-77.
Chiu B.W.Y. and Lai J.H.K. (2017) Project delay: key electrical construction factors in Hong Kong. Journal of Civil Engineering and management Vol 23 Pp.847-857
Clough R. H., Sears G. A. and Sears S. K. (2005). *Construction contracting: A practical guide to company management Seventh Edition*. New Jersey. John Wiley & Sons, Inc.

Cooke B. and Williams P. (2009). *Construction planning, programming and control. Third Edition.* Wiley-Blackwell, Inc.
Czarnigowska A. (2008). Earned value method as a tool for project control. Budownictwo I Architektura (3) p.15-32 http://wbia.pollub.pl/files/83/attachment/1914_3_2.pdf

Czarnigowska A., Jaskowski P. and Biruk S. (2011). Project performance reporting and predictions: Extensions of Earned Value Management. International Journal of Business and Management studies (3) p.11-20 http://www.earnedschedule.com/Docs/Czarnigowska%20-%20Project%20Performance%20Reporting.pdf
De Marco A. and Narbaev T. (2013). Earned value-based performance monitoring of facility construction projects*. Journal of Facilities Management Vol.11 No.1, pp.69-80*
De Vaus D.A. (2001) 'Research Design in Social Research.'
http://research.apc.org/images/5/5f/De_Vaus_chapters_1_and_2.pdf

Del Pico W. J. (2013*). Project Control: Integrating cost and schedule in construction*. New Jersey. John Wiley & Sons, Inc.
Demirkesen S. and Ozorhon B. (2017). Impact of integration management of construction management performance. International Journal of project management Vol. 35 Pp. 1639-1654
Dhawale A. and Tuljapurkar V. (2015). Cost control and tracking of a building by earned value method. International journal of technical research and applications (3) p.15-22
http://www.ijtra.com/view/cost-control-and-tracking-of-a-building-by-earned-value-method.pdf

Durdyev S., Omarov M. and Ismail S. (2017). Causes of delays in residential construction projects in Cambodia. Civil & Environmental Engineering
Durdyev S., Omarov M., Ismail S. and Lim M. (2017). Significant contributors to cost overruns in construction projects of Cambodia. Civil and Environmental Engineering
Dykstra A. (2011). *Construction project management: A complete introduction*. United States of America. Kirshner Publishing Company Inc
Elazouni A. and Salem O.A. (2011). Progress monitoring of construction projects using pattern recognition techniques. *Construction Management and Economics Vol.29 No.4, pp.355-370*
El-Omari S. and Moselhi O. (2011), Integrating automated data acquisition technologies for progress reporting of construction projects. Automation in construction (11) p.699-705 http://0-ac.els-cdn.com.innopac.wits.ac.za/S0926580510002098/1-s2.0-S0926580510002098-main.pdf?_tid=cc315ad8-c9f9-11e6-8d1d-00000aacb35d&acdnat=1482598719_7d3145fcff16db5e0137b859483491d2

Emuze F. and Smallwood J. (2012). Infrastructure project performance in the South African construction sector: Perceptions from two provinces. *Research Articles*
Emuze F.A. and Smallwood J.J. (2013). Management concepts and project performance: perceptions from the South African public sector environment. Journal of the South African institution of civil engineering (55) p21-28. http://www.scielo.org.za/pdf/jsaice/v55n2/04.pdf

Enshassi A., Al-Najjar J. and Kumaraswamy M. (2009). Delays and cost overruns in the construction projects in the Gaza strip*. Journal of Financial Management of Property and Construction Vol.14 No.2, pp.126-151*
Erasmus W. and Marnewick C. (2014), applied governance of ICT projects: A bridge between project goals and project success. Proceedings of the Project Management South Africa (PMSA) Conference 2014.
http://c.ymcdn.com/sites/www.projectmanagement.org.za/resource/resmgr/Academic_Papers_2014/PMSA_National_Conference_201.pdf

Eriksson P.E., Larsson J. and Pesamoa O. (2017). Managing complex projects in the infrastructure sector- A structural equation model for flexibility-focused project management. International journal of project management Vol. 35 Pp.1512-1523
Fapohunda P.L and Ayodeji J. (2016). The use of Building Information Modelling and related technology in the Cape Town urban centre. 9th CIDB Postgraduate conference

Farooqui R.U., Ahmed S.M. and Saqib M., 2010, 'Desirable attributes and skills for graduating construction management students,' PhD thesis, Florida International University
Fathi M.S., Anumba C., Carrillo P. and Aziz Z. (2007). Construction Programme Management - Current Context. https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/4367/1/Carrillo%20ASCE%20CRC%202007b.pdf [Accessed 05 April 2015]

Fouche D. P. and Rolstadas A. (2010). The use of performance measurements as a basis of project control of offshore modification oil and gas projects. *Production Planning & Control* (21) *pp.760-773*
Gabula Z.H. (2012). Factors influencing the construction project success rates of reconstruction development programme (RDP) housing projects in the Eastern Cape: A quality perspective: A census study
Gardezi S. S. S., Manarvi I. A. and Gardezi S.J.S. (2014). Time extension factors in the construction industry of Pakistan. *Procedia Engineering* (77) *pp.196-204*
Gershon A. (2013). Using Earned Value Analysis to manage projects. Journal of Applied Business and Economics (15) p.11-14 http://www.na-businesspress.com/JABE/GershonM_Web15_1_.pdf

Ghanem A.A., AbdelRazig Y.A. and Mahdi S.M. (2008). Evaluation of real-time construction project progress tracking. http://www.irbnet.de/daten/iconda/CIB4432.pdf

Giacobbi, Peter R. Jr.; Poczwardowski, Artur; and Hager, Peter F., "A Pragmatic Research Philosophy for Applied Sport Psychology"(2005). Kinesiology, Sport Studies and Physical Education Faculty Publications. Paper 80. http://digitalcommons.brockport.edu/pes_facpub/80

Goddard W. and Melville S. (2004). *Research Methodology: an introduction*. Juta and Company, Ltd

Goldkuhl G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European Journal of Information Systems* (21) *pp.135-146*

Golob K., Bastic M., Psunder I. (2013). Influence of project and marketing management on delays, penalties and project quality in Slovene organisations in the construction industry. Journal of management in engineering Vol. 29 Pp.495-502

Golparvar-Fard M., Pena-Mora F., Arboleda C.A. and Lee S. (2009), Visualization of Construction Progress Monitoring with 4D Simulation Model Overlaid on Time-Lapsed Photographs. Journal of Computing in Civil Engineering (23:6) http://0-ascelibrary.org.innopac.wits.ac.za/doi/full/10.1061/%28ASCE%290887-3801%282009%2923%3A6%28391%29

Gustavsson T.K. (2015). New boundary spanners: Emerging management roles in collaborative construction projects. Procedia Economics and Finance Vol. 21 Pp. 146-153

Gustavsson T.K. and Gohary H. (2012). Boundary action in construction projects: new collaborative practices. *International Journal of Managing Projects in Business* (3) *pp.364-376.*

Han K.K. and Golparvar-Fard M., (2015), Appearance-based material classification for monitoring of operation-level construction progress using 4D BIM and site photologs. Automation in construction (53) P.44-57 http://0-ac.els-cdn.com.innopac.wits.ac.za/S0926580515000266/1-s2.0-S0926580515000266-main.pdf?_tid=2da95b28-ca25-11e6-a19c-00000aab0f6c&acdnat=1482617351_f300de69373442a798a1e7c3147c5f51

Hapanova T. and Al-Jibouri S (2009). Identifying key performance indicators for use in control of pre-project stage process in construction. International Journal of productivity and performance management Vol. 58 Pp.160-173
Hegazy T. and Menessi W. (2010). Critical path segments scheduling technique. Journal of construction engineering management Vol.136 Pp.1078-1085
Heravi G. and Ilbeigi M. (2012). Development of a comprehensive model for construction project success evaluation by contractors. Engineering, Construction and Architectural Management Vol. 19 Pp.526-542
Howes C. (2008). Construction management versus construction project management
Jallow A.K., Demian P., Baldwin A.N. Anumba C. (2015). An empirical study of the complexity of requirements management in construction projects. Engineering, Construction and Architectural Management Vol. 21 Pp.505-531
Jaskowski P. and Sobotka A. (2006). Scheduling construction projects using evolutionary algorithms. *Journal of Construction Engineering and Management.* (132) pp.861-870
Jayaraman R. (2016). Project cost control: A new method to plan and control costs in large projects. Business process management journal Vol. 22 Pp. 1247-1268
Johansen E. and Wilson B. (2006). Investigating first planning in construction. *Construction Economics and Management Vol.24 No.12, pp.1305-1314*
Joslin R. and Muller R. (2016). The impact of project methodologies on project success in different project environments. International Journal of Managing projects in business Vol. 9 Pp.364-388

Jugdev K., Perkins D., Fortune J., White D. and Walker D. (2013). An exploratory study of project success with tools, software and methods. International Journal of Managing projects in business Vol. 6 Pp. 534-551
Khoshgoftar M., Bakar A. H. A. and Osmon O. (2010). Causes of construction delays in Iranian construction projects. *International Journal of Project Management* (10) *pp.53-69*

Kivila J., Martinsuo M. and Vuorinen L. (2017). Sustainable project management through project control in infrastructure projects. International Journal of project management Vol. 35 Pp. 1167-1183

Kropp C., Koch C. and Konig M. (2017). Interior construction state recognition with 4D BIM registered image sequences. Automation in construction Vol.86 Pp.11-32

Le Y., Wang Y., Luo C., and Peng Y. (2013). Intergration of Financial and Contract Management on the Shanghai Expo Construction Program. *Journal of Construction Engineering Management (139) pp.738-748*
Lee S.H., Pena-Mora F. and Park M. (2006). Dynamic planning and control methodology for strategic and operational construction project. *Automation in construction (15) p.84-97*

Leu S. and Yang C. (1999). GA-Based multicriteria optimal model for construction scheduling. *Journal of Construction Engineering & Management* (25) *pp.420-427*
Life cycle document management system for construction. Author
http://www.tdx.cat/bitstream/handle/10803/6160/02Nfm02de12.pdf?sequence=2

Lin M.C., Tserng H.P., Ho P.S. and Young D.L. (2012). A novel dynamic progress forecasting approach for construction projects. Expert systems with applications Vol.29 Pp.2247-2255

Ling Y.F. and Theng Ang W (2013). Using control systems to improve construction project outcomes. Engineering, Construction and Architectural Management Vol. 20 No.6 Pp.576-588

Love P. E. D., Holt G. D., Shen L. Y., Li H. and Irani Z. (2002). Using system dynamics to better understand change and rework in construction project management. *International Journal of Project Management* (20) *pp.425-436*

Lycett M., Rassau A. and Danson J. (2004). Programme management: A critical review. *International Journal of Project Management (22), pp.289-2*99
Mahamid I. (2014). Contractor's perception of risk factors affecting cost overruns in building projects in Palestine. *The IES Journal Part A: Civil & Structural Engineering Vol.7 No.1, pp.38-50*

Matthews J., Love P.E.D., Heinemann S., Chandler R., Rumsey C and Olatunjo O. (2015). Real time progress management: re-engineering processes for cloud based BIM in construction. Automation in construction Vol. 58 Pp.38-47
McConville J.G., 2015,'Possible solutions for cost overruns on construction projects' Viewed 30 May 2016 https://www.linkedin.com/pulse/possible-solutions-cost-overruns-construction-john-g-mcconville-ccp

McCord M., Davis P.T., Haran M. and Rodgers W.J. (2015). Understanding delays in housing construction: evidence from Northern Ireland*. Journal of Financial Management of Property and Construction Vol.20 No.3, pp.286-319*
Memon A. H., Rahman I. A., Zainun N. Y. and Karim A. T. A. (2013). Web-risk assessment technique for time and cost overruns (WRATTCO) – *A framework. Procedia – Social and Behavioural Sciences* (129) *pp.178-185*

Menches C.L., Hanna A.S., Nordheim E.V. and Russell J.S. (2008). Impact of pre-construction planning and project characteristics on performance in the US electrical construction industry. *Construction Management and Economics Vol.26 No.8, pp.855-869*
Mubarak S. (2010). *Construction Project Scheduling and Control. Second Edition*. New Jersey. John Wiley & Sons Inc.
Mukuka M.J., Aigbavboa C.O. and Thwala W.D (2014). Construction Experts' perception on the causes and effects of cost overruns in Johannesburg, Gauteng Province, South Africa. http://www.ppml.url.tw/EPPM/conferences/2014/download/Construction%20Experts%E2%80%99%20Perception%20on%20the%20Causes%20and%20Effects%20of%20Cost%20Overruns%20in%20Johannesburg,%20Gauteng%20Province,%20South%20Africa.pdf
Mukuka M.J., Aigbavboa C.O. and Thwala W.D (2014). Construction Professionals' perception on the causes and effects of project delay in Lusaka, Zambia
http://www.irbnet.de/daten/iconda/CIB_DC26253.pdf

Mukuka M.J., Aigbavboa C.O. and Thwala W.D. (2014) A theoretical review of the causes and effects of construction project cost and schedule overruns. International Conference on Emerging Trends in Computer and Image Processing (ICETCIP2014)
http://psrcentre.org/images/extraimages/27%201214036.pdf

Munns A.K. and Bjeirmi B.F. (1996). The role of project management in achieving project success. *International Journal of Project Management Vol.14 No.2, pp.81-87*

Muya M., Kaliba C., Sichombo B. and Shakantu W. (2013). Cost escalation, schedule overruns and quality shortfalls on construction projects: The case of Zambia. International Journal of construction management Vol. 13 Pp.53-68
Navon R. (2005). Automated project performance control of construction projects. *Automation in construction (14) pp.467-476*
Nguyen T.P. and Chileshe N. (2015). Revisiting the construction project failure factors in Vietnam. *Built Environment Project and Asset Management Vol.5 No. 4, pp.398-416*

Niazi G.A. and Painting N. (2017). Significant factors causing cost overruns in the construction industry in Afghanistan. Procedia Engineering Vol. 182 Pp. 510-517
Nkiwane N.H., Meyer W.G. and Steyn H. (2016). The use of earned value management for initiating directive project control decisions: A case study. South African journal of Industrial Engineering (27) p.192-203 http://www.scielo.org.za/pdf/sajie/v27n1/16.pdf

Nzekwe J.U., Oladejo E.I. and Emoh F.I. (2015). Assessment of factors responsible for successful project implementation in Anambre State, Nigeria. *Civil and Environmental Research Vol.7 No.8, pp.39-57*

Olawale Y. and Sun M. (2015). Construction project control in the UK: current practice, existing problems, recommendations for future improvement. *International Journal of Project Management* (33) *pp.623-637*

Olawale Y.A. and Sun M. (2010). Cost and time control of construction projects: Inhibiting factors and mitigating measures in practice. *Construction Management and Economics (28) pp.509-526*
Omar T. and Nehdi M.L. (2016), Data acquisition technologies for construction progress tracking. Automation in construction (70) p.143-155 http://0-ac.els-cdn.com.innopac.wits.ac.za/S0926580516301376/1-s2.0-S0926580516301376-main.pdf?_tid=b231993a-c9f5-11e6-be50-00000aacb361&acdnat=1482596957_5038d97f478c7f45d222347316a4b9d7
Park Y. and Papadopoulou T.C. (2012). Causes of cost overruns in transport infrastructure projects in Asia. *Built Environment Project and Asset Management Vol.2 No.2, pp.195-216*
Pinto J. K. and Mantel S. J. (1990). The causes of project failure. *IEEE Transactions on Engineering Management* (37) *pp.269-276*
Polat G., Okay F. and Eray E. (2014). Factors affecting cost overruns in micro scaled construction companies. *Procedia Engineering* (85) *pp.428-435*
Rahman S. H. A., Endut I.R., Faisol N. and Paydar S. (2014). The importance of collaboration in the construction industry from Contractors' perspective. *Procedia – Social and Behavioral Sciences* (129) *pp.414-421*
Ramon J. and Cristoba S. (2014). Cost allocation between activities that have caused delays in a project using game theory. *Procedia Technology* (16) p*p.1017-1026*

Rezania D., Baker R. and Burga R. (2016). Project Control: an exploratory study of levels of control in the context of managing projects. Journal of Accounting & organizational change Vol. 12 Pp.614-635
Rolstadas A., Tommelein I., Schiefloe P.M and Ballard G. (2014). Understanding project success through analysis of project management approach. International Journal of managing projects in business Vol. 7 Pp. 638-660
Saghatforoush E., Hasim S., Jaafar M. S. and Kadir M. R. A. (2009). Constructability implementation among Malaysian building contractors. *European Journal of Scientific Research* (29) p*p.518-532*

Sambasivan M. and Soon Y.W. (2007). Causes and effects of delays in the Malaysian construction industry. *International Journal of Project Management* (25) *pp.517-526*
Sanchez O.P., Terlizi M.A. and Moraes H.R.O.C. (2017). Cost and time project management success factors for information systems development projects. International Journal of project management Vol. 35 Pp.1608-1626
Saunders M., Lewis P. and Thornhill A. (2012). *Research methods for business students. Sixth Edition.* England. Pearson Education Limited
Sawhney A., Mund A. and Chaitavatputtiporn T. (2003). Petri net-based scheduling of construction projects. *Civil Engineering and Environmental Systems Vol.20 No.4, pp.255-271*
Sharma S., Bansal V.K. and Parti R. (2016). Location-based highway construction planning using geographic information systems. *International Journal of Construction Management, pp.1-16*
Shebob A., Dawood N., Shah R.K. and Xu Q. (2012). Comparative study of delay factors in Libyan and the UK construction industry. *Engineering, Construction and Architectural Management Vol.19 No.6, pp.688-712*
Shehu Z. and Akintoye A. (2010). Major challenges to the successful implementation and practice of programme management in the construction environment: A critical analysis. *International Journal of Project Management (28), pp.26-39*
Shehu Z., Endut I. R., Akintoye A. and Holt G.D. (2014). Cost overruns in the Malaysian construction industry projects: A deeper Insight. *International Journal of Project Management* (32) *pp.1471-1480*
Shunmugam S. and Rwelamila P.D. (2014), An evaluation of the risk management status on South African projects. Proceedings of the Project Management South Africa (PMSA) Conference 2014. http://c.ymcdn.com/sites/www.projectmanagement.org.za/resource/resmgr/Academic_Papers_2014/PMSA_National_Conference_201.pdf
Sirisomboonsuk P., Gu V.C., Cao R.Q. and Burns J.R. (2017). Relationships between project governance and information technology governance and their impact on project performance. International Journal of project management
Soman R.K., Raphael B. and Varghese K. (2017). A system identification methodology to monitor construction activities using structural responses. Automation in construction Vol.75 Pp.79-90

Spalek S. (2014). Does investment in project management pay off? Industrial management and data systems Vol. 114 Pp.832-856

Sweis G., Sweis R., Hammad A.A., Shboul A. (2008). Delays in Construction Projects: The case of Jordan. *International Journal of Project Management* (26) *pp.665-674*

Toor S. and Ogunlana S. (2009). Construction professionals' perception of critical success factors for large scale construction projects. *Construction Innovation Vol.9 No.2, pp.149-167*

Toor S. and Ogunlana S.O (2008). Problems causing delays in major construction projects in Thailand. Construction Management and Economics Vol. 26 Pp.395-408
Turner N., Kutch E. and Leybourne S.A. (2016). Rethinking project reliability using the ambidexterity and mindfulness perspectives. International journal of managing projects in business Vol. 9 Pp.845-864
Vegad K., Madurwar M. and Ralengaonkar R. (2014). Application of AV-ERP system for on-site project monitoring. *Construction Innovation Vol.14 No.4, pp.518-531*
Vertenten M., Pretorius L. and Pretorius J.H.C. (2009). Earned Value as a performance measurement tool for small and large construction projects in a South African environment. IEEE AFRICON 2009. P23-25. http://0-ieeexplore.ieee.org.innopac.wits.ac.za/stamp/stamp.jsp?tp=&arnumber=5308080

Walker D.H.T. and Keniger M. (2002). Quality management in construction: an innovative advance using project alliancing in Australia. The TQM Magazine Volume 14 Pp.307-317
Wang C., Li B., Li B. and Baldwin A. (2017). Case study of project controlling on a lsrge HOPSCA project in China. www.emeraldinsight.com.Innopac.wits.ac.za/doi/pdfplus/10.1108/ECAM-07-2015-0118
Wang K.C., Wang W.C., Wang H.H., Hsu P.Y., Wu W.H. and Kung C.J. (2016) Applying building information modelling to integrate schedule and cost for establishing construction progress curves. Automation in construction Vol. 72 Pp.397-410
Waris M, Khamidi M.F. and Idrus A. (2012), The cost monitoring of construction projects through Earned Value Analysis. KICEM Journal of Construction Engineering and project Managemet, Online ISSN 2233-9582
https://www.researchgate.net/publication/228520025_The_Cost_Monitoring_of_Construction_Projects_Through_Earned_Value_Analysis
Windapo A.O. and Cattell K (2013). The South African Construction Industry: Perception of Key Challenges Facing Its Performance, Development and Growth. *Journal of Construction in Developing Countries* (18) *pp.65-79*
Yang J., Park M., Vela P. and Golparvar-Fard M. (2015). Construction performance monitoring via still images, time-lapse photos, and video streams: Now, tomorrow, and the future. *Advanced Engineering Informatics Vol.29 No.2, April 2015, pp.211-224*
Z.A. Memon, M.Z.A. Majid and M. Mustaffar (2006). A systematic approach for monitoring and evaluating the construction project progress. The Institution of Engineers (67) p.26-32
https://core.ac.uk/download/pdf/11783966.pdf
Zarei B., Sharifi H. and Chaghouee Y. (2017). Delay causes in complex construction projects: Semantic network analysis approach. Production planning and control

Zwikael O. (2009). Critical planning processes in construction projects. *Construction Innovation Vol.9 No.4, pp.372-387*

APPENDICES

- INFORMED CONSENT LETTER
- RESEARCH INSTRUMENTS
- ETHICS APPROVAL