Cape Peninsula
University of Technology

THE USE OF DIGITAL PROJECT MANAGEMENT SOLUTIONS BY PROJECT BUSINESSES: A CASE STUDY OF A SELECTED MINE IN THE LIMPOPO PROVINCE

KGOTHATSO ERENS MAHLO

Dissertation submitted in partial fulfilment of the requirements for the degree

Master of Business & Information Administration

in the Faculty of Business & Management Sciences

at the Cape Peninsula University of Technology

Supervisor: Prof. JP Spencer

District Six, Cape Town

July 2021

DECLARATION

I, **Kgothatso Erens Mahlo,** student number 219275165, declare that the contents of this dissertation/thesis represent my own unaided work and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

_____ _____

Signed **Date**

ABSTRACT

There have been some technological shifts globally in the discipline of project management, which include the development of Project Management Software tools and Building Information Modelling systems. The apprehension in project management research is the unclear adoption and usage of the abovementioned developments, especially in developing countries. In addition, researchers have questioned the usefulness of digitalisation in project management since project management challenges are still prevalent.

The purpose of this study was to investigate the awareness and adoption levels of digital project management solutions by project businesses at a selected mine in the Limpopo Province. The study further investigated their project management challenges. It examined the impediments of adoption and the readiness of project businesses that had not yet adopted digital project management solutions, to adopt these solutions. The qualitative research survey was distributed and emailed to project businesses at a selected mine in the Limpopo Province, where 110 project businesses participated in this study. SPSS v26.0 software was utilised to process data.

The study revealed that the level of awareness of digital project management tools is higher than the level of adoption. It was found that project businesses that have not employed digital project management tools experience several internal challenges, while external challenges were faced by various project businesses. This study identified several barriers which affected project businesses that had not employed digital project management tools, for example, lack of knowledge and the high costs associated with the use of digital project management solutions. These barriers were also identified as factors that affected the readiness of project businesses to adopt digital project management tools.

The study proposed several recommendations, including that software developers should consider integrating their software packages with external systems that could enhance project management processes. It was further recommended that the South African mining sector should set a minimum standard requirement of project management training and the South African business development agencies should consider offering ongoing training programmes that are focused on digitalisation and knowledge building in the discipline of project management.

ACKNOWLEDGEMENTS

- I wish to thank the Almighty God for granting me countless blessings and the strength he provided me with during the entire Masters programme, most importantly I would like to thank him for this opportunity.
- Apart from my efforts, the success of this dissertation was largely dependent on the support, cooperation and intellectual guidance of my supervisor Professor JP Spencer, who I would like to thank for his incredible support and assistance. It would be difficult to find adequate words to convey my gratefulness to you. Thank you for being patient with me and allowing me the platform to showcase my creativity.
- I take this opportunity to also express my gratitude to thank my parents Mrs GM Mahlo and Mr KT Mahlo who have been supportive in encouraging me to successfully complete this dissertation.
- Special thanks to my siblings, Ms Mokgethi Mahlo and Ms Lerato Mahlo, for their upliftment in difficult times.
- I would like to greatly express my appreciation to the project businesses that participated in this study as well as the selected mine for allowing me to engage with their contractors.

DEDICATION

I proudly dedicate this work to my parents, Mrs GM Mahlo and Mr KT Mahlo, for being the pillars of strength that I needed to successfully complete this dissertation. They have been endlessly supportive, inspirational, loving and benevolent to me since the outset of my academic journey.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EQUATIONS

ACRONYMS AND ABBREVIATIONS

AVE	Average Variance Extracted
BIM	Building Information Modelling
CPM	Critical Path Method
CPUT	Cape Peninsula University of Technology
CR	Composite Reliability
EMV	Expected Money Value
ICT	Information and Communications Technology
IT	Information Technology
KPI	Key Performance Indicator
KPMG	Klynveld Peat Marwick Goerdeler
MSP	Microsoft Project
PERT	Program Evaluation Review Technique
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMO	Project Management Office
PMS	Project Management Software
PWC	PriceWaterhouse Coopers
SHERQ	Safety Health Environmental Risk and Quality
SPSS	Statistical Package for the Social Sciences
SWOT	Strengths Weaknesses Opportunities and Threats
UNCTAD	United Nations Conference on Trade and Development
WBS	Work-Breakdown Structure

KEY CONCEPTS

Project management software (PMS)

This is a “collection of electronic instruments that enhance the efficiency, planning and tracking of deliverables for a project team” (Bedneko, 2019:1). Kashyap (2018:1) defines PMS as “flexible cloud-based project solutions that ease the project workflow, collaboration and filing”.

Project business

These are businesses that are shaped by project management, they deliver project-related services, developments and products to their clients. Project businesses are the kind of businesses that function in an environment that is driven by projects such as the architectural, engineering and construction industries (Hermano & Martín-Cruz, 2020:2).

Project management

This is an act of leading and managing a project group towards reaching the main objective of the project (Amado et al., 2012:1). “Project management is the presentation of theoretical knowledge, skills, tools, expertise and techniques that are directed at the project activities in an aim to reach the stakeholders’ requirements” (Project Management Institute [PMI], 2017:10).

CHAPTER 1
STUDY OVERVIEW

1.1 Introduction

Since the early 1900s, the mining sector has been an important source of employment and a substantial contributor to the national economy of South Africa. In the past few years, the mining industry has offered numerous projects to many businesses, especially local businesses in the neighbouring community areas of the mines. Many of these projects have placed huge pressure not only on entry-level project businesses but also on experienced businesses where most companies are either experiencing project overruns or delays or sometimes both. According to Kuvshinkov et al. (2017:1), four out of five mining projects are often late or have exceeded the planned budget by an average of 43%. Project businesses worldwide are now realising the benefits associated with having proficient project management techniques that allow them to reach their goals by lowering project costs and driving stakeholder satisfaction; some of these techniques involve the use of digital systems (PMI, 2017:10).

The fundamental purpose of digital project management systems is to ease project management and provide project managers with an automated platform that assists them in ensuring quality, scheduling tasks, controlling project costs, improving consumer satisfaction, handling project resources and managing the project tasks. Furthermore, it is crucial to understand the substantial awareness, adoption and practical influence of digital project management tools, particularly in developing countries such as South Africa. Since there is an exigency for further research in the project management discipline, this study focuses on investigating the levels of awareness, adoption and acceptance of digital project management tools in the South African mining sector.

This chapter states the research problem that needs to be investigated, outlines the research objectives that must be attained and presents the research questions to be addressed. The chapter further includes the research methodology, ethical considerations, data collection methods and the limitations of the study.

1.2 Problem statement

Project businesses are faced with frequent challenges that affect their development. Liallc et al. (2013:2) opine that project management challenges often present several implications that can result in a market crash and the closure of project businesses in the future, thereby giving rise to unemployment that could be a major concern for countries such as South Africa with high unemployment rates. The authors further state that such challenges must be addressed through innovation. Therefore, digital project management tools such as PMS packages have been developed by software developers as solutions to curb project management challenges.

Although advances in project management technology have been made over the past 29 years, the adoption and acceptance levels of these digital tools by project businesses is unknown (Arnold & Javernick-Will, 2013:511). Furthermore, studies by Sajad et al. (2016:39), Puška et al. (2020:90) and Hassan and Asghar (2021:26840) have noted that digital project management tools have hardly simplified project activities and business processes but instead have been the cause of failure of some projects. This failure is claimed to have been caused by project overruns, over-charges and customer dissatisfaction arising from the failure to match customer expectations.

It is essential to note that technological and scientific developments have been experienced worldwide such that it has become crucial for project management research to be conducted to cover the consequent gaps of information. In this regard, the study of Liallc et al. (2013:2), suggests that project management studies should analyse the historical practices and evolution of projects to understand the generators of present crises. Therefore, this study focuses on the project-related problems experienced by different project businesses in the mining sector, while also assessing the use and adoption levels of project management technological tools.

1.3 Rationale and significance of the study

The significance of this study is that it will provide contractors with a better understanding of the usefulness of digital project management solutions in the mining sector and will help people to acknowledge the importance of digital project management technical tools. An in-depth understanding of the usefulness and importance of technology in project management will assist project organisations and stakeholders to understand the impact thereof. The study will further help mines and government agencies to better understand the importance of digitalisation and technology in project management. This understanding could result in them assisting small and medium contractors and community-based project businesses in the mining sector by providing them with training or incubators that promote the usage of technological tools in managing projects. Together with this, technical project management tools and techniques can provide several benefits to both emerging and established contractors.

1.4 Study aims and objectives

1.4.1 Aim of the study

The aim of the study is to investigate the challenges associated with various projects, as well as the awareness and adoption levels of technological project management solutions amongst project businesses within the selected mine in the Limpopo province, to achieve an understanding of how technological project management solutions can contribute to the growth, administration and management of project businesses.

1.4.2 Study objectives

1) To investigate the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo province;
2) To examine challenges of project management between project businesses that have adopted digital project management solutions and those that have not adopted digital project management tools at the selected mine in the Limpopo province;
3) To investigate the adoption barriers to digital project management solutions by project businesses at the selected mine in Limpopo province;
4) To determine the level of readiness to explore digital project management technical tools by project businesses at the selected mine in Limpopo province; and,
5) To understand the extent to which project management technology can influence the growth and success of project businesses at the selected mine in Limpopo Province.

1.5 Research questions and hypotheses

1.5.1 Research questions

a) What are the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo province?
b) What are the challenges of adopting digital project management tools and techniques by project businesses at the selected mine in Limpopo?
c) What is the level of preparedness to explore other digital project management solutions by project businesses in the selected mine in Limpopo?
d) To what extent can project management technology influence the growth and success of project businesses at the selected mine in Limpopo?

1.5.2 Hypotheses

Hypothesis 1 - the use of digital project management solutions is adopted and accepted more by experienced project businesses than less experienced project businesses.

Hypothesis 2 – the use of digital project management solutions has a positive impact on the project lifecycle than traditional methods.

Hypothesis 3 – the use of digital project management solutions addresses (some) of the challenges experienced by project businesses than traditional methods.

Hypothesis 4 – the use of digital project management solutions is neglected as a result of its barriers and as a result of project businesses being accustomed to utilising traditional methods.

1.6 Literature review

For this study to achieve the set objectives, literature on project management, project management technology and challenges was reviewed. The literature is relevant to project management and project management technology, in support of the aim and objectives of this study. Various literature sources were utilised, such as books, journals, articles, conference papers, dissertations, theses and reports. The study analysed relevant literature by critically forming comparisons and discussions of dissimilar views and assertions held by various authors. The literature is presented under the headings of Project Management, Project Management Technology, Project Management Software (PMS) and Project Management in South Africa.

1.7 Research methodology

1.7.1 Research paradigm

According to Saunders et al. (2019:130), a research paradigm is a "system of beliefs and assumptions about the development of knowledge". The aim of an interpretivism philosophy is to interpret the meaning in a social perspective (Žukauskas et al., 2018:123). An interpretive study is aimed at understanding how others comprehend events and theories (Rehman & Alharthi, 2016:55). Researchers with interpretive views are likely to comprehend subjective meanings of certain social views. Positivist and interpretive paradigms are the most commonly used paradigms (Kumar, 2011:14) Positivism or a scientific method contains a structured view where researchers see the world from an objective view that contains real-life events (Rehman & Alharthi, 2016:53). An interpretivism philosophy was used to understand how the use of digital technical tools and techniques influences project businesses. The interpretive paradigm is suitable for this study to interpret the research findings of various continuums with practicality as the epicentre: the interpretation of adoption levels of project management digital solutions and the challenges by project businesses at the selected mine in the Limpopo province.

1.7.2 Research method

Research method refers to methodical styles that are applied to produce data (Igwenagu, 2016:5). A quantitative study comprises mainly variables that are limited to a finite number of possible settings or consist of a range of real numbers (Goddard & Melville, 2013:15). A quantitative approach includes primary data collected by the researcher through observations that examine a correlation between factors and provide findings through numbers and surveys (Surbhi, 2016:1). According to Mishra and Alok (2017:3), qualitative research is aimed at presenting quality through a collection of detailed naturalistic and non-numeric data. Therefore, the empirical section of this study is grounded on a quantitative research design as a statistical method of data presentation employed to present the findings of the study. The focus of this study is to evaluate the statistical levels of adoption, awareness and challenges of using digital

project management technological solutions where primary data is collected from project businesses.

1.7.3 Research design

This research is based on a descriptive case study to examine the challenges and adoption levels of digital project management tools. According to Akhtar (2016:75), a case study approach is an in-depth recitation of factors and/or causes of an individual or group in a specific area or entity, while a descriptive method is for ascertaining and accumulating information about features of an individual or a group. A case study research method is appropriate for this study as the researcher is collecting data from different project businesses in the same area to compare and possibly highlight dissimilar aspects of the research problem (McCombes, 2019b:1).

1.7.4 Study demarcation

The study focuses solely on contracting project businesses at the selected platinum mine in the Waterberg district of the Limpopo Province in South Africa.

1.7.5 Target population

A target population should be specified in terms of its features, geographical location and attributes (Sekaran & Bougie, 2010:267). In research, a target population can be distinguished into two types of populations: the finite population whose number of items is known and the indefinite population whose number of items is unknown (Godwill, 2015:64). The target population for this study consists of a finite number of chosen contracting project businesses registered on the database of the selected mine in the Limpopo province. The population of this study comprises:

- Project managers
- Contracting site managers
- Contracting supervisors

1.7.6 Sample method and sample size

Sampling is a course of selecting several participants or items for a study from a population, in conformity to its boundaries, by using a sample design. Sampling is used to minimise challenges of managing a large population which usually presents challenges in terms of time, cost and energy of researchers (Locke et al., 2010:43; Godwill, 2015:63; Bruce & Bruce, 2017:44).

The most commonly used sample methods are probability and nonprobability sampling. Probability sampling is a technique in which every member of the sampling frame or population will have an equal chance of being chosen to participate in the study (Mahmud, 2008:89; Vanderstoep & Johnston, 2009:29; Guest et al., 2013:53; Yin, 2016:95). Nonprobability

sampling is not based on randomisation but rather on the researcher's aptitude to select specific components that form the ground for the sample (Singh, 2018:1).

In this study, a nonprobability sample technique is suitable, therefore, the form of sampling utilised was the purposive/judgemental sampling method since not all the contracting organisations are project businesses. Purposive/judgemental sampling selects a suitable group within a population (Taherdoost 2016a:20). The respondents of this study are project businesses drawn from the database of the selected mine in the Limpopo Province.

Project businesses will be categorised and selected from 313 diverse contracting organisations within the selected mine.

1.8 Data collection methodology

1.8.1 Data collection instrument

Questionnaires record responses for research purposes (Remenyi, 2011:92; Graustein, 2014:73; Godwill, 2015:82). In this study, data were gathered through a questionnaire containing structured, closed-ended questions. The questionnaire was based on an earlier study conducted by Le Hau Xuan et al. (2018:283-300) and modifications were made to fit the research context of this study. The questionnaire is divided into three sections. Section A covers the demographic and general profile of the participating companies, number of employees, number of years in business, nature of projects and type of project business in the demarcated area. Section B evaluates the project history and project challenges faced by project businesses within the specified area. In Section C, part 1 addresses adoption levels and part 2 accesses barriers to digital project management solutions by project businesses, while Section D evaluates the organisations' readiness and willingness to adopt digital project management solutions in the demarcated area. Validity and reliability requirements were considered as outlined by Vogt (2007:118) and Hammond and Wellington (2013:151). In this regard, a pilot study approach was utilised to test the validity of the questionnaire. A pilot study is a survey conducted to ensure that the questionnaire is understood by the respondents (Fink, 2010:184; Kumar, 2014:13; Adams et al., 2014:127). The researcher conducted a pilot study to ensure the accurateness of the questions and their sequence in the questionnaire. The process helped to ascertain the understanding of the questions and instructions as well as the time required to complete the questionnaires.

The questionnaire contained Likert-type multi-choice questions. A Likert scale is a type of response alternative where participants can select graduation of agreement within a stated attitude or judgement (Mahmud 2008:62; Vanderstoep & Johnston 2009:54; Nishishiba et al., 2014:96). The researcher utilised a five-point Likert scale to enable participants to express their degree of agreement as strongly disagree, disagree, neutral, agree or strongly agree.

1.8.2 Data collection method

In consideration of the response rate and the participants' time and convenience, this study utilised two types of data collection methods: 1) structured questionnaires containing closed-ended questions were physically administered and 2) emailed to participants. The questionnaires were specifically distributed and emailed to project managers, site managers, supervisors and other senior executives of the identified project businesses. Telephonic interviews were conducted in the data screening and error detection phase (see Section 4.2) to ensure data accuracy.

The data was recorded as follows:

- Distributed questionnaires: Participants physically completed the questionnaires in writing and returned the completed questionnaires to the researcher. The time taken to complete a questionnaire was approximately 30 minutes.
- Emailed questionnaires: Participants electronically completed the questionnaires on their computers and emailed the completed questionnaires back to the researcher. The time taken to complete a questionnaire was approximately 30 minutes.

1.9 Data coding and analysis

Data were analysed using Microsoft Excel for coding and the Statistical Package for the Social Sciences (SPSS) v26.0 was employed to process the data collected. To ensure comprehensiveness, reliability and readability of data, the researcher employed coding and editing methods. The measures were used to ensure the accurateness of information on the questionnaires. Descriptive statistical analysis was applied to present the principal tendency, arithmetic measures and the measures of variability of the data collected.

1.10 Ethical considerations

Ethics are rules to govern the way people behave in a social context (Ransome, 2013:4; Kumar, 2014:282). Ethical research principles upheld in this study included obtaining voluntary consent (Curtis & Curtis, 2011:15; Anderson & Corneli, 2018:93). The anonymity and confidentiality of the respondents were upheld at all times (Hammersley & Traianou, 2012:121; Babbie, 2013:35-36).

The researcher refrained from fabrication of authorship, evidence, information, data results, or conclusions; plagiarism; disclosing information that would harm participants, collaborating in vague and/or inappropriate language; sharing data with others; retaining data and other materials longer than necessary and replicating publications (Vanderstoep & Johnston, 2009:12-18; Creswell, 2014:99-101).

The researcher will assume responsibility for the way that this proposed research will affect others. The researcher will imitate how the results will be acknowledged by the community and how the results will be recognised by all those who may be affected by both the investigations and findings (Harding, 2013:26; Pruzan, 2016:303-304). Ethical approval to conduct this study

was sought and granted by the Cape Peninsula University of Technology (CPUT) Ethics Committee of the Faculty of Business and Management Sciences (see Appendix A).

1.11 Study outline

Chapter 1: Introduction and background to the study

This chapter presents the background and the scope of the study. The chapter also elaborates on the problem statement, the study aim and the research objectives. Furthermore, the research methodology, statistical analysis, ethical considerations as well as validity and reliability of the study are outlined.

Chapter 2: Literature review

Chapter 2 explores project management as a global phenomenon. The chapter includes a comprehensive discussion of the operational and technological challenges experienced by project businesses. A detailed discussion of project management digital tools and their implications is also covered in this chapter. In addition, factors that influence the adoption of project management digital solutions by project businesses are addressed.

Chapter 3: Research design and methodology

This chapter discusses the design and methods of research. It describes the adoption levels of digital project management solutions by project businesses within the selected mine in the Limpopo Province of South Africa. It explains the relationship between digital project management solutions and the challenges experienced by project businesses included in the study. Furthermore, statistical analysis, ethical considerations, reliability and validity are addressed.

Chapter 4: Results and discussion

Chapter 4 analyses, interprets and evaluates the findings of the study.

Chapter 5: Conclusion and recommendations

Chapter 5 consolidates the findings and gives an overview of the study. The limitations of the study are stated and recommendations for further research are suggested. Concluding remarks are presented.

1.12 Study limitations

The research instruments of this study need to be modified as this could influence their consistency. Because this is a case study, there might be a low response rate as the study focused on a restricted group of businesses. Furthermore, the study was conducted in a single mine region and the findings might not be generalisable to other project businesses in other mines and industries.

1.13 Definition of key concepts

Project Management Software (PMS). This is a “collection of electronic instruments that enhance the efficiency, planning and tracking of deliverables for a project team” (Bedneko, 2019:1). Kashyap (2018:1) defines PMS as “flexible cloud-based project solutions that ease the project workflow, collaboration and filing”.

Project. A project is a non-permanent process of developing or establishing a distinctive product or service (PMI, 2017:4). A project can be defined as a time-based venture that is aimed at developing something with an effort of producing an output. A project has a start and an end date; its result could conclude with the project team either reaching the set objectives or facing project dissolution, which is decided upon by the client ((Săvescu, 2018:299).

Project businesses. These are businesses that are shaped by project management. They deliver project-related services, developments and products to their clients. Project businesses are the kind of businesses that function in an environment that is driven by projects such as the architectural, engineering and construction industries (Hermano & Martín-Cruz, 2020:2). A project business is a business that “provides project services and industrial deliverables to its clients” (Arenius et al., 2000:1).

Project management. This is an act of leading and managing a project group towards reaching the main objective of the project (Amado et al., 2012:1). The PMI (2017:10) identifies project management “as the presentation of theoretical knowledge, skills, tools, expertise and techniques directed to the project activities in an aim to reach the stakeholders’ requirements”.

1.14 Summary

This chapter introduced and provided a background to the study. The research problem is stated, that project businesses face numerous challenges, and the study aim, research questions and study objectives are outlined. The chapter presented the research methodology applied in the study, including data collection and processing methods. The chapter concludes with the limitations of the study, ethical considerations and a definition of key terms relevant to this research study. The next chapter reviews literature relevant to the topic under investigation.

CHAPTER 2
LITERATURE REVIEW ON PROJECT MANAGEMENT

2.1 Introduction

This chapter reviews literature that is relevant to project management and project management technology. Furthermore, literature on project risks and factors that cause projects to succeed or fail is also discussed.

Most importantly, there is an overview of PMS and contemporary technological changes that have taken place in the field of project management.

The reviewed literature is pertinent to the aim and objectives of this study, which are:

1) To investigate the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo province;
2) To examine challenges of project management between project businesses that have adopted digital project management solutions and those that have not adopted digital project management tools at the selected mine in the Limpopo province;
3) To investigate the adoption barriers to digital project management solutions by project businesses at the selected mine in Limpopo province;
4) To determine the level of readiness to explore digital project management technical tools by project businesses at the selected mine in Limpopo province; and,
5) To understand the extent to which project management technology can influence the growth and success of project businesses at the selected mine in Limpopo Province.

These objectives are presented under the headings of project management, project management technology, PMS and project management in South Africa.

2.2 Definition of project businesses and projects

Project businesses are businesses that are shaped by project management, they deliver project-related services, developments and products to their clients. Project businesses are the kind of businesses that function in an environment that is driven by projects, such as the architectural, engineering and construction industries (Hermano & Martín-Cruz, 2020:2). A project business is a business that "provides project services and industrial deliverables to its clients" (Arenius et al., 2000:1).

Projects can be defined as time-based ventures that are aimed at developing something with an effort of producing an output. A project has a start and an end date; its result could conclude with the project team either reaching the set objectives or facing project dissolution that is decided upon by the client (PMI, 2017:4).

The characteristics of a project include:

- Creation of a distinctive output: a project is a creation of a unique palpable or immaterial product or service. The creation is guided by the requirements and needs of the client (Săvescu, 2018:299).
- A project has a start and an end date. In the process of planning, a project timeline is set that specifies the start and end date of a project (Săvescu, 2018:299).
- A project has a statement of finances or a budget. In every project, the costs and productivity are measured and a project budget is created to calculate the total costs of the project. The project financial transactions are also recorded to understand the flow of funds. The cost estimations of a project are essential to provide project managers with important information that enables them to take preventative measures where necessary while assisting the team to complete the project timeously without financial constraints (Narbaev & De Marco, 2014:1007).
- A project is embarked upon to fulfill stakeholders' needs and requirements. These needs and requirements emanate from the parties that are directly affected by the result of the project, which includes, for example, internal or external clients, end-users, government, shareholders, investors and the project team (Amado et al., 2012:1).
- A project is strategised, implemented and concluded through the use of Work Breakdown Structures (WBS) and Gantt charts (Gantt charts are charts invented by Henry Gantt, which are used for planning the project steps, scheduling tasks and monitoring the execution of projects). The WBS and Gantt chart are often used for strategising to achieve the project milestones and goals. Once the project strategy is complete, the next step is the implementation stage where the strategised plan is put into action by the project team (Tonchia, 2008:57; Lee & Shvetsova., 2019:7).

Projects are based on the magnitude, goals and activities, timeframe and scope of work (Săvescu, 2018:301). The magnitude of a project is the size of the project, which affects the time required to complete the project. Projects of high magnitudes have long-term goals, as opposed to small projects with short-term goals. The size of a project is the core of all the other functions, as both the activities and scope of work are shaped by the size of the project.

2.3 An overview of project management

Project management is the procedure and the act of applying information that is aimed at performing project activities effectively. Project management tools, skills and techniques are applied to ensure that projects are managed with the sole purpose of satisfying stakeholders, solving problems, reaching objectives and delivering correct products or services timeously. Poorly managed projects encounter several issues, ranging from refinements and over-budgets to producing poor quality work and failing to satisfy stakeholders (PMI, 2017:10).

However, Amado et al. (2012:1) assert that although there is a possibility of not meeting the stakeholders' requirements, project managers can still exceed stakeholders' expectations through meeting their project specifications.

Svejvig and Andersen (2015:279) point out six different categories that diversify project management literature:

- Contextualisation: includes information about the expansion of projects and elucidates how projects can be adjusted on organisational and environmental platforms. The motive of literature in this category is to drive project leaders to present creative ideas that are likely to result in sophisticated targets. An example is the Panama Canal expansion megaproject that followed this approach, where the project leaders enabled their project team to undergo project management training as a strategy to minimise complexities in the deliverance of their megaproject (van Marrewijk & Smits, 2016:534).
- Social and political aspects: includes information about social and political procedures which can influence the result of a project. This category has information that is mainly founded on societal and behavioral characteristics that affect projects, for example, project managers can at some stages be driven by emotions that affect their behaviors in a project (Svejvig & Andersens, 2015:283).
- Complexity and uncertainty: this refers to the complications and uncertainties that can affect the result of a project (Clarizen, 2015:1).
- Rethinking practices: this refers to alternative methods, perceptions and techniques to be considered in the lifecycle of a project (Svejvig & Andersens, 2015:283).
- Actuality project: refers to the practicality, deliverance and existence of a project. In this category, the final product is compared with the actual project plan (Svejvig & Andersens, 2015:284).
- Broader conceptualisation: refers to different views and the wideness of projects. In this category, projects can mean many things, for example, a machine can be referred to as a project in the same way as a mirror (Turner et al., 2013:12). This also leads to different views by project managers to defining project success (McLeod et al., 2012:76).

Hyttinene (2017:16) reports that the project management cycle includes five phases, being initiating, planning, execution, controlling and closure. In the initiation phase, projects are identified and elected, then permitted on the project charter document. During this phase project leaders define the project objectives and elaborate upon the project goals, while also addressing the project needs. Consequently, the planning phase is embarked upon whereby project leaders develop a baseline plan, which includes the project scope, resources, schedule, budget and risks. The planning phase is followed by the execution phase, which is about the delivery of the initial project plan and the accomplishment of the project milestones.

After the execution phase comes the control phase, which is established to manage all project tasks and accomplishments (Gido & Amado, 2012:7). Tereso et al. (2019:14) indicate that the final phase (closure phase) of a project lifecycle involves documenting the team performance, project payments, accomplishments and lessons learnt. Overall, Hyttinene (2016:16) concluded that the project management cycle phase was implemented with the sole purpose of forming a holistic breakdown structure of the project levels.

Several research projects found that since 2019 there has been a shift from customary project management processes to innovative solutions (Attarzadeh & Ow, 2008:3; Špundak, 2014:939-948; Spalek, 2016:499-506; Tabassi et al., 2019:633). Traditional project management approaches are becoming inadequate even though they have noticeable, well-recognized preplanning functions. Components of project management about traditional techniques have become inadequate in today's dynamic environment. As a result, project managers are now expected to rethink and make decisions that can blend into this ever-evolving and unpredictable environment. Cristóbal et al. (2018:8) make it clear that integrated approaches need to be implemented in the planning, scheduling, execution and controlling phases of projects. As a result, methodical investigations need to be carried out to assess the effectiveness of such approaches.

Chu (2015:286-287) held a different view, suggesting that project businesses should rather acclimatize to both local and universal fluctuations to be prosperous and adapt positively to the fluctuations that may take place. In this regard, Jaja and Amah (2014:6) opine that the discipline of project management requires organisational resilience to allow project businesses to foresee imminent challenges and put plans in place to tackle such challenges. The organisational resilience referred to above is separated into two parts:

- Firstly, put in place special tools for use in response to environmental fluctuations; and
- Secondly, implement enhanced potential measures that can be used to respond to environmental changes (Alrob, 2015:18).

Poston and Richardson (2011:56) report that project businesses have, over the years, experienced multifaceted growth patterns and project budgets that influence their project management. Consequently, the Project Management Body of Knowledge (PMBOK) alone has not been sufficient to address project management knowledge and skills for project managers. Hence, there is a need for project management methods to be redefined. PMBOK is an assortment of the greatest approaches, procedures, jargon and guidelines that are deemed to be acceptable in the discipline of project management. The PMBOK knowledge areas are a big part of project management and they are the set standards for its good practice (PMI, 2017:17). The PMBOK knowledge areas can be effective with the support of project managers who possess background knowledge in managing projects along with experience in

solving problems, leading a team and facilitating efficient communication channels. However, Hassan et al. (2017:75) argue that the success (or failure) of project management rests on the manager's personal characteristics. For example, a confident, narcissistic project manager is bound to guide the crew to a successful project by being proactive in planning, decision-making and applying advanced tools to manage a project (Hirschi & Jaensch, 2015:208). The above statement is supported by Zhu and Chen (2015:5), who claim that project managers' narcissism drives proactive decisions, reduces risks, enhances resilience and leads to successful projects.

2.3.1 Project management challenges

As indicated in the above subsection, project businesses are at the cutting edge to produce innovative strategies that can integrate project management processes and address challenges that hinder the development of projects (Ansah & Sorooshian, 2017:349). In conjunction with the above literature, some researchers have held different views about project management challenges. For example, Krajewski et al. (2013:71) note that projects can often lead to administrative challenges that can disturb the plans of attaining certain project management objectives. In addition, Le Hau Xuan et al. (2018:292) are of the view that the staff communication process of project management apparatuses and approaches is coupled with challenges that are caused by poor knowledge and technical capabilities of project team members. In the study of Tabassi et al. *(*2019:637), it was revealed that one of the major difficulties encountered by project managers in the 21st century relates to human resource management, which includes issues that are linked to employee recruitment, teamwork, labour issues, cultural and cross-cultural issues. Furthermore, the study reports that project managers face numerous technologically-allied challenges, such as:

- Risk Management: with technological risks as one of the parameters;
- Communication Management: about risks associated with encroachment of information communication technologies and computer-generated communications;
- Health and Safety Management: indicating the utilisation of technology as a strategic enabler; and
- Information Technology Management: with emphasis on the lack of knowledge, the lack of a Building Information Modelling (BIM) system adoption for construction businesses, adoption costs, cloud computing and security issues (Tabassi et al., 2019:635).

Also, Trinh et al. (2019:170) identified communication channels, technology complexities, project deadlines, staff capabilities and education processes of IT tools and techniques as project management challenges that affect the use of technology among project businesses.

With such a wide variety of challenges, the question remains as to which challenges specifically affect project businesses in South Africa, especially those in the mining sector.

2.3.2 Project risk management

Risk management is a critical part of project management. Legislation and internal guidelines obligate it to be pivotal and it must be considered when adopting digital project management solutions. Risk management is the creator and protector of values (ISO 31000:2018). Naeem et al. (2018:95) affirm that proper project planning contributes positively to the result of every project as it correlates to the success of that particular project. Moreover, the accomplishments of every project are affected by the management of risks, which can be greatly enhanced by discovering new ideas for risk mitigation.

Risk management involves decision-making that serves as an acknowledgement of potential risks and strategies. These strategies are implemented to alleviate the exposure of potential risks to reach the project objectives (Ennouri, 2013:291). In the views of Nikolova et al. (2015:76), uncertainty and risk remain as factors that threaten the development and accomplishment of project goals.

In every project, Cagliano et al. (2015:5-6), suggest that risky events can be analysed by applying numerous examinations such as:

- Decision Tree Analysis - which allows project managers to examine risky events and record them on a diagram. The purpose of this examination is to highlight different risky events that are associated with the planned activities of the project. This method provides several benefits such as clearness, efficiency, flexibility and compatibility in a project.
- Swift analysis - which enables project managers to examine risky events through brainstorming and using structured approaches that ascertain potential hazardous courses of action.
- Expected Money Value (EMV) - which is a statistical risk analysis method that enables project managers to measure and compare risks in multiple facets of a project. The good thing about EMV is that it provides project managers with typical qualitative results of all the risky events that are identified (Al Shaer, 2018a:1).
- Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis: - a SWOT analysis is a breakdown that contains project objectives and factors that can affect the project businesses from achieving such objectives. The strengths and weaknesses are often internal while opportunities and threats are external (Nicholas, 2015:41).
- What-if Analysis: this analysis is utilised for sightseeing and comparing different project plans and schedules depending on inconsistent conditions that can change at any

stage of the project. During risky project events the abovementioned analysis is used to measure subsequent consequences (Silvianita et al., 2018:4).

Rehacek and Bazsova (2018:10) suggest that for project managers to gain an advantage of risk management techniques they should apply such techniques in the preliminary stage of the project. The risk management techniques should have a single, clear and well-documented procedure for hazards that can occur in the cycle of the project.

Choudhry and Iqbal (2012:43-44) and Tipili and Ibrahim (2015:25) suggest the techniques shown in Table 2.1 below as the most useful techniques for identifying risks in developing countries.

Table 2.1: Risk **i**dentification t**echniques**

Technique	**Description**
Checklists	When identifying risks, the risk identifiers consider possible factors which have commonly led to catastrophes in past projects. In this way, risk identifiers and project managers can easily identify and acknowledge risks thereby placing measures in place for mitigation.
Consultations with specialists	Conducting interviews with experts to obtain historical facts and also studying the risks of related projects. Furthermore, considering the lessons learned by other project organisations are helpful means of attaining views on different project risks.
Historical experience	Analysing related past project experiences is not always a useful method as it depends on the degree of contingency. It is therefore crucial that the level of relativeness among projects should be immensely considered when analysing past project experiences.
Devising	Devising is useful when new changes are experienced in the organisation.

Source: Choudhry and Iqbal (2012:43-44); Tipili and Ibrahim (2015:25)

As illustrated in Table 2.1, risk identification techniques range from having checklists, consulting with specialists, referring to past experiences and devising new changes. Many project businesses require digital project management tools that contain features that are primed to help them assess and manage project risks, while also protecting and securing their project data when using such tools.

In the views of Hillson (2009:28) and Gachie (2017:167-168), Table 2.2 below lists the most-used risk mapping process.

Table 2.2: Risk management procedure

Description of process	Proposed to the project organisations
1. The process of risk initiation – in this process, project leaders set objectives and milestones that need to be attained.	Project leaders define risks following milestones and the scope of the project.
2. Risk management planning – this process involves setting a risk management method.	Project leaders decide on the most feasible and operative risk-controlling method for the reformation of the project while also setting restrictions, conditions and procedures.
3. Risk spotting – this process detects potential risks to form a chain of exposures from high to low.	Project leaders spot potential risks by doing risk assessments and putting relevant procedures in place.
4. Quantitative risk evaluation – this process comprises numbers used to analyse the impact of recognised risks. Qualitative risk evaluation – entails the analysis of identified risks to determine the possibility of reoccurrence.	Project leaders conduct quantitative risk examinations to study the statistical influence of the risks. Project leaders also access the qualitative likelihood of risk factors reoccurring by scrutinising the risk potential patterns and core characteristics.
5. Risk reaction plans and execution – this stage involves setting reaction plans that can be followed when the success of the project is threatened.	Project leaders set reaction plans for lessening the possibility of being exposed to risks. The reaction plans are tested to ascertain if they are effective.
6. Risk management and observation – involves tracing potential risks and observing those that might be persistent.	Project leaders frequently trace and identify risks and reactive action plans to minimise the impact of the identified risk.
Risk evaluation and post-project evaluation – this step involves documenting and keeping a record of undesirable and desirable lessons and details of the projects.	Project leaders keep a record of all project lessons for advancement and for reviewing historical details.

Source: Hillson (2009:28); Gachie (2017:167-168)

Table 2.2 above depicts a detailed risk-plotting process that is commonly used by project managers when they structure projects. Ideal project management technical tools are those that enable project managers to access the above-mentioned steps and still be able to keep a record of all information that was obtained when conducting a risk assessment.

2.3.3 Project success

According to Biafore (2013:266) and Harris (2016:5-7), a successful project is dependent on meeting the deadline within a reasonable financial budget that benefits all beneficiaries of the project. In this regard, the preliminary principles of project successes are time, cost and scope (Williams et al., 2015:12; Wilson et al., 2015:3).

The most-used traditional approach is the iron triangle approach as illustrated in Figure 2.1. It confirms that the project's success foundation is characterised by the scope, the duration and the budget. The scope of a project is the overall work that must be executed to distribute the required services or products (PMI, 2013:105). Cost management is the essential total expenditure and capital that is mandatory to deliver the final product, service, or sequel of the

project (PMI, 2013:195). Time management refers to the length or period required to manage and complete the project (PMI, 2013:141).

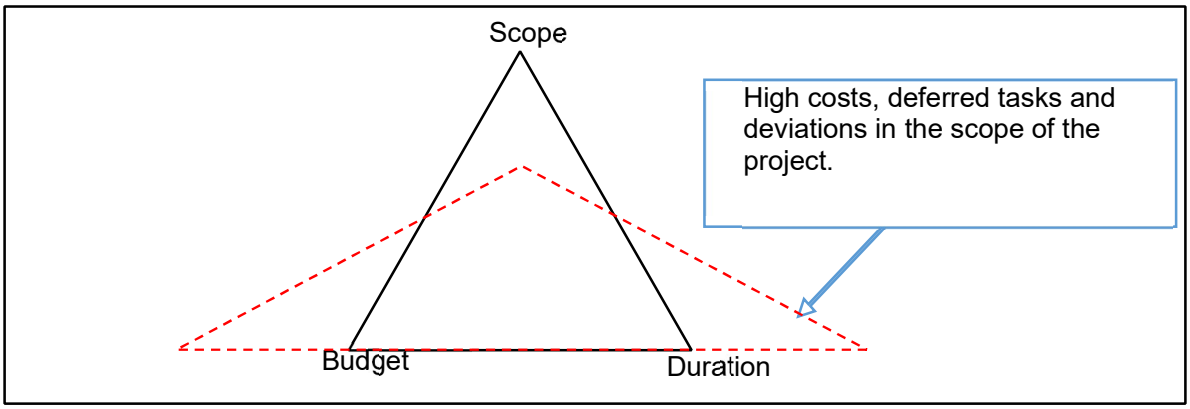


Figure 2.1: The iron triangle of managing a project

Source: Adapted from Machado and Martens (2015:30)

Considering the above, the following are vital dynamics of success identified by Ofori (2013:20), Verburg et al. (2013:15-16) and Haron et al. (2017:4). For a project business to be successful, the following dynamics must be considered:

- Clear project management objectives: these are the outcomes of a project and are determined by the set objectives. Therefore, for the adoption and use of project management technical tools to succeed, project managers need to set explicit objectives and ensure that they are communicated clearly.
- Top management support: for a project to succeed it is key for top management to support the members of the project team in their tasks despite the level or type of digital project management tools or techniques that are utilised by the organisation.
- Information/effective communication: information, concepts, plans and knowledge should be shared effectively throughout the project to ensure that the intentions are achieved most successfully.
- Client involvement: for project businesses to accomplish the requirements of the client they must have the client involved in every step of the project as this contributes to satisfying the client's needs.
- Competency of project team: for a project to succeed it is essential to appoint team members that are proficient and capable of completing their tasks diligently and promptly.
- Genuine financial and time estimates: to avoid financial issues that could most likely lead to project failure, it is critical to have sound forecasting figures for the projects.
- Adequate project control: for a project to succeed, it is imperative for project managers to completely control the whole project. This means that project managers must be able

to gather and analyse project information to track the financial costs and schedules of the project. Project managers must have the ability to control and improve project performance.

- Problem resolving aptitudes: the likelihood of achieving success is high when project managers have the aptitude to devise solutions to potential problems that could arise during the cycle of the project.
- Project performance and quality: this means project managers should ensure that all the project accomplishments are carried out commendably and professionally following the design, the project proposal and the objectives of the project.
- Enough resources: resources such as the workforce and materials are also determinants of success therefore, project managers should carefully monitor their project resources. A clear, daily tracking record should be maintained to avoid running low on resources. Furthermore, project managers need to ensure that there is efficient and effective administration and allocation of resources.
- Sufficiency of risk alleviation plans (Risk Management): if project risks are not mitigated, they are more like to lead the project to failure. For project managers to succeed in their projects, it is important to carry out thorough risk assessments of all stages of the projects to assess the possible occurrence of risk events with the aim of to putting reactive plans in place (Ofori, 2013:20; Verburg et al., 2013:15-16; Haron et al., 2017:4).

According to Radujković and Sjekavica (2017:609), Figure 2.2 below depicts some of the most-recognised factors of success in a project.

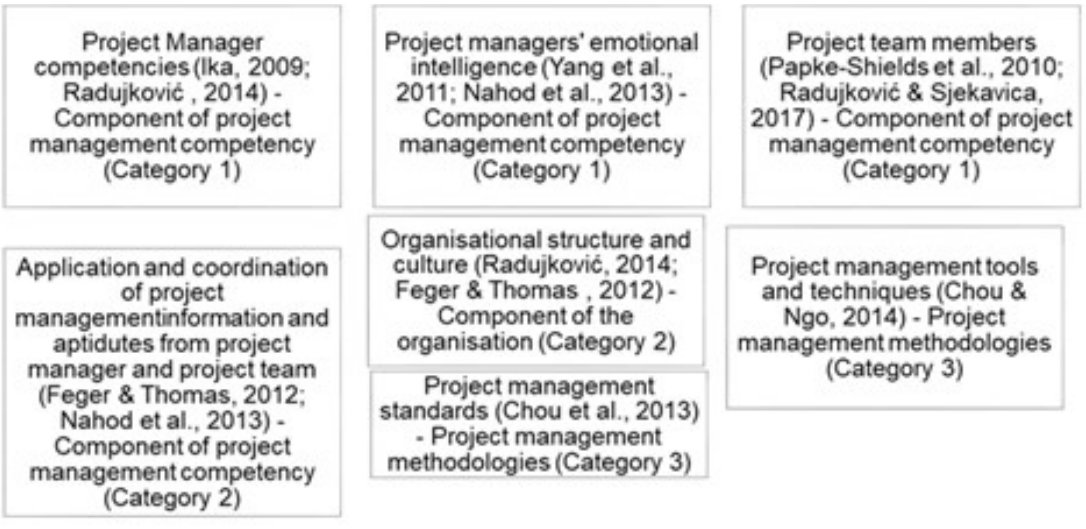


Figure 2.2: Success factors of project management

Source: Adapted from (Radujković & Sjekavica, 2017:609)

Category 1: refers to components of project management competence, being contextual proficiencies, the coordination of project managers and the overall performance of the project workers.

Category 2: includes the components of the organisation such as structural, cultural and organisational aptitudes that drive the success of the project business.

Category 3: refers to project management methodologies, including project management approaches such as PMS packages, project management tools, risk assessment tools, decision-making tactics and Information Communication Technology (ICT) solutions.

Both the success of a project and the accomplishment of the effective use of digital project management tools rely heavily on the project leader's competence and the project team performance referred to in Category 1 as seen in Figure 2.2. Category 2 in Figure 2.2 shows that the success of introducing and applying technical project management tools in an organisation is affected by the attitudes, cultures, conflicts of interest and aptitudes of project managers and other staff members who are directly affected by the introduction of such technical tools. Organisations with employees who are computer literate and have the capability, interest or willingness to utilise technical programs are more likely to apply technical tools in their project phases. However, Category 3 affirms that the success and direction of a project is constructed on the foundation of project management approaches set by project managers.

Successful projects ideally have project managers and team affiliates that are proficient and well-coordinated. Successful projects have a proper organisational structure, they have project managers that have adopted project management tools and techniques (Fortune et al., 2011:561-562; Jugdev et al., 2013:532; International Management Association, 2016:57). Emuzie and Smallwood (2011:13) assert that quality plays a huge role in the success of a project and consequently, efforts in the management of projects should be directed at improving quality. Chinyamundi (2017:9) believes that for site managers to ensure that the standard of projects is not compromised, they must use tools and techniques that are in place to aid effective decision-making.

2.3.4 Project failures

According to Graves (2014:1), unsuccessful projects are those that lack specialists who can engage with the project team members to tackle the root problems that cause projects to fail. Antony et al. (2018:729) argue that unsuccessful projects are those that lack full commitment from top management and sponsors of a project in avoiding project failures and ensuring development in their organisations. Furthermore, project managers can ensure developments by regularly assessing progressions in every stage of their projects. This could be achieved by

conducting periodical assessments to see the progress of their projects and eliminate any issues that are likely to prevent the projects from succeeding. The periodical project assessments consist of reviews and full involvement by project managers in every stage of the project, from setting project objectives and allocating resources, to the monitoring and controlling functions (Antony et al., 2018:732).

However, Tewari et al. (2017:106) present a different view, that the most-recognised cause of project failure is poor communication by the project leaders, while García-Alcaraz et al. (2018:4), Jadhav et al. (2014:337 and Marzagão and Carvalho (2016:213) point out that communication should not be singled out but should rather be joined with IT. Therefore, communication and IT facilitate effective communication and should be carried out conjointly by project leaders and project team members. This is effective for sharing and recording accurate, quality information as well as for reporting information about the progress of multiple projects.

Easton and Rosenzweig (2012:485) identified training and education for team members as a vital determinant of project success in the implementation phase. Therefore, to avoid being unsuccessful in many projects it is fundamental to ensure that the project team members are competent and have received adequate training and education. Since the business environment is bound to experience changes, it is advantageous to have team members that are well-trained and educated, with the aptitude to accept and take advantage of the expected changes that may occur in the project business industry (Laureani & Antony, 2017:727). Antony et al. (2018:728) maintain that project leaders should recognise the correlation between skills, performance and skills development.

Arumugam et al. (2014:8) found that rewards and incentives influence project failure and as such, project leaders should reward and incentivise well-deserving workers to drive project success. Rewards and incentives trigger the interest of employees and keep them motivated (García-Alcaraz et al., 2018:6).

Tewari et al. (2017:106) argue that a common factor that leads to project failure is poorly defined project scopes that lack detail. Deviations can occur in any phase of a project and as such, it is suggested that project leaders should be familiar with scope management methods in the planning process (Antony et al., 2018:733).

Concerning the above, the following factors can cause projects to fail:

- The disruption caused by competitors: the existence of the digital revolution creates room for new project businesses to enter the market and cause disruptions that lead to many variations in the business market. Digitalisation has resulted in increased competition from existing businesses that take advantage of new technological developments (Zagorsek et al., 2017:99).

- Major alterations to the initial plan and undefined consumer requirements: stakeholders who change their requirements at any stage of a project cause alterations in a project. Some major alterations in a project are also influenced by changes in regulations, sponsorship, business strategies and the lack of resources, as well as the introduction of modernised technology. Poorly defined specifications by the client and poorly defined project scopes by the project manager often have a negative impact on the development and building phase of the projects (Amoatey & Anson, 2017:396-397).
- Disputes and clashes among project divisions: the implementation of many projects has become difficult in instances where project businesses have limited time to plan their projects. This results in issues such as scope creep, conflict among project members and upsurges in the implementation stage of the project. It is at this level where clashes arise as a result of schedule delays, scope modifications and technical issues, which are likely to devastate the project manager and the overall team (Al-Zwainy et al., 2018:620-621).
- Financial imbalances: as a result of competition, many project businesses during the bidding process apply the strategy of providing lower prices to their clients to become the best bidder. This strategy, however, often creates an imbalance of costs if the costs of the project are higher than estimated by the project leader. Imbalances and mismanagement of funds can cause a project to fail. It is, therefore, important for a project leader to be experienced and have good financial management skills (Kwon & Kang, 2018:2).
- Poorly demarcated specifications: the project specifications are most likely poorly outlined when the design and development of the project is presented without conducting an in-depth analysis of the client's requirements and the cost benefits of the project (Stretton, 2018:3).
- Poor management of supplies and procurements: a project leader that sets unrealistic deadlines with high expectations from suppliers is likely to lead the project to failure. Project leaders must consider all the project's influential dynamics and constraints before setting deadlines and having expectations (Montequín et al., 2018:4).
- Absence of commitment, communication, competence and vision by the project manager: lack of commitment, communication and the necessary skills of the project team can affect the success of a project. It is the responsibility of the project managers to ensure that there is unity and that the project team is dedicated to achieving common goals (Stretton, 2018:5).
- Lack of quality inspection: quality management is essential and should be conducted at every stage of the project. To ensure that quality management is carried out, the project manager should formulate detailed quality management plans before the commencement of the project. The plan should cover the project in totality and be

accurate. The quality regulation process should be included and the plan should include a quality reassurance process (Nicholas & Steyn, 2012:1298).

- Lack of new technology or the incompetent use of technology: large projects require proper management of the calendar and the budget. If not well managed, it can result in impractical and unrealistic deadlines, last-minute endeavours and even backlogs. Technology plays a critical role, especially in large projects, by handling schedules, record-keeping, tracking tasks and helping with the management of the budget through the PMS, thereby creating an opportunity to invest in business growth (Stretton, 2018:4).
- Unexpected risks that occur without planned mitigation by the team: unexpected risks can threaten the success of a project if they are not tracked or reviewed. There are three kinds of risk:
    - Cost risk that is caused by poor planning and management of funds.
    - Schedule risk that is caused by tasks that are not well scheduled and are lengthy.
    - Performance risk that is caused by an inconsistent result of a project (Montequín et al., 2018:4).
- Client expectations that are impractical and unachievable: over-promises by the project manager and unrealistic project expectations by the client can lead to project failure as some goals will not be achievable. It is critical to manage client expectations and form a client expectation alignment that is consistent with the authenticity of the project in an attempt to lessen the possibilities of the client modifying the specifications of the project (Amoatey & Anson, 2017:397).
- Lack of resources (staff, equipment and money) to complete the project: the deficiency of resources can be caused by the overuse of resources and the lack of commitment to stick consistently to the initial plan or budget of the project. This can also be caused by the project manager lacking the obligation to ensure that the required resources are available when required and that a proficient workforce is in place to fulfil relevant tasks of the project (Kwon & Kang, 2018:2).

2.4 Overview of project management technology

Project management technology refers to the use of technological systems for planning, initiation, monitoring and controlling functions of project management (Puška et al., 2020:90). It involves the deployment IT systems and networks that are used for storing and handling project data (Arnold & Javernick-Will, 2013:510). The involvement of project management technology has become useful in simplifying the planning and communication processes of projects. According to McGrath and Kostalova (2020:1), it is now evident that globalisation and collaboration drive the growth of technological tools in project management. For example, BIM simplifies inter-organisation communication and information exchanges in projects. BIM is

defined as a system that virtually depicts a model of a structure or a building. BIM is utilised to create a virtual holistic view of a project before its initiation phase to assist project managers in understanding the design, geometry and the information required for supporting the entire project team. BIM provides a cybernetic presentation of the result of a project (Azhar, 2011:242). Gustavsson et al. (2012:527) report that the implication of project management technology is that most project businesses that have invested in technological tools have hardly reached their projected competitive advantages and as such, it is suggested that upon the adoption of technological tools, business processes should be amended and all project actors should partake in the utilisation of such tools (Gustavsson et al., 2012:522; McGrath & Kostalova, 2020:1).

Another implication of project management technology is that in many projects it has become evident that architects are authorities that make more use of technological tools than any other authorities, such as contractor project managers and engineers (Gustavsson et al., 2012:525). Architects have a strong awareness of technological tools, they are familiar with tools such as BIM, which are commonly used for planning construction projects. However, concerning the above, it is essential to note that the delay in using advanced project digital tools is caused by the lack of mobile devices and the lack of familiarity in the use of digital tools. The craftsmanship of contractor site managers has also been noted as a barrier to the use of digital tools as only 40% of contractors in 2012 were discovered to be using digital tools in the initiation of their projects, only to manage critical factors such as time and resource planning (Gustavsson et al., 2012:525). However, this is gradually changing as Klynveld Peat Marwick Goerdeler (KPMG) et al. (2019:8) and Wellingtone (2020:11) have noticed a few variations in the use of technological tools by contractors. In this regard, McGrath and Kostalova (2020:3), anticipated that more contractors are expected to introduce Information Technology (IT) tools into their projects.

Adriaanse et al. (2010:74) opine that the use of technology in organisations can be obligatory or voluntary, depending on the conditions of the industry; some projects have short-term durations that limit the period of initiating and introducing technical tools in their organisations. Son et al. (2012:83), argue that some project site managers are reluctant to use technology when their commercial contracts contain restrictions regarding the utilisation of technology in managing projects.

2.4.1 Recognition and adoption of technical project management solutions

PriceWaterhouse Coopers (PWC) (2012:18), point out that the adoption of project management technical tools and techniques has become standardised among project businesses. PWC (2012:17-18), record that only 77% of project businesses are mindful of technical project management solutions and use such tools in their projects. The figure is supported by KPMG et al. (2019:8) in their global survey of project management, which found

that project management technical tools and procedures are widely used by 71% of project businesses worldwide. However, the Wellingtone (2020:11) survey held a different view, which argues that the employment of project management technical tools and techniques is low, since only 25% of project businesses make use of project management technical tools. According to Wellingtone (2018:12) and Wellingtone, (2020:11), the adoption of project management technical tools has only changed gradually with an increment of 3% from 2018 to 2020. In light of the above, it is comprehensible that the awareness and adoption of project management technical solutions by project businesses are ambiguous and as such, more research is needed. Since the utilisation of project management technical tools and practices is associated with an organisation's performance, Figure 2.3 below shows the project performance ranks.

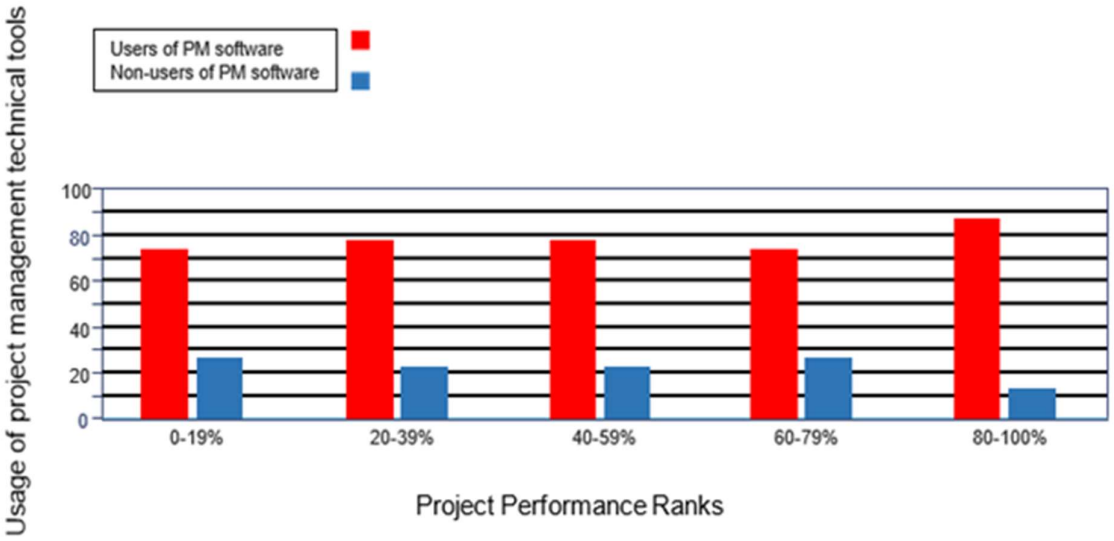


Figure 2.3: The usage of PMS

Source: Adapted from PWC (2012:19)

As shown in Figure 2.3, there is a link between the use of project management technical tools and the performance of a project. The figure shows that project businesses that use digital project management tools have higher performance levels as opposed to those that do not use digital project management tools. PWC (2012:18) asserts that there is an unswerving connection between the usage of project management technical tools and project performance. Among the well-performing projects, 87% of project businesses utilise project management technical tools and techniques (PWC, 2012:18).

Brynjolfsson and Yang (1996:39-40) noted that the implementation of project management technical tools and practices does not often result in anticipated outcomes. This is supported by McGrath and Kostalova (2020:8) who add that for project management technical tools and practices to produce anticipated results it is vital to have a high-performing team with a proficient leader. The unanticipated outcomes of project management technical tools are referred to as the paradox of productivity, which includes inaccurate measures of productivity, long observations that are focused on increasing productivity, poor management of PMS tools and the inability to anticipate Return on Investment (ROI) of PMS tools (Dewett & Gareth, 2001:337; Bresnahan et al., 2002:28; Bardhan et al., 2007:589; Aubert & Reich, 2009:32). In the past years, many researchers became interested in investigating the impact of project management technical tools and techniques as a result of the paradox of productivity in organisations. For example, the study of Bryde and Wright (2007:5) exposed the connection between project management technical tool efficiency and the project team members' expectations, as well as clients' expectations. Ali et al. (2008:5) investigated the effect of PMIS (Project Management Information System) and discovered that PMIS has a positive effect on project performance, while Raymond and Bergeron (2007:217-219) publicised the recurrent usage of PMIS and its positive impact on project performance. The study of Dostie and Jayaraman (2008:1) indicated a high productivity level of employees that use computers against those that did not, while Pellerin et al. (2013:21-22) highlighted the level of PMS usage and its correlation with project performance of engineering projects in Canada. However, these studies were less focused on ascertaining any correlation between the recognition and employment of project management technical solutions and their challenges in the African continent and as such, the current study focused on South African project businesses.

2.4.2 Extent of project management technology's influence growth and success

There is a direct connection between the use of technological tools and the growth of many organisations. Several experienced organisations that are at a high maturity level, are more likely to employ project management technical implements and systems, while 95% of project businesses at the high maturity level utilise project management technical implements and systems, opposed to 55% at a low level of maturity (PWC, 2012:18). According to a survey conducted by Wellingtone (2020:9), many organisations are progressively becoming dissatisfied with their level of project management maturity. This was concluded after 45% of project businesses in 2016 were unhappy about their level of maturity and in 2020 this had increased to 52%. Furthermore, only 35% of project businesses are satisfied with their level of project management maturity. The Wellingtone (2020:9) survey further highlighted project management tools and technology as critical factors in the project management maturity radar. In addition to the above, the KPMG et al. (2019:15) survey reflects that project businesses should invest in new technology for enhanced collaboration implements and artificial intelligence tools to allow quick and effective utilisation of project management information that

will aid decision-making. The adoption of collaborative technological tools (which can be used jointly) is relevant because it is revealed that 51% of project businesses utilise these tools to ensure the delivery of their projects, even although the effectiveness and efficiency of such tools have not been determined. In addition, it was noted that only 8% of project businesses globally have introduced artificial intelligence tools into their organisations to support their projects but the percentage is expected to increase (KPMG et al., 2019:11-12).

2.5 Project management software (PMS)

As stated in Chapter 1, PMS is the "collection of electronic instruments that enhance the efficiency, planning and tracking of deliverables for a project team" (Bedneko, 2019:1). PMS is a "flexible cloud-based project solutions that ease the project workflow, collaboration and filing" (Kashyap, 2018:1). The purpose of PMS is to ease business processes in the lifecycle phases of project management (Puška et al., 2020:90).

Project managers in recent times are assisted by many project management technical apparatuses and practices. The commercial field has noted that stakeholders have become accustomed to requesting quality projects that can be delivered in a short timeframe. Therefore, this has positioned a necessity for further improvements in the field of computer technology (Hajjaji et al., 2010:125). There are some software packages, which are commonly used in project management, such as Microsoft Excel and Microsoft Project, which are applied to analyse risks and construct project management models. Other PMS tools that are commonly used include the Palisade Software and PRISM, which are products of the Palisade Corporation founded in 1984. These tools can be utilised to analyse project risks by generating important statistical techniques such as Monte Carlo simulations (Monte Carlo simulation is a statistical method applied by project managers to gain an in-depth understanding of the effects that risks and improbabilities can have in project management (Al Shaer, 2018b:1). The Palisade Corporation is reputable for providing leading project risk analysis software packages. For example, the company established the @Risk package, which has graphical features incorporated with Monte Carlo simulation in MSE (Palisade, 2010:1).

According to Borštnar and Andreja (2014:19), top managers, project managers and the project team workers at large are backed by technological programs in every project. The authors highlight that IT serves as a communication platform between the organisational structures of project businesses and as such, every department utilises PMS tools for different functions. Top management uses PMS packages for tracking financial pointers and key performance indicators (KPIs), while project managers use PMS packages for project planning and reporting. The project team members utilise PMS packages for administration and communication purposes. Studies, such as those of Raymond and Bergeron (2007:219) and Pellerin et al. (2013:864), indicate that low-performing projects are those that have low usage of software packages. These studies further state that every project performance is linked to

multiple software subsystems. These software subsystems cannot be compromised as they include functions of documentation control, project definition, construction activity administration and cost management.

2.5.1 PMS selection criteria

Since 2012, there has been an upsurge in the number of available programs, applications and software packages that can be utilised to manage projects. According to Valenko and Klanšek (2017:1629), organisations usually find themselves in situations where they have multiple PMS tools from which to choose since there is no perfect solution for all organisations. For example, Australia, a country that uses advanced technology in project management, has e-business systems to address project-related issues that influence site managers to prioritise ease of use of technological tools. Furthermore, Gajendran and Perera (2017:9) also noted that Australia has introduced project communication platforms that make it difficult for project businesses to choose PMS tools that are suitable for their operations. Overall, the above information is an indication of the dilemma that exists when project businesses have to choose a PMS package that is suitable for their organisation. Below are factors that need to be considered when choosing a PMS package.

Tamang (2018:1) notes that the top reasons for project managers to choose or replace PMS packages include:

- Further improve ease of use: the ideal PMS package for project managers is one which is user-friendly. A user-friendly PMS package increases productivity since it makes it easy to track employees' resources.
- Seek an incorporated collection: project managers seek integrated PMS packages to cut costs, to have a single program that has all the required features and so avoid spending on multiple programs. In this way, data can be consolidated to audit behavioral patterns during management audits.
- Search for consistent workflows: advanced workflow administration systems are good for saving time between the preliminary point of the project and the point of internal approval. Consistent workflows enable managers to create a notification panel for employees to view upcoming or past deadlines. Consistent workflows are preferred as they assist project managers to ensure that employees are notified about recent and upcoming projects, guiding principles and changed schedules.
- Seek a time-tracking and project-tracing system: a track and trace PMS package provides the team with benefits to view present events and also forecast future events of the project. For project managers, this sort of benefit is vital to keep the projects' daily activities completed faultlessly.
- Ameliorate collaboration: innovative PMS packages enhance collaboration through the eradication of face-to-face interactions and paper chasing collaborations. PMS tools

promote a computer-based collaboration that is more efficient, environmentally friendly and offer real-time information that can be accessed continuously. Enhanced collaboration allows project managers to keep their teams up to date about the list of tasks that need to be completed, those that are completed, as well as those that are pending. Furthermore, PMS packages provide employees with a panel to deliver feedback and share task-related information of their projects.

- Revamp project planning: project managers want a PMS package that can provide them with a project plan that is sound as has a realistic timescale. Project managers prefer PMS packages that can produce accurate budget estimates, a clear record of milestones as well as deliverables. Enhanced PMS packages outline all the required resources for the project and flag the most important resources and risky events.
- Seek better customisation features: some PMS package developers can modify their software to meet the requirements of their clients. Project managers prefer a PMS package that is easy to use, is tailored to their needs, increases efficiency, as well as the confidence and productivity of their teams.

Furthermore, the success of a project is reliant on accurate data which delineates the whole project. Below is a list of factors that have to be considered when selecting a PMS package. In this regard, the adoption and effective utilisation of project management technical tools is influenced by the factors below:

- The types of reports generated by the PMS package – when deciding on the selection and usage of a PMS package, it is critical for project managers to seek a package that generates well-systematised and errorless reports (Ray, 2019:1). Project managers should consider PMS packages that can present information by amalgamating data from different zones to create reports that present the current state of the project. It is, therefore, clear that with the adoption of the right PMS packages project managers can easily obtain and access well-generated project reports (Upadhyay, 2019:1).
- The dashboard view of the PMS package – a dashboard view is a web-based administration control panel for setting preferences and shortcuts (Ray, 2019:1). Project managers should seek a PMS package that can provide integrated dashboards that can be modified (Upadhyay, 2019:1).
- The efficiency of managing tasks within the required PMS package – this is a significant feature as comprises integral parts that are used to set the direction of the project. The parts are calendars, project schedules, file SharePoint and other features that support the accomplishment of the project venture (Ray, 2019:1). Project executives need to consider highly professional scheduling tools with features such as a Gantt chart tool if they are managing major projects. The ideal software should enable project managers to organise tasks in chronological order while setting completion target dates where

communication alerts will be automatically sent to responsible team members (Upadhyay, 2019:1).

- The administration function of resources in the package – effective administration as well as the control of staff, equipment, time and the budget are essential in the development of a project. It is fundamental that resource management proficiency must be considered when selecting a PMS package (Ray, 2019:1).
- Continuous integration of the PMS package – it is ideal for project managers to have a PMS package that enables them to retrieve information from other tools and computer applications. It is also beneficial when a PMS package is cloud-based and supports numerous devices (Maffeo, 2017:1; Ray, 2019:1).
- System support of the PMS package – when buyers purchase a PMS package, they should analyse the form of support provided by the software provider. PMS software service providers serve a single or multiple channeled type of support structure; therefore, project businesses should ascertain which channel is suitable for them (Ray, 2019:1).
- The security coverage of the PMS package – security coverage is very significant to consider when selecting a PMS package. Data can be poached if the software provider does not provide tight data security. A project business must consider the level of security offered by software service providers. Security measures, such as verification of users, encryption methods and other security techniques should be considered (Ray, 2019:1). According to Upadhyay (2019:1), if project managers are planning to use online software packages, they should ensure that the package has 128-bit encryption.

2.5.2 PMS packages

Since there is a high number of PMS packages from which to choose, this section explains the various PMS packages that can be utilised by project managers.

2.5.2.1 Microsoft Project (MSP)

Microsoft Project (MSP) is a digital project management technical solution that was established to provide information regarding the development of projects. The information is generated in the form of reports that users can access and obtain (Deshmukh et al., 2019:421). MSP is mainly used for managing project schedules and plans. This PMS package can also be utilised for gathering project data, presenting project schedules, distributing information to the team, assigning duties and materials and streaming communication among project stakeholders (Marmel, 2013:489).

The adoption and usage of MSP compromises the features below:

- Milestone tracking (Microsoft, 2010:1; Chatfield & Johnson, 2016:40): MSP consists of a feature that highlights key events of a project;, with this feature, important events with limited timeframes are automatically highlighted with warning signals.
- Resource administration (Chatfield & Johnson, 2016:56): with the aid of MSP, the executive management of the project business can efficiently manage materials, equipment and assign tasks to workers.
- Calendar view feature: this feature offers special formatting functions which are easy to use while also providing a timetable that can be edited (Chatfield & Johnson, 2016:139).
- Project scheduling control function: MS project provides numerous functions that can be used to enhance control over schedules. With this function, project managers can form a list of tasks on MS Excel or MS Word, which can be transferred to MSP without reformatting (Microsoft, 2010:1; Chatfield & Johnson, 2016:78).
- Project plan refining (Microsoft, 2010:1; Chatfield & Johnson, 2016:13): this feature allows the project manager to manage changes that may occur that affect the phases and structures of the project plan, such as tasks, assignments, labour and materials (Microsoft, 2010:1; Chatfield & Johnson, 2016:179), for example, changes that occur within the project assignments or tasks affecting project resources.
- The Gantt chart: this feature consists of a graphical time-tracking chart, a bar chart and a table of tasks that can provide useful information for a project. This function provides a bar chart presentation of the project timesheet and the status quo of all project tasks that need to be completed urgently, those that are incomplete and those already executed (Microsoft, 2010:1; Chatfield & Johnson, 2016:89).
- File management: this feature supports different file formats and it makes it easy for project managers to customise, store and recover documents (Microsoft, 2010:1; Chatfield & Johnson, 2016:470).
- Tracking development: having a good record of the project developments allows project supervisors to identify discrepancies. In this regard, project leaders can modify their initial plans to facilitate the completion of the project (Microsoft, 2010:1; Chatfield & Johnson, 2016:440).

Project Management Learning (2010:1), O'Loughlin (2017:1) and Deshmukh et al. (2019:426) have identified the factors in Table 2.3 as the benefits and limitations of Microsoft Project.

Table 2.3: Benefits and limitations of Microsoft Project

Benefits	Limitations
It has a user interface	It lacks practicality in tracking tasks of short duration (minutes or hours).
It is adjustable and easy to use	Its flexibility function of scheduling tasks is limited.
Financial projections can be generated	
Allows tracking of work in progress	
It provides project guidelines	
It enables the user to compare the project plan and its developments	
It is less time consuming	

Source: Project Management Learning (2010:1), O'Loughlin (2017:1) and Deshmukh et al. (2019:426)

2.5.2.2 Gantt Project

The Gantt Project is a XML file saving software that can operate on every operating system and can be used to import Program Evaluation Review Technique (PERT) charts (PERT charts are project management diagrams that are commonly utilised to plan, organise and synchronise project tasks), export and import different file format charts (Fontana et al., 2011:452; Rouse, 2019:1). There are more than 500,000 project managers from 120 countries that have adopted and use Gantt Project (Gantt Pro, 2020:1).

Features of Gantt Project are:

- Project scheduling: the Gantt Project provides a reliable management platform for managing PERT charts and identifying project schedules (Ren et al., 2008:14; Lopez-Herrejon et al., 2011:185; Gantt Project, 2020:1).
- Task management: the Gantt Project software is capable of indicating the level of necessity for each project task while also providing a breakdown of tasks based on their importance (Ren et al., 2008:6; Lopez-Herrejon et al., 2011:187; Gantt Project, 2020:1).
- WBS: the Gantt Project PMS package includes a WBS that simplifies the scheduling and levelling process of each segment of the project (Ren et al., 2008:4-5; Lopez-Herrejon et al., 2011:186; Gantt Project, 2020:1).
- Milestone track: this function provides a presentation of the holistic synopsis view of the project that is easy for project leaders to comprehend (Ren et al., 2008:12; Lopez-Herrejon et al., 2011:186; Gantt Project, 2020:1).
- Calendar feature: this feature is available on Gantt Project for setting timeframes (Ren et al., 2008:12; Lopez-Herrejon et al., 2011:186; Gantt Project, 2020:1).
- Resource administration: with Gantt Project human resources duties can be easily administered.

Listed in Table 2.4 below are the benefits and limitations of the Gantt Project as recognised by Ren et al. (2006:167), Proença and Bernardino (2019:523) and Gantt Project (2020:1)

Table 2.4: Benefits and limitations of Gantt Project

Benefits	Limitations
The software operates on every operating system.	It lacks the guidelines of planning.
It is user- friendly.	Lacks the function of resource streamlining and trajectory conceptions.
It has simple Gantt chart functions.	
It has a good baselining function (the baseline examines the performance of the project).	
It is free of charge.	

Source: Ren et al. (2006:167), Proença and Bernardino (2019:523) Gantt Project (2020:1)

2.5.2.3 Primavera

Oracle Primavera is a planning and controlling project management digital solution and component designed on servers such as Oracle and Express SQL servers and databases. Oracle Primavera is adopted by many project businesses worldwide (Sarantis et al., 2010:3).

The features of Oracle Primavera are:

- Project scheduling: project businesses that use Oracle Primavera software have access to the Critical Path Method (CPM) for setting their project schedules (Suvarna et al., 2018:210; Oracle, 2019:1; Andre, 2020:1).
- Tracking: the project tracking feature of Oracle Primavera allows users to have access to real-time data about the progress and performance of their teams. With this feature, performance margins can be enhanced and the project plans, as well as resources can be updated or restructured (Oracle, 2019:1; Andre, 2020:1).
- Reports: project managers that use Oracle Primavera have the benefit of generating reports from the database of the software through the Report Wizard and Report Editor function (Oracle 2019:1; Andre, 2020:1).
- WBS: project managers can easily form a pyramid of various project activities with the Oracle Primavera software where activities are classified according to their level of relevance (Kohli, 2017, Oracle, 2019:1).
- The expenditure avatar: this feature provides an outline of once-off costs of resources that are not reusable during the project (Oracle, 2019:1).
- Project threshold view: project businesses that make use of the Oracle Primavera software can enjoy the benefit of editing and accessing information regarding their project's threshold.

- Risk identification: this feature enables users to view the breakdown of the project assessment and matrix (Oracle, 2019:1; Andre, 2020:1).
- Project problems: Oracle Primavera has a feature that indicates attention-seeking project issues that relate to the initial project plan (Oracle, 2019:1).

Listed below in Table 2.5 are the benefits and limitations of Oracle Primavera software.

Table 2.5: Benefits and limitations of Oracle Primavera

Benefits	Limitations
It is a well-organised system.	Development and rectification errors were established based on experiences faced by a team of management users who used the software for free.
It is a cost reliever.	It has limited tracking tools.
It has a SharePoint of resources.	It is expensive compared to other software tools.
It eliminates difficulties and organises tasks rationally in a chronological manner.	
It has unconstrained customisation rules.	
It is dynamic and convenient.	
It has a reliable singular solution for managing different sizes of projects.	

Source: Subramani et al. (2014:139-140), Kohli (2017:1075), Harsh et al. (2017:1484)

2.5.2.4 BaseCamp

BaseCamp is a collaboration project management solution that has a great capacity for storing a huge amount of data about project plans. The BaseCamp PMS is widely adopted by numerous project businesses in 32 diverse cities globally (BaseCamp, 2020:1).

Features of BaseCamp software comprise:

- Milestones tracking: The convenience factor that comes with adopting BaseCamp is that it provides a timetable that consists of scheduled milestones and a diary view that displays due or overdue tasks (Joo & Mark, 2008:11; Duffy, 2019:1).
- Calendar display: all scheduled tasks and activities are exhibited by this PMS package.
- View of accomplished tasks: tasks that are finalised are displayed and can be referred to in this software (Joo & Mark, 2008:11; Duffy, 2019:1).
- View of all activities: project activities that are being completed can be viewed on BaseCamp (Joo & Mark, 2008:11; Duffy, 2019:1).
- Incorporated message system: BaseCamp enables project team members to communicate via live chats using Campfire, which is a communication Internet-based chat application with code word security protection (Joo & Mark, 2008:9; Cajander et al., 2009:3; Duffy, 2019:1).
- Active communication channel: on the BaseCamp interface project managers can view online users and send and receive messages instantly with no delays (Joo & Mark, 2008:9; Duffy, 2019:1).

- Time tracing: with the use of BaseCamp users can track the utilisation of time and refer to the initial completion schedules of the project activities (Joo & Mark, 2008:10; Duffy, 2019:1).

Listed below in Table 2.6 are the benefits and limitations of BaseCamp.

Table 2.6: Benefits and limitations of BaseCamp

Benefits	Limitations
It is expedient for project collaboration.	Fundamental reports have to be created manually.
It provides free upgrades.	The add time function can easily be forgotten.
It has a communication channel.	It lacks the function of allocating deadlines and detailing them out.
It is easy to use.	
It can be customized.	

Source: Duffy (2019:1), Hull (2019:1)

2.6 Project management in a South African context

South Africa is confronted with a huge need for skills in the field of engineering, IT and project management (Mabelebele, 2006:248; Daniels, 2007:18). The deficiency of skills in project management in particular has a significant effect on the planning, budgeting, scheduling and controlling stages of a project (Okereke, 2017:13). This relates to the fact that many project businesses in South Africa face challenges when adopting new technology as they fear the complexity associated with technology. Chothia et al. (2016:9-10) found that lack of knowledge and experience is the cause of many challenges for project businesses when having to adopt technological tools in South Africa and as a result, sustainability in project management is compromised. According to Emuzie and Smallwood (2011:12), South African project businesses encounter numerous issues that need to be addressed. These issues include:

- Poor information management;
- Lack of mentorship;
- The lack of past project reviews and a comprehensive database of past projects;
- Incapability to overcome project risks and improve project performance;
- Lack of knowledge and poor work procedures; and
- Poor project time management and project procurement costs (Emuzie & Smallwood, 2011:12).

Taylor (2010:398) reports that South African project business respondents stated that they had not employed technological project management tools because they were unaware of such tools and techniques and that they were also uncertain whether such tools and techniques are relevant to their business activities. The respondents further elaborated that they preferred

their current business situations rather than the complicated situations that come with the introduction of new technological tools and techniques. Therefore, it is endorsed in literature that further research should focus on investigating the project managers' capability levels of different knowledge, tools and techniques to understand which tools and techniques are suitable for specific businesses and industries; the recommendation is also supported by du Plessis and Oosthuizen (2018:178).

2.7 Summary

This chapter reviewed several sources of literature that are important for the research topic under study. The literature review revealed that major difficulties encountered by project managers in this century relate to human resource management, including issues linked to employee recruitment, teamwork, labour issues, cultural and cross-cultural issues. Furthermore, it was also found that project leaders face numerous challenges ranging from human capital to cultural and cross-cultural issues, as well as technological-related challenges. Project managers find it difficult to manage risks, communication channels and safety procedures in project management technical tools. These difficulties are caused by the lack of knowledge and skills to utilise project management technical tools. Considering the above, it is suggested that project risks and uncertainties remain factors that affect the achievement of project milestones. In this result, project managers consider applying strategic risk analysing techniques to prevent risks from prevailing during a project. This chapter also provided in-depth introspection into the fundamentals of projects and project successes. It revealed that project success is defined as the accomplishment of the project objectives, which are classified under the project scope, budget and timeframe. The chapter highlighted the correlation between project success, team performance and the use of technical project management tools. Success is, however, opposed by failure and as such, the chapter identified factors that result in project failures, such as poor communication, incompetence and the lack of knowledge of the project team.

The employment of digital project management apparatuses and practices has become common among project businesses since it is linked to project performance. The employment of digital project management tools can produce different outcomes for different businesses, hence, a significant connection exists between the use of project management technical tools and the development of an organisation. Mature project businesses are more likely to employ project management technical tools than less mature organisations are. This literature review revealed that not many studies have focused on the African continent to ascertain the utilisation of project management technical tools and the accompanying challenges.

The chapter provided the benefits and limitations of commonly utilised PMS packages. Furthermore, it is discovered that South Africa lacks skilled workers in project management.

Project businesses in South Africa hardly recognise or use project management technical tools and this is a concern because the discipline of project management is continuously evolving.

The next chapter provides a detailed description of the research design, the research methodology applied, the research locality, the ethical considerations of the research, as well as data analysis and data collection methods employed.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The previous chapter reviewed literature relevant to the topic under study. It discussed the challenges faced by project managers, as well as the conditions surrounding the components of project management and project management technical tools. It outlined the relationship between the use of project management technical tools and the development of project businesses. As project businesses contribute to the economy and assist with alleviating socio-economic issues, there must be a study that is focused on their development and the mechanisms that are available to help them grow. If project businesses do not take full advantage of available project management digital tools, their development will decelerate and their economic contribution will cease.

The main objective of Chapter 3 is to detail the research design and methodology of this study, including sampling and data collection methods. A research design is a guideline of how the research question will be addressed. Moreover, a research design should include the sampling strategy, the target population and data collection methods (Kumar, 2011:20). Research methodology is the discipline of learning how research is conducted. Research methodology provides an analysis and description of research methods supplemented by the limits and aptitudes of those methods (Patel & Patel, 2019:48).

This chapter sets out the research approach, the research paradigm, the research design, the sampling strategies and techniques, the sample size and the research location. It details the data collection instrument and methods, followed by the reliability and validity procedures, as well as the ethical standards and coding methods. Lastly, the statistical analysis is discussed.

3.2 Research approach and design

The science of research contains two recognisable approaches for investigations, namely qualitative and quantitative methodologies. These two procedural paradigms of research are the most commonly acknowledged approaches of research but are dissimilar. Table 3.1 outlines the dissimilarities between the two methodologies.

Table 3.1: Distinctions between qualitative and quantitative methodologies

Quantitative	Qualitative
It is used to study unbiased facts.	It provides a real perception of social-cultural significance.
It is used to give more prominence to variables.	It gives more prominence to the processes of communication and events.
It deems reliability to be an important concept.	It deems clarity, existence and validity as important concepts.
It divides data from theory.	It combines data and theory.
It depends on the location.	It is limited and reliant on the situation.
It uses statistics and numerical analysis.	It is subjected to topics of examination that are of a similar nature and theme.
It isolates the researcher.	It implicates the researcher.

Source: Mehrad and Zangeneh (2019:4)

3.2.1 Quantitative research

A quantitative study approach first launches with an empirical logic that has extensive theories of arguments and models which are used to generate data themes. Quantitative studies assess philosophies, while qualitative studies are used to extend philosophies (Wright et al., 2016:97). Quantitative researchers collect data by utilising various data collection instruments to minimise irrelevant information. This is done to improve the research results and to possess widespread findings regarding the subject of the study.

Qualitative research differs from quantitative research in that it focuses on people's opinions. In a qualitative study, data is collected through observations, interviews and papers (journals, newspapers, articles and academic papers). Data can also be gathered through observations, videos and audiovisuals.

Researchers who employ a quantitative approach collect data through observations and interviews in their field of study, often utilising a survey (Elkatawneh, 2016:2). The dynamics of a quantitative methodology are based on statistical data. Statistical data offers convenience in terms of saving time and resources in a research project. In a quantitative study, generalisation is built based on scientific techniques that are utilised to gather data and researchers can focus on various research groups where participants provide their input based on their experiences (Daniel, 2016:94). The main objective of a quantitative study is to reduce the researcher's direct involvement in the information gathered for the study (Wright et al., 2016:98).

3.2.2 Qualitative research

Qualitative research is a recursive method that is aimed at obtaining a deeper understanding of the study phenomenon. It is conducted by gathering rich scientific data that is distinctive and significant in influencing the discoveries of the study phenomenon. A qualitative research approach is based on two measures: first, the method and design for investigating and second, the enriched result of knowledge shared with the academic community (Aspers & Corte, 2019:155). In a qualitative study, researchers gather information obtained through interviews, observations and other data instruments to create subjects in their field of study. Qualitative research forms themes based on data analysis where the researcher is expected to not formulate biased notions of theories (Elkatawneh, 2016:3).

In consideration of the information above, the empirical section of this study was constructed on a quantitative research design since theories of arguments and models were used to generate data themes and assess philosophies. Furthermore, data was gathered through surveys and research papers (journals, newspapers, articles and academic papers) to answer the research questions. Statistical methods were employed to present the findings of this study, where the main focus was to evaluate the statistical levels of adoption, awareness and challenges of using digital project management solutions and as such, primary data was collected from project businesses. The next section outlines the research paradigm and a discussion of the chosen research paradigm.

3.2.3 Research paradigm

According to Hussain et al. (2013:2375), a research paradigm is a global phenomenon of ontological and epistemological guiding principles that govern the researcher's choices in a study. Paradigms are mainly diverse approaches to epistemology and ontology, therefore, the characteristics of a paradigm are based on epistemology, which addresses the identifiable link between the researcher and the researched concept, while ontology addresses veracity and its nature in the theory being studied. Ontology is characterised by two ideologies: the objective ontology that assures knowledge through empirical findings, and subjectivist ontology that assures knowledge through elucidating the current practical and natural conditions of the concept being investigated (Rahl, 2017:1).

The research paradigm encompasses numerous elements as defined below.

- Epistemology (the constructed knowledge of realities): is the description of how knowledge has been built, as well as the procedures that have been applied to reveal realities that are universally regarded as genuine knowledge (Carnaghan, 2013:1; Kivunja & Kuyini, 2017:26-27).

- Ontology (the state and features of actualities): is the description of knowledge that correlates to the complexion of authenticities as well as the characteristics of realities (Carnaghan, 2013:1; Kivunja & Kuyini, 2017:26-27).
- Methodology (ways and means of researching): refers to the general guidelines and measures that shape the process of gathering and analysing data in association with the researcher's experience (Carnaghan, 2013:1; Kivunja & Kuyini, 2017:26-27).
- Axiology (the significance of beliefs and principles in research): it emphasizes the fact that investigators present their values and preconceptions in their studies while also presenting the value of their researched information in their field of study (Carnaghan, 2013:1; Kivunja & Kuyini, 2017:26-27).

Four types of research paradigms exist in the field of research according to Rahl (2017:1):

a) Positivist paradigm
b) Interpretive paradigm
c) Advocacy or participatory paradigm
d) Pragmatism paradigm

3.2.3.1 Positivist paradigm

Positivism is a paradigm that is contingent on methods that are hypothetically logical in nature to substantiate deducible hypotheses. With a positivist paradigm, it is noted that dynamic connections are derived amid independent variables and dependent variables (Park et al., 2020:690). The investigators who support the positivism paradigm cultivate dependable knowledge based on scientific approaches and experimentations. A positivist paradigm is characterised by knowledge that is grounded on scientific and empirical methodologies (Rahl, 2017:1).

According to Rehman and Alharti (2016:54), positivist investigators employ quantitative data to address their research problems and such investigators often use closed-ended questionnaires as instruments to generate surveys. Furthermore, their findings are often descriptive.

3.2.3.2 Advocacy/participatory paradigm

The advocacy paradigm is solely grounded on the view that research is associated with the social justice agenda for addressing activism, social policies or radical transformation. This paradigm is aimed at ensuring that full participation and support from the participants is achieved (Ang, 2015:2). Furthermore, Rahl (2017:1) supports the above statement, maintaining that researchers who employ the advocacy paradigm develop knowledge based on advocacy and social policies.

3.2.3.3 Pragmatic paradigm

A pragmatic paradigm is a philosophy that expounds the belief that experiences do not reoccur in the same manner as they did before, which means that the principles applied in past events may not be applicable in future events. Therefore, different actions should be applied to new experiences, where these actions are influenced by global perceptions that are shared by society. The pragmatic philosophy also denotes that every participant has their own distinct experiences and as such, their insight is dissimilar although they can share similar beliefs. The likelihood of participants applying similar actions in comparable situations is greatly determined by their degree of belief (Kaushik & Walsh, 2019:3). The core objective of this paradigm is to reinforce the potential weaknesses of the study by applying a mixed method approach to fill the gaps that can weaken the quality of the study. Researchers that utilise this approach support the conception that knowledge is built and reinforced through a mixed method approach (Rahl, 2017:1).

3.2.3.4 Interpretive paradigm

The interpretive paradigm supports the notion that social science and society have particular practicalities different from the physical sciences as society is more likely to elucidate their own practices and apply them constantly. Subsequently, interpretive investigators support the conception that instead of having a single interpretation for all courses, it is better to have numerous interpretations for an individual phenomenon (Lan, 2018:3). The interpretive paradigm implies that profound knowledge and the meaning of concepts, as well as certain substances, is built through the researcher's explorations and experiences of human beings (Rahl, 2017:1). Cao Thahn and Le Thahn (2015:24) affirm that the interpretive paradigm makes it possible for researchers to have global perceptions that are instilled by the participants. These global perceptions are, therefore, deep-rooted from the experiences of the participants.

In light of the above, the appropriate paradigm for this study is the interpretive paradigm since the researcher aimed to understand how others comprehend events and theories. The researcher also aimed to comprehend subjective meanings of certain social views and interpret the research findings of several continuums with pragmatism being the focal point. Interpretation in this study is applied to the adoption levels of project management digital solutions and the challenges encountered by project businesses at the selected mine in the Limpopo Province.

The next section describes the research design of this study.

3.3 Research design

A research design is a mind map of a research study that provides direction on how the research should be carried out. A research design is a compendium of research segments (samples, instruments, target groups, research paradigms), which are all combined to answer

the research questions. A research design is an exhibition of research sections; it is a framework or a set of procedures that are directed at shaping logic and enhancing the validity of data in a research study (Thomas, 2010:308). Therefore, the verdict of the researcher regarding the research design is imperative for data validation purposes and data collection methods of the study (Sileyew, 2019:1).

The research design of this study is constructed on a cross-sectional descriptive case study to examine the challenges and adoption levels of digital project management solutions.

3.3.1 Descriptive research

A descriptive study describes and forms correlations between variables, for example a quantitative health survey that is aimed at ascertaining the health condition of community members is rendered as being descriptive (Machado de Lima, 2014:5). According to Sakyi et al. (2020:300), a descriptive research design inspects the nature of the subject, its setting and state of affairs; such a study implicates the administration of a high number of surveys and consultations with unsystematic responses. This research design also involves the exhibition of econometric tests that are likely to result in many regression analyses, interval examinations, erroneous sampling assessments and correlation examinations. The main objective of a descriptive study is to provide precise findings of a target population with its status quo regarding the subject being studied, while also describing the study phenomenon and its features. This research technique can address voluminous questions of the research study but it is, however, unable to discover reasons behind the 'why' questions of the study.

The nature of a descriptive research study is often quantitative to determine the correlations between the study variables (Nassaji, 2015:129). Moreover, with this approach, numerous variables can be studied using multiple statistical dispersions (standard deviation, maximum, mean, range and variance) while the researcher simultaneously does not have any form of influence on the variables. Researchers utilise a descriptive approach when there is less known information regarding their subject matter and when they plan to address and detect characteristics, inclinations, occurrences and classifications in a particular field. A descriptive research approach is best followed when the researcher is familiar with the characteristics of the population and the field in which the phenomenon of the research is taking place (McCombes, 2019a:1).

According to Grimes and Schulz (2002:146), a descriptive study is characterised by two ultimate identifiable classes. The first class is longitudinal and it addresses a population-related phenomenon, which, for example, is often used to examine the correlation between risky factors and their developments as well as the result of their treatments in due course. Ultimately, a longitudinal study gathers data that is likely to fluctuate over time for a specific target population in a demarcated area and the fluctuations are therefore recorded (Caruana, 2015:537). The second class of descriptive research is a cross-sectional study, observational

and where the researcher simultaneously investigates the consequences of particular groups of populations. Unlike the longitudinal study, cross-sectional research selects participants based on a steady criterion (Setia, 2016:261).

3.3.2 Case study

A case study is a study that examines and analyses historical data in comparison with the developments and the conditions surrounding its subject matter and the unit that is being researched. The unit in a case study includes a group of people, an organisation, or a particular social group. Researchers that present case study research mainly acquire proper descriptive data to gradually analyse the connections amongst diverse phenomena and inclinations in their line of research (Machado de Lima, 2014:6). The method of case studies is mostly utilised in research studies that are social in nature where comprehensive investigations are applied to gather multiple sources of information. Case study research can be based on a descriptive style of research, an exploratory style of research, or even an explanatory technique (Hussain et al., 2013:2379). The most important process of a case study includes clearly outlining the unit of the study, identifying and deciding on the case or cases and investigating and gathering data to comprehend and present data. The research questions of case study research are mostly influenced by published literature and identifiable hypothetical subjects where the case study is characterised by its distinctiveness and qualities that capture the interest of the researcher (Crowe et al., 2011:5).

3.4 Sampling strategies

A sample is a segment of a population (Etikan et al., 2016:1). Sampling is the measure of deciding on a sample unit of participants that are of interest to the researcher and are significant to the study. Sampling is essential in research as the population of interest is usually too large for all to participate in a research project. The set standard of sampling is the numerical exemplification of the population of interest that is sufficient to assist the researcher in reaching the research objectives. Certain strategies for sampling exist that researchers can apply to determine the appropriate sample size and the appropriate characteristics of their population of interest. The techniques applied by researchers for sampling are referred to as sampling strategies and the choice of the researcher regarding these strategies is shaped by the characteristics of the target population of the study (Majid, 2018:3).

Several steps exist in choosing a sampling strategy and deciding on the target population. The first steps involve clearly describing the characteristics of the target population of the study, while the second step involves deciding on the appropriate sampling frame. A sampling frame is a class of definite cases from which the researcher will draw the sample frame. A population is therefore represented by the sampling frame. The third step is to clearly understand the various types of sampling methods and discuss sampling as the central subject matter.

Subsequently, provide justification that rationalises why the chosen sampling method was selected (Taherdoost, 2016a:20).

3.4.1 Sampling techniques

Since it is not possible to assess every individual in the population, the researcher uses sampling techniques to overcome this. A sample is a mere representation of the population and it is of convenience to the researcher in terms of financial costs and the timeframe of the research project. However, the researcher needs to be mindful of the ultimate goal to assess every individual to collect consistent, valid and truthful data. The sampling techniques are separated into two classes: probability and non-probability sampling (Sharma, 2017:749).

Probability sampling is a technique that provides every individual of the target population a chance to participate in the research project (Taherdoost, 2016a:20). On the other hand, non-probability sampling is a technique that researchers utilise where a non-random selection method is applied to select participants of the study and their probability of being selected cannot be anticipated (Etikan & Bala 2017:215). The common value of non-probability studies includes the measure to efficiently forecast the features of major populations that is established on the dimensions of a minor subgroup population (Cornesse et al., 2020:7).

According to Wright et al. (2016:98), quantitative researchers mostly utilise large random samples, aiming to form generalisations with populations. However, most researchers prefer purposive sampling, which allows them to focus on individuals who can offer rich data that can answer the research questions (Trochim, 2020:1).

The non-probability sampling technique was suitable for this study since a non-random selection technique was employed to select participants. Purposive/judgemental sampling was applied since not all the contracting businesses that were identified met the criteria of the project businesses that are needed to answer the research questions. Purposive/judgemental sampling was employed to increase the applicability of the sample so that only businesses that met the criteria of the study sample were included. Numerous reports of the contracting businesses from the selected mine were obtained and reviewed by the researcher against the category of the sample to ascertain the relevance of each contracting business.

The purposive sampling technique is defined as the researcher’s definite and non-random selection of participants that meet the characteristics of participants that are relevant to the study (Etikan et al., 2016:4).

Table 3.2 below lists the guidelines of purposive sampling.

Table 3.2: Guidelines for purposive sampling

1. Outline the study problem. 2. Outline the nature of the data that are required. 3. Outline the characteristics of the required participants. 4. Ensure that the participants possess the required qualities. 5. Ensure that the participants are competent and reliable. 6. Ensure that the data collection techniques are suitable for the study. 7. Interpretations should not overlap the sample of the study.

Source: Tongco (2007:151)

The researcher followed these steps as part of the sampling process in this study.

3.4.2 The study demarcation

The target population identified for this study is demarcated as contracting project businesses registered on the database of the selected mine. Figure 3.1 shows the selected mine region and its surrounding villages.

Figure 3.1: Selected region district – map view

Source: Google Maps (2021)

As illustrated in Figure 3.1, this study focuses on contracting project businesses at the selected mine complex in the Waterberg district of the Limpopo Province in South Africa.

3.4.3 Target population

The kind of population that forms the researcher's interest is considered as the target population. In research, the likelihood of recruiting the whole population of interest to take part in the study is not feasible. The target population is often recruited by researchers in the form of sampling to answer the research questions and form generalisations with the results obtained from the target population (Majid, 2018:3). It is mandatory for every qualitative and

quantitative study to have a well-defined target population. The targeting and conceptualisation, as well as the approachability of the population, apply to both qualitative and quantitative study designs. Unlike qualitative studies, a high number of participants is expected in quantitative research studies (Asiamah et al., 2017:1608). The researcher must define the target population by clearly stating the characteristics of the study population and deciding which group is to be included and which is to be excluded (Eldredge et al., 2014:5). According to Murphy (2016:8), the researcher must outline the primary evaluation factor of the population, provide a generally acceptable global factor for such evaluation and provide justification for why some groups should be excluded from the target population.

The target population for this study was a restricted number of selected contracting project businesses at the selected mine in the Limpopo Province of South Africa. The population of this study comprised:

- Project managers appointed by the contracting projects businesses in line with the prescripts of the Mine Health and Safety Act, 29 of 1996 in the Republic of South Africa.
- Contracting Site Managers employed in line with the prescripts of the Mine Health and Safety Act, 29 of 1996 of the Republic of South Africa under regulation 2.6.1 of the Act.
- Contracting Supervisors employed in line with the prescripts of the Mine Health and Safety Act, 29 of 1996 in the Republic of South Africa under regulation 2.9.2 of the Act.

3.4.4 Sample size

Sample size is the number of targeted participants that is determined by a researcher at the beginning of a research project. Most researchers refer to previous studies as a guideline for calculating their sample size (Gutterman, 2015:1). This idea is supported by Omair (2014:143), who emphasises that the best practice is to refer to previous research papers for guidance or to include all the reachable subjects and cases during the period of the study (consecutive sampling). The author further states that another alternative is to select a sample size that is between 50 and 100, contingent on the duration and resources of the study. Moreover, sample size must be in a rational order so that the results of the study can be accurate to indicate any link or distinction available within the study population.

An important factor that researchers should be aware of regarding sampling is that there is a direct correlation between the sample size, the sample design and the data collection method. The supporters of the quantitative approach utilise numerical formulas to calculate their sample size and they are usually in support of random sampling, while the supporters of the qualitative approach rarely utilise numerical or systematic methods (Omona, 2013:174).

The project businesses participants were categorised and selected from 313 contracting organisations at a selected mine in Limpopo Province. Based on the contractor management system of the selected mine, 180 contracting organisations were identified as project

businesses on system report (that categorised contracting businesses per their scope of work and nature of business).

A total of 110 project businesses participated in the study.

3.5 Questionnaire design and data collection

According to Roopa and Rani (2012:273), gathering pertinent data relies upon the researcher's choice in designing the questionnaire. Good questionnaires are well thought out and much effort is put into designing them, while the planning and development are carefully considered by the researcher. There are various forms of questionnaires, such as paper trail questionnaires that can be distributed through the mailbox and electronic questionnaires that can be distributed via email or through Internet programs. However, it is believed that providing participants with numerous options for answering the questionnaires can lead to a high response rate (Ponto, 2015:170).

To improve the response rate, data were collected through structured closed-ended questionnaires. Close-ended questionnaires contain questions that have multiple-choice answers from which respondents choose one (Wilkinson & Birmingham, 2003:11). The researcher reviewed the data collection instruments of other related studies in designing the questionnaire for this study. The questionnaires were distributed between June 2020 and January 2021.

The survey questionnaire consisted of three sections:

a) Section A of the survey includes a demographic and general profile about business details, number of employees, number of years in business, nature of projects and type of project business in the demarcated area. Multiple-choice questions were utilised.

b) Section B evaluates the project history and project challenges faced by project businesses within the specified mining area. Multiple-choice questions were utilised. The research objective was to examine project management-related challenges of project businesses in the demarcated area.

c) Section C part 1 evaluated adoption levels of digital project management solutions by project businesses. Multiple choice and dichotomous questions were used. The research objective was: To investigate the awareness and adoption levels of technological project management solutions by project businesses in the demarcated area.

   Part 2 of Section C accessed the barriers to digital project management solutions by project businesses. A five-point Likert scale was applied. The research objective was: to investigate the adoption barriers to digital project management solutions by project businesses in the demarcated area.

d) Section D evaluated the organisations' readiness and willingness to adopt digital project management solutions in the demarcated area. A five-point Likert scale was applied. The research objective was to determine the level of readiness to explore digital project management technical tools by project businesses in the demarcated area.

The data analysis of Sections A, B and C addressed the last research objective, which was to understand the extent to which project management technology can influence the growth and success of project businesses at the selected mine in Limpopo.

3.5.1 Likert scale

The researcher utilised a five-point Likert scale to enable participants to express their degree of agreement selecting from strongly disagree, disagree, neutral, agree, and strongly agree. A Likert scale is a combination of items of statements that are presented with the sole purpose of testing the study hypotheses where respondents are required to indicate their level of judgement regarding certain factors (on a scale between strongly agree to strongly disagree). When conducting a Likert scale approach for a questionnaire it is vital to consider the suitability of the subject concerned and the degree of understanding by the respondents. To reduce the uncertainty of the participants' responses it is recommended that researchers should present options that are close to the original thoughts of the participants. Moreover, sufficient time for judging the Likert scale points should be provided and the points should be communicated clearly to ensure understanding (Joshi et al., 2015:399).

Table 3.3 below illustrates the methods of constructing a Likert scale:

Table 3.3: Likert scale methods

	Level One	**Level Two**	**Level Three**	**Level Four**	**Level Five**
Method 1	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Method 2	Certainly Not	Rarely	Sometimes	Regularly	Always

Source: Sullivan and Artino (2013:542)

In their study, Sullivan and Artino (2013:542) recommend that researchers should start with ascertaining the format that they would prefer to elucidate and examine findings. The authors further recommend that researchers should justify their choice in this regard. For the Likert scale, the researcher utilised the second method as the statements in the data collection instruments were declarative.

In a Likert scale evaluation, researchers should consider presenting standard deviations to interpret the series of answers that are presented by the respondents. However, for distinct questions, it is recommended that means, medians, rates of recurrence and Likert-type items

should be utilised in line with Table 3.4 (Boone & Boone, 2012:3). Table 3.4 below lists the procedures that are suggested for analysing Likert scale data.

Table 3.4: Recommended procedures of analysing data: Likert scale and Likert-type information

Measure	Likert-type figures	Likert scale figures
Principal Tendency	Range, Mode or median	Mean
Changeability	Rates of recurrence	Standard deviation
Links	Kendall Tau B or C – is a correlation coefficient measure that is not parametric and is utilised to trial correlations amongst ordinal variables and non-interval (Bolboacă & Jäntschi, 2006:192).	Pearson correlation coefficient – is a measure of a constant function of association among variables (Schober et al., 2018:1763).
Other Measurements	Chi-square – is a measure that is utilised to test the level of independence between variables as well as to assess the suitability of the sample style to the population of the study (Franke et al., 2012:450).	ANOVA/T-test/regression analysis – the T-test is applied for comparing the means for clusters that are less than two while the comparison of ANOVA is for more than two clusters (Mishra et al., 2019:407).

Source: Boone and & Boone (2012:3)

Considering Table 3.4, this study utilised Likert scale items to measure the central tendency, measures of variability and arithmetic means of the data that were collected.

3.5.2 Fieldwork data collection

In consideration of the availability and variety of the participants, the researcher either physically distributed or emailed the questionnaire to the project managers, site managers and supervisors of the project businesses at the selected mine in the Limpopo Province.

- Distributed questionnaires: participants physically completed the questionnaires in writing. The time taken to complete the questionnaire was 25 minutes or less.
- Emailed questionnaires: participants electronically completed the questionnaires and mailed them back to the researcher. The time taken to complete the questionnaire was 25 minutes or less.

According to Wilkinson and Birmingham (2003:17), a questionnaire should not take longer than 25 minutes to complete.

The following section discusses the reliability and validity of this study.

3.6 Reliability and validity

Reliability refers to the capacity of a research data collection instrument to produce the same findings on a repetitive platform similar to other investigators. Reliability mainly pertains to yielding steady and reliable findings regarding a particular phenomenon (Delíce, 2010:5). The Cronbach's alpha coefficient was also utilised to measure the level of internal reliability consistency of the relevant items that are tested. Cronbach's alpha is a measure of internal consistency that is used by most researchers to ensure that constructs, tests and scales that have been used serve the fundamental purpose of the research study (Taber, 2018:1273). The internal consistency acts as evidence that the items tested are consistent and correlated in measuring the research concept or construct (Tavakol & Dennick, 2011:53). Reliability was confirmed through composite reliability (CR) and Average Variance Extracted (AVE). CR is the calculation of the internal reliability of all items being tested in their dimension of the central construct while AVE is applied for validating constructs in a study. AVE is the calculation of the variability measure sum that is captured by the construct (Wipulanusat et al., 2017:64).

Validity is the aptitude of the data collection instrument to measure and evaluate factors that are mainly planned to be evaluated. Validity describes how the findings of a study wrap up information regarding the definite field of investigation (Taherdoost, 2016b:28).

The researcher ensured reliability and validity by applying the techniques below:

- Reviewing literature papers to grasp knowledge and guidance.
- Enabling experts in the field of research such as the supervisor and the CPUT Research and Ethics Committee of the Faculty of Business and Management Sciences to review the research study.
- The researcher conducted a pilot study to eliminate factors that can degrade the quality of the survey.

3.6.1 Literature and experts' evaluation

According to Dellinger (2005:51) and Snyder (2019:339), reviewing literature for study validity is essential and it is therefore vital that this process is not disregarded as it plays a crucial role in enhancing the quality of the research paper. Moreover, the researcher applied this measure to identify potential gaps in the field of study.

3.6.2 Expert validation

The data collection instrument of a study should have an established validity procedure. Questionnaires can undergo validity by passing them through a board of experts who will judge the construct theory of the study. The experts judge the quality of the construct theory idea to determine how well it presents the data collection instrument (Bolarinwa, 2015:196). This form of validity method pertains to content validity.

Content validity is used to assess the newly designed questionnaire to make certain that the key questions are included and that any other unnecessary factors are eliminated. The

substantiation of content validity can be carried out through conducting literature reviews and getting the inputs of experts in the field of research regarding the data collection instrument (Taherdoost, 2016b:30).

The researcher engaged with an experienced supervisor for assistance and support. The CPUT Research and Ethics Committee of the Faculty of Business and Management Sciences provided its input regarding the context of the study and the research instrument.

3.6.3 Pilot study

A pilot study is a rational study that is conducted to test the viability of the procedures and methods that are put in place by the researcher. Pilot studies are generally utilised to assess the aptness of the approaches and procedures of collecting data (Lowe, 2019:177). For the researcher to test the appropriateness of the data collection technique of the study, it is essential to conduct a pilot study. The purpose of a pilot study is to authenticate the viability of a data collection method through assessing some of the study participants to test the theoretical construct of the questionnaire and identify any difficulties that might be experienced by the participants (In, 2017:601).

The researcher conducted a pilot study at platinum mines in the Waterberg District with selected participants in January 2021 to ensure accurateness in the questions and the format of the questionnaire. The researcher selected the first 13 project businesses that provided permission letters to partake in a pilot study. The process helped the researcher to ensure that the questions and instructions were easily understood by the participant. The pilot study further assisted the researcher to correct errors, add “tick-boxes” to the questionnaire, and to record the actual time that was required to complete the survey.

3.7 Ethical considerations

Ethical approval to conduct this study was sought from the CPUT Research and Ethics Committee of the Faculty of Business and Management Sciences. The researcher was led by the guidelines provided by the CPUT Research Directorate and Graduate Centre of Postgraduate Management Studies. The researcher desisted from the fabrication of authorship, evidence, information, data results or conclusions, plagiarism, revealing information that would harm participants, using vague and inappropriate language, sharing data with others, retain data and other materials longer than necessary and replicating publications.

According to Vanclay et al. (2013:243), there are five universally accepted objectives of ethics and professionalism for researchers as stated below:

a) Initiating and expanding the notion of moral mindset – the central objective is for researchers to gain in-depth knowledge about ethics and the issues surrounding the subject of ethics to create sympathy for the population.
b) Giving recognition to moral matters – it is regarded as being vital for researchers to familiarise themselves with the potential sources of ethical issues.
c) Enhancing the skills of analysing – researchers should construct the knowledge of acceptable standards and terminologies of ethics while also practising how to analyse and address ethical conditions.
d) Stimulating the idea of moral commitment and accountability – researchers should be thoughtful about their personal commitments and accountabilities.
e) Accepting and dealing with moral uncertainties – researchers should identify and deal with situations that conflict with the codes of ethics and be able to address such situations.

The researcher followed the above objectives to uphold the standard of research ethics and ensure professionalism in conducting the study.

According to Yip et al. (2016:684-685), the purpose of engaging with the population in research is to acquire information and as such, it is the researcher's responsibility to respect and safeguard the lives, dignity, sincerity and nondisclosure standards of the participant's private data. Yip et al. further provide a charter that consists of three core values of ethics in assessing a research study:

- Respecting participants – researchers are required to respect and protect the self-determination of all individuals (those that are participating and those that are not participating).
- Avoiding harm – it is the responsibility of researchers to avoid any possible harm that may be caused to society.
- Maintaining fairness – researchers are always required to follow the principle of impartiality when conducting research.

In conducting research for this study, the researcher followed the guidelines provided in the charter above.

3.7.1 Informed consent and voluntary participation

The stages of gaining consent from research participants should meet the following standards (Arifin, 2018:30):

- The researcher must ensure that the participants understand the content of the research and the participant must be fit to give consent freely.

- It is the responsibility of the researcher to ensure that participants understand the information provided and the purpose of the research. Participants must be informed about their right to accept or reject the opportunity of participating in the research.

The researcher followed the above guidelines in obtaining consent from the respondents.

3.7.2 Confidentiality and risk of harm

Participants' identities should always be protected and kept confidential; as such, any self-identifying information should be avoided by the researcher. The researcher needs to identify and refrain from any possible harm that is tangible, sentimental, reputational and/or resourceful and might affect any party that is involved in the research study (the participants, the public and the researcher). The researcher should form an understandable hierarchy of potential factors and their mitigating measures to minimise the risk for all parties involved (Fleming, 2018:211).

The researcher applied the above principles to ensure confidentiality and the avoidance of any risk of harm to participants.

3.7.3 Fabrication, falsification and fraud

Fabrication is defined "as the act of forming false data or findings that are then documented and presented as truthful information. Fraud and falsification are defined as the unethical influence of research instruments and the alteration or misrepresentation of the study findings" (Akaranga & Makau, 2016:4). The researcher did not practise any form of fabrication, fraud or falsification as defined by Akaranga and Makau above.

3.7.4 Plagiarism

As a measure to refrain from any form of plagiarism, the researcher followed the guidelines provided by Fennell (2017:10):

- The researcher kept a record of all the sources that were reviewed concerning this study. Relevant sources were acknowledged and cited as required by the CPUT Postgraduate Harvard method of bibliography citation.
- In the case of direct quotations, the researcher enclosed these in quotation marks to indicate quoted sentences.
- The researcher ensured proper understanding of the original data by referring to other sources that are related to the main information that is being presented. Furthermore, the researcher formed a thorough comparison of the paraphrased information and the original data. The researcher avoided direct copying and pasting of any writings or data.

3.8 Coding, editing and proofreading

To ensure comprehensiveness, reliability and readability of data the researcher employed coding and editing methods. These measures were also used for ensuring the accurateness of information on questionnaires.

Coding is defined as the process of organising fragments of data to downsize them into subjects (as codes) to ease understanding (Maher et al., 2018:2). Coding is a process of classifying and linking data to the objectives of the research. Coding is also applied as a measure to avoid the challenge of having to use long variables that are not viable in the statistical analysis stage (Elliot, 2018:2851).

Table 3.5: Illustration of the study coding book

Variable		Label on SPSS	Label value on SPSS (coding value)
Gender		Male Female	= 1 = 2
Occupation		Project Manager Contracting Site Manager Contracting Supervisor Other	= 1 = 2 = 3 = 4
Number of employees		1-9 10-20 21-50 51-99 Over 100	= 1 = 2 = 3 = 4 = 5
DQ1	Awareness of digital project management tools	Yes No	= 1 = 2
DQ2	Use of digital project management tools.	Yes No	= 1 = 2
Project Management Software Packages		Trello	Not Selected = 0 Selected = 1
		BaseCamp	Not Selected = 0 Selected = 1
		Microsoft Project	Not Selected = 0 Selected = 1
		Smart Sheet	Not Selected = 0 Selected = 1
		Huddle	Not Selected = 0 Selected = 1
		Oracle Primavera	Not Selected = 0 Selected = 1
Barriers to adoption			
SWLS1	Lack of knowledge	Strongly Disagree = SD	= 1
		Disagree = D	= 2
		Neutral = N	= 3
		Agree = A	= 4
		Strongly Agree = SA	= 5
SWLS2	High costs of adoption	Strongly Disagree = SD	= 1
		Disagree = D	= 2
		Neutral = N	= 3
		Agree = A	= 4
		Strongly Agree = SA	= 5

In the first column of Table 3.5, the variables are detailed in full without codes, while the second column entails data sets and their codes are outlined in the third column. The above columns show how the researcher coded responses on SPSS v26.0.

Editing is the process of conducting a review and an alteration of information that is drafted to improve it, while proofreading is the process of modifying errors that relate to orthography and writing mechanics in the final paper (Davies & Beaumont, 2014:2). In this study, editing and proofreading were ensured by consulting with a board of experts.

3.9 Statistical analysis

Statistical analysis is the examination of primary data that is collected to form a presentation and an interpretation of arithmetic means (averages, modes and median) and spread measures (ranges and standard deviations) that are extracted from the data sets of the primary data that is collected (Samuels, 2020:1). Statistical analysis is the process of summarising the data that are collected and fill the research gap by answering the research questions of the study (Ibrahim, 2015:99).

This study applied the recommendation of Ong and Puteh (2017:20), that a quantitative research project that aims to study arithmetic means and spread measures should employ SPSS software. SPSS is a computer program that is mostly utilised by quantitative researchers to record, interpret and analyse data (Gogoi, 2020:2424). SPSS v26.0 was used to analyse data in this study.

3.9.1 Descriptive statistical analysis

Primary data that are gathered must pass through the processing stage where alphabetic data needs to be converted into numeric data. The stage after the processing stage is the analysis stage where data is analysed utilising a descriptive or an inferential descriptive analysis (Bhandari, 2020:1). Descriptive statistics convert data into variables to provide descriptions and interpretations of the central tendency and arithmetic average measures as well as measures of variability. Inferential statistics is utilised to study the differences between groups and the correlation between variables, by utilising t-tests, analysis of variances, regression and correlation (Gutterman, 2019:11-12). In this study, a descriptive statistical analysis was applied to present the principal tendency, arithmetic measures and the measures of variability.

3.9.2 Tables and graphs

A descriptive statistical analysis is utilised by researchers that aim to form a summary that will present arithmetic means or spread measures to answer the research questions. Descriptive statistics visualise data through diagrams, tables and charts (Bhandari, 2020:1). Tables were

used to present the results of analysed data and graphs were used to visually demonstrate the findings of this research study.

3.10 Summary

This chapter discussed the research methodology applied, which is grounded on a quantitative methodology. The preliminary data of this study were based on surveys and statistics that qualified it to be quantitative. The research paradigm of this study was interpretive, as the purpose was to comprehend subjective meanings regarding the several social views that relate to the theme of this study. The paradigm was further utilised to form interpretations of the research findings.

The chapter outlined the research design, which is a cross-sectional descriptive case study. This research design was suitable as it was key in assisting the researcher to examine the variables.

The sampling strategies were discussed. Non-probability sampling was employed to select participants non-randomly, in line with the purposive sampling style that was used to eliminate any limitations that existed in selecting participants. The target population included contracting project businesses in the Waterberg district of Limpopo Province in South Africa at the selected mine. The contracting project businesses are registered on the database of the selected mine. The population comprised project managers, site managers and supervisors who are employed following the standards of the Mine Health and Safety Act of the Republic of South Africa. The sample size was extracted from 313 contracting businesses at the selected mine. Data were collected using a structured closed-ended questionnaire. The questionnaire included dichotomous questions, multiple-choice questions and five-point Likert scale questions.

It was demonstrated that reliability and validity were ensured through reviewing literature papers, experts' validations, conducting a pilot study and obtaining approval from the CPUT Research and Ethics Committee. All ethical research principles were upheld in the conduct of this study. Coding was applied when processing data and statistics. The researcher consulted with a line of experts for editing and proofreading purposes. Lastly, SPSS v26.0 was used to analyse data and a descriptive statistical analysis was employed to process data. Tables and graphs were utilised to depict frequencies, as well as the relevant arithmetic means and spread measures that were used to answer the research questions.

CHAPTER 4

STATISTICAL ANALYSIS AND DATA PRESENTATION

4.1 Introduction

Chapter 3 addressed the research methodology, sampling techniques, ethical considerations, data collection methods and the methods of analysing statistics. This chapter focuses on the statistical findings and results of the study and includes information that is aimed at accomplishing the research objectives of this study. The chapter further addresses the research questions of this study as outlined below:

a) What are the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo province?
b) What are the challenges of adopting digital project management tools and techniques by project businesses at the selected mine in Limpopo?
c) What is the level of preparedness to explore other digital project management solutions by project businesses in the selected mine in Limpopo?
d) To what extent can project management technology influence the growth and success of project businesses at the selected mine in Limpopo?

This chapter is structured into five sections as follows:

- The first section discusses the general information and demographics of the participants.
- The second section provides information about projects as well as business-related challenges that are faced by the participants.
- The third section provides statistical data concerning the awareness and adoption levels of digital project management solutions.
- The fourth section focuses on the barriers to adopting digital project management solutions and includes the measures of reliability (Cronbach alpha test, CR and AVE) applied on the Likert scale items.
- The final section is a comprehensive analysis of the data gathered.

4.2 Data screening and error detection

Telephonic interviews were conducted in this phase to ensure data accuracy.

According to Brown et al. (2018:2563), the screening of data for error detection purposes is crucial in the field of research. Therefore, the study thoroughly analysed the data captured on Microsoft Excel and SPSS v26.0 to guarantee a level of accuracy and logic. Each data variable was analysed and the statistical frequencies were recurrently examined on SPSS to detect errors. The study applied the ‘sort cases’ function on SPSS to rectify and/or delete erroneous values. A reliability test was also employed and as a result, a few items were removed from

the survey. According to Nimon et al. (2012:10), when researchers conduct a reliability test some (doubtful) items may have to be removed to increase reliability.

4.3 General information and demographics

This section contains general information and the demographics of the participants, for example, gender, occupation, educational level, the nature of their respective project businesses, the number of employees, the number of years in business, the number of years in the mining industry and the level of the locality to emphasize the expertise of the participants.

4.3.1 Participants' gender split

The motive of this part of the section was to establish the number of male and female participants in senior positions. This segment was mainly to establish which gender is dominant in terms of managing projects, particularly for project businesses in the mining sector. To gain this information, a close-ended question with multiple choice answers was posed.

Figure 4.1 below depicts the gender split of the participants of the project businesses in the study.

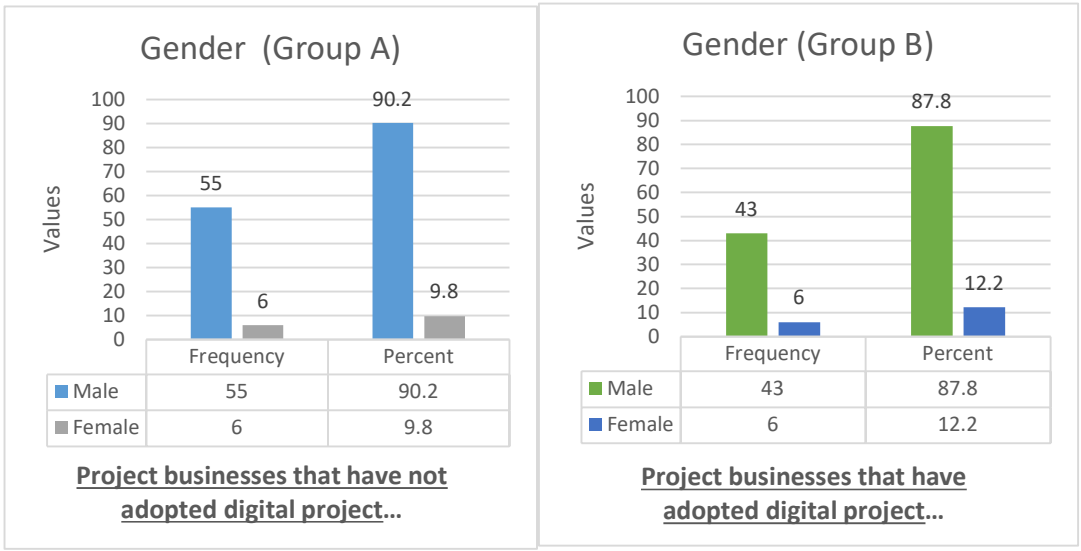


Figure 4.1: Gender split of participants

Most of the participants employed by the project businesses are male for both groups; n=55, representing 90% for Group A and n=43; representing 87.8% for Group B. Very few participants were female (n=6; representing 9.8% for Group A and n=6; representing 12.2% for Group B). This data suggest that most project businesses within the mining industry employ predominantly male candidates for their senior positions. These findings correlate with the findings of the Gender Disparity Report that confirms that the promotion of women in the South African mining industry is low compared to other industries (Piggott et al., 2017:3). The

strategic plan of the South African Department of Women (2020:3) confirms this, finding that the South African mining sector has only a 14.2% representation of women in top management positions. These findings were further supported by Statistics South Africa's (SSA) (2020:123) annual report, which shows that the number of male candidates in senior positions is greater than the number of female candidates. Furthermore, Rodríguez et al. (2017:9) support the fact that project management senior positions are dominated by male candidates, while Abdu et al. (2017:9) affirm that gender inequality is still prevalent in project management and needs to be addressed. The implication here is that there are significantly fewer female candidates in senior roles within project businesses than there are male candidates.

4.3.2 Participants' occupation

This investigates the occupations of the participants that are accountable for managing projects in the respective project businesses of this study. A close-ended question was used to explore the role of the participants. An open-ended question was also included for participants with complex senior job titles. The options included:

- Project Manager
- Contractor Site Manager
- Contractor Supervisor
- Other (for complex senior positions)

Figure 4.2 below depicts the participants' occupations.

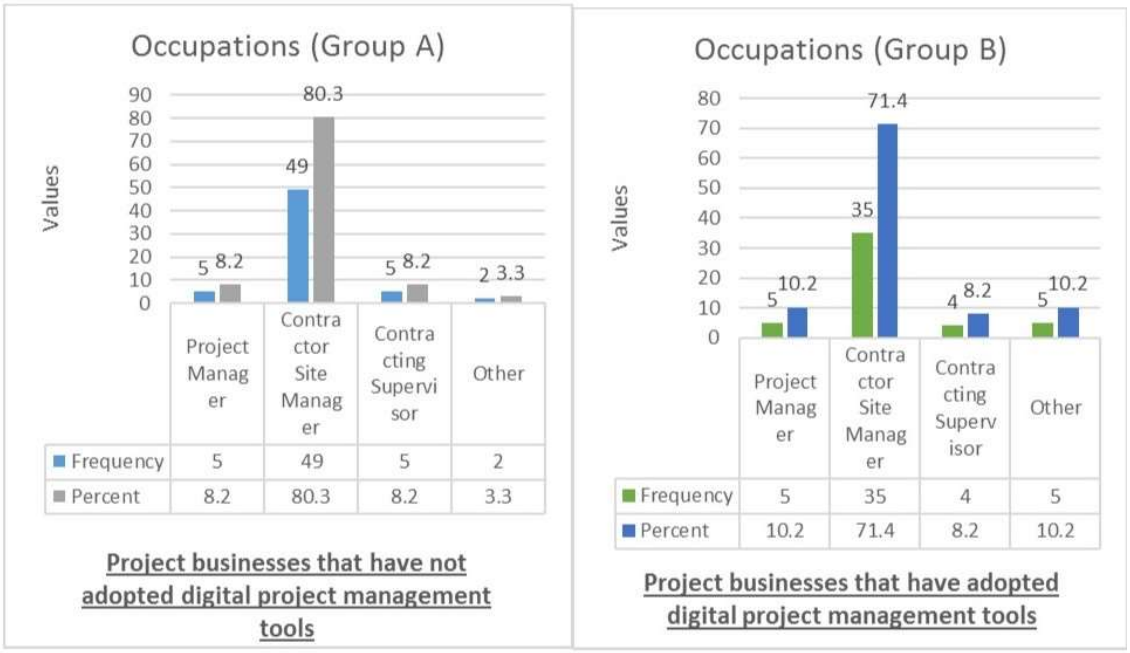


Figure 4.2: Occupations of respondents

The figure depicts two groups of project businesses—Group A is project businesses that have not adopted project management tools and Group B is project businesses that have adopted project management tools.

The predominant occupation for both groups is contractor site manager (n=49; representing 80.3% and n=35; representing 71.4%). In Group A, the second most dominant occupation is contracting site supervisor (n=5; representing 8.2%) and the project manager (n=5; representing 8.2%). For Group B, the second highest occupation is project manager (n=5; representing 10.2%) and the 'other' occupations (n=5; representing 10.2%). The 'other' occupations for Group B included two safety officers, one construction manager and two Quality Assurance, Environmental, Health and Safety managers. The least dominant occupation for Group A is the 'other' occupations (n=2; representing 3.3%) that consists of one managing director and one safety officer. For Group B, the least dominant occupation is contracting supervisor (n=4; representing 8.2%). From this data, it can be concluded that the key occupation of project manager is not as dominant as anticipated for project businesses that operate in the mining sector. Previous research papers (City Insight Report, 2020:108; Takawira, 2019:115; Oke et al., 2018:307) affirm that South Africa needs qualified and experienced project managers. The study data suggest that there is a deficiency of project managers in most organisations and as such, project management skills and knowledge are not being shared and explored within the organisation under study. The findings of Tomomitsu et al. (2018:362) highlight that it is essential for organisations to have project managers, as they have the aptitude to apply and share knowledge with the project team, they can enhance business processes and instil success and growth in the organisation. Furthermore, the City Insight Report (2020:10) states that the project management profession and skills are vital in an organisation and should not be neglected. Hussain et al. (2020:9) propound that highly experienced, educated and trained project managers generally succeed in all the dynamic elements of a project (time, cost and quality). Unfortunately, most project businesses in the mining sector rarely employ project managers but rather appoint site managers and supervisors. This shows that most project businesses in the mining sector do not derive the benefits of having a qualified project manager leading their projects.

4.3.3 Participants' educational level

The purpose was to obtain information about participants' levels of education and establish the highest level. The data were collected to determine if the educational level has an impact in influencing the adoption of digital project management tools. This segment included a close-ended and an open-ended question for other types of educational qualifications. The options included the following educational levels:

- Primary school
- Secondary school

- Technical college
- First diploma/degree
- Master's degree
- Doctoral degree
- Other (for different types of qualifications)

Figure 4.3 below illustrates the participants' educational levels. The figure includes two groups of project businesses, where Group A comprises project businesses that have not adopted project management tools and Group B is project businesses that have adopted project management tools.

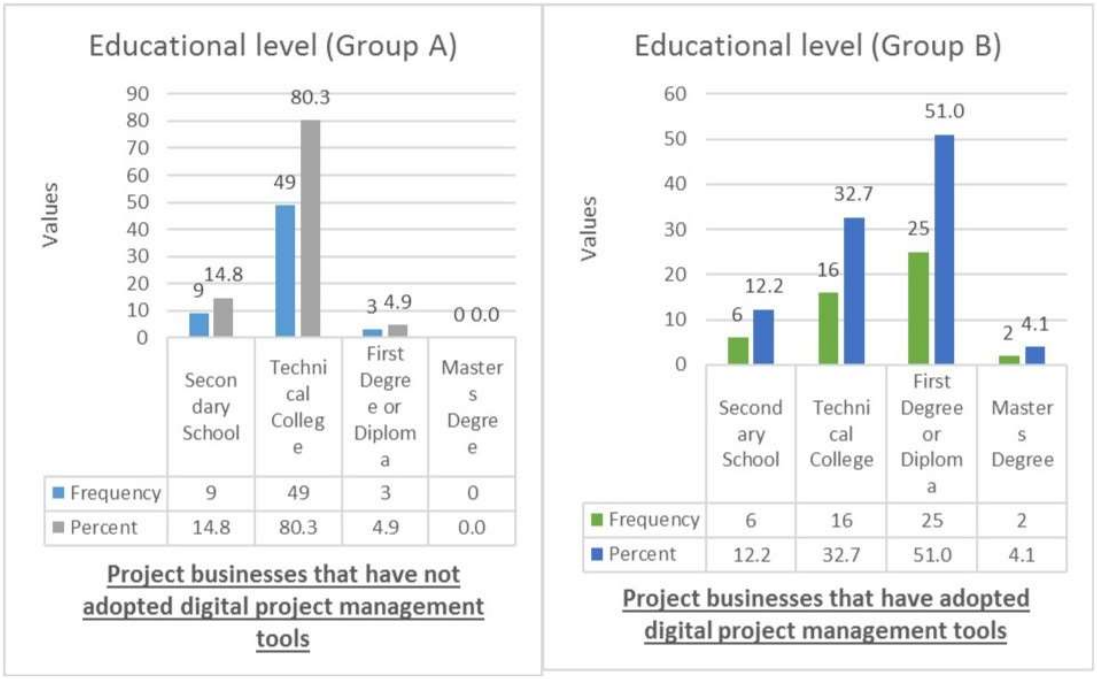


Figure 4.3: Educational levels of respondents

As can be seen from the above figure, most respondents in Group A have technical college qualifications (n=49; representing 80.3%), while the highest educational level for Group B is a first degree and/or diploma qualification (n=25; representing 51%). The second highest educational level for Group A is secondary school (n=9; representing 14.8%) and technical college education for Group B (n=16; representing 32.7%). Master's degrees were lacking among participants, with Group A returning 0 and Group B (n=2, representing 4.1%). Talukder et al. (2012:54) found that employees who undergo educational courses and training that inspire them to embrace new technological developments are more likely to adopt digital solutions. García-Moreno et al. (2016:557) also identified a positive relationship between the

education level of employees and the adoption of new technology. In Pillay's (2016:82) study, the author emphasises that when employees are more educated they tend to adopt digital tools. This shows that a good educational level has an impact on the adoption of digital project management tools.

4.3.4 Nature of business

The researcher sought to determine into which categories of business the participating organisations fall. A close-ended question was used that included three business categories, namely engineering, construction and 'other' (for different project businesses). The data were collected to determine if the nature of business influences the adoption of digital project management tools.

Figure 4.4 below reflects the nature of the business of the respondents.

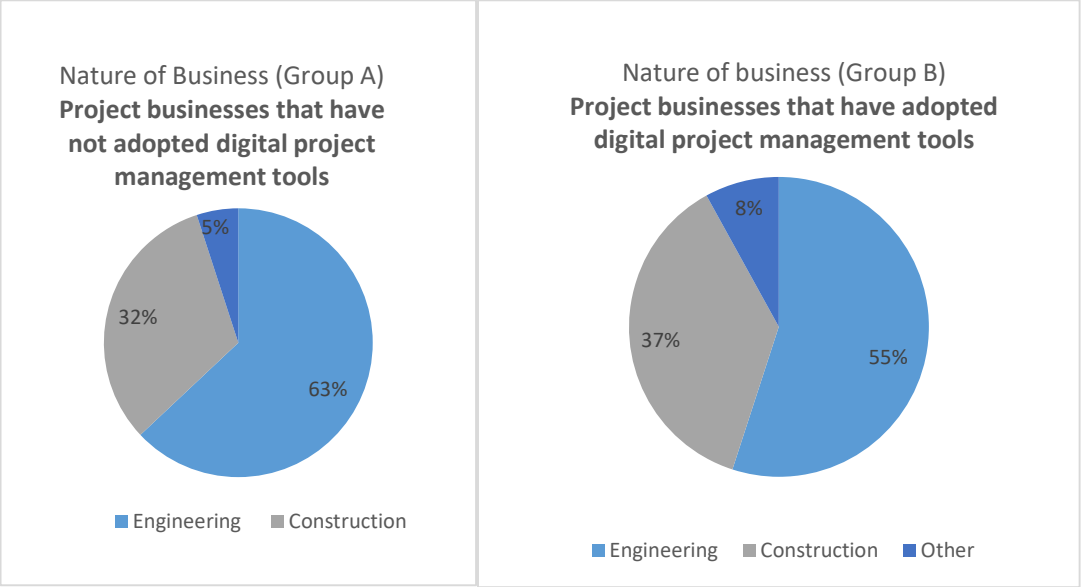


Figure 4.4: Nature of business of the project businesses

The figure shows two groups of project businesses, where Group A comprises project businesses that have not adopted project management tools and Group B comprises project businesses that have adopted project management tools.

Figure 4.4 shows that most of the project businesses that participated in this study selected engineering as their nature of business (Group A is represented by 63% and Group B is represented by 55%), followed by construction (Group A at 32% and Group B 37%). The 'other' category represents the lowest values for both groups (Group A at 5% and Group B at 8% selection rate). The 5% for Group A represents mining (1%), pest control (1%) and waste

management (2%), while the 8% for Group B represents mining (2%) and information technology (6%).

The findings above suggest that the engineering and construction disciplines are the most dominant forms of business in the mining sector. This supports the results produced by the South African project management report by (Marnewick et al., 2013:35), which revealed that engineering, construction and ICT forms of business are dominant in the project management discipline. The implication is that the nature of business has an impact on the adoption of digital project management tools, as some project businesses feel the need to adopt new competitive tools in their line of business.

4.3.5 Number of employees

The study sought to assess the number of persons employed by the contracting project business in the demarcated area. This information was needed to determine if the size of the workforce has an impact on the adoption of digital project management tools for project businesses. A close-ended question was utilised to obtain the required data.

Table 4.1 below compares Group A, which comprises project businesses that have not adopted project management tools and Group B, which comprises project businesses that have adopted project management tools.

Table 4.1: Number of employees employed by the project businesses

Group A: Project businesses that have not adopted digital project management tools				Group B: Project businesses that have adopted digital project management tools			
	Number of employees				Number of employees		
	Range	Frequency	Percent		Range	Frequency	Percent
	1-9	40	66%		1-9	20	41%
	10-20	15	25%		10-20	7	14%
	21 or more	7	11%		21 or more	22	45%

Table 4.1 above shows that most of the project businesses that have not adopted digital project management tools (Group A) have between 1–to 9 employees, representing 66% (n=40), while most of those that have adopted digital project management tools (Group B) have 21 or more

employees, representing 45% (n=22). The second highest ranking for Group A is project businesses that have between 10–20 employees (representing 25%; n=15) and 1–9 employees for Group B (representing 41%; n=7). The lowest ranking for Group A consists of businesses that have 21 or more employees (representing 11%; n=7) and 10–20 employees for Group B (representing 14%; n=7). These results were important in indicating the influence of workforce size in adopting digital project management solutions. The results suggest that project businesses with a higher number of employees are more likely to adopt digital project management solutions than those with fewer employees. This aligns with the findings of El-Sayegh et al. (2016:242), which affirm that decision-making in project businesses is influenced by the number of employees. The PMO Insight Report (2019:3) contains similar findings and confirms that most organisational decisions, such as whether to adopt digital project management tools, are evaluated with the consideration of the size of the project team. Furthermore, it is evident in the report that organisations with more employees tend to adopt digital project management tools compared to those with fewer employees. The implication for this study is that project businesses that use digital project management tools tend to have a high number of employees.

4.3.6 Number of years in business

The study sought to ascertain the number of years the project businesses have been in operation to determine whether this variable had any influence on the adoption of digital project management tools.

Figure 4.5 below depicts how long the project businesses have been in operation.

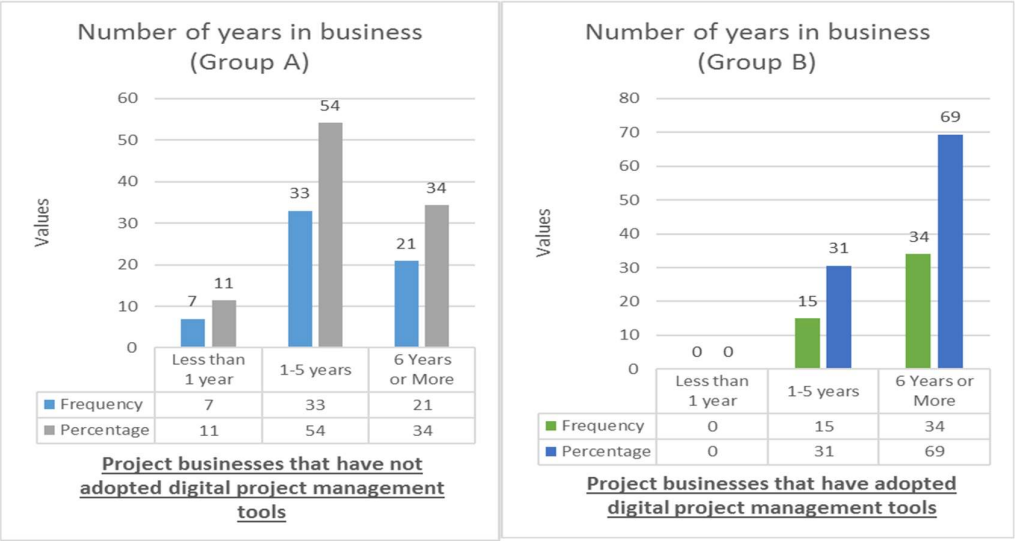


Figure 4.5: Number of years business in operation

Two groups of project businesses are presented. Group A comprises project businesses that have not adopted project management tools while Group B comprises project businesses that have adopted project management tools

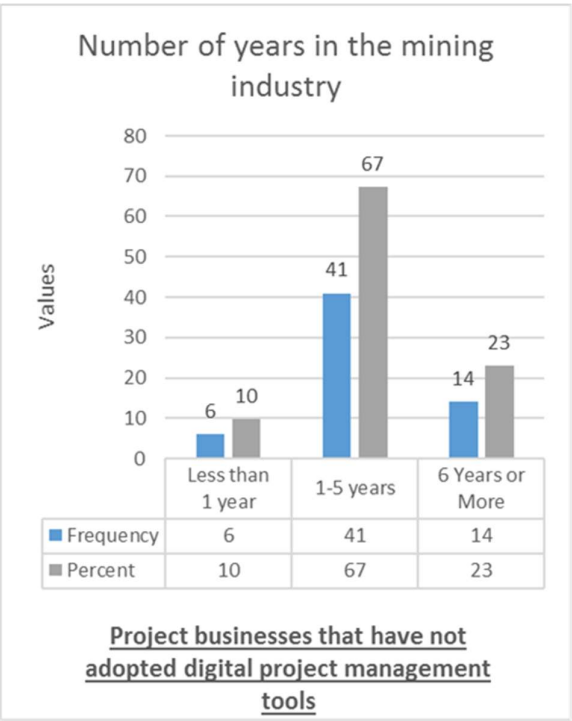
Figure 4.5 above shows that most of the project businesses that have not adopted digital project management solutions (Group A) are those that have been in operation for between 1–5 years (representing 54%; n=54), while most of the project businesses that have adopted digital project management tools (Group B) are those that have been in operation for 6 or more years (representing 69%, n=34). The second cluster of project businesses that have not adopted digital project management tools (Group A) are those with 6 or more years of business operation (representing 34%; n=21). The second cluster of project businesses that have adopted digital project management tools (Group B) contains businesses that have been operating for 1–5 years (representing 31%; n=15). There are also seven project businesses in Group A with less than one year of business operation, which have not adopted digital project management tools, representing 11%. Group B does not have businesses that have been operating for less than one year. These findings suggest that the number of years in operation does have an impact on the adoption of digital project management tools.

4.3.7 Number of years in the mining industry

This section presents data on the number of years that the project businesses have been operating in the mining sector. The study sought to determine if this variable influenced adopting digital project management tools.

Figure 4.6 below presents the number of years the project businesses have been operating in the mining sector. Group A contains project businesses that have not adopted project management tools while Group B contains project businesses that have adopted project management tools.

Group A



Group B

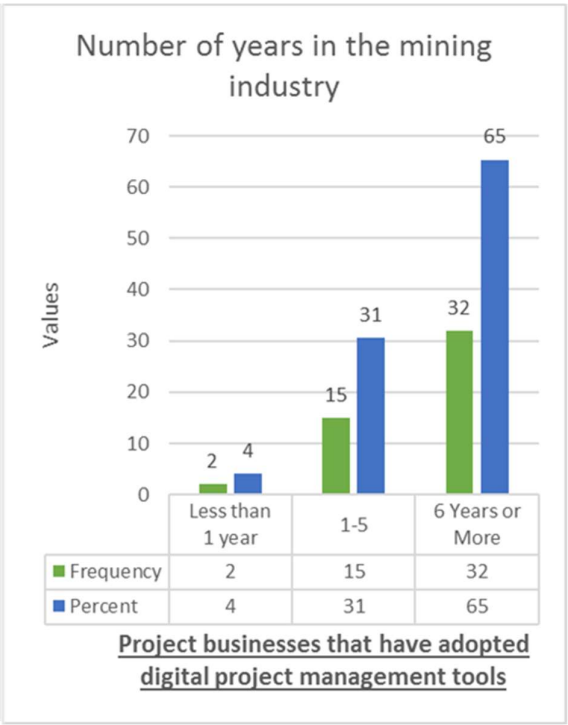


Figure 4.6: Number of years in the mining sector

The pattern of the results shown in Figure 4.6 above is similar to the pattern in Figure 4.5. The figure shows that most of the project businesses that have not adopted digital project management solutions (Group A) are those with between 1–5 years of business operation in the mining sector (n=41; representing 67%), while most of the project businesses that have adopted digital project management tools (Group B) are those with six or more years of business operation in the mining sector (n=32; representing 65%). The second grouping of project businesses that have not adopted digital project management tools (Group A) are those with six or more years of business operation in the mining sector (n=14; representing 23%). Group B, that have adopted digital project management tools, includes businesses that have been operating in the mining sector for 1–5 years (n=15; representing 31%). There are also six project businesses in Group A with less than one year in business operation in the mining sector (representing 10%) and two project businesses for Group B that have adopted digital project management tools (representing 4%). Group B does not have businesses that have been operating for less than one year. These results show that industry experience has an influence on the adoption of digital project management tools in the same way as experience in the mining industry, as seen in Figure 4.5.

4.3.8 Locality of the project businesses

The importance of gathering data about the locality of the project business participants was to cluster data sets, as most business opportunities at the selected mine in this study are offered to local businesses that are located near the mine. The main purpose of collecting data about locality was to test whether there is a relationship between locality and the adoption of digital project management tools among the participating project businesses. This strategy was also applied by Geldenhuys (2013:67), who tested the impact of the geographic area on the adoption of ICT tools for construction project businesses.

Figure 4.7 below shows the number of project businesses located in and around the Mogalakwena district. The data were obtained through the use of a dichotomous question in the study survey. Of the two groups of project businesses, Group A is the project businesses that have not adopted project management tools, while Group B is the project businesses that have adopted project management tools.

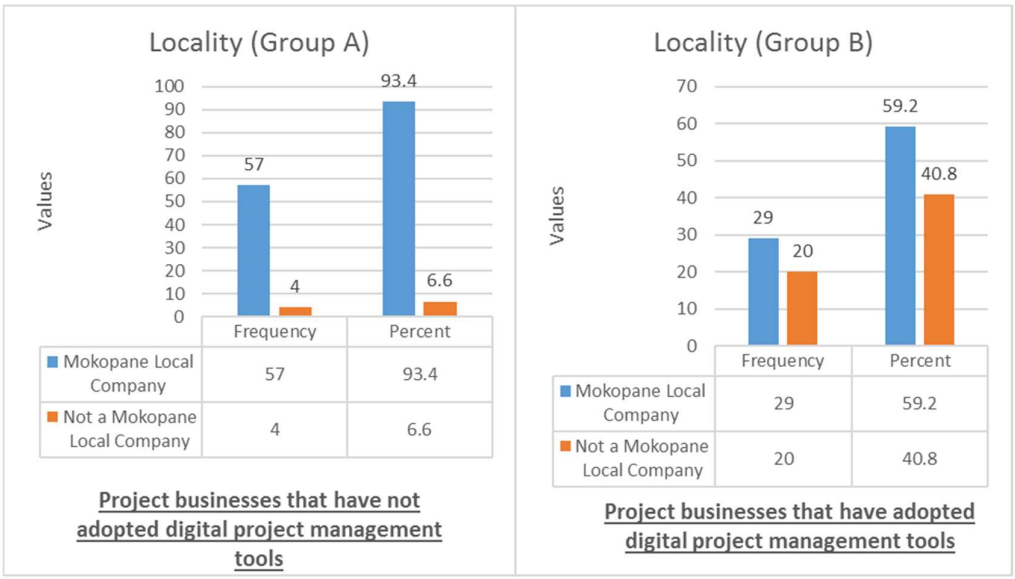


Figure 4.7: Locality of the project businesses

As can be seen from the above figure, most of the project businesses are from the Mokopane (Waterberg) district. Figure 4.7 above indicates a high bar of 93.4% (n=57) of Group A, Mokopane district project businesses that have not adopted digital project management tools; and 6.6% (n=4) project businesses that are not from the Mokopane district.

For Group B there is a 59.2% level (n=29) of Mokopane district project businesses that have adopted digital project management solutions and 40.8% (n=20) of project businesses that are not from the Mokopane district.

The results in Figure 4.7 shows that there is a high frequency level of adoption for non-local Mokopane (Waterberg) district project businesses than from the Mokopane district project businesses. There is a high number of Mokopane district project businesses that have not adopted digital project management tools. This suggests that locality does play a role in influencing the adoption of digital project management tools, as supported by Geldenhuys (2012:67), that geographical location plays a role in the adoption of digital project management tools.

4.4 Information about the projects and their challenges

This section contains information about the project involvement, project types, project success rates and project challenges. This section was necessary for presenting data about the project experiences of project businesses that have adopted digital project management tools and those that have not adopted digital project management tools.

4.4.1 Number of projects initiated

An open-ended question was posed to obtain information on the number of projects that have been initiated by the project business participants. This information was sought to ascertain the respondents' level of involvement and experience in the discipline of project management.

Table 4.2 below indicates the number of projects initiated by the project business participants.

Table 4.2: The number of projects initiated by the project businesses

Descriptive Statistics					
Project Businesses that have not adopted digital project management tools	Group A	N Participants	Mean	Maximum	Sum
Number of Projects		61	18	98	1084
Project Businesses that have adopted digital project management tools	B	N Participants		Maximum	Sum
Number of Projects		49	36	100	1782

The average number of projects initiated by Group A project businesses is 18 and 36 for Group B. The highest number of projects initiated among Group A businesses is 98 and 100 for Group B. These data reflect that Group B project businesses have embarked on far more projects than those in Group A, even though the number of Group A participants is slightly higher than that of Group B. This indicates that project businesses that have more experience and exposure tend to adopt digital project management tools. Although not many recent studies exist on this factor, Magwali (2018:56) confirms that project businesses that tend to adopt digital management tools are those that have more experience and exposure.

4.4.2 The type of projects

Figure 4.8 below presents the types of projects initiated by the two groups, A and B, of project businesses. Group A is project businesses that have not adopted project management tools,

while Group B comprises project businesses that have adopted project management tools. An open-ended question was utilised to obtain the data presented below.

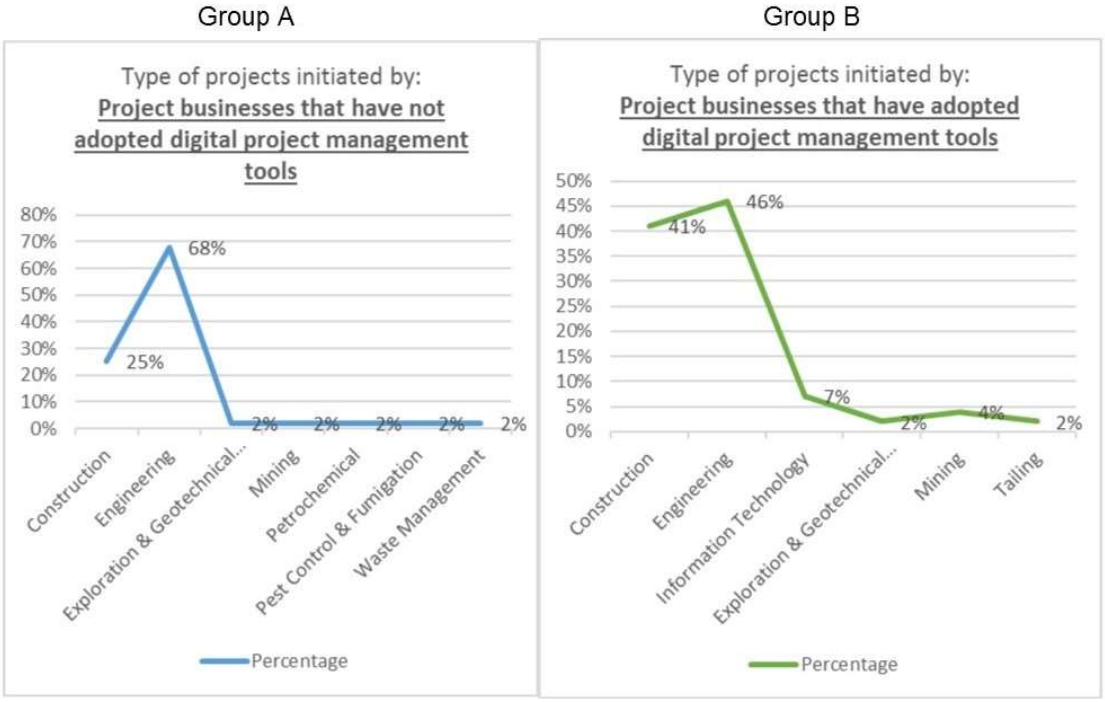


Figure 4.8: Types of projects

From Figure 4.8, it can be seen that most of the projects initiated for both groups are engineering (Group A – 68%; Group B – 46%) and construction projects (Group A - 25%; Group B – 41%). Projects that are rated the lowest according to Figure 4.8 are IT projects (Group B – 7%); mining projects (Group A – 2%; Group B – 4%); exploration and geotechnical drilling projects (Group A – 2%; Group B – 2%); petrochemical projects (Group A – 2%); tailings projects (Group B – 2%). Tailings are the underground rock and course of wastes produced in a mining plant. Motorised and biochemical processes are utilised for mining the anticipated product from the mine ore and producing a surplus watercourse identified as tailings (Mohapatra & Kirpalani, 2017:12). Waste management projects (Group A – 2%) and pest and fumigation projects (Group A – 2%) are insignificant values. The results presented above show that most projects initiated in the mining sector are engineering and construction projects. This information was compiled to understand the nature of projects initiated and their influence on the adoption of digital project management solutions among the project business participants. Figure 4.8, therefore, shows that 41% of the construction projects at the Mogalakwena mine are delivered using digital project management solutions, as opposed to 25% that is delivered without the use of digital project management tools. This reflects a difference of 16%, which strongly suggests that construction projects are managed with the aid of digitalisation.

However, engineering projects have a rating of 22%, which shows that the majority of the projects are managed without the support of digitalisation.

Although Figure 4.4 of this study shows the participants' natures of business, it was also imperative to ascertain the project types, since some project businesses might have carried out multiple types of projects despite the nature of business. These data were necessary as the study intended to establish if the project type influences the adoption of digital project management tools. Although there is not much known about the role of project types in influencing the adoption of digital project management solutions, Khalife and Dunay (2019:111) suggest that research should be undertaken in the form of case studies to investigate different business segments and their implications on project management digitalisation. The findings of this study show that the project management of construction projects is gradually moving to digitalisation, more so than in engineering projects in the South African mining sector. This may be caused by the difference in terms of the levels of complexity between engineering projects and construction projects. The study of Lukosevicius et al. (2018:339) confirms that engineering projects are often complicated in nature and are difficult to manage; they also have more risks, their technological systems are difficult to use and they are often multidisciplinary. According to an article published by Pro Crew Schedule (2020:1), digital project management solutions are more convenient and easier to use in construction.

The implication for this study is that the type of project delivered by the project businesses influences the adoption of digital project management tools.

4.4.3 Number of successful and unsuccessful projects

Measuring project success levels of project businesses that have adopted digital project management solutions versus those that have not adopted such solutions was significant for determining the contribution of digital project management tools to project success. An open-ended question was used to obtain the required data, which is illustrated in Table 4.3 below.

Table 4.3: **Successful** and unsuccessful project**s**

Descriptive Statistics			
	N	**Number of projects**	**%**
Project Businesses that have adopted digital project management tools			
Unsuccessful Projects	49	27	1.5%
Successful Projects	49	1755	98.5%
Project Businesses that have not adopted digital project management tools			
Unsuccessful Projects	61	16	1.5%
Successful Projects	61	1068	98.5%

The above table shows that the participant project businesses yielded similar results of project success. Project businesses that have adopted digital project management solutions were successful in 98% of their projects, which is similar to project businesses that have not adopted digital project management tools. Many studies (Raymond & Bergeron, 2007; Ali et al., 2008;

Pellerin et al., 2013; Magwali, 2018) have not focused on comparing the use and non-use of digital project management tools. However, Magwali (2018:67) recommends that research should be carried out to compare the success rate of project businesses that use digital project management tools versus those that do not use them. In conducting this comparison, the current study yielded similar project success results for both groups of project businesses.

4.4.4 Factors of project success

The researcher aimed to present statistical proof of the elements of project successes. A close-ended question was posed with the option of selecting the project success elements outlined below. Space was provided for participants who had more elements to add.

Figure 4.9 below illustrates the determinants of project success recognised in two groups of project businesses (Groups A and B). Group A is project businesses that have not adopted project management tools while Group B is project businesses that have adopted project management tools

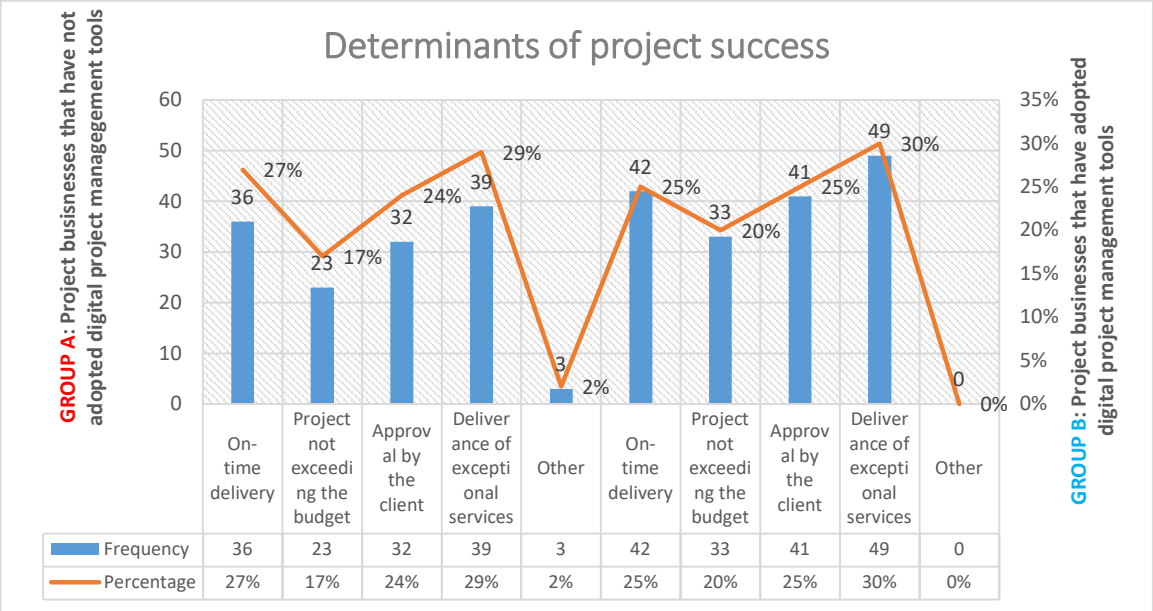


Figure 4.9: Determinants of project success

The figure shows the similarity of the element selection between Group A and Group B. It also shows that the 'deliverance of exceptional services' is an element that was highly selected by both groups of participants (Group A – 29%, n=39; Group B – 30%, n=49;), followed by 'on-time delivery' (Group A – 27%, n=36; Group B – 25%, n=42); and 'approval by the client' (Group A – 24%, n=32; Group B – 25%, n=41). 'Project not exceeding the budget' element is the second last element selected (Group A – 17%, n=23; Group B – 20%, n=33;). Three participants from Group A listed 'other' elements (representing 3%), which included 'efficient teamwork and good rapport' (n=1; representing 1%); 'good risk management' and 'good safety

management' (n=2; representing 1%). The key purpose of this exercise was to ascertain the priority pattern of project success factors among project businesses that have adopted digital project management tools and those that have not. The results show that both groups of project businesses focused on project quality (represented by delivery of exceptional services), the project timeframe (represented by on-time delivery) and client satisfaction (represented by approval by the client). This substantiates the results in Table 4.3, which show high success rates for both groups of project businesses. The results in Figure 4.9 are similar to the findings of Magwali (2018:55), which yielded the same pattern of project success for project businesses that have adopted digital project management tools. Moreover, the study of Pirotti et al. (2020:4) affirms that project success is driven by project quality, time and client satisfaction. Doan et al. (2020:224) also opine that project success is determined by consumer satisfaction, quality, time and cost. However, the results of the current study reflect that project businesses that use digital project management tools and those that do not, both have similar patterns of success elements.

4.4.5 Phases of project success

As highlighted in the literature review (Chapter 2, section 2.3, project management overview section), it is recommended that methodical investigations should be carried out to assess the effect of integrated approaches represented by the project phases (Cristóbal et al., 2018:8). Therefore, in the current study, the researcher evaluated the project phases to understand the perceptions of project businesses that have adopted digital project management tools versus those that have not adopted such tools. Project phases are an integral part of project management. In this regard, a close-ended question was posed in the survey with the option of selecting the project phases. A space was also provided for participants who wished to add more information about this.

Table 4.4 shows the results for Group A (those that have not adopted digital project management solutions and Group B (those that have adopted digital project management solutions).

Table 4.4: Challenging project phases – digital project management adoption vs non-adoption

Project Phases	**Group A: Project businesses that have not adopted digital project management solutions**				Total 100%	**Group B: Project businesses that have adopted digital project management solutions**			
	Selected		Not Selected			Selected		Not Selected	
Project Planning	34	55.7%	27	44.3%	100%	25	51%	24	49%
Project execution	28	45.9%	33	54.1%	100%	28	57.1%	21	42.9%
Project control & performance	36	59%	25	41%	100%	31	63.3%	18	36.7%
Project initiation	17	27.9%	44	72.1%	100%	19	38.8%	30	61.2%

The table above shows a common pattern of selections for both Groups A and B. It can be seen that both groups of project businesses view the 'project control and performance' phase as greatly affecting their project success (Group A – 59%, n=36; Group B – 63.30%, n=31). The groups also indicated that the 'project planning' phase is the phase that affects their project success (Group A – 55.7%, n=34; Group B – 51%, n=25). However, there is a slight distinction in the results presented for the 'project execution' phase, where Group A outcomes yield a positive result and Group B outcomes yield a negative result. This, therefore, means that the approaches applied by project businesses that utilise digital project management tools trigger challenges in the project execution stage. According to both groups, the 'project initiation' phase is the phase that least affects project success. These findings are supported by Magwali (2018:56), who found that the project planning phase, followed by the project control and performance phase as well as the project execution phase, are project phases that affect project success. The information above was relevant for providing an understanding of the success perceptions held by project businesses that have adopted digital project management tools, versus those that have not adopted such tools. These success perceptions relate to the influence of project phases on project success.

4.4.6 Internal challenges that affect project success

The researcher sought to obtain knowledge about internal challenges that affect the project success of the project business participants. Regarding the literature review in Chapter 2, in the project management challenges section, it was clear that several challenges face the progression of most projects. However, uncertainty remains of the challenges affecting project businesses that use modern digital methods compared with those that use traditional methods. Therefore, this sub-section was designed to form a division of classifying internal challenges that affect project businesses that have adopted digital project management tools against those that have not adopted such tools. The information presented in this sub-section was essential for extending knowledge about internal project business challenges and their prevalence in the discipline of project management.

To collect this data, a close-ended question was used, with the option of selecting the challenges that are likely to hinder project success. Space was also provided for participants who wanted to add more data.

Table 4.5 below presents information regarding two groups of project businesses, being those that have adopted digital project management solutions (Group A) and those that have not adopted digital project management solutions (Group B).

Table 4.5: Internal project management challenges – digital project management adoption vs non-adoption

Group A: Project businesses that have adopted digital project management solutions					Total %	Group B: Project businesses that have not adopted digital project management solutions			
Internal challenges	Selected		Not Selected			Selected		Not Selected	
Lack of Technology	11	22.40%	38	77.60%	100%	21	34.40%	40	65.60%
Lack of resources	15	30.60%	34	69.40%	100%	40	65.60%	21	34.40%
Limited budget	14	28.60%	35	71.40%	100%	36	59%	25	41%
Project requirements not clearly defined	11	22.40%	38	77.60%	100%	9	14.80%	52	85.20%
Project plan not understood by the team	9	18.40%	40	81.60%	100%	7	11.50%	54	88.50%
Project scope not understood by the team	9	18.40%	40	81.60%	100%	7	11.50%	54	88.50%
Poor communication	25	51%	24	49%	100%	30	49.20%	31	50.80%
Limited skills	17	34.70%	32	65.30%	100%	22	36.10%	39	63.90%
Changes in project requirements	21	42.90%	28	57.10%	100%	32	52.50%	29	47.50%
Organisational change	17	34.70%	32	65.30%	100%	15	24.60%	46	75.40%
Project requirements not understood by the team	12	24.50%	37	75.50%	100%	6	9.80%	55	90.20%

Table 4.5 above shows that project businesses that are not using digital project management solutions (Group B) in the South African mining sector are affected by the lack of resources. The findings provided herein relate to the results presented by contemporary literature, such as that of Bhika and Pretorius (2019:488), who established that the lack of resources is the uppermost challenge that affects most project businesses in South Africa. Other literature studies, including Okereke (2017:16) and Egwuonwu (2015:63), revealed that the lack of resources contributes greatly to project failure. As for the PMO Insight Report (2019:13) of South Africa, it publicised that resource management is not carried out by most project managers, therefore, the challenge of lacking resources will remain ubiquitous for most project businesses. The key cause of lack of resources stems from improper utilisation and management of resources. If project businesses that do not use digital project management tools, circumvent addressing this challenge from reoccurring, they might experience project failure in some of their projects. As seen in Table 4.5, it is clear that Group A project businesses picked limited budget as another internal weakness for them in the South African mining sector. This challenge was identified by Bhika and Pretorius (2019:491) and Egwuonwu (2015:63), who emphasised that the project budget plays a pivotal role in influencing the success of projects in many South African organisations. As for Murwira and Bekker (2017:141), they

discovered that in South Africa the common root source of a limited budget in a project is inadequate financial forecasting techniques, accompanied by poor cost controls and management, as well as the inability to set cash flows and project cost estimations. The Group B project businesses in Table 4.5 also pointed out project requirement changes as another internal hindrance of project success in the mining sector of South Africa. This challenge however, is a common one in South African literature, as noted by Komal et al. (2020:17) and Kagogo and Steyn (2019:266), who said that in their studies altered project requirements that are left unapproved, undocumented and mishandled are the root source of equivocal project requirements that are hard to control. The study of Rwelamila (2017:78) affirms that the complexity of the mining environment and its production components results in alterations that shake the majority of the project requirements in the mining sector.

Nevertheless, project businesses that make use of digital project management solutions listed poor communication as an internal challenge that mostly affects project success in the South African mining sphere, despite the positive results they have produced for other challenges. However, this study implies that internal challenges seem to be faced more by project businesses that do not use digital project management tools than those that do use digital project management tools.

4.4.7 External challenges that affect project success

The principal purpose of this part of the section was to acquire data about the external challenges that affect the project success of the project businesses that participated in this study. Corresponding with the previous sub-section, the objective of this part of the section was to create a division of the external challenges that affect project businesses that have adopted digital project management tools in comparison with those that have not. The sort of information presented in this sub-section was sought with the effort of extending knowledge around external project business challenges.

To accumulate relevant data in the survey, a close-ended question was used with the option of ticking the challenges that are probable to hinder project success, as outlined below. Space was also provided for participants that wanted to add more data.

Table 4.6 contains the information of two groups of project businesses (Group B: those that have adopted digital project management solutions and Group A: those that have not adopted digital project management solutions).

Table 4.6: External project management challenges – digital project management adoption vs non-adoption

	Group A: Project businesses not using digital project management solutions				Total %	Group B: Project businesses using digital project management solutions			
External challenges	Selected		Not Selected			Selected		Not Selected	
Economic changes	40	65.6%	24	34.4%	100%	28	57.1%	21	42.9%
Unanticipated weather patterns	29	47.5%	32	52.5%	100%	25	51%	24	49%
Political changes	20	32.8%	41	67.2%	100%	15	30.6%	34	69.4%
Supplier-related issues	34	55.7%	27	44.3%	100%	22	44.9%	27	55.1%

From Table 4.6 above it can be seen that economic changes (such as high interest rates, high tax rates, low employment levels and low consumer expenditure) have a significant impact on project successes for both groups of project businesses that are operating in the South African mining sector. This was also recognised by Rwelamila (2017:79), who reported that unfavourable economic conditions affect the iron ore of managing projects in terms of time, cost and quality. McQuerrey (2019:1) goes as far as to state that economic changes in South Africa affect project businesses on the four dimensions of high interest rates, high tax rates, low employment levels and low consumer expenditure. Increased interest rates result in high costs of debt for project businesses, while high tax rates affect their business income and profits. A declining economy deprives a project business of the advantage of making full use of the skills that can be provided by the labour market due to low employment levels and the affordability of skilled labour. When project businesses experience high costs, they are more likely to increase their prices, which can limit the clients' willingness to purchase the product, making it difficult to secure new projects. Boyle (2020:1) affirms that economic declines in South Africa result in diminishing profit margins and cause a downturn in labour hire for project businesses. Boyle further states that an economic decline can cause suppliers to compromise on the quality of their products to still fulfil the demands of project businesses. Mukwakungu et al. (2018:1178) support the fallout of economic decline, adding that poor economic conditions in South Africa contribute to skills shortages in the discipline of project management.

Another external challenge identified by project businesses that are not using digital project management tools is 'supplier-related issues', which is a concern for them in the South African mining sector. This external challenge is also stated in the research of Kafile and Fore

(2018:185), Shehu et al. (2019:3) and Fourie and Malan (2020:13-14), who also identified supplier-related issues as an ongoing challenge for South African project businesses. The study of Kafile and Fore (2018:185) revealed that favouritism of certain buyers, poor communication and vendor management are the main causes of supplier-related issues that mostly result in product delivery delays, non-delivery or the delivery of wrong goods. The study of Shehu et al. (2019:3) opine that supplier-related issues are caused by a lack of knowledge on the side of procurement business leaders and administrators to carry out procurement tasks. However, Fourie and Malan (2020:13-14) report that poor forecasting, poor performance evaluation techniques, inadequate procurement management knowledge and the lack of proficiency to link product demands and financial plans are all causes of supplier-related issues that affect project businesses.

Unanticipated weather patterns seem to marginally affect Group B project businesses that use digital project management tools but this could be because they deliver a higher number of construction projects. Construction project activities are more sensitive to weather patterns (Ballesteros-Pérez et al., 2018:680), while El-Sawalhi and Mahdi (2015:9) indicate that severe weather patterns affect the project execution phase. This aligns with the results shown in Table 4.4, which substantiates those project businesses that make use of digital project management tools view project execution as a phase that affects project success. In the current study, external challenges seem to be experienced by both Group A and Group B project businesses.

4.5 Digital project management solutions: level of awareness, adoption and the barriers to adoption

This section discusses the awareness and adoption levels of digital project management solutions of the participating project businesses, as well as the challenges of implementing such digital solutions. A set of dichotomous questions was utilised as outlined below.

Table 4.7 below shows dichotomous scaling values regarding the awareness and usage of digital project management tools based on project businesses that participated.

Table 4.7: Level of awareness and adoption of digital project management tools

Coding	Variables	PM PHASE	Dichotomous scaling			
			YES		NO	
			Percentage	Frequency	Percentage	Frequency
DQ1	Level of digital PM tools Awareness	Project Initiation	59.1%	65	40.9%	45
DQ2	Level of digital PM tools usage in Projects	Project Initiation	44.5%	49	55.5%	61

Table 4.7 reveals that 59.1% (n=65) of project businesses were aware of digital project management solutions, whereas 40.9% (n=45) were not aware. The table also shows that

44.5% (n=49) of project businesses use digital project management solutions and 55.5 (n=61) do not use digital project management solutions.

Figure 4.10 below illustrates the awareness levels of digital project management systems. The chart is classified per the number of business operating years in the mining sector as (as illustrated in Figure 4.6).

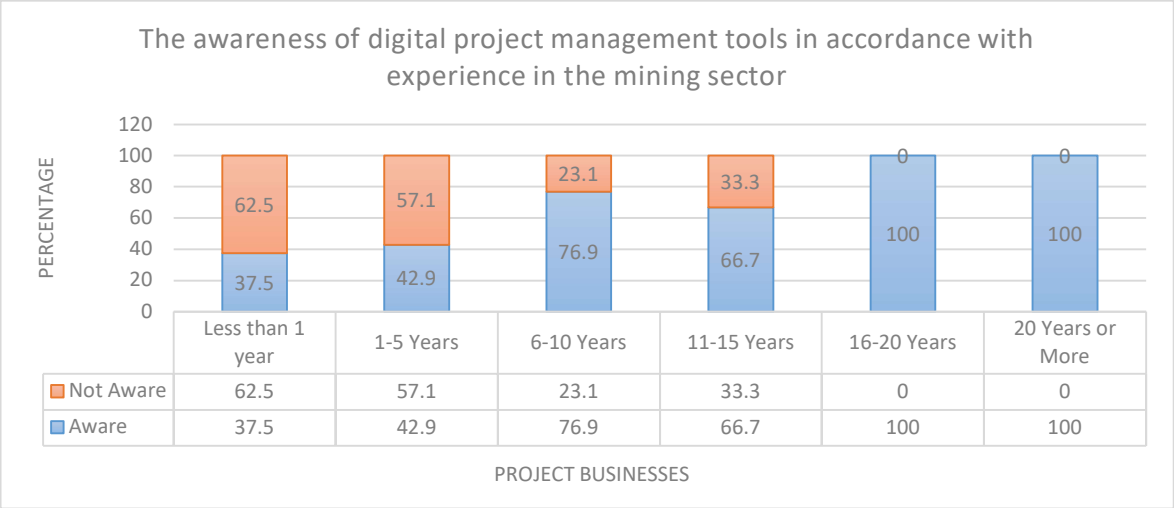


Figure 4.10: Awareness levels of digital project management systems

Figure 4.10 above shows that project businesses that have been operating in the South African mining sector for 16–20 years and more have the highest rate of digital project management tools awareness, followed by those with between 6–10 years (representing 76.9%), then by those with between 11–15 years (representing 66.7%). The project businesses with less than one year and those with 1–5 years in operation represent the lowest rates of awareness. The results above suggest that experienced project businesses in the South African mining sector are more aware of digital project management tools than those that are less experienced. The study of Mazzarol et al. (2010:111) affirmed that businesses that are more experienced tend to have the confidence to adopt new technical systems. Businesses that are large and have more experience are found to have robust financial resources that drive their eagerness to become aware of systems introduced in their line of business (Mazzarol et al., 2010:111). In this current study, it can be seen that project businesses with more years of experience are more aware of digital project management systems than those with fewer years of experience.

Table 4.8 below presents data on the levels of digital project management tools awareness and adoption. The only group of project businesses applicable in this instance was project businesses that have adopted digital project management tools as they have the relevant exposure and experience of using digital project management tools.

Table 4.8: Levels of digital project management tools awareness and adoption

	PROJECT BUSINESSES THAT USE DIGITAL PROJECT MANAGEMENT TOOLS			Dichotomous scaling			
Class	SPSS Coding	Variables	PM PHASE	N=49			
				YES		NO	
				%	Frequ-ency	%	Frequ-ency
1st Class	DQ3	Use digital PM tools for planning in projects	Project planning	95.90%	47	4.10%	2
	DQ11	Use digital PM tools for managing risks in projects	Project execution	87.80%	43	12.20%	6
	DQ12	Use digital PM tools for managing safety in projects	Project execution	91.80%	45	8.20%	4
2nd Class	DQ4	Use digital PM tools for scheduling in projects	Project planning	85.71%	42	14.29%	7
	DQ7	Use digital PM tools for time-tracking in projects	Project control & performance	75.50%	37	24.50%	12
	DQ8	Use digital PM tools for Workflow Management in projects	Project execution	75.50%	37	24.50%	12
	DQ9	Use digital PM tools for collaboration in projects	Project execution	75.50%	37	24.50%	12
3rd Class	DQ5	Use digital PM tools for budgeting projects	Project control & performance	67.30%	33	32.70%	16
	DQ6	Use digital PM tools for human resource management in projects	Project control & performance	69.40%	34	30.60%	15
	DQ10	Use digital PM tools for procurement purposes in projects	Project initiation	59.20%	29	40.80%	20
	Number of all respondents		49				

The information in the table above shows the extent of utilisation of digital project management tools, which addresses one of the research aims of this study. It can also be seen that digital project management solutions are utilised for numerous purposes. In light of this data, it can be confirmed that most project businesses use digital project management frequently for planning projects and managing safety and risk (categorised as the 1st class of usage). Digital project management solutions are also used for scheduling, time-tracking and managing workflows in projects (categorised as the 2nd class of usage). However, digital project management solutions are less utilised for managing the budget, human resources and procurement (categorised class 3 usage).

From the table above it is clear that project businesses in the South African mining sector mostly focus on the 1st class and 2nd class functionalities when having to adopt digital project management solutions. Some project businesses, however, are not making full use of digital

project management tools. This is confirmed by the PMO Insight Report (2019:2), which revealed that the adoption of digital project management tools is increasing but project managers are currently not making full use of these tools. The report went on to publicise that there are more than 50% of project managers who need to adjust their budgeting, forecasting and reporting approaches around digital project management tools. Savvides (2015:102) has similar findings, that if South African project businesses fully utilise superior and dependable digital project management solutions, more benefits and advantages will be enjoyed.

Table 4.9 below focuses on the most commonly used PMS packages. The researcher sought to ascertain what are the most popular digital project management tools adopted by the project business participants. This was important because it provided clarity on the digital project management solutions that are generally adopted and preferred by project businesses in the mining sector. The only group of project businesses applicable was project businesses that have adopted digital project management tools, as they are the only ones using PMS packages.

Table 4.9: Most used project management software packages

Project Management Software (PMS) Packages	Usage	
	Selection Frequency	Percentage
Trello package	1	1.4%
BaseCamp package	-	-
Microsoft Project	42	59.2%
Smart-sheet	3	4.2%
Huddle	1	1.4%
Oracle Primavera	6	8.5%
Proofhub	-	-
Zoho Projects	-	-
GanttPro	6	8.5%
Other	12	16.9%

Table 4.9 above shows that the most commonly used PMS package is Microsoft Project (representing 59.2%). The study by Magwali (2018:60) also revealed that Microsoft Project is the most well-known and commonly used system. Oracle Primavera (representing 8.5%), GanttPro (representing 8.5%) and Smart-sheet (representing 4.2%) PMS packages were also used. The 'Other' group of various software packages represents 16.9%. This group included Beltanalyst, Dynamicanalyst and Conveyer Design software; Business Intelligence (BI) Project and Asset Maintenance (AMT) Software; Drillsoft HDX; Focal Point & ERS Bio; 'GPM2 & SKF Project Tools; 'Liebherr Crane Planner 2.0; Monday.com; Microsoft Teams and TORAS-Techincal Operational Risk Assessment System. Huddle, Zoho Projects, BaseCamp and Trello software packages were the least-used packages in this study. The variety of choices is due to the preferences and knowledge of the digital project management tools, as well as the diversified scope of work of each project business.

Although there is not much information on the general use of various PMS packages, this study has shown that most project businesses prefer using independent and industry-specific systems. Magwali (2018:61) further notes that the size of the projects, the knowledge of digital project management solutions and the nature of work play a pivotal role in the selection and use of PMS packages for the project businesses. However, the most commonly used PMS package remains Microsoft Project.

4.6 Barriers to adopting digital project management tools and the level of readiness for adoption by project businesses

Only project businesses that have not adopted digital project management tools were relevant here. This criterion was motivated by the fact that project businesses that have not adopted digital project management tools were the appropriate group to provide the relevant information to justify the challenges that prevent them from adopting digital project management tools.

4.6.1 Barriers to adopting digital project management tools

The significance of this part of the section was to collect data regarding the barriers to adopting digital project management tools by the project business participants. A Likert scale method was utilised to measure items in this section, as outlined in Table 4.10. It is vital to measure the items of the Likert scale to ensure dependability. This measure was carried out by conducting a reliability test using Cronbach's alpha coefficient. Internal reliability was measured using the Cronbach's alpha test (α) and CR test (CR) to assess the reliability. It was imperative to apply such measures, as the measuring scales of this study were amended and reformed.

The Cronbach's alpha coefficient value has an impact on the researcher's interpretation, thus researchers need to be mindful of alpha coefficient properties to properly collect and interpret statistical findings (Ritter, 2010:15). The purpose of these measures was to ensure internal consistency of the items included in Table 4.10.

Internal consistency is used for indicating the degree to how the items in a test measure a single research construct (Tavakol & Dennick, 2011:53). According to Taber (2018:1285), Cronbach's alpha is used for measuring the connection of the items to ensure reliability. Cronbach's alpha is influenced by the inter-item correlation that denotes the bond of the items. Table 4.10 indicates the outcomes of the reliability test that was conducted.

Table 4.10: Barriers to adopting digital project management solutions

Research construct		Descriptive statistics			Cronbach's test	CR	AVE	Factor loading λ
	Coding	Mean	Standard deviation	Item-total correlation	α Value			
Barriers to adopting Digital PM tools	SDNAS1	3.95	0.921	0.612	0.800	0.979	0.403	0.677
	SDNAS2	4.10	0.810	0.703				0.671
	SDNAS3	3.90	0.978	0.690				0.647
	SDNAS4	4.03	0.894	0.676				0.722
	SDNAS5	4.11	0.839	0.607				0.670
	SDNAS6	4.10	0.676	0.388				0.316
	SDNAS7	4.25	0.699	0.268				0.691
	SDNAS8	3.93	0.854	0.150				0.589

(CR: Composite Reliability; (α): Cronbach Alpha value; AVE: Average Variance Reliability; * Scores: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 5=Agree; 6=Strongly agree)

4.6.2 Level of readiness for project businesses to adopt digital project management tools

This section addresses the readiness of the project businesses to adopt digital project management tools. It includes a discussion on the reliability measures of the Likert scale items listed in Table 4.11 below.

Since a Likert scale was utilised in this section, a consistency measure was applied. The measure was carried out by conducting a reliability test using Cronbach's alpha coefficient. Internal reliability was tested using the Cronbach's alpha test (α) and CR to assess the reliability of this research study. It was imperative to apply such measures as the measuring scales of this study were amended and reformed.

Table 4.11: Outcomes of the reliability test that was conducted

Research construct		Descriptive statistics			Cronbach test	CR	AVE	Factor loading λ
	Coding	Mean	Standard deviation	Item-total correla-tion	α Value			
Readiness of adopting Digital PM tools	SDNAS9	2.295	1.054	0.760	0.932	0.996	0.5	0.652
	SDNAS10	2.328	1.044	0.834				0.770
	SDNAS11	2.344	1.109	0.820				0.751
	SDNAS12	2.262	1.031	0.787				0.762
	SDNAS13	2.131	0.939	0.849				0.804
	SDNAS14	2.131	0.974	0.817				0.809
	SDNAS15	2.082	1.005	0.805				0.735
	SDNAS16	2.180	0.904	0.824				0.739
	SDNAS17	2.066	1.047	0.808				0.727
	SDNAS18	2.410	1.116	0.728				0.655
	SDNAS19	2.738	1.264	0.304				0.343
	SDNAS20	2.148	0.946	0.765				0.666
	SDNAS21	3.393	1.159	0.270				0.557
	SDNAS22	2.951	1.117	0.387				0.666

(CR: Composite Reliability; (α): Cronbach Alpha value; AVE: Average Variance Reliability; * Scores: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 5=Agree; 6=Strongly agree)

4.6.3 Cronbach's alpha test (α)

Cronbach's alpha coefficient was utilised to measure the level of internal reliability consistency of the items listed in Tables 4.10 and 4.11.

From Tables 4.10 and 4.11 it can be seen that Cronbach's alpha coefficient values range from 0.800–0.932, implying that the items included in the tables have a high internal consistency. According to Tavakol and Dennick (2011:52), Almomani et al. (2018:5) and Taber (2018:1296), a Cronbach coefficient value >0.50 is acceptable and a value >0.91 is strong and reliable. This is because when items are well connected and they produce a value that is beyond 0.50 successively they are consistent and are measuring the same construct (Ritter, 2010:13). The alpha coefficient rate is influenced by the number of items tested and their inter-connection. When items generate a low coefficient alpha value it is an indication that the survey does not

have enough information/questions and there is an existence of poor inter-connectivity between the items. This may require revision of some items (Tavakol & Dennick, 2011:54).

4.6.4 Composite reliability test (CR)

The accuracy of the analysis for Tables 4.10 and 4.11 was measured utilising the CR measure. According to Abdul-Rahman and Kamarulzman (2012:1026), Chien et al. (2017:6) and Veiga et al. (2019:339), CR is measurable using the steps below:

Step 1: λ^2 (Factor loading)^2

Step 2: (1 - λ^2)

Step 3: Composite Reliability (CR) =

$$\frac{\text{Sum } (\lambda \text{ of all items}) \text{ x Sum } (\lambda \text{ of all items})}{\text{Sum } (\lambda \text{ of all items}) \text{ x Sum } (\lambda \text{ of all items}) \ + \ \text{Sum } (1 \ - \ \lambda^2 \text{ of all items})}$$

Equation 4.1: Composite Reliability (CR) calculation

Source: Abdul-Rahman and Kamarulzman (2012:1026), Chien et al. (2017:6); Veiga et al. (2019:339)

Where λ is the factor loading,

CR is the calculation of the internal reliability of all items being tested in their dimension of the central construct (Wipulanusat et al., 2017:64). This determines how reliable the items are in defining the main construct. The CR calculation method was utilised in Microsoft Excel as illustrated above. The factor loading data was obtained from SPSS v26.0. According to Yong and Pearce (2013:80), factor loading measures the existing similarity among the responses provided by the participants. Factor loadings are used for narrowing variables into main factors that can then be interpreted. The CR value needs to be >0.6 as recommended by Gu et al. (2019:7). The CR of the items in Table 4.10 of this study is 0.979 and in Table 4.11 it is 0.996, which indicates good CR values, as recommended by various researchers (Fornell & Larcker, 1981:46; Lam, 2012:1332; Huang et al. 2013:219; Yong & Pearce, 2013:80; Wipulanusat et al. 2017:64).

4.6.5 Average variance extracted (AVE)

AVE is applied for validating constructs in a study. AVE is the calculation of the variability measure sum that is captured by the construct (Wipulanusat et al., 2017:64). The AVE was measured using Microsoft Excel as suggested by Abdul-Rahman and Kamarulzman (2012:1026) by applying the steps below:

Step 1: λ^2 (Factor loading)^2

Step 2: Average Variance Extracted (AVE) =

$$\frac{\text{Sum}(\lambda^2 \; of \; all \; items)}{Total \; number \; of \; items}$$

Equation 4.2: Average Variance Extracted (AVE) calculation

Source: Abdul-Rahman and Kamarulzman (2012:1026)

According to Lam (2012:1332), it is suggested that an AVE value of 0.4 is acceptable if its CR value is above the threshold of 0.6. The reason for this is that the abovementioned threshold values are sufficient to prove the existence of an authentic connection that occurs among the items measured (Fornell & Larcker, 1981:46; Lam, 2012:1332; Huang et al., 2013:219). Consequently, this authentic connection is rendered to be appropriate for measuring the relevant constructs.

Therefore, the AVE value of 0.4 in Table 4.10 of this study is acceptable as it carries a CR value of 0.979, which Fornell and Larcker (1981:46), Lam (2012:1332) and Huang et al. (2013:219) confirm that it is ample to verify the existence of a valid connection among the items tested in this study. However, Table 4.11 displays an AVE value of 0.5 (with a CR value of 0.996), which is acceptable as required in the literature.

Table 4.12 below shows the results of the items measured in Table 4.10. The table displays data that were analysed by comparing Likert scale points where the frequency cases of ‘strongly disagree’ (SD) and ‘disagree’ (D) represent an unsupportive result, while ‘strongly agree’ and ‘agree’ represent a supportive result. The neutral (N) point represents unbiased frequency values.

Table 4.12: Analysis of the barriers to adopting digital project management solutions

Code	Items measured:	Scale			Results
		SD + D	N	SA + A	Supported/ unsupported
SDNAS1	Lack of knowledge about digital project management solutions	5	3	53	Supported
SDNAS2	High costs associated with digital project management solutions	3	2	56	Supported
SDNAS3	Lack of resources to use digital project management solutions	7	2	52	Supported
SDNAS4	Lack technological experts to handle digital project management solutions	5	2	54	Supported
SDNAS5	Lack of information and popularity about digital project management solutions	4	3	54	Supported
SDNAS6	Lack of competition driven by the adoption of digital project management solutions	2	5	54	Supported
SDNAS7	Uncertainty about return on investment (ROI) of digital project management solutions	2	3	56	Supported
SDNAS8	Complexity of processes in the mining sector	5	9	47	Supported

Table 4.12 above shows that most of the participants in this study supported the items that were used to determine the existence of the barriers to adopting digital project management solutions. Items that have higher values of 'strongly disagree' and 'disagree' include 'lack resources to use digital project management solutions', 'lack of knowledge about digital project management solutions', 'lack of technological experts to handle digital project management solutions' and 'complexity of processes in the mining sector' that represent a slight shift of unsupportiveness. However, from the data in Table 4.12, it can be seen that the most recognised barriers to adopting digital project management tools in the South African mining sector are the 'high costs associated with digital project management solutions' and 'uncertainty about the ROI of digital project management solutions'. Moreover, the results presented here correlate with the barriers listed in the study of Ramilo and Embi (2014:443), which include:

- The absence of technology skills – stemming from unskilled labour and the lack of interest to learn about digitalization.
- The lack of technology training – caused by the lack of awareness and willingness to seek such training.
- The lack of computerised equipment – caused by the lack of funds or unwillingness to allocate funds for computers.

Linderoth et al. (2018:6) highlight the lack of capability in the organisation to try new digital tools and the lack of knowledge as the major barriers to adopting digital tools. Pillay (2016:82) also emphasises the lack of infrastructure, ROI uncertainty and the lack of resources and funds. Ejaku (2014:65) affirms that the role of technology has made it vital for African countries to adopt digital tools. However, it is unfortunate that barriers such as inadequate infrastructure and skills make it a challenge for businesses to adopt digital tools. In this study, project businesses that do not use digital project management tools face numerous barriers to digital adoption, as listed in Table 4.12.

Table 4.13 below presents the results of the items measured in Table 4.11, which were analysed by comparing Likert scale points where the frequency cases of 'strongly disagree' (SD) and 'disagree' (D) represent an unsupportive result, while 'strongly agree' (SA) and 'agree' (A) represent a supportive result. The neutral point (N) represents unbiased frequency values.

Table 4.13: Analysis of the readiness to adopt digital project management solutions

CODE:	ITEMS MEASURED:	SCALE			Sample size	RESULTS:
		SD + D	N	SA + A		Supported/ Unsupported
SDNAS9	Recognise various digital project management solutions	43	6	12	61	Unsupported
SDNAS10	Recognise opportunities and challenges of digital project management solutions	44	4	13	61	Unsupported
SDNAS11	Recognise digital project management solutions that are applicable to the organisation	44	3	14	61	Unsupported
SDNAS12	Recognise the benefits of digital project management solutions	46	3	12	61	Unsupported
SDNAS13	Have a clear vision about implementing digital project management solutions	50	4	7	61	Unsupported
SDNAS14	Have communicated the vision of implementing digital project management solutions throughout the organisation	51	3	7	61	Unsupported
SDNAS15	Have defined roles, responsibilities and accountabilities regarding the adoption of digital project management solutions	51	3	7	61	Unsupported
SDNAS16	Have enough technical skills (human capacity) to deploy and adopt digital project management solutions	49	4	8	61	Unsupported
SDNAS17	Have evaluated the impact of digital project management solutions in the sector	50	2	9	61	Unsupported
SDNAS18	Have sufficient resources to initiate the utilisation of digital project management solutions	44	1	16	61	Unsupported
SDNAS19	Have the affordability to use digital project management solutions	33	6	22	61	Unsupported
SDNAS20	Have analysed the organisational changes associated with the adoption of digital project management solutions	49	5	7	61	Unsupported
SDNAS21	Staff members are ready for the changes associated with the adoption of digital project management solutions	21	4	36	61	Supported
SDNAS22	Business data and transactions with employees online can be executed safely when using digital project management solutions	30	7	24	61	Unsupported

Table 4.13 reveals that most of the items herein were not supported by the participants of this study. The results show that most project businesses that participated are not fully ready to adopt digital project management tools. These results are influenced by the results shown in Table 4.13. According to Noh et al. (2014:148), the barriers to digital tools adoption affect the organisation's readiness to adopt digital tools. Webster and Gardner (2019:1230) also support the view that barriers to adoption have an impact on influencing the readiness to be innovative in an organisation. Similar results are reported by Sánchez and Zuntini (2018:90), who found that the barriers to digital tools adoption have an impact on the organisation's readiness to adopt such tools. Azman et al. (2015:25) hold a different opinion, suggesting that the adoption of digital tools is influenced by the perceptions of those who have not adopted such tools. These perceptions are often about the usefulness, ease of use and benefits of adopting digital tools. Therefore, when project businesses are not convinced by the usefulness, ease of use and benefits of adopting digital project management tools, they are less likely to be ready to adopt such tools. However, from Table 4.13 it can be seen that the barriers to adopting digital project management tools play a crucial role in influencing the readiness of project businesses to adopt digital project businesses.

4.7 Summary

This chapter began with the process of data screening and error detection, followed by an outline of the participants' demographics and general information. The findings in this chapter show that the awareness of digital project management tools is greater than the adoption level. It was further noted that project businesses that use digital project management tools have initiated more projects than project businesses that do not use digital project management tools. For example, project businesses that use digital project management tools have initiated 1,782 projects, while project businesses that do not use digital project management tools have only embarked on 1,084 projects. It was also discovered that most of the projects that were initiated were engineering and construction projects. The nature of these projects has an impact on the adoption of technical project management tools. The chapter further revealed that digital project management tools and traditional project management techniques produce similar success rates, depending on their applicability and usage in projects. For example, both groups of businesses have a success rate of 98.5%, which represents similar project success levels.

The same patterns of project success elements existed between project businesses that use digital project management tools and those that do not use these tools. For example, the project success elements in this study were selected by both groups as follows. The 'deliverance of exceptional services' was the first element, 'on-time delivery' was the second element, 'approval by the client' was the third element and 'project not exceeding the budget'

was the last element. In addition, internal challenges affected project businesses that do not use digital project management tools more than those that do. For example, the ‘lack of resources’, ‘limited budget’ and ‘changes in project requirements’ were internal challenges that affected project businesses that do not use digital project management tools, whereas project businesses that use such tools are only affected by ‘poor communication’ in their projects.

Regarding external challenges, they similarly affected both groups of project businesses. For example, ‘economic changes’ and ‘supplier-related issues’ affected both groups of project businesses. The only external challenge that individually affected project businesses that use digital project management tools was ‘unanticipated weather patterns’, which was prompted by the higher number of outdoor construction projects.

The chapter also established that the most commonly used PMS package in this study is the Microsoft Project PMS package.

It became clear that project businesses that do not use digital project management tools have affirmed the existence of barriers that encumber their aptitude to adopt digital project management solutions. For example, barriers such as the ‘lack of knowledge about digital project management solutions’, ‘uncertainty about return on investment (ROI) of digital project management solutions’ and the ‘lack of resources to use digital project management solutions’ acted as barriers to adoption. This chapter also revealed that the majority of project businesses that have not employed digital project management are not fully ready to adopt such tools. The adoption barriers that they face affect their readiness to adopt digital tools.

In this chapter, reliability was measured using the Cronbach’s alpha test, AVE, as well as the CR test. The Cronbach’s alpha coefficient values ranged from 0.800–0.932, which indicated a high level of internal consistency, as the values were above the required threshold of 0.50. The CR of the items utilised ranged from 0.979–0.996, thus representing good CR values. The AVE values ranged from 0.4–0.5 (supplemented by CR values that were above the threshold of 6.0), which indicated an acceptable level of connection among the items tested.

CHAPTER 5
CONCLUSIONS AND PROPOSITIONS

5.1 introduction

This research study was triggered by the gap in information that existed regarding the awareness and adoption of digital project management tools as described in the research problem section in Chapter 1. Project management challenges and the role of digital project management tools have also been considered in the empirical section of this study.

This chapter concludes and makes recommendations derived from the findings. An overview of all the chapters is given. The research objectives are addressed, as well as the limitations of the study.

5.2 Synopsis of the study

This section summarises the content of each chapter.

5.2.1 Chapter 1

Chapter 1 introduced the study and gave a background to the mining sector in South Africa. The chapter outlined the study aim, research problem, research objectives, research questions, research methodology, data collection methods, data processing methods, study limitations and ethical considerations.

The research problem section of this chapter highlighted that project businesses face numerous challenges and as such, digital project management solutions were developed to address these challenges. However, the level of adoption and acceptance of these digital project management tools by project businesses is low, especially in developing countries. The problem statement also suggested that the convenience of digital project management tools is uncertain.

The research objectives of this study were:

1) To investigate the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo province;
2) To examine challenges of project management between project businesses that have adopted digital project management solutions and those that have not adopted digital project management tools at the selected mine in the Limpopo province;
3) To investigate the adoption barriers to digital project management solutions by project businesses at the selected mine in Limpopo province;
4) To determine the level of readiness to explore digital project management technical tools by project businesses at the selected mine in Limpopo province; and,

5) To understand the extent to which project management technology can influence the growth and success of project businesses at the selected mine in Limpopo Province.

The research questions of the study were:

a) What are the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo province?
b) What are the challenges of adopting digital project management tools and techniques by project businesses at the selected mine in Limpopo?
c) What is the level of preparedness to explore other digital project management solutions by project businesses in the selected mine in Limpopo?
d) To what extent can project management technology influence the growth and success of project businesses at the selected mine in Limpopo?

5.2.2 Chapter 2

Chapter 2 reviewed various sources of literature that are relevant and important to the research topic of this study, in line with the research objectives and research questions as stated in Chapter 1. In reviewing the literature, it was learnt that most of the challenges encountered by project managers in this century relate to human resource management, which includes issues such as employee recruitment, teamwork, labour issues, and cultural and cross-cultural issues. The chapter also identified technology-related challenges facing project managers, as well as the challenges of the practicality of managing risks, communication channels and safety procedures utilising digital project management tools. The project management challenges were triggered by a lack of knowledge and skills to implement technical tools. It was further noted that project risks and uncertainties remain factors that affect the achievement of project milestones. As a result, project managers apply strategic risk examination methods to mitigate any form of risk that can be encountered in the project lifecycle.

This chapter offered an in-depth introspection into the fundamentals of projects, as well as project successes. It revealed that project success is defined as the accomplishment of the project objectives that are classified under the project scope, budget and timeframe. The chapter highlighted the correlation between project success, team performance and the use of technical project management tools. Furthermore, the factors that result in project failures, such as poor communication, incompetence and the lack of knowledge by the project team member, were identified.

The chapter also explained that the adoption of digital project management apparatus and practices had become common among project businesses, as it is linked to project performance. The adoption of digital project management tools can produce different outcomes for different businesses as there is a significant connection between the use of these tools and the development of an organisation. The chapter further stated that mature project

businesses were more likely to employ project management technical tools than less matured organisations were. It was learnt that very few studies have focused on the African continent in investigating the application of project management technical tools and the challenges thereof.

The chapter concluded by providing the benefits and limitations of commonly utilised PMS packages such as Microsoft Project, Gantt Project, Primavera and BaseCamp. The chapter revealed that project businesses in South Africa hardly recognise, or make use of project management technical tools and this is a concern for the discipline of project management.

5.2.3 Chapter 3

This chapter focused on the research methodology and research design of this study. A quantitative research methodology was followed as the main research approach. The preliminary collection of this data was based on surveys and statistics that qualified it to be quantitative. The research paradigm was interpretive, as the purpose was to understand subjective meanings regarding several social views that related to the research topic. The paradigm was further utilised to form interpretations of the research findings. The research design of this dissertation was a cross-sectional descriptive case study. This design was deemed suitable since it was key in assisting the researcher to examine the variables of this study.

The chapter further included a discussion of the non-probability sampling method that was employed. The sampling method was utilised to select participants non-randomly, with the support of a purposive sampling style that was applied to eliminate any limitations that existed in selecting participants. The target population was identified as contracting project businesses at a selected mine in the Waterberg district of the Limpopo Province in South Africa. The contracting project businesses are registered on the database of the selected mine. The population comprised project managers, site managers and supervisors who were employed following the standard of the Mine Health and Safety Act of the Republic of South Africa. The sample size was 313 contracting businesses. The data were collected using a structured closed-ended questionnaire, which included dichotomous questions, multiple-choice questions and five-point Likert scale questions. The survey questionnaire was distributed physically and via e-mail.

Reliability and validity in this study were achieved by reviewing literature papers, attaining validations from experts, conducting a pilot study and obtaining approval from the CPUT Research and Ethics Committee of the Faculty of Business and Management Sciences. Internal reliability was measured using the Cronbach's alpha test (α) and the CR test. The researcher was led by the guidelines of the CPUT Research Directorate and Graduate Centre of Postgraduate Management Studies. Coding was applied in the data processing stage. The SPSS v26.0 system was employed to analyse data and a descriptive statistical analysis

approach was employed to process data. Tables and graphs were generated to depict frequencies, as well as the relevant arithmetic means and spread measures. The dissertation was referred to a line of experts for editing and proofreading.

5.2.4 Chapter 4

This chapter presented and discussed the data that were collected. The data were processed using SPSS v26.0 and presented in tables and graphs. The chapter first outlined the participants' demographics and general information. The findings in this chapter further revealed that the awareness of digital project management tools was higher than the adoption level. From the project business participants, it was discovered that those that employed digital project management tools had initiated more projects than those that did not employ these tools. For example, project businesses that used digital project management tools have worked on 1,782 projects, while those that did not have only embarked on 1,084 projects. The majority of these projects were engineering and construction projects. The chapter further revealed that the nature of these projects had an impact on the adoption of technical project management tools. It was recorded that digital project management tools and traditional project management techniques yield similar success rates, depending on their applicability and usage in projects. For example, both groups of businesses returned a success rate of 98.5%, which represents similar project success levels.

Similar patterns of project success elements were discovered from project businesses that use digital project management tools and those that do not. For example, the project success elements were selected in a ranking order by both groups as the 'deliverance of exceptional services' as the first element, 'on-time delivery' as the second element, 'approval by the client' as the third element and 'project not exceeding the budget' as the last element. In addition, internal challenges impacted more on project businesses that did not use digital project management tools than those that did. For example, the 'lack of resources', 'limited budget' and 'changes in project requirements' were internal challenges that affected project businesses that did not make use of digital project management tools, whereas project businesses that use such tools are only affected by 'poor communication' in their projects.

The chapter further discovered that external challenges affected both groups of project businesses similarly, for example, 'economic changes' and 'supplier-related issues' affected both groups. The only external challenge that affected project business participants that used digital project management tools was 'unanticipated weather patterns', which was prompted by their higher number of outdoor construction projects. It was also established that the most commonly used PMS package in this study was the Microsoft Project package.

It became clear that project businesses that did not employ digital project management tools were affected by certain barriers that hindered their ability to adopt such tools. For example, barriers such as 'lack of knowledge about digital project management solutions', 'uncertainty

about return on investment (ROI) of digital project management solutions' and 'lack of resources to use digital project management solutions' were recognised as barriers to adoption.

It was discovered that the majority of project businesses that did not employ digital project management tools were not fully ready to adopt such tools. The adoption barriers that were identified seemed to have influenced their readiness to adopt digital tools.

5.3 Research objectives addressed

The impact of digital project management tools for managing projects was explored to determine the awareness and adoption levels of such tools. The study identified the barriers to adopting digital project management tools, as well as the internal and external business challenges that could harm the success of projects and the levels of usage of digital project management tools were clearly understood.

5.3.1 Research Objective 1

To investigate the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo Province.

Read together with research question 1:
What are the awareness and adoption levels of digital project management tools and techniques among project businesses at the selected mine in the Limpopo Province?

The research outcomes reflect a marginally higher number of project businesses that are aware of digital project management solutions in the mining sector than those that are not aware (see section 4.5.1, Table 4.7). The research presumed the presence of an elevated rate of awareness among diverse project businesses in the mining industry. The research further tried to probe the influence of business operation years on the adoption of digital project management solutions. Moreover, the results of the probe showed that project businesses with more years of operation in the mining sector are more aware of digital project management tools. The research study implied that businesses that have been in operation for a greater number of years result in digital awareness. The digital project management tools awareness in the mining sector is driven by business operation- years.

The results of this study revealed a relatively low figure of project businesses that have adopted digital project management solutions. The implications of the data collected in this study show that the adoption of digital project management tools is influenced by the educational background of the managers of the projects, size of the workforce, the natures of business, the business experience and the industry experience. Therefore, the examination and elucidation of this study showed that the educational level of both the project leaders and the project workers has an impact on the adoption of digital project management tools in an

organisation. Organisations with project leaders and employees who are better educated are likely to adopt digital project management tools in the mining sector. The study further publicised that the size of the organisation's workforce also contributes to adoption of digital project management solutions. Project businesses with a high number of employees are probable to adopt digital project management solutions in the mining industry. The adoption of digital project management solutions is also driven by the nature of the projects. This research study presumed that engineering and construction project businesses are more likely to embrace and utilise digital project management tools in the mining sector. This study also discovered that the years of business operation and industry experience play a role in influencing project businesses to adopt digital project management tools.

Among many of the project businesses that adopted digital project management solutions, it was revealed that the most highly adopted PMS was Microsoft Project. Other systems such as Huddle, Zoho Projects, BaseCamp and Trello software packages yielded low adoption values. However, some of the project businesses preferred using software packages that are crafted specifically for their project needs and activities.

This study further attempted to collect information about the usage level of digital project management solutions. As illustrated in chapter 4 (subsection 4.5.1 – Table 4.8), it has been concluded that various functions of project management are carried out using digital project management tools. The findings show that majority of the projects businesses that have adopted digital project management solutions use them frequently for planning, managing risks and ensuring safety in their projects (as the first degree of usage. The second degree of usage included project scheduling, time-tracking and workflow management. The third degree of usage included budget management, human resource management and procurement management. Above all this is an indication that digital project management solutions are used to their full potential.

5.3.2 Research Objective 2

To examine challenges of project management between project businesses that have adopted digital project management solutions and those that have not adopted digital project management tools at the selected mine in the Limpopo Province.

Read together with research question 2:

What are the challenges of project management between project businesses that have adopted digital project management solutions and those that have not adopted digital project management tools at the selected mine in the Limpopo province?'

Project businesses identified several internal business challenges that are prevalent in their line of business. Project businesses that have not adopted digital project management tools listed the following as internal challenges that affect their business in the mining sector:

- Lack of resources
- Limited budget
- Changes in project requirements

The lack of resources was discovered to be a common challenge for most project businesses in South Africa, particularly those that have not adopted digital project management solutions. The limited budget was presumed to stem from inadequate financial forecasting techniques, poor cost controls and management, as well as the incapability to set project cash flows and project cost estimations. Furthermore, the study showed that changes in project requirements are caused by mismanagement and the complexities in the mining sector.

This study further attempted to uncover internal challenges that harmed project businesses that have adopted digital project management tools in the mining industry. From a case study perspective, organisations that have adopted digital project management tools identified only poor communication as their biggest drawback, thereby reflecting a limitation on the digital project management systems that are used.

The project businesses further identified several external challenges prevalent in their industry, which included economic changes and supplier-related issues, as well as unanticipated weather patterns (identified only by project businesses that use digital project management tools). The economic changes included high interest rates, high tax rates, low employment levels and low consumer expenditure, which are all unfavourable economic conditions that impact the time, cost and quality of projects. It was highlighted during the study that a declining economy affects profit margins of the project businesses as well as their business leads (for example clients' willingness to spend on projects). This study also exposed that supplier-related issues for project businesses stem from the suppliers' shortfalls that include favouritism of certain buyers, poor communication, poor vendor management, poor forecasting techniques, poor production performance and the lack of procurement knowledge by the supplier. Project businesses that have adopted digital project management tools publicised that unanticipated weather patterns affect their line of business in the mining sector since most of their projects are outdoor construction projects.

Overall, this study revealed and confirmed the existence of internal challenges and external challenges that affect project businesses in the mining sector. Some of the internal challenges can be eliminated using digital project management tools and some of the external challenges can be eliminated by improved digital project management tools. For example, the lack of resources internal challenge can be eliminated through systems such as Oracle Primavera or Microsoft that enable users to administer their resources efficiently. External challenges such as economic changes can be mitigated by enhanced digital project management tools that can be integrated with forecasting systems or through consultations with forecasting experts.

5.3.3 Research Objective 3

To investigate the adoption barriers to digital project management solutions by project businesses at the selected mine in Limpopo.

Read together with research question 3:

What are the challenges of adopting digital project management tools and techniques by project businesses at the selected mine in Limpopo?

Project businesses that have not adopted digital project management tools were found to be facing several impediments that stop them from adopting digital project management solutions. These include the lack of knowledge about digital project management solutions, the high associated costs, lack of resources and a lack of technological experts to handle digital project management tools, In addition, there is a lack of information and popularity about digital project management tools, the lack of rivalry in the industry to influence the adoption of such tools and the uncertainty of ROI for adopting such tools. The complexity of industry-related processes was also recognised as an obstacle to adopting digital project management tools.

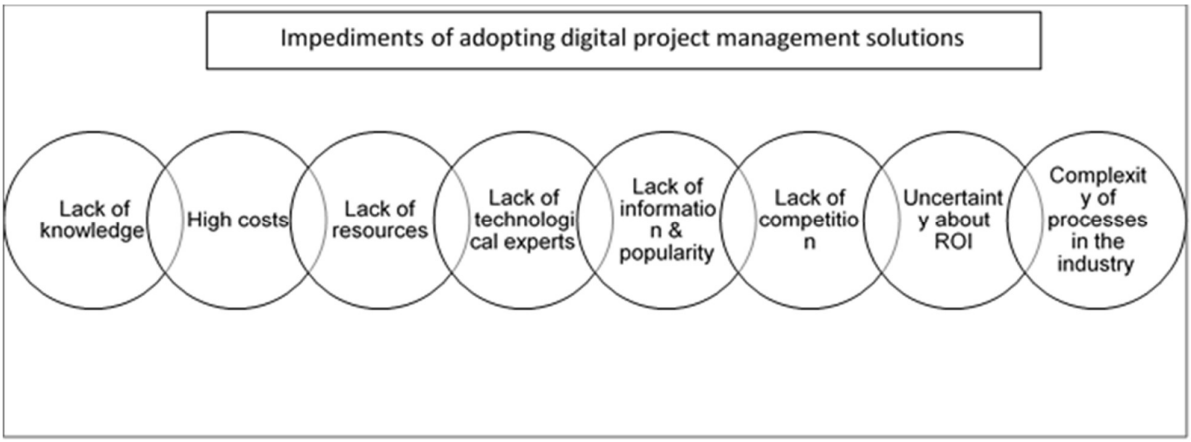


Figure 5.1: The impediments of adopting digital project management solutions

5.3.4 Research Objective 4

To determine the level of readiness to explore digital project management technical tools by project businesses at the selected mine in Limpopo.

Read together with research question 4:

What is the level of preparedness to explore other digital project management solutions by project businesses in the selected mine in Limpopo?

The findings show that project businesses that do not use digital project management tools seem to lack a clear vision and a communication channel that clarifies their roles,

responsibilities and accountabilities regarding the usage of digital project management solutions. These project businesses seem not to have grasped technical skills that are sufficient to adopt and use digital project management tools. However, these businesses seem to be confident that their teams are ready to adapt to any changes that may occur in their line of business as a result of adopting the digital tools but they are not confident that their business data and transactions with employees can be executed safely on the project management digital systems. The project businesses indicated that they have not analysed organisational changes and effects that may take place if they do adopt digital project management tools. This study found that these project businesses do not have sufficient resources to initiate the adoption of digital project management tools and they cannot afford using such tools. Project businesses that have not adopted digital project management tools in the mining sector are not ready to adopt digital project management tools as a result of the barriers they encounter in their business environment.

5.3.5 Research Objective 5

The extent to which project management technology can influence the growth and success of project businesses at the selected mine in Limpopo.

The findings in this study indicate a lack of enthusiasm for the use of digital project management solutions to expedite business growth and success. Project businesses that have adopted digital project management tools and those that have not, reflect similar project success satisfaction levels. It was noted that most project businesses in the mining sector were aware of these tools but faced barriers that lessen their confidence in adopting such tools. This makes it difficult for them to tackle their project management challenges while accelerating business growth and success. Although digital technology does not guarantee growth and success, it does play a role in improving business processes. This is supported by the United Nations Conference on Trade and Development (UNCTAD) (2019:34) report in which experts affirm that advanced organisations that have introduced digital technology into their business sphere experience greater production growth, employment and economic progression than businesses that are not technologically advanced. Linton and Solomon (2017:198) add that even if digital technology does not result in growth it is necessary for enhancing business practices and presenting competitive advantages. Further support is provided by Grewal et al. (2020:1) who maintain that businesses that adopt new technology in their early stages tend to develop business processes in their industries and end up setting new and higher benchmarks for clients.

It was noted that the respondents had been experiencing diverse project-related challenges, most of which could be mitigated by adopting and utilising digital project management tools that are designed to tackle such challenges.

5.4 Research recommendations

Emanating from the empirical findings of this research study, several recommendations are suggested for inventions and strategies that can be utilised to address particular issues that were quantified in the study. Below are the recommendations (first stated as a problem) that could be considered for future business progression in the discipline of project management:

Problem 1: A high awareness rate of digital project management tools but low adoption rate in the mining sector.

Problem 2: Many internal challenges are encountered by project businesses that have not adopted digital project management tools. From a case study perspective, organisations that have adopted digital project management tools identified only poor communication as their biggest drawback, thereby reflecting a limitation on the digital project management systems that are used. External challenges such as economic changes can be mitigated by enhanced digital project management tools that can be integrated with forecasting systems or through consultations with forecasting experts.

Problem 3: Project businesses that have not adopted digital project management tools faced several impediments that stopped them from adopting digital project management solutions.

Problem 4: Project businesses that have not adopted digital project management tools in the mining sector appear not ready to adopt digital project management tools as a result of the barriers that they encounter in their business environment.

Problem 5: Project businesses that have adopted digital project management tools and those that have not, reflect similar project success satisfaction levels in this study.

5.4.1 South African government agencies and mineral mines

Government agencies that are focused on business development and entrepreneurship can provide ongoing training programmes that are focused on digitalisation and knowledge development in the discipline of project management. This could include streamlining certain digital project management tools for specific industries and business sizes since not all tools are appropriate for all businesses (for example agricultural project management training could encompass digital project management tools that are recommended for the industry). The training could be offered to project managers and employees who work on projects. Unemployed individuals could also be offered a chance to participate in the abovementioned training for upskilling.

The South African mining sector could set a minimum standard requirement of project management training for contracting site managers, supervisors and safety officers, especially for project businesses that deliver frequent projects and those that deliver big projects. The project management training must focus on the fundamentals of project management and

digital project management tools. The mines could also have incubator sites on-site to promote the usage of technological tools in project management for emerging and struggling community-based contractors.

These suggestions could help tackle the barriers to adopting digital project management tools that were listed in this study (as illustrated in Figure 5.1).

5.4.2 Project businesses in the mining industry

The emerging technological shifts that are taking place worldwide, such as the developments of PMS and BIM, require project businesses to introduce technological approaches into their line of work (Sajad et al., 2016:39; Puška et al., 2020:90; Hassan & Asghar, 2021:26840). Therefore, project businesses should invest in innovation and technology. Project businesses should learn about current technological shifts that are taking place in their line of business, they should attend project management seminars and online courses. They should also build relationships with PMS developers to get the best rates and features of the software packages. This approach can help project businesses to present their project management challenges to the software developers.

5.4.3 Project management software designers

It was noted that digital project management tools cover more of the internal project management business processes than external processes. PMS developers should consider integrating with other systems that could enhance project management processes and they should also consider creating different packages for all business sizes and project magnitudes (for example, small software packages could be created for small projects and businesses). Figure 5.2 below illustrates proposed system integrations.

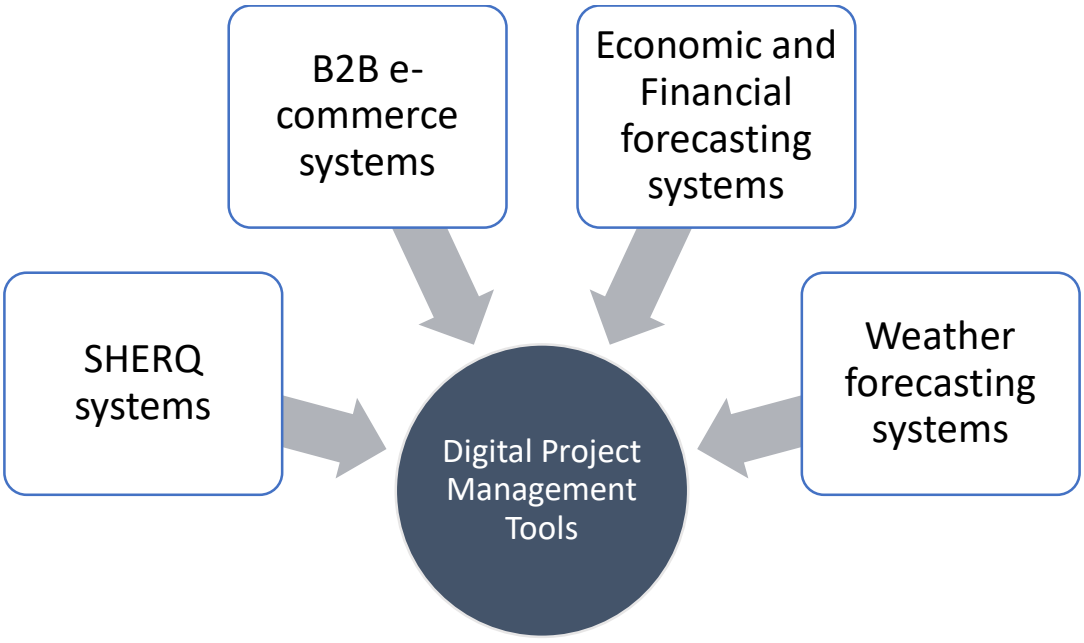


Figure 5.2: Proposed software integration strategy

5.4.3.1 Safety Health Environmental Risk and Quality (SHERQ) systems

A SHERQ system is a safety integrated management system aimed at ensuring safety compliance, preventing on-site fatalities and injuries. These systems ensure effective compliance through managing analysis and safety reports (O'Brien, 2018:1). In the context of this study digital project management tools could be integrated with SHERQ systems to ensure effective safety compliance. For example, digital project management tools could be integrated with the SheqScan Mobile software that provides real-time risk assessment and detection features that help users to eliminate incidents and accidents on-site.

5.4.3.2 Business-to-business e-commerce systems

A business-to-business electronic commerce (e-commerce) system is an online system that allows businesses to order products online (Khurana, 2018:1). With this system integrated into digital project management tools, the project businesses will be able to have full control of their supplies. The project businesses will have the benefit of choosing from a range of suppliers and prices. They will also be able to set secondary purchases in case primary suppliers fail or delay in delivery.

Project management could also have a platform where suppliers register to offer and list their products on the system. For example, South African suppliers such as Builders Warehouse could have their products listed on the project management system.

5.4.3.3 Economic and financial forecasting systems

This could be added as a feature with economic forecasts that predict future economic conditions and their implications on specific industries. Integration could also be made with financial forecasting systems that serve to predict future economic and financial conditions, for example, digital project management tools could integrate with systems such as the Centage system, which allows businesses to form future financial forecasts.

5.4.3.4 Weather forecasting systems

Weather forecasting systems are digital resources that are used to predict weather conditions (Zielinski, 2017:1). Integration could be applied with weather forecasting systems, for example, digital project management tools could be integrated with IBM weather forecasting software to generate weather information that could reflect on the project schedules.

5.4.4 Suggested marketing approach for service providers

Project management digital system providers and academic institutions that offer project management courses have to target contracting project businesses in the South African mining sector.

5.5 Study limitations

Several limitations were identified that have implications for future investigations and research projects:

- The research instrument of this study was closed-ended, thereby rendering the research methodology of this research to be quantitative, which restricted the opinions of the respondents.
- This study was based on a case study method, which focused on a limited group of project businesses in a restricted location of the Limpopo Province of South Africa.
- The study was also conducted in a platinum mine region and cannot be generalised, as such empirical findings in different mining industries and other business sectors are needed.

5.6 Recommendations for future research

The recommendations below are listed in alignment with the limitations outlined above. These recommendations are to be considered in future studies:

- A qualitative or longitudinal method of collecting data could be used in future research and investigations to collect further information regarding the use of digital project management tools.
- Future research and investigations could be based on experimental research design to investigate the implications of future developments of digital project management tools. A correlational research design could also be considered in future research when investigating the connection of numerous experiences among project businesses in different business sectors.
- Future studies could focus on different mining industries, business sectors and other developing countries.

5.7 Summary

This chapter firstly summarised the chapters of this study. It also addressed the theoretical and empirical objectives of the study. It was found that the level of awareness of digital project management tools is higher than the level of adoption. Projects businesses that have not employed digital project management tools experience internal challenges, such as lack of resources, limited budget and changes in project requirements. Project businesses that did employ digital project management tools highlighted poor communication as the most significant internal challenge that affected their projects. External challenges such as economic changes and supplier-related issues were recognised as challenges that affected all project businesses, while unanticipated weather patterns affected only project businesses that employed digital project management tools. The study further discovered several barriers that affected project businesses that did not employ digital project management tools. For example,

the lack of knowledge about digital project management solutions, the high costs associated with these solutions, a lack of resources for using these solutions and the lack of technological expertise to handle digital project management tools were identified as barriers to adoption. These barriers were also identified as factors that affected the readiness of project businesses to adopt digital project management tools.

This chapter suggested recommendations for future research. The recommendations are made for the South African government agencies, the mineral mines of South Africa, project businesses and software developers. For example, it is suggested that the South African business development agencies should consider offering ongoing training programmes that are focused on digitalisation and knowledge building in the discipline of project management. It is also suggested that the South African mining sector should set a minimum standard requirement for project management training, while it is recommended for project businesses to invest in innovation and technology. It is further recommended that software developers should consider integrating with external systems that can enhance project management processes.

The limitations are identified as the restriction of the research instrument of the study, the limited group of project businesses that participated in the study and the restricted research setting of this study.

It is suggested that future research should follow qualitative or longitudinal methods of collecting data while applying an experimental or correlational research design. It is further suggested that the usefulness of this research study would be broadened if future studies focused on different mining industries, business sectors and other developing countries.

REFERENCES

Abdu, K., Kulthum, N. & Neema-Abooki, P.N. 2017. Gender issues in project management planning and management. *PM World Journal,* 6(6):1–13.

Abdul-Rahman, M. & Kamarulzman, Y. 2012. The influence of relationship quality and switching costs on customer loyalty in the Malaysian hotel industry. *Social and Behavioural Sciences,* (62):1023–1027.

Adams, J., Khan, H.T.A. & Raeside, R. 2014. *Research methods for business and social science students.* 2nd ed. New Delhi: SAGE.

Adriaanse, A., Voordijk, H. & Dewulf, G. 2010. The use of interorganisational ICT in United States construction projects. *Automation in Construction*, 19(1):73–83.

Akaranga, S.I. & Makau, B.K. 2016. Ethical considerations and their applications to research: A case of the University of Nairobi. *Journal of Educational Policy and Entrepreneurial Research,* 3(12):1–9.

Akhtar, I. 2016. Research design. In *Research in Social Science: Interdisciplinary perspective*: 68–84. https://dx.doi.org/10.2139/ssrn.2862445

Al Shaer, S. 2018a. *Expected monetary value – EMV*. https://eliteminds.co/2018/11/27/expected-monetary-value-emv/[24 September 2020].

Al Shaer, S. 2018b. *Monte Carlo simulation technique*. https://eliteminds.co/2018/11/27/monte-carlo-simulation-technique/[11 October 2020].

Ali, A.S.B., Anbari, F.T. & Money, W.H. 2008. Impact of organizational and project factors on acceptance and usage of project management software and perceived project success. *Project Management Journal,* 39:5–33.

Almomani, F., Tamara, A., Naor, D., Naomi, J. & Murad, A.O. 2018. Construct validity an internal consistency reliability of the Loewenstein occupational therapy cognitive assessment (LOTCA). *BioMed Psychiatry,* 18(Article 184): 1–9.

Alrob, M.M.F.A. 2015. Enhancing organizational resilience: The case of Palestinian Islamic banking sector. Thesis. MEM, Nabus: An-Najah National University, Palestine.

Al-Zwainy, F. M., Jaber, F. & Hachem, S. 2018. Diagnostic of the claims and disputes between the contractor and owner in construction project using narrative analysis approach. *International Journal of Civil Engineering and Technology,* 9(12):619–626.

Amado, M., Ashton, K., Ashton, S., Bostwick, J., Clement, G., Drysdale, J., Francis, .J., Harrison, B., Nan, V., Nisse, A., Randall, D., Rino, J., Robison, J., Snyder, A. & Wiley, D. 2012. *Project management for instructional designers*. https://pm4idorg/Licensed under Creative Commons Attribution NonCommercial [23 March 2020].

Amoatey, C. & Anson, B. 2017. Investigating the major causes of scope creep in real estate construction projects in Ghana. *Journal of Facilities Management*, 15(4):393–408.

Anderson, E.E. & Corneli, A. 2018. *100 questions and answers about research ethics.* Newbury Park, CA: SAGE.

Andre, L. 2020. *Oracle primavera review*. https://reviews.financesonline.com/p/oracle-primavera/ [25 May 2020].

Ang, L. 2015. Using participatory research for early childhood advocacy: Reflections on methodology. *Asis-Pacific Journal of Research in Early Childhood Education,* 9(2):1–21.

Ansah, R.H. & Sorooshian, S. 2017. Effect of lean tools to control external environment risks of construction projects*. Sustainable Cities and Society*, 32:348–356.

Antony, J., Gupta, S., Sunder M. V. & Gijo, E.V. 2018. Ten commandments of Lean Six Sigma: A practitioners' perspective. *International Journal of Productivity and Performance Management*, 67(6):1033–1044.

Arenius, M., Artto. K. A., Lahti, M. & Meklin, J. 2000. Project companies and the multiproject paradigm: A new management approach. *PMI Research Conference,* Paris, 24 June 2000. Paris: Project Management Institute. https://www.pmi.org/learning/library/project-companies-multiprojects-paradigm-approach-125 [23 March 2020].

Arenius, M., Artto, K. A., Lahti, M., & Meklin, J. (2000). Project companies and the multiproject paradigm: a new management approach. Paper presented at PMI® Research Conference 2000: Project Management Research at the Turn of the Millennium, Paris, France. Newtown Square, PA: Project Management Institute.

Arifin, S.R.M. 2018. Ethical considerations in qualitative study. *International Journal of Care Scholars,* 1(2):30–33.

Arnold, P, & Javernick-Will, A. 2013. Project-wide access: Key to effective implementation of construction project management software systems. *Journal of Construction Engineering and Management,* 139:510–518.

Arumugam, V., Antony, J. & Linderman, K. 2014. A multilevel framework of Six Sigma: A systematic review of the literature, possible extensions and future research. *Quality Management Journal*, 21(4):36–61.

Asiamah, N., Mensah, H.K. & Oteng-Abayie, E.F. 2017. General, target and accessible population: demystifying the concept for effective sampling. *The Qualitative Report*, 22(6):1607–1627.

Aspers, P. & Corte, U. 2019. What is qualitative in qualitative research. *Qualitative Sociology,* 42:139–160.

Attarzadeh, I. & Ow, S.H. 2008. Modern project management essential skills and techniques. *Communications of the IBIMA,* 2:1–9.

Aubert, B.A. & Reich, B.H. 2009. Extracting value from information technologies, CIRANO Burgundy Reports. 2009rb-04, CIRANO. https://ideas.repec.org/p/cir/cirbur/2009rb-04.html [12 May 2019].

Azhar, S. 2011. Building information modelling (BIM): Trends, benefits, risks and challenges for the AEC industry. *Leadership and Management in Engineering,* 11(3):241–252.

Azman, H., Salman, A., Hussin, S., Razak, N.A., Hashim, M.S., Hussan, M.A., Sidin, S.M., Idrus, R.M., Manap, M.R. & Ahmad, A. 2015. Measuring readiness, acceptance and satisfaction of innovative digital economy: Preliminary findings. *Journal of Social Sciences and Humanities,* (1):23–30.

Babbie, E. 2013. *The practice of social research.* 13th ed. Belmont, CA: Wadsworth Cengage Learning.

Ballesteros-Pérez, P., Smith, S.T., Lloyd-Papworth, J.G. & Cooke, P. 2018. Incorporating the effect of weather in construction scheduling and management with sine wave curves: Application in the United Kingdom. *Construction Management and Economics*, 36(12):666–682.

Bardhan, I.R., Krishnan, V.V. & Lin, S.S. 2007. Project Performance and the Enabling Role of Information Technology: An Exploratory Study on the Role of Alignment. *Manufacturing & Service Operations Management*, 9:579–595.

BaseCamp. 2020. We the BaseCamp. https://BaseCamp.com/about [24 May 2020].

Bedneko, O. 2019. *Top 5 project management software.* https://www.bitrix24.com/articles/ttop-5-project-management-software.php [31 March 2020].

Bhandari, P. 2020. *An introduction to quantitative research.* https://www.scribbr.com/methodology/quantitative-research/ [17 January 2021].

Bhika, B. & Pretorius, J.H.C. 2019. Challenges facing projects due to a lack of resources. *Proceedings of the International Conference on Industrial Engineering and Operations Management,* 23–26 July 2019. Pilsen, Czech Republic: IEOM Society International: 485–494.

Biafore, B. 2013. *Microsoft Project 2013: The missing manual*. Sebastopol, CA: O'Reilly Media.

Bolarinwa, O.A. 2015. Principles and methods of validity and reliability testing of questionnaires used in social and health science researchers. *Nigerian Postgraduate Medical Journal,* 22(4):195–201.

Bolboacă, S. & Jäntschi, L. 2006. Pearson versus Spearman, Kendall's Tau correlation analysis on structure-activity relationships of biologic active compounds. *Leonardo Journal of Sciences,* (9):179–200.

Boone, H.N. & Boone, D.A. 2012. Analyzing Likert data. *Journal of Extension*, 50(2):1–5.

Borštnar, M.K. & Andreja, P. 2014. Impacts of the implementation of a project management information system – a case study of a small R&D company. *Research Papers,* 47(1):14–23.

Boyle, M. 2020. *The impact of recessions on businesses.* https://www.investopedia.com/articles/economics/08/recession-affecting-business.asp [18 March 2021].

Bresnahan, T.F., Brynjolfsson, E. & Hitt, L.M. 2002. Information technology, workplace organization and the demand for skilled labor: Firm-level evidence. *Quarterly Journal of Economics,* 117:339–376.

Brown, A.W., Kathryn, A.K. & Allison, D.B. 2018. Issues with data and analyses: Errors, underlying themes and potential solutions. *Proceedings of National Academy of Sciences (PNAS),* 115(11):2563–2570. DOI: 10.1073/pnas.1708279115

Bruce, P. & Bruce, A. 2017. *Practical statistics for data scientists: 50 essential concepts*. Sebastopol, CA: O'Reilly Media.

Bryde, D.J. & Wright, G.H. 2007. Project management priorities and the link performance management systems. *Project Management Journal*, 38:5–11.

Brynjolfsson, E. & Yang, S. 1996. information technology and productivity: A review of the literature. *Advances in Computers,* 43:1–70.

Cagliano A.C., Grimaldi S. & Rafele C. 2015. Choosing project risk management techniques. A theoretical framework. *Journal of Risk Research*, 18(2):232–248.

Cajander, A., Clear, T. & Daniels, M. 2009. Students analyzing their collaboration in an international open-ended group project. *Proceedings of the 39th International Conference on Frontiers in Education*, 21 November 2009. San Antonio TX: IEEE Xplore: 1–6.

Cao Thanh, N. & Le Thanh, T.T. 2015. The interconnection between interpretivist paradigm and qualitative methods in education. *American Journal of Education Science,* 1(2):24–27.

Carnaghan, I. 2013. *Philosophical assumptions for qualitative research*. https://www.carnaghan.com/philosophical-assumptions-for-qualitative-research/ [22 November 2020].

Caruana, E.J., Roman, M., Hernάndez-Sάnchez, J. & Solli, P. 2015. Longitudinal studies. *Journal of Thoracic Disease,* 7(11):37–40.

Chatfield, C.S. & Johnson, T.D. 2016. *Microsoft Office Project 2016*. Copyright © 2016. ISBN: 978-0-7356-9874-1.

Chien, T., Shao, Y. & Jen, D. 2017. Development of a Microsoft Excel tool for applying a factor retention criterion of a dimension coefficient to a survey on patient safety culture. *Health and Quality of Life Outcomes,* 15:1–8.

Chinyamurindi, W.T. 2017. The role of information management in project management success: Narratives from entrepreneurs operating within the South African construction industry. *South African Journal of Information Management,* 19(1):1–9.

Chothia, T., Booi, Z. & Madonsela, N. 2016. Sustainability in project management in the South African context. Unpublished BSc (Honours). University of Witwatersrand, Johannesburg.

Chou, J.S. & Ngo, N.T. 2014. Identifying critical project management techniques and skills for construction professionals to achieving project success. In *Proceedings of International Conference on Industrial Engineering and Engineering Management*, Malaysia, 09 December 2014. IEEE Xplore: 1204–1208.

Chou, J.S., Irawan, N. & Pham, A.D. 2013. Project management knowledge of construction professionals: cross-country study of effects on project success. *Journal of Construction and Engineering Management*, 139:1–15.

Choudhry, R.M. & Iqbal, K. 2012. Identification of risk management system in construction industry in Pakistan. *Journal of Management in Engineering,* 29:42–9.

Chu, Y. 2015. Resilience capabilities in the face of environmental turbulence: A case of Hong Kong small to medium enterprises. Unpublished PHD. Thesis. Melbourne: RMIT University.

City Insight Report. 2020. *Research on the effects of skills mismatch in the local government sector and how it can be addressed.* https://dullahomarinstitute.org.za/multilevel-govt/local-government-bulletin/archives/volume-15-issue-4-december-2020-1/skills-mismatch-in-south-african-local-government [22 March 2021].

Clarizen. 2015. *Project Management Survey Results*. https://www.clarizen.com/wp-content/uploads/2016/09/PM-SurveyResults1.pdf [18 March 2020].

Cornesse, C., Blom, A.G., Dutwin, D., Krosnick, J.A., DE Leeuw, E.D., Legleye, S., Pasek, J., Pennay, D., Phillips, B., Sakshaug, J.W., Struminskaya, B. & Wenz, A. 2020. A review of conceptual approaches and empirical evidence on probability and nonprobability sample survey research. *Journal of Survey and Methodology,* 8:4–36.

Creswell, J.W. 2014. *Research design*. 4th edition. Newbury Park, CA: SAGE.

Cristóbal, J.R.S., Carral, L., Diaz, E., Fraguela, J.A. & Iglesias, G. 2018. Complexity and project management: A general overview*. Indexed in Science Citation Index Expanded*, (1):1–10.

Crowe, S., Cresswell, K., Robertson. A., Huby, G., Avery, A. & Sheikh, A. 2011. The case study approach. *Medical Research Methodology,* 11:1–9.

Curtis, B. & Curtis, C. 2011. *Social research: A practical introduction*. London: SAGE

Daniel, E. 2016. The usefulness of qualitative and quantitative approaches and methods in researching problem-solving ability in science education curriculum. *Journal of Education and Practice*, 15(7):91–100.

Daniels, R.C. 2007. *Skills shortages in South Africa: a literature review*. University of Cape Town, Development Policy Research Unit. Cape Town.

Davies, W.M. & Beaumont, T.J. 2014. *Editing and Proofreading*. Melbourne: University of Melbourne.

Dellinger, A.B. 2005. Validity and the review of literature. *Research in Schools*, 12(2):41–54.

Delíce, A. 2010. The sampling issues in quantitative research. *Educational Sciences: Theory & Practice,* 10(4):1–18.

Deshmukh, S.P., Sagale, A.V. & Bais, M.M. 2019. Study of scheduling in Microsoft Project software. *International Journal of Scientific Research & Engineering Trends,* 5(2):2395–2466.

Dewett, T. & Gareth, R.J. 2001. The role of information technology in the organization: A review, model and assessment. *Journal of Management,* 27:313–348.

Doan, T.T.T., Nguyen, L.C.T. & Nguyen, T.D.N. 2020. Emotional intelligence and project success: The role of transformational leadership and organisational commitment. *Journal of Asian Finance, Economics and Business,* 7(3):223–233.

Dostie, B. & Jayaraman, R. 2008. Organizational redesign, information technologies and workplace productivity. *SSRN Electronic Journal*, 12(1):1–43. https://www.researchersgate.net/publication/23528894_Organizational_Redesign_Information_Technologies_and_Workplace_Productivity [25 June 2020]

Du Plessis, H. & Oosthuizen, P. 2018. Construction project management through building contracts, a South African Perspective. *Acta Structila*, 25(1):152–181.

Duffy. J. 2019. BaseCamp review. https://www.pcmag.com/reviews/BaseCamp [25 May 2020].

Easton, G.S. & Rosenzweig, E.D. 2012. The role of experience in six sigma project success: An empirical analysis of improvement projects. *Journal of Operations Management*, 30(7–8):481–493.

Egwuonwu, G. 2015. An exploratory study to improving project success through contractor-project manager planning in South Africa: A collaborative approach. Unpublished MSc Thesis. University of the Witwatersrand, Johannesburg.

Ejaku, S.A. 2014. Technology adoption: Issues and challenges in information technology adoption in emerging economies. *Journal of International Technology and Information Management,* 23(2):59–68.

Eldredge, J., Weagel, E.F. & Kroth, P.J. 2014. Defining and identifying members of a research study population: CTSA-Affiliated faculty members. *National Institute of Health*, 26(1):5–11.

Elkatawneh, H. 2016. Comparing qualitative and quantitative approaches. *SSRN Electonic Journal,* 1–5. DOI: 10.2139/ssrn.2742779

Elliot, V. 2018. Thinking about the coding process in qualitative data analysis. *The Qualitative Report,* 23(11):2850–2861.

El-Sawalhi, N. & Mahdi, M. 2015. Influence of climate change on the lifecycle of construction projects at Gaza strip. *Journal of Construction Engineering and Project Management,* 5(2):1–10.

El-Sayegh, S., Kashif, M., Alsharqawi, M., Nikoula, N. & Alhimairee, M. 2016. Significant factors affecting the size and structure of project organisations. In *Proceedings of International Conference on Industrial Engineering, Management Science and Application (ICIMSA), May 23–26, 2016, Jeju Island, South Korea*.
New York City: Institute of Electrical and Electronics Engineers (IEEE): 238–242.

Emuzie. F. & Smallwood. J. 2011. Improving service delivery in South African construction: engineering perspective. In Thwala, D. (ed). *The 6th Build Environment Conference,* Johannesburg, 31 July–2 August 2011. Johannesburg: Association of Schools of Construction Southern Africa: 1–16.

Ennouri, W. 2013. Risks management: New literature review. *Polish Journal of Management Studies*, 8:288–297.

Etikan, I. & Bala, K. 2017. Sampling and sampling methods. *Biometrics and Biostatistics International Journal,* 5(6):215–217.

Etikan, I., Musa, S.A. & Alkassim, R.S. 2016. Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics,* 5(1):1–4.

Feger, A.L.R. & Thomas, G.A. 2012. A framework for exploring the relationship between project manager leadership style and project success. *The International Journal of Management*. 1(1):1–19.

Fennell, C. 2017. *Ethics in research and publication.* Amsterdam: Elsevier.

Fink, A. 2010. *Conducting research literature reviews from the internet to paper.* 3rd ed. Newbury Park, CA: SAGE.

Fleming, J. 2018. Methodologies, methods and ethical considerations for conducting research in work-integrated learning. *International Journal of Work-Integrated Learning*, 19(3):205–213.

Fontana, F.A., Mariani, E., Morniroli, A., Sormani, R. & Tonello, A. 2011. An Experience Report on Using Code Smells Detection Tools. In *Proceedings - 4th International Conference on Software Testing*, Milano, 25 April 2011. New York City: Institute of Electrical and Electronics Engineers (IEEE): 1–38.

Fornell, C. & Larcker, D.F. 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research,* 18:39–50.

Fortune, J., White, D., Jugdev, K. & Walker, D. 2011. Looking again at current practice in project management. *International Journal of Managing Projects in Business*, 4(4):553–572.

Fourie, D. & Malan, C. 2020. Public procurement in South African economy: Addressing the systemic issues. *Sustainability*, 12(20): 8692. https://doi.org/10.3390/su12208692 [21 March 2021].

Franke, T.M., Ho, T. & Christie, C.A. 2012. The Chi-Square test: often used and more often misinterpreted. *American Journal of Evaluation,* 33(3):448–458.

Gachie, W. 2017. Project risk management: A review of an institutional project life cycle. *Risk Governance and Control: Financial Markets & Institutions*, 7(4-1):163–173.

Gajendran, T. & Perera, S. 2017. *The Australian Construction e-Business Review Report for CIB TG83.* https://www.academia.edu/32363427/The_Australian_Construction_e_Business_Review_Report_for_CIB_TG83 [12 May 2020].

Gantt Pro. 2020. *Get a free demo of GanttPro chart software.* https://www.ganttpro.com/demo/ [28 October 2020].

Gantt Project. 2020. *Gantt project free project scheduling and management app for Windows, OSX and Linux*. https://www.ganttproject.biz [25 May 2020].

García-Alcaraz, J., Alor-Hernández, G., Sánchez-Ramírez, C., Jiménez-Macías, E., Blanco-Fernández, J. & Latorre-Biel, J. 2018. Mediating role of the six sigma implementation strategy and investment in human resources in economic success and sustainability. *Sustainability,* 10(6):1–21.

García-Moreno, M.B., García-Moreno, S., Nájera-Sánchez, J.J. & Pables-Heredo, C.D. 2016. An explanatory model of organisational factors that explain the adoption of e-business. *Journal of Industrial Engineering and Management,* 9(2):547–581.

Geldenhuys, G.T. 2012. Determining the influence of Information Communication Technology in South African construction project management environment. Unpublished MBA thesis, North-West University, Potchefstroom.

Gido, J. & Clements, J.P. 2012. *Successful project management*. 5th ed. Mason, OH: South-Western College.

Goddard, W. & Melville, S. 2013. *Research methodology and introduction.* 2nd ed. Cape Town: Juta.

Godwill, E.A. 2015. *Fundaments of research methodology: a holistic guide for research completion, management, validation and ethics.* New York: Nova Science Publishers.

Gogoi, P. 2020. Application of SPSS programme in the field of Social Science research. *International Journal of Recent Technology and Engineering,* 8(5):2424–2427.

Google Maps. 2021. *Bosveld.* https://goo.gl/maps/ph33c71Wu8jyZUnp7 [19 March 2020].

Graustein, J.S. 2014. *How to write an exceptional thesis or dissertation: a step-by-step guide from proposal to successful defense.* Ocala, FL: Atlantic Publishing Group.

Graves, A. 2014*. Avoiding a six sigma project failure, Six Sigma Daily*. https://www.sixsigmadaily.com/avoiding-failed-six-sigma-projects/ [26 May 2020].

Grewal, D., Hulland, J. & Karahanna, E. 2020. The future of technology and marketing: a multidisciplinary perspective. *Journal of the Academy of Marketing Science,* 48:1–8.

Grimes, D.A. & Schulz, K.F. 2002. Descriptive studies: What they can and cannot do. *Epidemiology Series,* 359:145–149.

Gu, D., Guo, J., Liang, C., Lu, W., Zhao, S., Liu, B. & Long, T. 2019. Social media-based health management systems and sustained health engagement: TPB perspective. *Environmental Research and Public Health,* 16:1–15.

Guest, G., Namey, E.E. & Mitchell, M.L. 2013. *Collecting qualitative data.* London: SAGE.

Gustavsson, T.K., Samuelson, O. & Wikforss, Ö. 2012. Organizing it in construction: present state and future challenges in Sweden. *Journal of Information Technology in Construction*, 17:520–523.

Gutterman, T.C. 2015. Descriptions of sampling practices within five approaches to qualitative research in education and health sciences. *Qualitative Social Research*, 16(2):1–23.

Gutterman, T.C. 2019. Basics of statistics for primary care research. *Family Medicine* and Community Health, 7(2):522–528. DOI: 10.1136fmch-2018-000067 [17 January 2021].

Hajjaji, M., Denton, P. & Jackson, S. 2010. The effectiveness of using project management tools and techniques for delivering projects. In: *Proceedings of Computing and Engineering Annual Researchers' Conference 2010: CEARC'10*. University of Huddersfield, Huddersfield: 124-129. ISBN 9781862180932.

Hammersley, M. & Traianou, A. 2012. *Ethics in qualitative research.* London: SAGE.

Hammond, M. & Wellington, J. 2013. *Research methods: The key concepts.* New York: Routledge.

Harding, J. 2013. *Qualitative data analysis from start to finish.* London: SAGE.

Haron, N.A., Devi, P., Hassim, S., Allias, A.H., Tahir, M.M. & Harun, A.N. 2017. Project management practice and its effects on project success in Malaysian construction industry. *International Conference on Architecture and Civil Engineering*, Malaysia: Materials Science and Engineering: 1–7.

Harris, P.E. 2016. *Planning and Control Using Microsoft Project 2013 and 2016*. Doncaster Heights: Eastwood Harris.

Harsh, S., Rajgor, M. & Pitroda, J. 2017. A critical literature review on implementation of primavera software on construction project. *International Journal of Creative Research Thoughts*, 5(4):1483–1486.

Hassan, I. & Asghar, S. 2021. A framework of software project scope definition elements: an ISM-DEMATEL approach. *Institute of Electrical and Electronics Engineers,* 9:26839–26870.

Hassan, M.M., Bashir, S. & Abbas, S.M. 2017. The impact of project managers' personality on project success in NGOs: The mediating role of transformational leadership. *Project Management Journal*, 48(2):74–87. DOI: 10.1177/875697281704800206

Hermano, V. & Martí-Cruz, N. 2020. The project-based firm: A theoretical framework for building dynamic capabilities. *Sustainability*, 12(16):1–14.

Hillson, D. 2009. *Managing risk in projects: Fundamentals of risk management*. Milton Park, UK: Routledge. ISBN 9780566088674.

Hirschi, A. & Jaensch, V.K. 2015. Narcissism and career success: Occupational self-efficacy and career engagement as mediators. *Personality and Individual Differences*, 77:205–208.

Huang, C., Wang, Y., Wu, T. & Wang, P. 2013. An empirical analysis of antecedents and performance consequence of using the Moodle platform. *International Journal of Information and Education Technology,* 3(2):217–221.

Hull, L. 2019. *BaseCamp review.* https://www.merchantmaverick.com/reviews/BaseCamp-review/ [25 May 2020].

Hussain, M.A., Elyas, T. & Nasseef, O.A. 2013. Research paradigms: A slippery slope for fresh researchers. *Life Sciences Journal*, 10(4):2374–2381.

Hussain, S., Xuetong, W. & Hussain, T. 2020. Impact of skilled and unskilled labour on project performance using structural equation modelling approach. *SAGE Open,* January-March 2020:1–16. https://doi.org/10.1177/2158244020914590

Hyttinene, K. 2017. *Project Management Handbook*. Vantaa, Finland: Laurea Publications.

Ibrahim, M. 2015. The art of data analysis. *Journal of Allied Health Sciences Pakistan*, 1(1):98–104.

Igwenagu, C. 2016. *Fundamentals of research methodology and data collection*. Chișinău, Mauritius: Lambert Academic Publishing.

Ika, L.A. 2009. Project success as a topic in project management journals*. Project Management Journal,* 40(4):6–19.

In, J. 2017. Introduction of a pilot study. *Korean Journal of Anesthesiology,* 70(6):601–605.

ISO 31000. 2018. *Risk Management – Guidelines.* https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-2:v1:en [23 May 2020].

Jadhav, J.R., Mantha, S. & Rane, S.B. 2014. Exploring barriers in lean implementation. *International Journal of Lean Six Sigma,* 5(2):122–148.

Jaja, S. A. & Amah, E. 2014. Mentoring and organizational resilience: A study of manufacturing companies in Rivers State. *IOSR Journal of Business and Management* (IOSR-JBM), 16(10):1–9. DOI: 10.9790/487X-161010109

Joo, T. & Mark. J. 2008. An evaluation of tools supporting enhanced student collaboration. In *Proceedings of 38th Annual Frontiers in Education Conference, Saratoga Springs, 22–25 October 2008*. New York: IEEE: 3–12.

Joshi, A., Kale, S., Chandel, S. & Pal, D.K. 2015. Likert scale: Explored and explained. *British Journal of Applied Science and Technology*, 7(4):396–403.

Jugdev, K., Perkins, D., Fortune, J., White, D. & Walker, D. 2013. An exploratory study of project success with tools, software and methods. *International Journal of Managing Projects in Business*, 6(3):534–551.

Kafile, M. & Fore, S. 2018. Effects of procurement process on project execution in a project management company in Cape Town South Africa. *International Journal of Business and Administrative Studies,* 4(4):176–186.

Kagogo, T.S. & Steyn, H. 2019. Effect of scope readiness on capital projects in mining: A Namibian case study. *South African Journal of Industrial Engineering,* 30(1):257–269.

Kashyap, S. 2018. *The importance of project management software to improve team productivity*. https://www.proofhub.com/articles/importance-of-project-management-software [31 March 2020].

Kaushik, V. & Walsh, C.A. 2019. Pragmatism as a research paradigm and its implication for social work research. *Social Sciences*, 8:1–17.

Khalife, M.A. & Dunay, A. 2019. Project business model with the role of digitization and circular economies in project management. *Modern Science,* (6):106–113.

Khurana, A. 2018. *Business to Business (B2B) e-commerce.* https://www.thebalancesmb.com/business-to-business-ecommerce-1141703 [06 June 2021].

Kivunja, C. & Kuyini, A.B. 2017. Understanding and applying research paradigms in educational contexts. *International Journal of Higher Educational,* 6(5):26–41.

Klynveld Peat Marwick Goerdeler (KPMG), Australian Institute of Project Management (AIPM) & International Project Management Association (IPMA). 2019. *The future of project management: global outlook 2019*. Amstelveen, Netherlands: KPMG, AIPM & IPMA.

Kohli, A.J. 2017. Enterprise project management using Primavera P6 EPPM. *International Research and Technology,* 4(12):1074–1081.

Komal, B., Janjua, U., Anwar, F., Madni, T.M., Cheema, M.F., Malik, M.N. & Shahid, A.R. 2020. The impact of scope creep on project success: Empirical investigation. *IEEE Access*, 8:125755–125775. DOI: 10.1109/ACCESS.2020.3007098 [21 March 2021].

KPMG see Klynveld Peat Marwick Goerdeler

Krajewski, L.J., Malhotra, M.K. & Ritzman, L.P. 2013*. Operations management: Processes and supply chains*. New York, NY: Pearson.

Kumar, R. 2011. *Research methodology: A step by step guide for beginners.* 3rd ed. London: SAGE.

Kumar, R. 2014. *Research methodology: A step by step guide for beginners.* 4th ed. London: SAGE.

Kuvhinikov, M., Pijkul, P. & Samek, R. 2017. *Getting big mining projects right: Lessons from and for the industry*. https://www.mckinsey.com/industries/metals-and-mining/our-insights/getting-big-mining-projects-right-lessons-from-and-for-the-industry [14 March 2020].

Kwon, H. & Kang, C.W. 2018. Improving project budget estimation accuracy and precision by analyzing reserves for both identified and unidentified risks. *Project Management Journal*, 50(1):1–15.

Lam, L.W. 2012. Impact of competitiveness on salespeople's commitment and performance. *Journal of Business Research,* 65:1328–1334.

Lan, P. 2018. A review of key paradigms: Positivism, interpretivism and critical inquiry. The University of Adelaide, Chapter XX,1–7. DOI: 10.13140/RG.2.2.13995.54569 https://www.researchgate.net/publication/324486854_A_Review_of_key_paradigms_positivism_interpretivism_and_critical_inquiry [26 December 2020].

Laureani, A. & Antony, J. 2017. Leadership characteristics for lean six sigma. *Total Quality Management & Business Excellence*, 28(3–4):405–426.

Le Hau Xuan, Q., Moslehpour, M. & Tien, D.T. 2018. An evaluation of project management tools and techniques in Vietnam. *Management Science Letters,* (9):283–300.

Lee, S. & Shvetsova, O.A. 2019. Optimization of the technology transfer process using Gantt charts and critical path analysis flow diagrams: Case study of Korean automobile industry. *Multidisciplinary Digital Publishing Institute Proceedings*, 917(7):1:27.

Liallc, B., Gajlc, S., Jovanivic, M. & Morača, S. 2013. Future challenges in project management. *DAAM International Scientific*, 1–15.

Linderoth, C.J.H., Jacobsson, M. & Elbanna, A. 2018. Barriers for digital transformation: The role of industry. In *Proceedings of Australasian Conference on Information Systems,* 03–05 December 2018. Sydney, Australia: Association for Information Systems Research: 1–12.

Linton, J.D. & Solomon, G.T. 2017. Technology, innovation, entrepreneurship and the small business – technology and innovation in small business*. Journal of Small Business Management,* 55(2):196–199.

Locke, L., Silverman, S.J. & Spirduso, W.S. 2010. *Reading and understanding research*. 3rd ed. Thousand Oaks, CA: SAGE.

Lopez-Herrejon, R.E., Montalvillo-Mendizabal, L. & Egyed, A. 2011. From requirements to features: an exploratory study of feature-oriented refactoring. In *Proceedings of 15th International Software Product Line Conference, Munich, 22–26 August 2011.* New York: IEEE Computer Society: 181–190.

Lowe, N.K. 2019. What is a pilot study? *The Journal of Obstetric, Gynecologic & Neonatal Nursing,* 48:117–118.

Lukosevicius, A.P., Soares, C.A.P. & Joia, L.A. 2018. Characterization of complexity in engineering projects. *Gestão e Produçã,* 25(2):190–342.

Mabelebele, J.M. 2006. Prospects and challenges of implementing projects in public service, South Africa. Growth and collaboration for project management profession. In *Proceedings of PMSA International Conference, Johannesburg, 30 May–1 June 2006*. Johannesburg: PMSA: 247–254.

Machado de Lima, D.V.M. 2014. Research design: A contribution to the author. *Online Brazilian Journal of Nursing*,1(2):1–18.

Machado, F.J. & Martens, C.D.P. 2015. Project management success: A bibliometric analysis. *Revista de Gestão e Projetos*, 6(2):28–44.

Maffeo, L. 2017. *3 Project management software evaluation criteria to help your business go the distance*. https://lab.getapp.com/3-project-management-software-evaluation-criteria-to-help-your-business-go-the-distance/ [28 May 2020].

Magwali, S.N. 2018. Application of project management software and its influence on project success: A case of NPOs in the Western Cape. Unpublished MTech thesis, Cape Peninsula University of Technology, Cape Town.

Maher, C., Hadfield, M., Hutchings, M. & de Eyto, A. 2018. Ensuring rigor in qualitative data analysis: A design research approach to coding combining NVivo with traditional material methods. *International Journal of Qualitative Methods,* 17:1–13.

Mahmud, Z. 2008. *Handbook of research methodology: A simplified version.* Shah Alam, Malaysia: University Publication Centre.

Majid, U. 2018. Research fundamentals: study design, population and sample size. *Undergraduate Research in Natural and Clinical Science and Technology Journal,* 2(1):1–7.

Marmel, E. 2013. *Project 2010 Bible*. Indianapolis, IND: John Wiley & Sons.

Marnewick, C., Labuschagne, L., Steyn, H., Eloff, M. & Tobin, P. 2013. Project management maturity vs project outcomes in Africa. *Prosperus Report – The African Edition,* 31 December 2013. South Africa: Project Management South Africa:1–144.

Marzagão, D. S. L. & Carvalho, M. M. 2016. Critical success factors for Six Sigma projects. *International Journal of Project Management*, 34(8):1505–1518.

Mazzarol, T., Reboud, S. & Volery, T. 2010. The influence of size, age and growth on innovation management in small firms. *International Journal of Technology*, 52(1):98–117.

McCombes, S. 2019a. *Descriptive research*. https://www.scibbr.com/methodology/descriptive-research/[28 November 2020].

McCombes, S. 2019b. *How to do a case study*. https://www.scribbr.com/methodology/case-study/[20 March 2020].

McGrath, J. & Kostalova, J. 2020. Project management trends and new challenges 2020+. In Jedlicka, P., Maresova, P., Firlej, K. & Soukal, S. (eds). 2020. *Proceedings of 18th International Conference Hradec Economic Days 2020, 2–3 April 2020, Hradec Kralove, Czecy.* Hradec Kralove: University of Hradec Kralove: 534–542. http://dx.doi.org/10.36689/uhk/hed/2020-01-000 [6 October 2020].

McLeod, L., Doolin, B. & MacDonell, S.G. 2012. A perspective-based understanding of project management success. *Project Management Journal*, 43(5):68–86.

McQuerrey, L. 2019. *The economy's effects on small businesses*. https://smallbusiness.chron.com.economys-effects-small-businesses-10269.html [18 March 2021].

Mehrad, A. & Zangeneh, M.H.T. 2019. Comparison between qualitative and quantitative research approaches: Social sciences. *International Journal for Research in Educational Studies,* 6(7):1–7.

Microsoft. 2010. *Project Pro 2010 new features.* https://www.microsoft.com/project/en/gb/project-pro-2010new-features.aspx [24 May 2020].

Mishra, P., Singh, U., Pandey, C.M., Mishra, P. & Pandey, G. 2019. Application of students t-test, analysis of variance and covariance. *Annals of Cardia Anaesthesia*, 22(4):407–411.

Mishra, S.B. & Alok, S. 2017. *Handbook of research methodology*. New Delhi: Educreation Publishing.

Mohapatra, D.P. & Kirpalani, D.M. 2017. Process effluents and mine tailings: sources, effects and management and role of nanotechnology. *Nanotechnology for Environmental Engineering,* (1):1–12.

Montequín, V.R., Balsera, J.V., Fernάndez, S.M.C. & Fernάndez, F.O. 2018. Exploring project complexity through project failure factors: analysis of cluster patterns using self-organizing maps. *Complexity*, 2018(2):1–17. doi:10.1155/2018/9496731

Mukwakungu, S.C., Mabasa, M.D. & Mbohwa, C. 2018. A review on standards, practices and future prospects of project management in a South African context. In *Proceedings of the International Conference on Industrial Engineering and Operations Management,* 26–27 July 2018. Paris: IEOM Society International: 1174–1183.

Murphy, M. 2016. Population definitions for comparative surveys in education. *Australian Council for Educational Research (ACER).* https://research.acer.edu.au/ar_misc/22 [29 November 2020].

Murwira, D. & Bekker, M. 2017. Building an infrastructure project performance in the North-West Province Department of Public Works Roads. *Acta Structilia,* 24(2):128–145.

Naeem, S., Khanzada, B., Mubashir, T. & Sohail, H. 2018. Impact of project planning on project success with mediating role of risk management and moderating role of organizational culture. *International Journal of Business and Social Science*, 9(1): 88–98.

Nahod, M.M., Vukomanović, M. & Radujković, M. 2013. The impact of ICB 3.0 competences on project management success. *Procedia – Social and Behavioral Sciences*, 74:244–254.

Narbaev, T. & De Marco, A. 2014. An earned schedule-based regression model to improve cost estimate at completion. *International Journal of Project Management,* 32(6): 1007-1018.

Nassaji, H. 2015. Qualitative and descriptive research: Data types versus data analysis. *Language Teaching Research,* 19(2):129–132.

Nicholas, A.I. 2015. The effect of swot analysis in project management in South Eastern Nigeria. *European Journal of Business and Management,* 7(13):41–47.

Nicholas, J. & Steyn, H. 2012. Project quality management. In *Project management for engineering, business and technology*: 320-350. DOI: 10.1016/B978-0-08-096704-2.50020-X

Nikolova, L.V., Kuporov, J.J. & Rodionov, D.G. 2015. Risk management of innovation projects in the context of globalization. *International Journal of Economics and Financial Issues*, 5:73–79.

Nimon, K., Zientek, L.R. & Henson, R.K. 2012. The assumption of reliable instrument and other pitfalls to avoid when considering the reliability of data. *Frontiers in Psychology*, 3(102):1–13.

Nishishiba, M., Jones, M. & Kraner, M. 2014. *Research methods and statistics for public and non-profit administrators.* Thousand Oaks, CA: SAGE.

Noh, N.M., Mustafa, H.M.A. & Ahmad, C.N.C. 2014. Predictive relationship between technology acceptance readiness and the intention to use Malaysian EduwebTV among library and media teachers. In *Proceedings of 5th World Conference Educational Sciences,* 06-08 February 2013. Rome, Italy: Elsevier: 145–148.

O'Brien, J. 2018. *Is an integrated SHEQ management system necessary.* https://www.xgrcsoftware.com/is-an-integrated-sheq-management-system-necessary/[06 June 2021].

O'Loughlin, E. 2017. *3 Reasons you should invest in Microsoft (and 3 why you shouldn't*). https://www.softwareadvice.com/resources/microsoft-project-pros-and-cons-for-smbs/ [24 May 2020].

Ofori, D. F. 2013. Project management practices and critical success factors – A developing country perspective. *International Journal of Business and Management*, 8(21):14–32.

Oke, A., Aigbavboa, C. & Khangale, T. 2018. Effects of skills shortages on sustainable construction. In Arezes, P.M.F.M. (ed). *Proceedings of the 2017 International Conference on Applied Human Factors and Ergonomics, Los Angeles, CA, 17–21 July 2017*. New York, NY: Springer International: 303–309.

Okereke, O.C. 2017. Causes of failure and abandonment of projects and project deliverables in Africa. *PW World Journal,* 6(1):1–16.

Omair, A. 2014. Sample size estimation and sampling techniques for selecting a representative sample. *Journal of Health Specialities,* 2(4):142–147.

Omona, J. 2013. Sampling in qualitative research: improving the quality of research outcomes on higher education. *Makerere Journal of Education,* 4(2):169–185.

Ong, M.H.A. & Puteh, F. 2017. Quantitative data analysis: Choosing between SPSS, PLS and AMOS in Social Science research. *International Interdisciplinary Journal of Scientific Research,* 3(1):14–25.

Oracle. 2019. *Explore primavera P6 EPPM product features.* https://www.oracle.com/industries/construction-engineering/primavera-p6/[24 May 2020]

Palisade. 2010. *@RISK customer testimonials.* http://www.palisade.com/risk/testimonials_risk.asp [03 May 2020].

Papke-Shields, K.E., Beise, C. & Quan, J. 2010. Do project managers practice what they preach and does it matter to project success. *International Journal of Project Management,* 28(7):650–662.

Park, S.Y., Konge, L. & Artino, A.R. 2020. The positivism paradigm of research. *Academic Medicine,* 95(5):690–694.

Patel, M. & Patel, N. 2019. Exploring research methodology: Review article. *International Journal of Research & Review,* 6(3):48–55.

Pellerin, R., Perrier, N., Guillot, X. & Léger, P.M. 2013. Project characteristics, project management software utilization and project performance: An impact analysis based on real project data. *International Journal of Information Systems and Project Management,* 1(3):5–26.

Piggott, E., Fajardo, C. & Erasmus, M. 2017. *Gender disparity in South Africa addressing the heart of the matter*. https://www.bain.com/insights/gender-disparity-in-south-africa/ [22 March 2021].

Pillay, P. 2016. Barriers to information and communication technology adoption and use among SMEs: A study of the South African manufacturing sector. Unpublished MM thesis, University of the Witwatersrand, Johannesburg.

Pirotti, A., Keshavarzsaleh, A., Rahim, F.A.M. & Zakaria, N. 2020. Effective factors on project success in Malaysian construction industry. *Journal of Engineering, Project and Production Management*, 10(1):1–10.

PMI see Project Management Institute.

PMO Insight Report. 2019. *A survey and analysis of project offices in South Africa.* https://www.go2ppo.com/pmo-insights-report/[22 March 2021].

Ponto, J. 2015. Understanding and evaluating survey research. *Journal of the Advanced Practitioner in Oncology,* 6(2):168–171.

Poston, R.S. & Richardson, S.M. 2011. Designing an academic project management program: A collaboration between a university and a PMI chapter. *Journal of Information Systems Education*, 22(1):55–72.

PriceWaterhouse Coopers (PWC). 2012. *Insights and trends: current program and project management practices: The second global survey on the current state of project management maturity in organisations across the world*. McLean, VA: PWC.

Pro Crew Schedule. 2020. *Technologies for better construction project management*. https://www.procrewschedule.com/technologies-for-better-construction-project-management/[11 April 2021].

Proença, C.R. & Bernardino, J. 2019. Evaluating Gant Project, Orange Scrum and ProjeQtOr open source project management tools using QSOS. In *Proceedings of ICSOFT 2019 - 14th International Conference on Software Technologies, Prague, Czech Republic, July 26–28, 2019:* 522-528. DOI: 10.5220/0007956605220528 [24 May 2020]

Project Management Institute (PMI). 2013. *A guide to Project Management Body of Knowledge (PMBOK)*. 5th ed. Newtown Square, PA: Project Management Institute, Inc.

Project Management Institute (PMI). 2017. *A Guide to Project Management Body of Knowledge (PMBOK)*. 6th ed. Newtown Square, PA: Project Management Institute, Inc.

Project Management Learning. 2010. *What are the advantages and disadvantages of Microsoft Project?* https://projectmanagementlearning.com/what-are-the-advantages-and-disadvantages-of-microsoft-project-html [25 May 2020].

Pruzan, P. 2016. *Research methodology the aims, practices and ethics of science.* Cham, Switzerland: Springer.

Puška, A., Stojanović, I., Maksimović, A. & Osmanović, N. 2020. Project management software evaluation by using the measurement of alternatives and ranking accosting to compromise solution Marcos method. *Operational Research in Engineering Sciences: Theory and Applications*, 3(1):89–102.

PWC *see* PriceWaterhouse Coopers.

Radujković, M. & Sjekavica, M. 2017. Project management success factors. Procedia Engineering, 196:607–615. https://www.sciencedirect.com/science/article/pii/S1877705817331740 [12 May 2018].

Radujković, M. 2014. The role of project management in construction industry modernization. In *Proceedings of the 13th China International Construction Project Management Summit, Hangzhou, 11–13 October 2014*:10–28. https://www.bib.irb.hr/725588 [22 May 2020].

Rahl, S. 2017. Research design and methods: a systematic review of research paradigms, sampling issues and instruments development. *International Journal of Economics & Management Sciences,* 8(2):1–5.

Ramilo, R. & Embi, M.R.B. 2014. Critical analysis of key determinants and barriers to digital innovation adoption among architectural organizations. *Frontiers of Architectural Research,* (3):431–451.

Ransome, P. 2013. *Ethics & values in social research*. London: Palgrave Macmillan.

Ray, R. 2019. *6 Essential criteria to consider while selecting project management* software. https://medium.com/@rachaelray018/6-essential-criteria-to-consider-while-selecting-project-management-software-714ed171be6e [28 May 2019].

Raymond, L. & Bergeron, F. 2007. Project management information systems: An empirical study of their impact on project managers and project success. *International Journal of Project Management*, 26(2):213–220.

Rehacek, P. & Bazsova, B. 2018. Risk management methods in projects. *Eastern Europe Research in Business and Economics*, 2018(Art. 790198):1–11. https://ibimapublishing.com/articles/JEERBE/2018/790198/790198.pdf DOI: 10.5171/2018.790198 [22 May 2018].

Rehman, A.A. & Alharthi, K. 2016. An introduction to research paradigms. *International Journal of Educational Investigations*, 3(8):51–59.

Remenyi, D. 2011*. Field methods for academic research – interviews, focus groups and questionnaires in business and management studies.* Reading, UK: Academic Conferences and Publishing International.

Ren, Z., Anumba, C.J., Augenbroe, G. & Hassan, T.M. 2008. A functional architecture for an e-Engineering hub. *Automation in Construction*, 17(8):930–939.

Ren, Z., Hassan, T.M., Carter, C.D. & Anumba, C.J. 2006. E-Contracting for SMES through an engineering E-HUB. *IT Con*, 11:161–173.

Ritter, N.L. 2010. Understanding a widely misunderstood statistic: Cronbach's alpha. In *Proceedings of The Annual Meeting of the Southwest Educational Research Association,* 18 February 2010. New Orleans. College Station, TX: Texas A&M University: 1–20.

Rodríguez, P., Montequín, V.R., Morán, H. & de Arriba, L. 2017. Gender influence in project management: Analysis of a case study based on master students. *Procedia Computer Science*, 121:461–468.

Roopa, S. & Rani, M.S. 2012. Questionnaire designing for a survey. *The Journal of Indian Orthodontic Society,* 46:273–277.

Rouse, M. 2019. *PERT chart (Program Evaluation Review Technique)*. https://www.google.com/amp/s/searchsoftwarequality.techtarget.com/definition/PERT-chart%3famp=1 [29 October 2020].

Rwelamila, E.K. 2017. Understanding the risk in South African construction projects: A case of the Western Cape. Unpublished MSc thesis. University of Cape Town, Cape Town.

Sajad, M., Sadiq, M., Naveed, K. & Iqbal, M.S. 2016. Software project management: Ttools assessment, comparison and suggestions for future development. *International Journal of Computer and Network Security,* 16(1):31–42.

Sakyi, K., Musona, D. & Mweshi, G. 2020. Research Methods and Methodology. *Advances in Social Sciences Research Journal*, 7:296–302.

Samuels, P. 2020. *A really simple guide to quantitative data analysis*. Birmingham, UK: Birmingham City University.

Sánchez, M.A. & Zuntini, J.I. 2018. Organizational readiness for the digital transformation: A case study research. *Revista Gestão and Technologia,* 18(2):70–99.

Sarantis, D., Charalabidis, Y. & Askounis, D. 2010. A Goal Oriented and Knowledge Based eGovernment Project Management Platform. *43rd Hawaii International Conference on System Sciences,* Hawaii, 08 February 2010: IEEE Xplore:1–13

Saunders, M.N.K., Lewis, P. & Thornhill, A. 2019. *Research methods for business students*. 8th ed. Harlow, UK: Pearson Education Limited.

Săvescu, D. 2018. Projects management. Some aspects. *Fiability & Durability/Fiabilitate Si Durabilitate,* (1):299–304.

Savvides, M.G. 2015. The adoption of ICT project management software to facilitate the transition to becoming medium sized contractor. Unpublished MSc thesis. University of the Witwatersrand, Johannesburg.

Schober, P., Boer, C. & Schwarte, L. A. 2018. Correlation coefficients: Appropriate use and interpretation. *International Anesthesia Research Society,* 126(6):1763–1768.

Sekaran, U. & Bougie, R. 2010. *Research methods for business: A skill-building approach.* 5th ed. Haddington, UK: John Wiley and Sons.

Setia, M.S. 2016. Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*, 61(3):261–264.

Sharma, G. 2017. Pros and cons different sampling techniques. *International Journal of Applied Research,* 3(7):749–752.

Shehu, A., Ibrahim, Y. & Inuwa, I. 2019. Knowledge requirement theoretical framework for construction procurement management. In *Proceedings of 7th International Conference on Euro Asia Civil Engineering forum,* 30 September – 02 October 2019. Stuttgart, Germany: IOP Publishing: 1–8.

Sileyew, K.J. 2019. *Research design and methodology.* London: Intech Open. DOI: 10.5772/intechopen.85731 [23 December 2020].

Silvianita, R., Firmansyah, D.M., Rosyid, S. & Chamelia, D.M. 2018. Fast missile boat project planning using CPM and What If analysis method. *IOP Conference Series: Earth and Environmental Science*, (135):1–6. DOI :10.1088/1755-1315/135/1/012014

Singh, S. 2018. *Sampling techniques*. https://towardsdatascience.com/sampling-techniques-a4e34111d808 [29 April 2020].

Snyder, H. 2019. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research,* 104:333–339.

Son, H., Park, Y., Kim, C. & Chou, J.S. 2012. Toward an understanding of construction professionals' acceptance of mobile computing devices in South Korea: An extension of the technology acceptance model. *Automation in Construction*, 28:82–90. DOI: 10.1016/j.autcon.2012.07.002

South Africa. Department of Women. 2020. *Department of Women Strategic Plan 2015–2020*. Pretoria: Government Printer. https://www.women.gov.za/Department-of-Women-Strategic-Plan.pdf&ved=2ahUKEwi9tom6sL3wahVWaRUIHVRvColQFjAAegQIBhAC&usg=AOvVaw2DO9Y5Tf0LMK9txxfGtas5&cshid=1620590473379 [22 March 2021].

Spalek, S. 2016. Traditional vs. Modern project management methods: theory and practice. In *Proceedings of 21st International Scientific Conference Economics and Management,* Brno, Czech Republic, 19-20 May 2016. Brno: Brno University of Technology: 499–506.

Špundak, M. 2014. Mixed agile/traditional project management methodology – reality or illusion. *Procedia – Social and Bahavioural Sciences*, 119:939–948.

Statistics South Africa (SSA). 2020. *Annual report 2019/20.* https://www.statssa.gov.za/publications/AnnualReport/AR201819_Book_1.pdf&ved+2ahUKEwiYubfkuL3wAhXMfMAKHeQqD7cQFjAAegQIAxAC&usg=AOvVaw0_izOMXKOX9q4uOwBsiwh [22 March 2021].

Stretton, A. 2018. Relating causes of project failure to an organizational strategic business framework. *PM World Journal,* 7(1):1–10.

Subramani, T., Sarkunam, A. & Jayalakshmi, J. 2014. Planning and scheduling of high-rise building using Primavera. *International Journal of Engineering Research and Applications,* 4(6):134–144.

Sullivan, G.M. & Artino, A.R. 2013. Analyzing and interpreting data from Likert-type scales. *Journal of Graduate Medical Education,* 5(4):541–542.

Surbhi, S. 2016. *Difference between primary and secondary data*. https://keydifferences.com/difference-between-primary-and-secondary-data.html [30 March 2020].

Suvarna, P., Lokesh, Y. & Mahendra, S.P. 2018. Planning scheduling and tracking of ongoing bridge construction project using Primavera software and EVM technique. *International Journal of Applied Engineering Research*, 13(7):209–214.

Svejvig, P. & Andersen, P. 2015. Rethinking project management: A structured literature review with a critical look at the brave new world. *International Journal of Project Management,* 33(2):278–290.

Tabassi, A.A., Bryde, D.J., Kamal, E.M., Dowson, J. & Michaelides, R. 2019. Challenges for project management in the 21st century. In *Proceedings of 4th International Conference on Rebuilding Place*, Penang, 6–7 November 2019: Future Academy: 632–641.

Taber, K.S. 2018. The use of Cronbach's Alpha when developing and reporting research instruments in science education. *Research Science Education*, (48):1273–1296.

Taherdoost, H. 2016a. Sampling methods in research methodology; how to choose a sampling technique for research. *International Journal of Academic Research in Management,* 5(2):18–27.

Taherdoost, H. 2016b. Validity and reliability of research instrument; how to test the validation of a questionnaire/survey in a research. *International Journal of Academic Research in Management,* 5(3):28–36.

Takawira, M. 2019. Addressing skills shortages in the South African residential construction industry through automation – a case of Gauteng region. Unpublished MSc thesis, University of the Witwatersrand, Johannesburg.

Talukder, M. 2012. Factors affecting the adoption of technological innovation by individual employees: An Australian study. *Procedia Social and Behavioral Sciences,* (40):52–57.

Tamang, P. 2018. *How to choose the right project management technology: what type of buyer are you*? https://www.softwareadvice.com/resources/author/pritamtamang/ [22 May 2020].

Tavakol, M. & Dennick, R. 2011. Making sense of Cronbach's Alpha. *International Journal of Medical Education, (*2):53–55.

Taylor, R. 2010. Systems thinking for project management implication for practice and education. *Acta Structila*, 17(1):79–103.

Tereso, A., Ribeiro, P., Fernandes, G., Loureiro, I. & Ferreira, M. 2019. Project management practices in private organizations. *Project Management Journal,* 50(1):6–22.

Tewari, P.C., Mittal, K. & Khanduja, D. 2017. On the right approach to selecting a quality improvement project in manufacturing industries. *Operations Research and Decisions,* 27(1):105–124.

Thomas, P.Y. 2010. Towards developing a web-based blended learning environment at the University of Botswana. Unpublished PHD. Thesis. University of South Africa, Pretoria.

Tipili, L.G. & Ibrahim Y. 2015. Identification and assessment of key risk factors affecting public construction projects in Nigeria: Stakeholders' perspectives. *International Journal of Engineering and Advanced Technology Studies, 2*2(4):20–32.

Tomomitsu, H.T.A., de Carvalho, M.M. & de Oliveira Moraes, R. 2018. The evolution of the relationship between project management and knowledge management: a bibliometric study. *Gestão & Produção Journal,* 25(2):354–369.

Tonchia, S. 2008. *Industrial project management*. London: Springer.

Tongco, D.C. 2007. Purposive sampling as a tool for informant selection. *A Journal of Plants, People and Applied Research,* 5:147–158.

Trinh, B.N., Huynh, Q.T., & Nguyen, X.T. 2019. Nash equilibrium model for conflicts in project management. *Journal of Computer Science and Cybernetics*, 35(2):167–184.

Trochim, W.M.K. 2020. *Research methods knowledge base.* https://conjointly.com/kb/nonprobability-sampling/[29 November 2020].

Turner, J., Huermann, M., Anbari, F. & Bredillet, C. 2013. Perspectives on projects. *Global Business Perspectives*, 1:3–28.

United Nations Conference on Trade and Development (UNCTAD). 2019. Digital economy report 2019: value creation and capture: implications for developing countries. *United Nations Conference on Trade and Development,* 27 October 2019. Geneva, Switzerland: United Nations Publications: 1–154.

Upadhyay, G. 2019. *10 Considerations for choosing a project management tool*. https://project-management.com/10-considerations-for-choosing-a-project-management-tool/[29 May 2020].

Valenko, T. & Klanšek, U. 2017. An integration of spreadsheet and project management software for cost optimal time scheduling in construction. *Organization, Technology and Management in Construction,* (9):1627–1637.

Van Marrewijk, A. & Smits, K. 2016. Cultural practices of governance in the Panama Canal Expansion Megaproject. *International Journal of Project Management*, (34):533–544.

Vanclay, F., Baines, J.T. & Taylor, C.N. 2013. Principles for ethical research involving humans: ethical professional practice in impact assessment part 1. *Impact Assessment and Project Appraisal,* 31(4):243–253.

Vanderstoep, S.W. & Johnston, D.D. 2009. *Research methods for everyday life: Blending quantitative and qualitative approaches*. San Francisco, CA: Jossey-Bass.

Veiga, R.T., Moura, L.R.C. & Higuchi, A.K. 2019. Validation of scales to research the personal financial management. *Review of Business Management,* 2(2):332–348.

Verburg, R.M., Bosch-Sijtsema, P. & Vartiainen, M. 2013. Getting it done: Critical success factors for project managers in virtual work settings. *International Journal of Project Management,* 31(1):68–79.

Vogt, W.P. 2007. *Quantitative research methods for professionals.* Boston, MA: Pearson Education.

Webster, A. & Gardner, J. 2019. Aligning technology and institutional readiness: the adoption of innovation. *Technology Analysis and Strategic Management,* 31(10):1229–1241.

Wellingtone. 2018. *Annual report: the state of project management 2018*. Australia: Wellingtone.

Wellingtone. 2020. *Annual report: the state of project management 2020*. Hobart,Tasmania, Australia: Wellington Bridge Press.

Wilkinson, D. & Birmingham, P. 2003. *Using research instruments a guide for researchers.* Abingdon, UK: Routledge.

Williams, P., Ashill, N. J., Naumann, E. & Jackson, E. 2015. Relationship quality and satisfaction: Customer-perceived success factors for on-time projects. *International Journal of Project Management*, 33(8):1–15.

Wilson, R. 2015. *Mastering project time management, cost control and quality management.* Hoboken, NJ: Pearson Education.

Wipulanusat, W., Panuwatwanich, K. & Stewart, R. 2017. Workplace innovation: exploratory and confirmatory factor analysis for construct validation. *Management and Production Engineering Review,* 8(2):57–58.

Wright, S., O'Brien, S.C., Nimmon, L., Law, M. & Mylopoulos, M. 2016. Research design considerations. *Journal of Graduate Medical Education,* 8(1):97–98.

Yang, L.R., Huang, C.F. & Wu, K.S. 2011. The association among project manager's leadership style, teamwork and project success. *International Journal of Project Management*. 29(3):258–267.

Yin, R.K. 2016. *Qualitative research from start to finish*. 2nd ed. New York: The Guilford Press.

Yip, C., Han, N.R. & Sng, B.L. 2016. Legal and ethical issues in research. *Indian Journal of Anaesthesia,* 60(9):684–688.

Yong, A.G. & Pearce, S. 2013. A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in Quantitative Methods for Psychology,* 9(2):72–94.

Zagorsek, B., Zagoršeková, N. & Bolek, V. 2017. The current role of project management in competitiveness of companies. *Actual Problems of Economics*, (5):99–106.

Zhu, D.H. & Chen, G. 2015. Narcissism, director selection and risk-taking spending. *Strategic Management Journal*, 36(13):2075–2098.

Zielinski, S. 2017. *Explainer: Weather and weather prediction.* https://www.sciencenewsforstudents.org/article/explainer-weather-and-weather-prediction/amp. [06 June 2021].

Žukauskas, P., Vveinhardt, J. & Andriukatienė, R. 2018. *Philosophy and paradigm of scientific research*. https://www.intechopen.com/books/management-culture-and-corporate-social-responsibility/philosophy-and-paradigm-of-scientific-research [31 March 2020].

APPENDIX A: RESEARCH SURVEY

Letter of informed consent

Dear Participant

You are invited to participate in a research study titled "The use of digital project management solutions by project businesses: a case study of Mogalakwena Platinum mine in the Limpopo Province".

This study is being conducted by Mr Kgothatso Erens Mahlo under the supervision of Professor JP Spencer from the Faculty of Business and Management Sciences at the Cape Peninsula University of Technology. The study is projected to benefit contracting project businesses, the mines and the government in understanding the role of digital project management technology for project businesses.

Participation will be in the form of answering questions in questionnaire below. The questionnaire will require 15-30 minutes of your time to complete. Participation is voluntary and participants may ignore questions that they are not comfortable with answering. Your anonymity and confidentiality will be respected.

For more info you may contact Mr Mahlo on 0714745324/kgothatsoerens@gmail.com or his supervisor jpsafron@mweb.co.za.

QUESTIONNAIRE

Instructions

- Please answer all questions.
- For each question that you do not understand please ask for clarity.
- Your responses are confidential and no company name or any name associated with your company will be published therefore, please kindly give your honest answer.

SECTION A: GENERAL INFORMATION. (Please mark the appropriate box with an X)

1. Name of organisation

   ---

2. What is your gender? Male ☐ Female ☐

3. What is your position in the company?

   - Project Manager ☐
   - Contractor Site Manager ☐
   - Contractor Supervisor ☐
   - Other (specify): ----------

4. What is your educational level?

Primary school	☐	Masters degree	☐
Secondary school	☐	Doctoral degree	☐
Technical college	☐	Other	☐
First Degree/Bachelors	☐		☐

If other, please specify: ----------

5. What is your type of business?

Engineering	☐
Construction	☐
Other (specify)	☐

6. How many employees do you have?

1-9	☐
10-20	☐
21-50	☐
51-100	☐
Over 100	☐

7. How many years has your business been operating?

20 years or more	☐
16-20	☐
11-15	☐
6-10	☐
1-5	☐
< 1 year or less	☐

8. How many years has your business been operating in the mining industry?

20 years or more	☐
16-20	☐
11-15	☐
6-10	☐
1-5	☐
< 1 year or less	☐

9. Is your business local? Yes ☐ No ☐

SECTION B: PROJECT HISTORY AND CHALLENGES.

1. How many projects has your organisation been involved in? ----------

2. What type of projects have you been involved in?

---

3. How many projects have been successful in your organisation? ----------

4. How many projects have failed in your organisation? ----------

5. What do you consider as project success? (please tick those that apply)

☐ On-time delivery

☐ A project that does not exceed the budget

☐ Approval by the client

☐ Deliverance of exceptional quality

☐ Other (please specify) ----------

6. Which project phase affects your project success?

☐ Project planning

☐ Project Execution

☐ Project control/performance

☐ Project initiation

☐ Other (please specify) ----------

7. What challenges do you face when having to succeed in a project?

☐ Lack of technology

☐ Lack of resources

☐ Poor communication

☐ Limited skills☐Limited budget

☐ Project requirements not clearly defined

☐ Change in project requirements

☐ Organisational change

☐ Project plan not understood by the team

☐ Project scope not understood by the team

☐ Project requirements not understood by the team

☐ Other (please specify) ----------

8. What external challenges often affect the progress of your projects?

☐ Economical changes

☐ Unanticipated weather patterns

☐ Political changes

☐ Supplier-related issues

☐ Other (please specify) ----------

SECTION C: ADOPTION LEVEL AND THE BARRIERS TO ADOPTING DIGITAL PROJECT MANAGEMENT TOOLS.

1. Part 1: the following factors are for determining the adoption of digital project management tools.

Factors	**YES**	**NO**
1. We are aware of digital project management tools		
2. We make use of digital project management tools in our projects		
3. We make use of digital project management tools in the planning of our projects		
4. We make use of digital project management tools in the scheduling of our projects		
5. We make use of digital project management tools in the budgeting of our projects		
6. We make use of use of digital project management tools for human resource in our projects		
7. We make use of use of digital project management tools for time-tracking in our projects		
8. We make use of use of digital project management tools for ensuring consistent workflow in our projects		
9. We make use of digital project management tools for collaboration		
10. We make use of digital project management tools for procurement purposes		
11. We make use of digital project management tools to manage the risks associated with projects		
12. We make use of digital project management tools to manage safety in our projects		
Project Management Software (PMS) Package		
11. Please tick below the Project Management Software package/s that you make use of in our organisation		
☐ Trello package ☐ Base-Camp package ☐ Microsoft Project ☐ Smart-sheet ☐ Huddle ☐ Oracle Primavera ☐ Proofhub ☐ Zoho Projects ☐ GanttPro ☐ None		
Please specify below any other PMS package that you use:		

2. Part 2: The following factors are for determining the barriers to adoption.

Please rate by indicating [X] whether you (1. SD) Strongly Disagree; (2. D) Disagree (3. N) Neutral; (4. A) Agree and (5. SA) Strongly Agree					
Factors	**1**	**2**	**3**	**4**	**5**
	SD	**D**	**N**	**A**	**SA**
1. Lack of knowledge about available digital project management tools					
2. High costs associated with the adoption of digital project management tools					
3. Lack of resources to facilitate the usage of digital project management tools					
4. Lack of technological experts (skill) to handle the computer systems					
5. Lack of information and popularity of digital project management tools					
6. Few businesses use digital project management tools there is no competition in this regard					
7. Government regulations					
8. Uncertainty about return on investments					
9. Processes are complex in the mine than in other industries					
Please specify, (**if** any), some of the other barriers that you have identified which affect adoption of digital project management solutions in your organisation:					

SECTION D: READINESS OF YOUR BUSINESS TO ADOPT DIGITAL PROJECT MANAGEMENT TOOLS.

Please rate the extent to which your organisation is ready to adopt digital project management solutions as a business strategy. Rate by indicating [X] whether you (1) [SD] Strongly Disagree; (2) [D] Disagree; (3) [N] Neutral; (4) [A] Agree and (5) [SA] Strongly Agree

Readiness	**1**	**2**	**3**	**4**	**5**
	SD	**D**	**N**	**A**	**SA**
1. Our organisation is aware of digital project management tools					
2. Our organisation recognises the opportunities and challenges enabled by digital project management tools					
3. Our organisation understands digital project management tools that can be applicable to our organisation					
4. We are aware of the potential benefits of digital project management tools to our organisation					
5. Our organisation has a clear vision of the implementation of digital project management tools					
6. Our vision of digital project management tools is widely communicated and understood throughout our business					

7. Roles, responsibilities and accountability are clearly defined regarding the usage of digital project management tools					
8. We have enough technical skills (human capacity) to deploy and adopt digital project management tools					
9. We have considered/evaluated the impact of digital project management tools to the way our sector operates					
10. We have sufficient resources to initiate the utilisation digital project management tools					
11. We can afford to make use of digital project management tools					
12. We have thoroughly analysed the possible changes required to take effect in our organisation as a result of the adoption of digital project management tools					
13. We believe that our staff members are ready for the changes					
14. We feel that company data and transactions with employees online can be executed safely using digital project management tools					
15. The government demonstrates strong commitment to promote digitalisation					
16. The mine demonstrates strong commitment to promote digitalisation					
17. We are comfortable with how things are and do not see the need to adopt digital project management tools					
18. Inadequate legal frameworks for business to use digital project management tools					
19. Lack of digital project management tools in the country					
20. Poor security systems to check internet fraud and privacy issues					
21. Lack of technological experts (skill) in our organisation to handle the computer systems					
22. We are discouraged by the economic environment					
23. Digital technology is too complex to implement					
24. Low management commitment to use digital project management tools					

Thank you so much for taking your time to participate in this questionnaire. I wish to guarantee you once again that the information that you provided will be utilised for the intended purpose only and will be treated with strictest confidentiality.

APPENDIX B: CPUT ETHICAL CLEARANCE

P.O. Box 1906 • Bellville 7535 South Africa •Tel: +27 21 4603291 • Email: fbmsethics@cput.ac.za
Symphony Road Bellville 7535

Office of the Chairperson Research Ethics Committee	Faculty: **BUSINESS AND MANAGEMENT SCIENCES**

The Faculty's Research Ethics Committee (FREC) on **28 April 2020**, ethics **Approval** was granted to **Kgothatso Mahlo (219275165)** for a research activity for **Master in Business & information Administration** at Cape Peninsula University of Technology.

Title of dissertation/thesis/project:	**THE USE OF DIGITAL PROJECT MANAGEMENT SOLUTIONS BY PROJECT BUSINESSES: A CASE STUDY OF MOGALAKWENA PLATINUM MINE IN THE LIMPOPO PROVINCE** Lead Supervisor (s): Prof JP Spencer

Comments:

Decision: Approved

	**4 May 2020**
Signed: Chairperson: Research Ethics Committee	**Date**

Clearance Certificate No | 2020FOBREC758

APPENDIX C: GRAMMARIAN LETTER

22 Krag Street
Napier
7270
Overberg
Western Cape

25 July 2021

LANGUAGE & TECHNICAL EDITING

Cheryl M. Thomson

THE USE OF DIGITAL PROJECT MANAGEMENT SOLUTIONS BY PROJECT BUSINESSES: A CASE STUDY OF A SELECTED MINE IN THE LIMPOPO PROVINCE

Supervisor: Prof JP Spencer

This is to confirm that I, Cheryl Thomson, executed the language and technical editing of the above-titled Master's dissertation of **Kgothatso Erens Mahlo,** student number 219275165, at the CAPE PENINSULA UNIVERSITY OF TECHNOLOGY in preparation for submission of this dissertation for assessment.

Yours faithfully

CHERYL M. THOMSON

Email: cherylthomson2@gmail.com

Cell: 0826859545