

**EFFECTIVE IMPLEMENTATION OF MANAGEMENT TECHNIQUES TO ENHANCE SITE
WORKER SAFETY IN SOUTH AFRICA**

by

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Declaration

I, Ayodele Olajire Fatoba, declare that the content of this thesis represents my own unaided work, and that this 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.

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Date

Abstract

These days, with regard to construction management techniques, safety of construction site workers is crucial both during and after construction project execution. In the process, while many incidents relating to occupational hazards have been encountered and reported, they have not been thoroughly investigated to determine their causes and effects, mostly due to inadequate safety procedures. Lack of adequate safety procedures has been an enormous challenge to all concerned stakeholders, as numerous construction site workers have been physically affected. This problem persists due to the inability of the stakeholders to maintain an accident-free environment at the construction site.

Appropriate research questions were formulated to aid in the development of relevant objectives in fostering a suitable methodology to assess and determine the responsible factors that cause the inadequate safety procedures within construction management techniques in South Africa. Methodology applied in this study cuts across the extensive study of literature relating to causes and effects of inadequate safety procedures in construction management techniques in South Africa. The outcome of the literature review paved the way for the formulation of steps required for collection and analysis of data. Due to the type of investigation carried out, mixed methodology was adopted to collect the required data through observations, semi-structured and unstructured interviews, and qualitative closed-end questionnaires were distributed to the respective construction professionals within the Western Cape Province. Data were carefully evaluated, analysed, and interpreted through the application of quantitative and qualitative approaches of descriptive analysis using SSPS and Excel statistical tools to demonstrate the outcome of the analysis.

Findings gathered reveal that certain factors critically affect stakeholder ability to sustain accident-free sites, with more than 80% of these stakeholders affirming the effect of these factors in implementing effective management techniques for the occupational safety sustenance of the site workers in South Africa. The implementation of safety initiatives at the initial stage of production is essential for accident prevention on construction sites, thereby enhancing worker productivity. This study improves operational management techniques of construction worker safety in South Africa by suggesting proper implementation of the recommendations formulated and the framework developed to facilitate the effective implementation of management techniques for safer construction environments to halt the present prevalent occurrence of occupational accidents and ensure consistent site worker safety in South Africa.

Keywords: occupational safety; construction industry; construction site; management techniques; safety management; worker safety

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DEDICATION

I completely and without any reservation dedicate this thesis to God Almighty, whose grace ensured the opportunity for my admission, made adequate provision for my sustenance, and ultimately, saw me through the 'ups and downs' of the programme.

DEFINITION OF TERMS

Accident: This refers to an event, and the consequences of that event, in relation to safety on a construction site. In this context, accident is described as an undesired event that produced undesired results that can be physical, environmental, or both (Hughes, 2007).

Construction site: This is the location at which building and various other construction activities are carried out.

Hazard: This is the ability of an object or something to cause harm to human, hearth, property or the environment, and can also be the outcome of the interaction of components, as in the chemical fume (Hughes, 2007).

Injury: This refers to the physical consequence of an accident or incident. In many cases in the construction industry, numerous incidents take place at a construction site, causing injuries to workers (Hughes, 2007).

Management techniques: This is a system by which an organisation aims to reduce and ultimately remove non-conformance to conditions, ethics and customer expectation in the most effective and efficient manner.

Risk: This refers to the chance or likelihood of loss or gain resulting from taking a risk (Hughes, 2007).

Site Safety: This is the act of preventing construction site worker fatalities or hazards.

South Africa: This is a country on the southern tip of the African continent marked by several distinct ecosystems.

TABLE OF CONTENTS

Declaration.....	ii
Abstract.....	iii
ACKNOWLEDGEMENTS	iv
DEDICATION.....	v
DEFINITION OF TERMS	vi
TABLE OF CONTENTS.....	vii
LIST OF FIGURES	xvi
LIST OF TABLES.....	xviii
LIST OF ABBREVIATIONS AND MEANINGS.....	xx
ARTICLES FOR PUBLICATION	xxii
CHAPTER ONE.....	1
1. Introduction.....	1
1.1 Background of the study	1
1.2 Problem statement.....	3
1.3 Research questions	4
1.4 Aim and objectives.....	4
1.4.1 Aim	4
1.4.2 Objectives.....	4
1.5 Significance of the study	5
1.6 Research methodology	5
1.6.1 Quantitative research approach	6
1.6.2 Qualitative research approach	6
1.6.3 Mixed method research	7
1.6.4 Population and sample size	7
1.6.5 Research sampling technique.....	8
1.6.6 Data analysis for the study.....	10

1.7	Limitation of research.....	10
1.8	Key assumptions	10
1.9	Ethical considerations	10
1.10	Thesis structure	11
1.11	Chapter summary	11
CHAPTER TWO		12
2.	Literature Review	12
2.1	Introduction	12
2.2	Safety in context	12
2.2.1	Safety basic terms	12
2.3	Global situation of safety hazard on construction sites.....	13
2.4	Management, causes and effects of accidents on construction sites	14
2.5	Types of safety hazards on construction sites.....	15
2.5.1	Fall from height.....	15
2.5.2	Slips, trips and falls.....	16
2.5.3	Equipment, machinery, tools and transport.....	16
2.5.4	Electric shock.....	16
2.5.5	Fire hazard	17
2.5.6	Manual handling	17
2.5.7	Noise at workplace.....	17
2.5.8	Inhaling chemical substances	18
2.5.9	Dust hazard	18
2.5.10	Bullying, violence and aggression.....	19
2.6	Construction industry	19
2.6.1	Construction firms and projects.....	20
2.6.2	Construction safety involvement	21
2.6.2.1	Client involvement	21

2.6.2.2	Main contractor involvement	22
2.6.2.3	Regulatory agencies involvement	22
2.6.2.4	Employee involvement.....	22
2.7	Involvement of employers and employees in relation to safety.....	22
2.8	Factors that affect the operation of construction site safety management	23
2.8.1	Role of safety management as a factor of business management	23
2.8.2	Cost of accidents	24
2.8.3	Cost involved in site accident management and risks encountered on site	25
2.8.4	Cost of safety during tender	25
2.8.5	Cost of safety during construction	26
2.8.6	Time and its effect on safety management.....	27
2.8.7	Integrating of safety into site planning management	28
2.8.8	Client involvement in safety management on site	28
2.9	Effective safety management techniques.....	29
2.9.1	Safety training and induction.....	33
2.10	Management safety policy statement.....	34
2.10.1	Risk assessment and control measures.....	35
2.11	Different factors on safety management techniques.....	36
2.11.1	Resources factor on safety management.....	36
2.11.2	Management factor on safety management	36
2.11.3	Personnel factor on safety management.....	37
2.11.4	Relationship factor on safety management	37
2.11.5	Human resource factor on safety management.....	38
2.12	Safety improvement through design.....	39
2.13	Operational technique for safety management in construction site.....	40
2.13.1	Influence network technique for safety management performance.....	41
2.13.2	Perception surveys for safety management performance	42

2.13.3	Behavioural audits for safety management performance	43
2.13.4	Conformance to safety management system	43
2.13.5	Developing a safety culture.....	44
2.14	Safety planning on construction sites.....	44
2.15	Safety implementation in the construction industry.....	45
2.15.1	Implementing a zero-injury construction site safety concept.....	46
2.15.2	Zero-injury concept	47
2.15.3	Zero-injury achievement	47
2.16	Compliance with safety legislations in construction sites.....	48
2.17	Chapter summary	49
CHAPTER THREE.....		50
3.	Research Methodology and Design	50
3.1	Introduction	50
3.2	Research philosophies.....	50
3.2.1	Interpretivism	50
3.2.2	Positivism	51
3.3	Research methodology	51
3.3.1	Quantitative research approach	52
3.3.2	Qualitative research approach	53
3.3.3	Mixed method research	54
3.4	Research approach.....	55
3.4.1	Deductive research approach	55
3.4.2	Inductive research approach.....	56
3.5	Research strategies	56
3.5.1	Experimental designs.....	56
3.5.2	Survey research.....	57
3.5.3	Historical research	57

3.5.4	Comparative research.....	58
3.5.5	Action research.....	58
3.6	Questionnaire design.....	58
3.6.1	Open-ended questions.....	59
3.6.1.1	Advantages of open-ended questions.....	59
3.6.1.2	Disadvantages of open-ended questions.....	59
3.6.2	Closed-ended question.....	60
3.6.2.1	Advantages of closed-ended questions.....	60
3.6.2.2	Disadvantages of closed-ended questions.....	60
3.7	Research design.....	60
3.7.1	Research design for this study.....	61
3.7.2	Exploratory study.....	62
3.7.3	Research sampling technique.....	62
3.7.4	Data collection techniques.....	63
3.7.4.1	Secondary data collection.....	63
3.7.4.2	Primary data collection.....	64
3.7.4.3	Interview.....	64
3.7.4.4	Questionnaire design.....	65
3.7.5	Population and sample size.....	66
3.7.6	Data analysis of the study.....	66
3.7.6.1	Descriptive statistics.....	67
3.7.6.2	Content analysis.....	67
3.8	Validity and reliability of the data.....	67
3.8.1	Validity.....	68
3.8.2	Reliability.....	68
3.9	Chapter summary.....	68
CHAPTER FOUR.....		69

4.	Data Analysis	69
4.1	Introduction	69
4.2	Pilot study	69
4.3	Questionnaire survey for the main study	70
4.4	Biographical information of respondents	70
4.4.1	Respondents' firms	70
4.4.2	Respondents' gender	72
4.4.3	Respondents' ages	73
4.4.4	Respondents' qualifications	73
4.4.5	Respondents' jobs designation	73
4.4.6	Respondents' years of experience	74
4.5	Testing the reliability of research instruments	74
4.6	Presentation of findings	75
4.6.1	Types of hazards on construction site	76
4.6.2	Factors affecting construction site production	77
4.6.3	Measures for effective management techniques for site worker safety	79
4.6.4	Companies' safety training undertaken for workers	81
4.6.5	Record keeping of accidents on site	83
4.6.6	Provision of incentives for good safety performance	85
4.6.7	Influence of planning factors on the effective management techniques of construction site worker safety	86
4.6.8	Influence of organising factors on effective management techniques of construction site worker safety	88
4.6.9	Influence of controlling factors on effective management techniques of construction site worker safety	89
4.6.10	Influence of motivational factors on effective management techniques of construction site worker safety	91
4.6.11	Safety management techniques related barriers	92

4.6.12	Organisation related barriers.....	94
4.6.13	Contractor related barrier.....	96
4.6.14	Site manager factors.....	98
4.6.15	Safety officer factors.....	100
4.6.16	Contractor factors.....	102
4.6.17	Client factors.....	105
4.7	Qualitative interview.....	108
4.7.1	Interview performed with four selected respondents.....	109
4.8	Discussion of findings.....	112
4.8.1	Type of hazard on construction site.....	112
4.8.2	Factors that affect construction site production.....	113
4.8.3	Measures for effective management techniques for site worker safety.....	113
4.8.4	Company undertaking safety training for workers.....	114
4.8.5	Record keeping of accidents on site.....	114
4.8.6	Provision of incentives for good safety performance.....	114
4.8.7	Influence of planning factor on effective management techniques of construction site worker safety.....	115
4.8.8	Influence of organising factor on effective management techniques of construction site worker safety.....	115
4.8.9	Influence of controlling factor on effective management techniques of construction site worker safety.....	116
4.8.10	Influence of motivational factor on effective management techniques of construction site worker safety.....	116
4.8.11	Safety management technique related barriers.....	116
4.8.12	Organisation related barriers.....	116
4.8.13	Contractor related barrier.....	117
4.8.14	Site manager factors.....	117
4.8.15	Safety officer factors.....	117

4.8.16	Contractor factors	118
4.8.17	Client factors.....	128
4.9	Validity assurance of the research outcome.....	128
4.10	Achieving the objectives of the research study.....	129
4.10.1	The first objective of the research study was to identify the causes and effects of site accidents on construction site production	129
4.10.2	The second objective of this research study was to ascertain effective management techniques for site worker safety in South Africa	129
4.10.3	The third objective of this research study was to evaluate the factors that affect the effective operation of the construction site worker safety.....	130
4.10.4	The fourth objective of this research study was to assess the involvement of construction management team on workers safety implementation on site	131
4.11	Operational framework.....	131
4.12	Chapter summary	134
CHAPTER FIVE.....		135
5.	Summary, Conclusions and Recommendations.....	135
5.1	Introduction.....	135
5.2	Summary	135
5.3	Conclusion.....	135
5.3.1	Causes and effects of site accidents on construction site production	136
5.3.2	Effective management techniques for site worker safety in South Africa.....	136
5.3.3	To evaluate the factors that affect the effective operation of the construction site worker safety	137
5.3.4	To assess the involvement of construction management team on worker safety implementation on site	137
5.4	Limitations of the research	138
5.5	Recommendations.....	138
5.6	Suggestions for further study	139
REFERENCES		140

Appendix I: Ethics approval for data collection	161
Appendix II: Survey participation invitation letter	163
Appendix III: Questionnaires	164
Section A: Biographic information of participants/ respondents	164
Section B: Factors that contribute to the following causes and effect of site accident on construction site production	165
Section C: Effective management techniques for site worker safety	166
Section D: Barriers to the effective management techniques of construction site worker safety	167
Section E: Involvement of construction team on workers' safety implementation on site	168
Appendix IV: Interview	171

LIST OF FIGURES

Figure 1.1: Conceptual framework	3
Figure 1.2: Research procedure flowchart.....	9
Figure 2.1: The plan-do-check-act-cycle (Moen & Norman, 2010); Jilcha <i>et al.</i> 2014).....	30
Figure 2.2: Sequential process of health and safety management system (Health and Safety Executive, 2008)	31
Figure 2.3: Flowchart depicting the management policy factors for effective safety implementation (Teo & Ling, 2006)	38
Figure 2.4: Continuous improvement performance (Creative Safety Supply, 2017).....	40
Figure 3.1: Research cycle (Solanke, 2015; Leedy & Ormrod, 2010)	52
Figure 3.2: Deductive research method (Bryman, 2016)	56
Figure 3.3: Inductive research method (Bryman, 2016)	56
Figure 4.1: Chart illustrating the firms for which the respondents work.....	71
Figure 4.2: Chart illustrating gender of the respondents	72
Figure 4.3: Chart illustrating job designations of the respondents	74
Figure 4.4: Graph illustrating types of hazards experienced on the construction site	77
Figure 4.5: Graph illustrating factors that affect construction site production	79
Figure 4.6: Graph illustrating effective management techniques available for site worker safety	81
Figure 4.7: Graph illustrating safety training initiatives executed by construction firms for site workers	82
Figure 4.8: Graph illustrating documentation of accidents on construction sites.....	84
Figure 4.9: Graph illustrating provision of incentives for good safety performance	86
Figure 4.10: Graph illustrating impact of planning factors on effective management techniques	87
Figure 4.11: Graph illustrating impact of organising factors on effective management techniques	89

Figure 4.12: Graph illustrating impact of controlling factors on effective management techniques	90
Figure 4.13: Graph illustrating influence of motivating factors on effective management techniques	92
Figure 4.14: Graph illustrating safety management techniques related barriers	93
Figure 4.15: Graph illustrating organsiational related barriers on general activities	96
Figure 4.16: Graph illustrating barriers affecting contractor safety management techniques implementation.....	98
Figure 4.17: Graph illustrating impact of site managers in improving the implemenation of worker safety	100
Figure 4.18: Graph illustrating impact of safety officers improving the implementation of worker safety	102
Figure 4.19: Graph illustrating contractor impact in ensuring appropriate implementation of safety management techniques	104
Figure 4.20: Graph illustrating client impact in ensuring appropriate implementation of safety management techniques.....	108
Figure 4.21: Summary of key findings	132
Figure 4.22: Operational framework for management of construction site worker safety for effective production.....	133

LIST OF TABLES

Table 1.1: Illustration of the relationship between research questions, research objectives and research method.....	6
Table 2.1: Construction H&S statistics—as of May 2016 (Van Heerden <i>et al.</i> , 2018).....	14
Table 3.1: Characteristic summary of qualitative and quantitative research approaches (Macdonald & Headlam, 2007).....	54
Table 3.2: Questionnaire design	65
Table 4.1: Respondent details.....	71
Table 4.2: Testing for reliability of Likert scale questions	75
Table 4.3: Types of hazards on the construction site	76
Table 4.4: Factors that affect construction site production.....	78
Table 4.5: Effective management technique for site worker safety.....	80
Table 4.6: Safety training initiatives exercised by construction firms for site workers.....	82
Table 4.7: Recordkeeping of accidents on site.....	83
Table 4.8: Provision of incentives for good safety performance.....	85
Table 4.9: Influence of planning factors on effective management techniques of construction site worker safety	87
Table 4.10: Influence of organising factors on effective management techniques of construction site worker safety	88
Table 4.11: Influence of controlling factors on effective management techniques of construction site worker safety	90
Table 4.12: Tabularised illustration of the influence of motivational factors on effective management techniques of construction site worker safety.....	91
Table 4.13: Safety management techniques related barriers.....	93
Table 4.14: Organisation related barriers.....	95
Table 4.15: Contractor related barriers.....	97
Table 4.16: Site manager factors	99
Table 4.17: Safety officer factors	101

Table 4.18: Contractor factors	103
Table 4.19: Client factors	107
Table 4.20: Summary of qualitative interviews	111
Table 4.21: Summary of findings of qualitative data	119
Table 5.1: Summary of research outcomes	135

LIST OF ABBREVIATIONS AND MEANINGS

BCAWU	Building Construction and Allied Workers Union
CIDB	Construction Industry Development Board
CII	Construction Industry Institute
CIRIA	Construction Industry Research and Information Association
COID	Compensation for Occupational Injuries and Diseases
ECC	Engineering and construction contract
ESD	Emergency shut-down
FEM	Federate Employer's Mutual Assurance Company
FIDIC	International Federation of Consulting Engineers
GCC	General condition of contract
GDP	Gross Domestic Product
HSE	Health and Safety Executive
ILO	International Labour Organisation
JBCC	Joint Building Contracts Committee
JISHE	Japan Industrial Safety and Health Association
MBA	Master Builder Association
MBSA	Master Builders South Africa
M&E	Mechanical and Electrical
OHS	Occupational Health And Safety
OHSA	Occupational Health and Safety Act

OSMS	Occupational Safety Management System
PPE	Personal protective equipment
SADC	Southern African Development Community
SAFSEC	South Africa Federation of Civil Engineering Contractors
SCB	Safety Citizenship Behaviours
SPSS	Statistical Package for Social Sciences
UK	United Kingdom

ARTICLES FOR PUBLICATION

- Evaluation of factors that affect effective management of construction site worker safety during production.
- Worker safety a prerequisite toward effective productivity during project production process.

CHAPTER ONE

1. Introduction

Construction site worker safety remains a challenge in the construction industry. This safety issue encompasses planning, management, safety policy and implementation. Noteworthy, construction operator activities, government officials and policy implementation agencies all have influence on the approach to minimise or eradicate the challenges of construction accidents (Ofori, 2012). Thus far, a high rate of construction accidents are recorded on a daily basis (Cheng, Ryan & Kelly, 2012; Hinze, Hallowell & Baud, 2013; Sousa, Almeidaet & Dias, 2014). Similarly, Yoon, Lin, Chen, Yi, Choi and Rui (2013) reveal how workers were injured or killed on construction sites as a result of negligence of safety policy, codes and conduct. Many researchers have investigated the safety practices of construction firms; but in developing nations, safety policy planning management is not assessed properly (Othman, Shafiq & Nurudin, 2017). According to Alli (2008), the inspections of occupational safety management techniques (OSMT) in the workplace should include assessment of the environmental factors that could affect worker safety, such as provision of welfare and sanitation facilities, personal protective equipment (PPE) and availability of hazards in the working environment. Thus, this research will focus on effective implementation of management techniques for site worker safety.

1.1 Background of the study

Operational safety is a problem that thwarts the efficient production process in the construction industry, which has implications on productivity. In addition, construction management strategies, equipment management, delivery procedures, and construction resources management are all considered challenges because a safety management plan is lacking on site. Mock, Joshipura, Arreola-Risa and Quansah (2012) state that safety concerns have heightened in the wave of globalization, labour standards, environment and public health. Moreover, Okoro, Musonda and Agumba (2016) explain that the risk of injury and fatalities in construction is seven to ten times higher than that of other industries in South Africa. Similarly, CIDB (2009) reports that accidents in the industry are among the highest in all industrial sectors. Furthermore, construction accidents and incidents affect over 5% of the gross domestic product (GDP) of a nation's economy. Previous research has reported that construction workers are exposed to more accidents, ill-health and fatalities as compared to other industrial sectors (Takala *et al.*, 2014; Legg *et al.*, 2015). This is a result of individuals, stakeholders and government errors. Consequently, it is suggested that safety management

be carried out throughout all different stages of operations, that is, from the inception to the completion of operational stages of the project.

Alhajeri (2011) states that in the developing countries, safety regulations do not usually exist but when they do, the authority lacks the ability to implement safety policy design for effective regulation of project production process. South Africa is among the developing countries that presently carries out construction activities (Othman *et al.*, 2017) though some industrial sectors still suffer from poor safety conditions (Chen & Chan, 2004; Ansary & Barua, 2015). The framework for the existing safety conditions is uneven and poorly enforced rendering construction sites even more dangerous; in addition, it is alleged that relevant laws are obsolete, further affecting proper execution of activities on the construction site (Rizwan, 2015; Raihan *et al.*, 2017). According to Golovina, Teizer, and Pradhananga (2016) training of construction workers on safety implementation is required on and off the job sites. The training is generally undertaken through frontal teaching and instruction of hazard, wherein little or no experimental training or practical education is actually being carried out on job sites. Few construction workers received safety training or continued education on the small or midsize operations.

Toole and Carpenter (2013) emphasise that education and training are applied to avert human mistakes that cause accidents, with the purpose of raising worker performance based on their skill level. The process must be a continuous exercise to aid familiarity. In addition, Hallowell and Gambatese (2010) challenge the construction expert to be involved in the design stage and planning process of any construction projects, with the aim to identify and eliminate hazard *before* they appear in a construction operation. Effective monitoring and control of construction safety in modern projects require adequate planning and management to succeed. Various measures – such as lagging indicator, leading indicators and safety climate – have improved safety. Lingard, Wakefield and Blismas (2013) explain that the uniqueness and short duration of a construction project could be the reason for slow and inadequate adoption of technology in recording construction site accidents during construction activities.

This research identifies and establishes various factors that affect the safety management principles and effective implementation of safety at the various phases of project production processes. Thus, one of the basic reasons for this study is to analyse the ability or possibility of construction contractors to achieve zero accidents on the construction site through effective implementation of safety policy on site. This is one of the objectives this research intends to achieve through the conceptual framework, as presented in Figure 1.1, a conceptual framework illustrating the effect of safety planning, safety management, safety design, and

summarising the direct and functional relationship of these variables for effective implementation of management techniques for site worker safety.

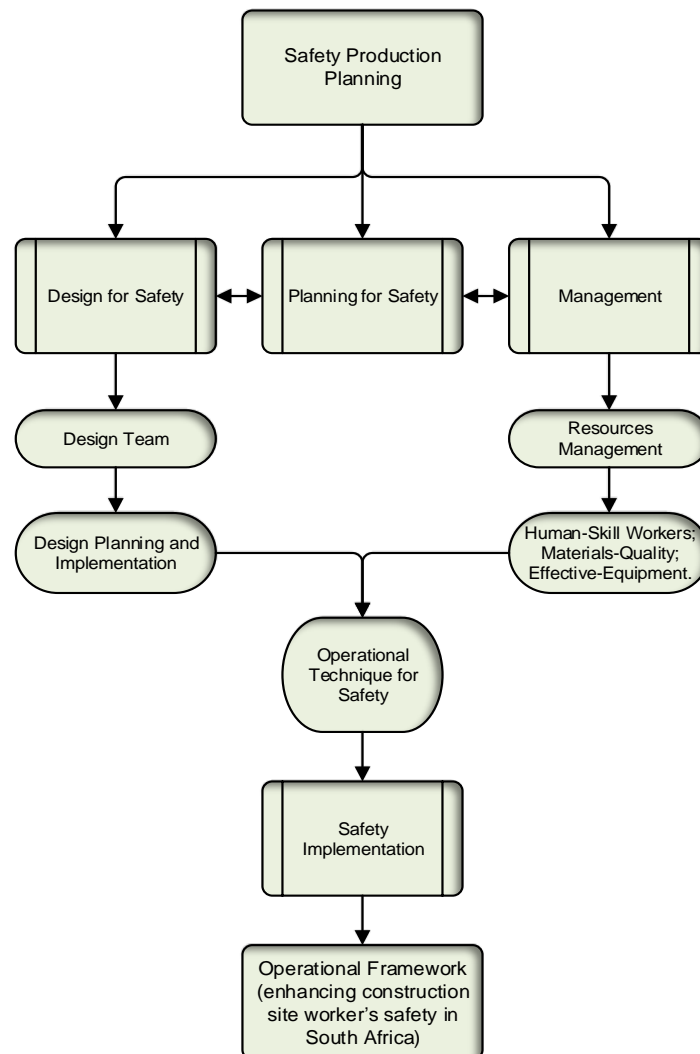


Figure 1.1: Conceptual framework

1.2 Problem statement

Construction industries enhance socio-economic development of a nation. Despite this advantage, developing nations, particularly African nations, continue to experience high rates of accident and ill health (Phoya, 2012). Over 1000 construction workers die annually throughout the world due to work-related accident and disease (Hinze & Giang, 2008). These workplace deaths and injuries are as a result of employers' and employees' failure to comply with legislation regulating safety (Zhou, Whyte & Sacks, 2012).

In addition, several prevalent operations carried out at construction sites expose construction workers to occupational hazards and risks (Pinto, Nunes & Ribeiro, 2011). Liu and Tsai (2012) establish that the construction industry's hazard causes personal injuries, which affect the

health status of construction workers, and the timely completion of construction projects, resulting in financial losses. Essentially, these occupational situations such as injuries, accidents and disease have adverse effects on the productivity and economic development of African countries (Liao & Chiang, 2016). Past literature presents studies acknowledging that construction workers are faced by a number of safety challenges regardless of a country's economic level (Abrey & Smallwood, 2014). Lack of leadership commitment and failure to implement occupational health and safety (OHS) procedures in South Africa contribute to the constant increase of injuries and fatalities in the SA construction industry (Jacobs, 2010).

In 2010 and 2011, fatality and injury rates in the South African construction sector stood at 19.2% and 14.63% per 100,000 workers, respectively. Nonetheless, these proportional estimates show improvement when compared to a fatality rate of 53.51% per 100,000 workers reported in South Africa in the 1990s. Clearly, occupational safety challenges remain high in South Africa (Arquillos, Romero & Gibb, 2012). Hence, this study has been initiated to develop a framework that can promote the safety of construction site workers.

1.3 Research questions

- i. What are the causes and effects of site accidents on construction site production?
- ii. How could effective management system techniques be established for site worker safety?
- iii. What factors affect effective operation of the construction site worker safety management system?
- iv. What is the involvement of the construction management team toward worker safety implementation on site?
- v. How could an operational framework for the management of construction site worker safety be established for effective production?

1.4 Aim and objectives

1.4.1 Aim

The aim of the study is to develop a framework for effective implementation of management techniques to enhance site worker safety in South Africa (Table 1.1).

1.4.2 Objectives

- i. To identify the causes and effects of site accidents on construction site production.
- ii. To ascertain effective management techniques for site worker safety in South Africa.

- iii. To evaluate the factors affecting effective operation of the construction site worker safety.
- iv. To assess the involvement of construction management team on worker safety implementation on site.
- v. To establish an operational framework for the management of construction site worker safety for effective production.

1.5 Significance of the study

This study describes current occupational safety management system (OSMS) status in the construction industries in South Africa. In addition, the study offers policymakers the chance to value improved OSMS situations in the construction industry, with the ways in which the sector can be enhanced. Moreover, the recommendations of this study will influence the development of policies seeking to promote OSMS in the construction industry in South Africa. Furthermore, the standard developed as a primary output of this study will assist the construction industries in South Africa to promote the importance of OSMS and to suggest strategies for prevention of occupational injuries, diseases and fatalities, while simultaneously improving the workplace environment. The final part of the study will contribute to the research knowledge in the occupational safety management system in construction site.

1.6 Research methodology

Research methodology is a holistic process of acquiring, analyzing and interpreting data with the aim of reaching a concluding knowledge about a research (Leedy & Ormrod, 2010). According to Fapohunda (2014), research methodology is the process of weighing advantage and disadvantage of various research methods (Table 1.1) so as to identify the best suitable method for research. Leedy and Ormrod (2010) additionally explain that the primary functions of the research methodology are as follows:

- to set the standard for data collection, and
- to collate the data after collection and interpret them.

Research is a repeated process of study in nature; it involves several logical steps in reaching a complete solution to the research questions. Furthermore, Collins and Hussey (2009) and Biggam (2011) highlight the significance of relationships between the research methodologies, methods of data collection and techniques of data analysis.

Table 1.1: Illustration of the relationship between research questions, research objectives and research method

Research Objective	Research Question	Research Method
To identify the causes and effects of site accidents on construction site production	What are the causes and effects of site accidents on construction site production?	Review of relevant literature and administration of a structured questionnaire
To ascertain effective management techniques for site worker safety in South Africa	How could an effective management technique be established for site worker safety?	Review of relevant literature and administration of a structured questionnaire
To evaluate the factors that affect the effective operation of construction site worker safety management	What are the factors that affect the effective operation of the construction site worker safety management techniques?	Review of relevant literature and administration of a structured questionnaire
To assess the involvement of construction management team toward worker safety implementation on site.	What is the involvement of the construction management team toward worker safety implementation on site?	Review of relevant literature and administration of a structured questionnaire
To establish an operational framework for the management of construction site worker safety for effective production	How could an operational framework for the management of construction site worker safety be established for effective production?	Analysis of the retrieved structured questionnaire

1.6.1 Quantitative research approach

A quantitative research approach, fundamentally the measurement of quantities, numbers and amounts (Landrum & Garza, 2015), is an orderly process of using numerical data, derived from a selected sample group of a population, to generalise findings for the population of study (De Vos *et al.*, 2011). Furthermore, the method uses statistical approach of analysis and presenting the results arithmetically (O’Leary, 2017). According to Thomas (2003), a quantitative research method allows researchers to derive relevant research results from a group of data at low cost within a short period of time.

1.6.2 Qualitative research approach

Leedy and Ormrod (2005) describe that a qualitative research approach uses distinguished techniques and philosophies for the collection of various empirical data. These empirical data are collected through observations, interviews, life stories and historical studies (Creswell & Clark, 2007; Creswell, 2017). A qualitative research approach is applied in collecting related

descriptive data concerning a specific phenomenon with the objective of demonstrating analytical results derived (O'Leary, 2017). Similarly, Flick (2015) posits that this approach basically involves the acquisition of an intent of understanding the social, cultural and behavioural patterns of people in an environment by interacting with the participants of the study. Significantly, a qualitative research methodology demonstrates the relationship between ranges of research paradigm (Howitt & Cramer, 2000; Maree, 2007).

1.6.3 Mixed method research

Mixed method research comprises the adoption of philosophical assumptions in the collection and analysis of quantitative and qualitative data in a single research work (Creswell & Clark, 2007). In addition, the implementation of the combined state of qualitative and quantitative methods produces a better understanding on the research focus (Creswell & Clark, 2007). The mixed research approach increases the validity of the research, where one method complements the other without any bias (Henn, Weinstein & Foard, 2009). Thus, a mixed method enhances the integration of a variety of pragmatic and theoretical perspectives that are perceived as quantitative and qualitative challenges (Fetters, Curry & Creswell, 2013; Almalki, 2016).

1.6.4 Population and sample size

The space of units from which a sample is taken is called a *population* (Mason, 2010; Trotter, 2012; Bryman, 2016). Sample population does not refer to people being sampled in the study, but depends on the nature of the researcher's study. O'Leary (2017) defines *population* as the total involvement of a defined class, objects or events. The purpose of this research is to address the problem attributed to the poor implementation of the safety management system in construction sites. A population, as defined specifically for construction sites, consists of construction workers, construction professionals and safety teams.

In simple description, the *sample frame* is a list of elements comprising the population of a study (Babbie, 2013). Flick (2015) suggests that the sample of a study should be a smaller representation of the population in terms of heterogeneity of the elements and illustration of the variables. However, O'Leary (2017) opines that the larger the sample in a quantitative research project, the better it is represented, as then the conclusions are generalised.

Thus, the sample frame for this research is an adequate representation of construction professionals, safety professionals and construction workers in South Africa. The majority of survey participants are construction professionals and safety professionals with extensive construction knowledge, safety knowledge skills and formal educational backgrounds except

site supervisors with minimal formal education but adequate construction experience background. Site managers, contract managers, project managers, site supervisors, architects, quantity surveyors, site engineers, safety managers and safety supervisors are the selected sample to represent the population in this study. As construction workers selected as sample in this research are tasked with responsibilities on construction sites, they are, arguably, a good representation of the South African construction workforce.

1.6.5 Research sampling technique

According to O'Leary (2017), *sampling* is referred to as the process of selecting elements of the population to be included in research. O'Leary further emphasises that a significant number of research samples are representative sample distributions and process characteristics that allow findings to be generalised to the entire population (O'Leary, 2017). Population samples render the research process manageable. The research adopts convenient and purposive sampling techniques.

Despite the busy schedules faced by the project participants, questionnaires were distributed to the construction professionals in the Western Cape Province to gain access to the available professionals on the construction sites. Marshall and Rossman (2014) express *convenient sampling* as a sampling technique adopted on the basis of availability and accessibility of respondents. As such, construction site supervisors and safety managers interviewed were purposively selected based on the direct working relationship between site supervisors, safety managers and construction labour. The site supervisors interviewed

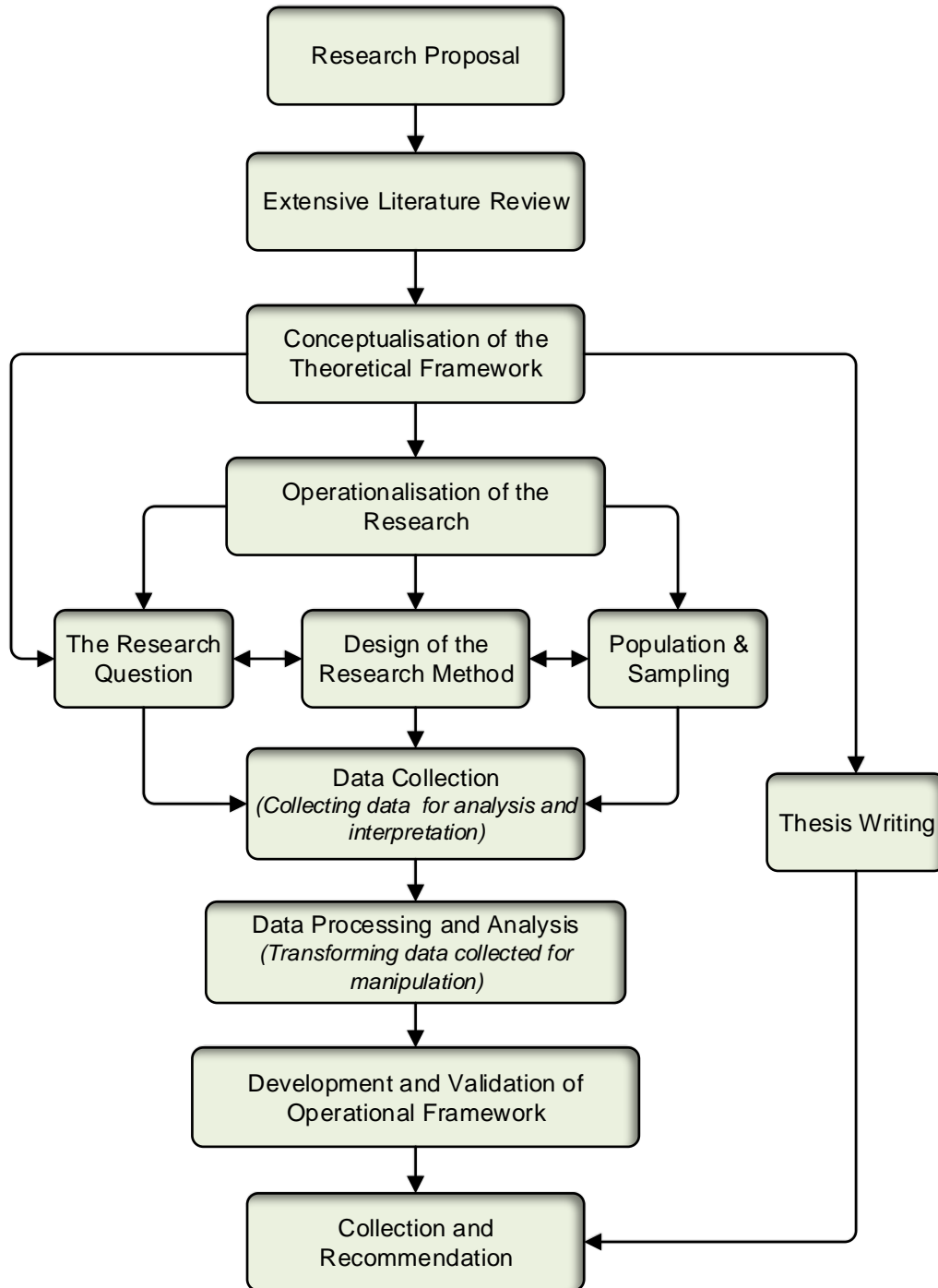


Figure 1.2: Research procedure flowchart

were all experienced personnel, with adequate years of supervisory responsibilities in the construction sector. The experience of the site supervisors is a helpful instrument to assess the validity of data obtained from construction professionals. Richards and Morse (2013) describe *purposive sampling* as a sampling technique that enables the researcher to select study participants with respect to their characteristics, that is, participants with the right

information. Mertens (2016) argues that a *purposive sampling strategy* is a system whereby the researcher deliberately chooses a sample for a study, by having a purpose in mind. O’Leary (2017) indicates that an adequate sample frame and large sample size prevent unbiased research, which represents a population and presents relevant findings with respect to the population through the questionnaire.

1.6.6 Data analysis for the study

Data analysis constitutes tabulating, data testing, categorising and carefully examining results to address the purpose of a study (Yin, 2003). The quantitative and qualitative data were gathered using the Statistical Package for Social Sciences (SPSS) software. Quantitative data obtained via questionnaire were analysed with descriptive statistics. Similarly, qualitative data were analysed technically by content analysis. A descriptive flowchart that explains the research procedure is presented above (Figure 1.2). Validation test, such as the content analysis, will be used to analyse the qualitative data collected and each interview will be write out and checked for accuracy for respondent validation. Reliability test of the data collected will be tested using the “Cronbach’s Alpha” test.

1.7 Limitation of research

The study is restricted to data collection from construction firms only within the Western Cape province of South Africa due to massive construction operations happening in the Province.

1.8 Key assumptions

- Selected construction firms encounter challenges regarding effective implementation of management techniques of safety in the construction sites.
- Selected construction firms will provide access to their various construction sites.
- Respondents will provide relevant information that will answer the study objectives and research questions.

1.9 Ethical considerations

The names of organisations and individual participating will remain unidentified within this research document with the express purpose of complying with the accepted global ethical standard, and research participants are not subjected to any payment or compensation. Ethical standards discard plagiarism by acknowledging the authors of previous related literature studied.

1.10 Thesis structure

Chapters in the study are outlined as follows:

Chapter 1 – Introduction: this chapter comprises subsections such as background of the research, problem statement, aim and objectives, research questions, significance of the study, research methodology and limitation of research. Other subsection headings include key assumptions, ethical considerations, definition of terms, thesis structure and chapter summary.

Chapter 2 – Literature Review: this chapter presents the review of relevant prior literature on research surrounding effective implementation of management techniques to enhance site worker safety in South Africa. This involves international construction industry safety viewpoints, styles in developing countries' worker skills, history of safety regulation, construction accidents and compensation to workers. Further discussions cover areas such as construction safety associated with management techniques of safety. Moreover, the best suitable implementation strategies for this research will be widely reviewed in this chapter.

Chapter 3 – Research Methodology: this chapter comprises the research method adopted in the study to attain the research aim and objectives. This chapter examines the research design, research population, sampling technique, instrument for data collection, administration of instruments, techniques for data analysis and model formation.

Chapter 4 – Data Analysis and Discussion of Findings: this chapter provides the report on the type of data collected and analysed. In addition, it discusses the findings obtained in graphical and tabular forms through appropriate interpretations.

Chapter 5 – Conclusions and Recommendations: this chapter discusses the deductions derived from the findings interpreted. Final recommendations will be made concerning the aim of the research.

1.11 Chapter summary

This chapter provides a summary of what is to be accomplished in the research study. The research background, problem statement, research aim, objectives, research questions, significance, literature review, research methodology and the scope of the research were briefly discussed. The subsequent chapters will elaborate on the literature review, research methodology, analysis and discussion of results, conclusions and recommendations derived from research.

CHAPTER TWO

2. Literature Review

2.1 Introduction

This chapter presents a review of the literature on the safety management implementation in the construction industry, causes of accidents, hazard types, and control measures taken by different organisations at both national and international levels. The regulations provided by the International Labour Organisation (ILO) were also analysed. In addition, the chapter discusses the elements, safety planning, and implementation of a safety management system as a tool for addressing occupational hazards and their risks within organisations. Furthermore, the review discusses the developmental concepts and hierarchy for hazard control. The effort to improve the safety management techniques of construction sites requires adequate awareness for effective implementation, as discussed later in this chapter.

2.2 Safety in context

According to Health and Safety Executive (2009), *safety* is the absence of danger from harm or loss and/or freedom from hazards. Fisk (1999) suggests that as no risk is involved in a specific work, in this sense, it is possible to completely eliminate a risk factor. So, there is no such thing as absolute safety, as no situation in the workplace can be utterly risk-free. In that case, safety management at a workplace must be properly supervised, by using construction site codes, practices and procedures (Health and Safety Executive, 2016).

2.2.1 Safety basic terms

To understand the principles of this research, there are a number of basic terms that require clarifying:

- i. *Accident* – this refers to an event, and the consequences of that event, in relation to safety on a construction site. In this context, *accident* is described as an undesired event as it produces undesired results that can be physical, environmental or both (Hughes, 2007).
- ii. *Hazard* – this is the ability of an object or something to cause harm to human, hearth, property or the environment; it can also be the outcome of the interaction of components as in the chemical fume (Hughes, 2007).

- iii. *Injury* – this refers to the physical consequences of an accident or incident. In some cases in the construction industry, numerous incidents occur at a construction site causing injuries to several workers (Hughes, 2007).
- iv. *Risk* – this simply means the chance or likelihood of loss or gain resulting from taking risk (Hughes, 2007).

Cascio (1986) defines *hazardous events* as aspects of harm in the work environment, such as working at a great height, working on a roof, working on scaffolding, formwork excavation and electrical work. These hazards have the potential to cause immediate harm. Other kinds of harm might affect the health of the workers more slowly, over a long period of time, and sometimes in an irreversible way such as respiratory system disease and cancer, for example (Mohammed, 2014).

2.3 Global situation of safety hazard on construction sites

Construction safety risks are always a serious concern for both practitioners and researchers all over the globe. Consequently, the construction sector has been determined to be the most hazardous place, with work is done with a high level of safety risk (Musonda & Smallwood, 2008). According to Lingard (2013), the International Labour Organisation (ILO) estimates that the construction sector accounts for one in every six fatal accidents recorded at work annually; at least 60,000 fatal accidents occur each year on construction sites around the world, with one fatal accident every ten minutes. Poor health and safety performance in the industry accounts for roughly 30 to 40% of the world's related fatal injuries (Van Heerden *et al.*, 2018). The construction sector in developed countries employs between 6 to 10% of the workforce, but accounts for between 25 to 40% of work-related deaths (Lingard, 2013; Van Heerden *et al.*, 2018).

In the United State of America (USA), there were over 10,000 fatalities and 195,000 non-fatal injuries between 2001 to 2010, figures impacting US economic values, compensation costs and productivity reduction (Van Heerden *et al.*, 2018). More recent statistics revealed that 19.4% of the total fatal work injuries were in the construction industry (Bureau of Labour Statistic, 2018). Similarly, the construction industry in the United Kingdom (UK) accounts for 5% of the workforce, 22% of fatal injuries and 10% of reported major injuries occur in this sector (Construction Health and Safety Group, 2019). The construction sector has the highest number of fatal injuries at work (Health and Safety Executive, 2016).

In some other industrial regions like Indian, construction industry contributes 16.4% of total occupational accidents worldwide, despite having only 7.5% of the total world labour force (Kanchana, Sivaprakash & Joseph, 2015). Similarly, in Nigeria, the construction sector

contributes 3.82% to the Gross Domestic Product (GDP) of the economy (Okoye *et al.*, 2016). Globally, growth in the number of reported and unreported accidents still persists (Okoye *et al.*, 2016). The situation is not different in South Africa (Van Heerden *et al.*, 2018).

According to the statistical findings presented by the Federated Employer’s Mutual Assurance Company, construction industries in the Gauteng Province of South Africa suffer a substantial quantity of industrial accidents annually (2016), as presented in Table 2.1. The table demonstrates that the number of industrial accidents recorded over four years indicates that 2014 recorded a lower total of accidents than in 2012 and 2013. As a consequence, many companies suffered huge costs. Further results revealed that 2013 recorded an increase in quantity (36,763) of lost workdays due to industrial accidents, as compared to 29,212 in 2014 and 22,163 in 2015 (Van Heerden *et al.*, 2018).

Meanwhile, developed countries have demonstrated commitment in the industrial accident reduction exercises; but in the case of the developing countries, little or no exercises have been committed (Kheni *et al.*, 2010). The status quo, therefore, necessitates continuous research into improvement strategies.

Table 2.1: Construction H&S statistics—as of May 2016 (Van Heerden *et al.*, 2018)

Year of accidents	No. of accidents	Lost days	Average cost/accident
2012	3,870	44,945	25,642
2013	3,942	36,763	27,264
2014	3,642	29,212	27,087
2015	3,767	22,163	31,869

2.4 Management, causes and effects of accidents on construction sites

Work conditions and work behaviours are the direct causes of many accidents. With the purpose of controlling these causes, management is expected to create or maintain a safe and conducive working environment. Safety management usually minimises the possibility of accidents in the working arena by introducing and enforcing standards and regulations to protect the employees from any occupational risk in the form of injury or even death. This kind of management needs to be committed to administering a safe working environment (Mohammed, 2014). To understand the causes of accidents and related injuries, researchers have attempted to develop concepts pertaining to why accidents occur, as accidents are caused by human or technical error (Okoro *et al.*, 2014).

The *multiple accidents causation concept* suggests that there are many influential causes leading to an accident (Heinrich, 1931), including attitudes, skills and knowledge.

Environmental factors include worksite hazards and procedures that contribute to injuries (Hosseinian & Torghabeh, 2012). A similar view was explained by Irumba (2014) on the causes of construction accidents in Uganda, where possible causes of accident were attributed to a lack of knowledge about safety rules, engaging an inexperienced workforce and lack of respect for safety. Kanchana (2013) supports the view by stating that the main factors affecting safety in China were managers' poor safety awareness, lack of training, unwillingness to earmark resources for safety and irresponsible operations. Moreover, Leonavičiūtė *et al.* (2016) conducted a study on the causes of accidents, wherein factors like inexperienced employees, lack of qualifications and understanding risk on a construction site are associated with accident causes.

Ghafari, Omid, Fardi and Akbarzadeh (2014) carried out a survey to identify the causes of accidents on construction sites, with their survey indicating that unsafe approaches, including inappropriate procedures, knowledge level, and violating procedures are the most common reasons for accidents on construction sites. Additionally, Malekitabar *et al.* (2016) argue that secondary causes of accidents centre on management pressures such as financial limitations, lack of commitment, inadequate policy and standards, lack of knowledge and information, limited training and task selection, and poor-quality control systems. They further emphasise that inadequate structural connections, temporary facilities, tight work areas, varying work surface conditions, endless changing of work sites, multiple operations and crews working in close proximity are common causes of construction-related deaths and injuries.

To summarise these findings, it is observed that causes of construction accidents can generally be classified into the five most influential factors: 1) site conditions, 2) equipment and materials, 3) human, 4) management and 5) job factors.

2.5 Types of safety hazards on construction sites

2.5.1 Fall from height

Worksite related hazards occur mainly when working from a height, which entails objects and people falling on the people standing directly below. A fall from height is considered as one of the common accidents regularly happening on construction sites. Statistics show that about 1,000 construction workers are killed on sites annually around the world, with over 300 deaths caused by falls at the construction site (ILO, 1999). To buttress this statement, research carried out in New Zealand likewise shows that falls from heights are the leading cause of occupational injuries on construction sites (Nadhim *et al.*, 2016; Kibe, 2016). Similarly, a report from China reveals that 51% injuries are attributed to work-related falls (Yung, 2009). Other

countries like Hong Kong and Taiwan recorded more than 30% work-related falls resulting from roof related falls, crane falls, elevator shaft falls, falls resulting from holes in flooring, scaffolding falls and even falling objects (Liu & Tsai, 2012; Hon & Chan, 2013). These could occur because of insufficient edge protection, or from objects in the storage being poorly secured. The primary workers at risk of falling from a height include painters, masons, decorators, and window cleaners, as well as workers with inadequate training, planning and equipment (Okoro *et al.*, 2014).

2.5.2 Slips, trips and falls

Another types of workplace hazards includes slips and trips, which commonly contribute to over one-third of all major injuries occurring on construction sites (Holt & Allen, 2015; Gürcanli & Müngen, 2013). Over 10,000 workers suffer serious injury because of slips or trips annually. These types of injury occur in almost all workplaces, with 95% of injuries due to slips resulting in bones fractures (Kibe, 2016).

2.5.3 Equipment, machinery, tools and transport

Transportation of equipment, machinery, tools and workers to the worksites happening every day when there are tasks awaiting. In the process of transporting these items, some accidents happen that could lead to the injury or death of workers in several ways: trapped and trampled by equipment and machinery at construction sites; reversing machinery; falling of site machinery from the excavation area; machines overturning when travelling down a steep slope; material falling from construction equipment, especially haulage trucks; and accidental collision of moving machines with workers (Kibe, 2016). Crush injuries can have a wide range of serious effects, such as fractures, internal injuries, and head back injuries. In some cases, crush injuries can result in a permanent disability of the affected employee. Meanwhile, numerous other injuries are due to the misuse and inappropriate maintenance of equipment (Phoya, 2012), with incidents attributed to operational error of handheld tools, leading to hand or finger injury with tools such as chisels, screwdrivers, saws, nails, knives and drilling machines.

2.5.4 Electric shock

Electricity, commonly used on construction sites, has the potential to cause accidents or injuries with possibly fatal results. Electrical conductors are deadly substances that can injure or cause the death of a site worker. In the UK, for instance, 2% of all fatalities at work are caused by electric shocks (Holt & Allen, 2015). Most injuries and deaths from electricity are

due to the use of poorly maintained electrical equipment, working near overhead high-tension lines, contact with underground power cables during excavation work and working without appropriate safety gear (Kibe, 2016).

2.5.5 Fire hazard

Fire is one of numerous hazards that construction employees could encounter on the site. Although fire hazards are not regarded as high risk as compared with fall from height and slipping, tripping and falling, it is still imperative that fire hazards be considered at all stages of the construction process (Kibe, 2016). A score of numbers demonstrate that many construction sites, workers are killed or injured because of fire annually. There are about 400 construction fires annually in the UK, wherein about 100 of them cause over fifty thousand pounds' (£50,000) worth of damage, interrupting the project schedules (Holt & Allen, 2015). Fires on site are caused by braising work carried out by plumbers, gas lines for underground work, power lines, power leads and tools, machinery requiring petrol, and diesel and hazardous chemicals (Afosah, 2014).

2.5.6 Manual handling

Manual handling, defined as the movement of load by human effort alone (Hughes & Ferret, 2011), requires the exertion of force by a person to lift, push, pull, carry, or otherwise to move or restrain any moving or stationary object (Kibe, 2016). Back injuries and emasculatory disorders, sciatica, hernias, and slipped discs are prevalent among construction injuries (Holt & Allen, 2015). Furthermore, Smallwood, Haupt, and Shakantu, (2008) report that 25% of construction injuries are back injuries, in which nearly 30% of all construction employees complained of back pain that required more than a month off work. The average number of days of work missed by construction employees is higher than in other fields of work.

2.5.7 Noise at workplace

Occupational noise-induced hearing loss is defined as hearing damage that arises from exposure to excessive noise at the workplace. This effect is commonly known as *industrial deafness*, as classified by the NOHSC National Code of Practice (2004). According to Phoya (2012), exposure to hazardous noise levels is regularly encountered at the construction site, rendering occupational deafness common among building workers. Some activities on construction sites are notoriously noisy – rock breaking during demolition work or the operation of a jackhammer. The use of vibrating Wacker plates, electric tools, explosive powered nail guns, and vibrators during concrete pours all cause noise problems for workers and their

environment (Holt & Allen, 2015). Other possible sources of noise at construction sites are operation of plant and machinery, power tools and vehicular movement for materials delivery (Kibe, 2016).

2.5.8 Inhaling chemical substances

Construction activities frequently involve the use of chemicals that pose health and safety risks to workers. For instance, solvents of many different kinds are used in paints, pesticides (timber treatment), bonding materials, lacquers and adhesives (Kibe, 2016). There is, evidently, a high probability that workers will be exposed to chemicals at the construction site, particularly if inhaled, ingested, or absorbed through the eyes or skin (Hasan *et al.*, 2017). Chemicals at the construction site, causing eye irritation, dizziness, faintness, headaches and sleepiness, as well as affect coordination, are harmful to the central nervous system and unsafe for the skin, kidneys, liver and cardiovascular system. Regular exposure to these solvents potentially leads to illnesses like cancer and reproductive problems (Holt & Allen, 2015). Holt and Allen (2015) further stress that the respiratory system suffers damage if these chemicals are inhaled, affecting the brain and other internal organs as well. Similarly, they can cause fertility reduction, birth defects and miscarriages (Charehzehi & Alireza, 2012; Okoye, 2016; Heerden *et al.*, 2018). Some paints and varnishes, bonding materials and gums can cause asthma and dermatitis. Welding fumes, which may include a cocktail of metal fumes, can cause serious health issues in the long term.

2.5.9 Dust hazard

Dust is a common hazard in building and road works at many construction sites. The health risks associated with an occupation that involves dusty tasks is determined by the dust types. Moreover, the risks that come with the dust types are determined by their toxicological properties. The health consequences involved in contact with such dust types as mineralogical, physical and chemical by inhaling, ingesting, or absorbing them (Hasan *et al.*, 2017). Logically, whenever any type of dust is released into the atmosphere, there is a probability that *anyone* can encounter it, not merely construction workers. And if the dust is harmful, then it could lead to a plethora of health issues: from minor impairments extending to irreversible diseases, and even life-threatening conditions such as respiratory disease, lung, and stomach cancers in dusty jobs. (Holt & Allen, 2015; Kibe, 2016).

2.5.10 Bullying, violence and aggression

Violence and aggression occur when people are verbally abused or threatened in work related circumstances. At construction sites, violence and aggression are manifested through the use of foul languages and physical attacks (Kibe, 2016). According to Kibe (2016), where there is violence and aggression, human dignity is affected. Violence and aggression may come from co-workers or superiors. Bullying occurs when workers experience unfair treatment from their boss or co-worker. Examples of such incidents encompass any situation where a worker is unfairly criticised, or shouted at by co-workers or superiors. Bullying, violence and aggression can contribute to other risks such as stress (Holt & Allen, 2015).

2.6 Construction industry

A government's role in the construction industry is to formulate the H&S legislation, that is, the Occupational Health and Safety Act No. 85 of 1993 (OHS Act) and the complementary Compensation for Occupational Injuries and Diseases Act No. 130 of 1993 (COID. Act). Construction regulations were promulgated under the OHS Act in July 2003. The primary objective of health and safety legislation is to minimise accident occurrence and thereby diminish their consequences which include fatalities, disablement, injury and ill-health (Windapo & Goulding, 2015; Masimula, 2018). The achievement of these objective necessitates effective legislation.

In that case, to achieve an effective legislation, legislation enforcement should be taken very seriously. In South Africa, it is the responsibility of the Department of Labour Inspectorate to enforce health and safety legislation (CIDB, 2009; Masimula, 2018). It is also important to note that many stakeholders in the construction organisation have taken matters seriously, for example, employer associations like the Master Builders South Africa (MBSA), Master Builder Association (MBA), Construction Industry Development Board (CIDB) as well as the South Africa Federation of Civil Engineering Contractors (SAFSEC). These organisations have been instituted to promote health and safety, along with training and competition in construction (Smallwood, 2007; CIDB, 2009; Masimula, 2018).

Likewise, the media have showed support by demonstrating an outstanding performance in agitating and publicising the significance of safety in the construction industry (Masimula, 2018), an activity that has generated awareness of safety to the general public. Moreover, media has encouraged construction workers to be cognizant of injuries and fatalities that may occur in the construction industry because of poor or inadequate safety practices. More so, tertiary institutions can be urged to participate in the safety campaign by instituting safety

related courses or subjects in the construction industry within the engineering and built environment fields. It is understood that trade unions such as Building Construction and Allied Workers Union (BCAWU) have done little in promoting safety in the construction industry (Masimula, 2018). Employee associations, consequently, must play a strong role in empowering their members by raising awareness in terms of safety in the construction industry (CIDB, 2009; Windapo & Oladapo, 2012).

2.6.1 Construction firms and projects

Firms in the construction industry include consultants (project managers, designers, and quantity surveyors), contractors, manufacturers and suppliers. Consultants are those managing projects on behalf of their clients, and therefore are actively involved in safety when they are on the construction site, particularly at the designing and procurement stages. Contractors, on the other hand, influence safety continually through tender assessment, safety instruction campaign and project duration evaluation. Furthermore, construction material manufacturers and suppliers should also contribute to improving safety (CIDB, 2009; Masimula, 2018).

For the procurement of construction projects, the following standard forms of contract are widely utilised in the construction industry in South Africa:

- General Condition of Contract (GCC) for Construction Works (South African Institution of Civil Engineering);
- NEC3 Engineering and Construction Contract (ECC) Institution of Civil Engineers);
- Principal Building Agreement or Minor Works (published by Joint Building Contracts Committee (JBCC); and
- Conditions of Contract for Construction for Building and Engineering Works (International Federation of Consulting Engineer, FIDIC) (Masimula, 2018).

These standard forms of contracts indicate that different forms of contract are subjected to the laws of their respective countries (Masimula, 2018). Understandably, JBCC does not make clear reference to safety, but rather declares that the parties associated with the contract need to comply with the laws and regulations, including by-laws that related to the implementation of the works. However, JBCC refers to the appointment of principal-agent whose duties are to ensure a site that complies with safety requirements. In the same way, GCC also does not make special reference to safety, but mentions the requirements for reporting accidents. The ECC and FIDIC, originating overseas, make special reference to health and safety, even though with terminology and referencing not parallel with South African requirements for health

and safety legislative framework (CIDB, 2009). In the above situation, it is necessary to review the standard forms of contract with the intention of integrating reference with safety in the construction industry. This approach must cut across areas such as construction regulations, contractor obligations, and the provision of additional safety requirements that are client driven (Masimula, 2018).

2.6.2 Construction safety involvement

All parties involved in safety exercise at the construction site are strictly advised to put stronger effort into achieving an accident free environment to aid performance. To consolidate the above illustration, the ILO recommends the importance of developing a single authority with the ultimate responsibility of determining the overall safety policy and harmonising standards (ILO, 2002). ILO (2002) suggests that a safety policy incorporate the following aspects are developing awareness of promoting OHS as a positive factor for enhanced productivity to demonstrate that 'safety pays', undertaking special reviews of environmental risk to H & S in the informally operated sectors, communicating information regarding safety norms as well as dangerous substances, products and mechanism to workplace groups, and undertaking measures to incorporate occupational safety in all organisational business plans to encourage safe working environments.

According to Laryea and Mensah (2010), regulatory agencies, clients, contractors and employees are the primary stakeholders responsible for safety in the construction site. They operate in different ways to instigate and establish safe environments for construction activities in accordance with their distinguished responsibilities. The descriptive summary of their responsibilities is given in the subsequent subsection.

2.6.2.1 Client involvement

Smallwood (2002, as cited in Masimula, 2018), believes that clients can successfully influence safety at a construction site because that is one of their involvements. This is done by influencing contracts and lowering injury rates, which dictates how work is implemented. Some other researchers further emphasise the other responsibilities performed by the clients. Laryea and Mensah (2010), for example, suggest that clients assess the project undertaken together with the working environment to determine the suitable personal protective equipment (PPE) for the employees. The Business Roundtable (1991, as cited in Smallwood, 2002) recommends the following actions for the clients are conducting regular safety audit during the construction process, adopting a partnering approach, maintaining a commitment to construction safety, scheduling safety requirements before the bidding process, financially

supporting contractor efforts toward safety, structuring documentation for the equal provision for safety by contractors, and making safety part of the criteria for pre-qualification.

2.6.2.2 Main contractor involvement

The contractor should demonstrate commitment by instigating and conveying safety compliance as an essential requirement to construction workers to ensure safety of lives and properties (Zin & Ismail, 2012; Masimula, 2018). Also, the main contractor is to check that all sub-contractors comply with the provision of PPE for their employees (Laryea & Mensah, 2010).

2.6.2.3 Regulatory agencies involvement

Regulatory agencies enact regulations to ensure the safety of the construction project, in terms of building, using and maintain it (Laryea & Mensah, 2010; Masimula, 2018). Occupational safety requirements such as the OSHA (1993) and construction regulations (2003) are examples of the government's commitment towards regulatory compliance, as they are recognised as critical protection against hazards in construction (Zin & Ismail, 2012).

2.6.2.4 Employee involvement

Workers are expected to comply with the rules and regulations of construction work, including the proper wearing of personal protective equipment (PPE) like hardhats and goggles, the maintenance of equipment, and the speedy reporting of defects (Masimula, 2018). Workers also need to avoid unsafe acts by determining any potential hazards on the construction sites.

2.7 Involvement of employers and employees in relation to safety

Safety of the employees should be guaranteed at the construction site. To this end, it is the duty of employers to adopt procedures that promote the safety of *all* employees. Thus, employers are directed to consider the following obligations are preparing accident reports, preparing records of maintenance, posting visible safety notices, communicating necessary construction related information timeously, and educating and training workers on safety measures.

Similarly, the workers should communicate the importance of safety to their co-workers at the workplace. By doing so, they encourage each other on the use of appropriate equipment and specific protective clothing, and report any violation of the rules or codes of practice to necessary superior in-charge (Dessler, 2001). According to Henerathgoda and Dhammika (2016), the responsibilities and rights of employees are as follows identifying probable hazards

at the workplace, participating in the process of safety, and refusing any work that one believes to be unsafe.

2.8 Factors that affect the operation of construction site safety management

Adverse influences of work-related accidents call for the need to reposition the management role in safety practices. Although accidents caused by the uncertain environment may not be easily avoided, it is however possible to regulate and improve current safety management to safeguard workers from artificial work-related hazards by instilling positive employee behaviour. For instance, employees must avoid premature acts and awareness of safety work driven by an effective management system (Bottani, Monica & Vignali, 2009; Cheng *et al.*, 2012).

2.8.1 Role of safety management as a factor of business management

The costs associated with safety management are typically related to legal requirements and monetary aspects of a business (Harris, McCaffer & Edum-Fotwe, 2013; Glendon & Clarke, 2018). There is clear awareness of the role of safety management as a factor of business management (Glendon *et al.*, 2018). It is an undisputable fact that safety regulation and safety management are integral to business, wherein costs related to safety management are an important feature. O'Faircheallaigh (2015) discusses the importance of considering yield as an essential element in the business growth, because without it, the business fails. In that view, O'Faircheallaigh (2015) advises that business can only adapt to the regulations provided that social regulations are deterred from threatening eventual productivity. Social regulations can be violated except when implementation increases the cost of non-compliance above the costs of adaptation. The industry is dedicated to the improvement of standards in safety.

Hayes, Eljiz, Dadich, Fitzgerald and Sloan (2015) suggest the relative importance of considering the prominence of legislation and its related cost in appropriation with the recognized and actual risk to the business. Similar opinions were given by Reason (2016) on public anxiety, which the researcher declared "clear" based on the nature of some disastrous events; even so, safety at any cost is intolerable because this might eventually force some companies out of operation. The researcher explains that "policies that reduce the frequency and severity of industrial accidents are desirable only if they can be demonstrated that industrial safety is presently below the socially optimal level which minimises the sum of accident prevention cost". (PAGE)

2.8.2 Cost of accidents

Many relevant discussions pertaining to the economic effects of safety have been carried out and studied in recent years, including the cost of occupational accidents (Heinrich,1959). Heinrich's study, focusing on the direct and indirect cost associated with accidents, indicates that indirect costs were averaged four times in the same magnitude as the direct costs (Heinrich,1959; Hughes & Ferrett, 2015). Many researchers were encouraged to check the validity of the findings (Davies & Teasdale, 1994). However, Heinrich (1959) presents a valid understanding or explanation of the method used as a purely statistical relationship. The findings definitely differ between organisations and/or departments of the same company based on the different accident types. Additionally, the cost of accidents to companies, raised in a leaflet produced for the Health and Safety Executive, gives an account of accident cost and accident types, with *accident* including damage to property, equipment, materials, and delays in production and services.

In this context, the costs of accidents vary by the types and sizes of the companies. A similar study surrounding the cost of accidents was carried out by the Health and Safety Executive on five case studies. This study determines comparison figures for four of the case studies, illustrating that uninsured cost was approximately between eight and 36 times greater than the cost of the insurance premium paid. Furthermore, Reinfort (1992) states that the cost of on-the-job and off-the-job accidents are approximately 2 to 6% of the gross domestic product (GDP) of any countries. The monetary value of these estimates can amount to billions of pounds for some countries in the developed world. Safety costs money, and the financial, economic, environmental and social costs of deaths, injuries, disabilities and diseases to industry and society in general (Zahoor *et al.*, 2012). Organisations are advocated to pay the financial costs of complying with legislation rather than suffering from economic or social loss associated with a lack of safety management.

The construction industry is a significant segment in the economic growth and development of the gross domestic product (GDP) of any nation's economy (Van Heerden *et al.*, 2018). However, there is a high incidence of accidents in the construction site that makes renders environment one of high risk (unsafe) for the workers, with socio-economic improvement nearly impossible (Shin *et al.*, 2014; Li *et al.*, 2015; Mazlina Zaira & Hadikusumo, 2017). The rate of accidents is excessively high in the construction industry, where poor safety implementation is common resulting in consequences to workers, industries, society and the entire nations (Shin *et al.*, 2014; Li *et al.*, 2015; Mazlina Zaira & Hadikusumo, 2017). The consequences are determined as direct and indirect costs.

Direct cost is associated with accidents, injury treatments, and compensation offers to the injured workers, as well as hospitalisation and medical cost of sick leave, liability, and property losses, impermanent incapacity payment and insurance premium for workers (Okorie & Aigbavboa, 2011; Hughes & Ferrett, 2015; Suresh *et al.*, 2016). *Indirect cost*, on the other hand, emerges from a series of costs that are not directly associated with accident (Hughes & Ferrett, 2015). The indirect costs suffered within the construction industry include delay cost, workforce productivity reduction cost, additional supervision cost, cost of cleaning after accident, reduced productivity of injured workers, cost of rescheduling incomplete project, cost of lost work days and cost of training of new workers (Okorie & Smallwood, 2010). Safety implementation is therefore essential to minimise the influence of accident costs.

2.8.3 Cost involved in site accident management and risks encountered on site

The risk encountered by employees in their work situations varies in accordance to their occupation. According to Yankah (2012), the level of acceptable risk differs from job to job and company to company. But the costs of safety measures required to reduce those risks are difficult to quantify. Due to some best practices in the industry, however, quantification of costs is probable. The other major factor that can influence safety costs is the legal requirement to comply with legislation. Comparing the costs of safety to the risks encountered by organisations is a business decision. Averill (2016) explains that financial principles can be applied to get safety implemented. He further explains that a company must quantify what it spends money on and compare this expenditure to the established standard to ensure compliance.

Reason (2016) explains the allocation of funds in protective measures when analyzing accidents. The researcher evaluated three scenarios with the concomitant cost of each accident compared to the length of time the activity had been performed; this resulted in a probability loss factor. The loss factor is multiplied by cost of the accident, with the result generated being the expected value saved by the company while preventing the accident from happening. Then, a figure is deduced for further analysis required to implement measures.

2.8.4 Cost of safety during tender

According to Yankah (2012) and Cooney (2016), cost is acknowledged as a major resource when managing projects. UK Contract report 45 (1992) identifies from respondents three major problems with the costing and allocating of resources to projects are safety issues are not addressed thoroughly during tender phase: "*this aspect of the construction project will be difficulty in pricing safety, since in many cases such aspects are inseparably linked to the*

anticipated technique of construction,” rather than the provision of discrete safety items. Safety performance compromised because of insufficient tendering practice: ‘anecdotal evidence suggests that subcontractors may under cost. Where there is a chain of subcontracting, the current system does not provide a means whereby the safety requirements of subcontractors are essentially combined in the bid to the main contractor’’. Openly addressing safety would increase the cost of tender: ‘‘common point made by the respondents related to the financial and commercial consequences including safety requirements at tender phase had been definitely demanded by the client’’.

Construction (Design and Management) regulations of the UK (1994) stress the need to guarantee suitable resources for project management. The three points highlighted in the 1992 report above are re-enforced in the contract research report 178 (1998) which acknowledged that: *‘there was no clear optimistic encouragement for companies to give safety high importance in project planning. Companies with a high safety profile were not really placed at any commercial advantage, apart from petrochemical clients. It may appear that selection of tenders is driven by commercial principles, mainly cost, with safety absent at the tendering phase’’.*

2.8.5 Cost of safety during construction

Safety management cost in construction is limited. According to Yankah (2012), the Construction (Design and Management) regulations 1994 (CDM) of UK address the question of satisfactory resourcing for project. Regulation 9 requires that responsibility holders such as the designers, planning supervisors and contractors assign satisfactory resources required to execute their responsibilities under the CDM regulations. CDM regulations explain what resources might involve, such as plant, machinery, technical facilities, trained personnel and time.

According to Manu, Ankrah, Proverbs and Suresh (2014), once construction starts, certain decisions are critical for saving costs in light of the under-assessment of safety during the tender period. Cost burdens have encouraged extensive involvement of many unqualified contract bidders and poor delivery of services such as welfare facilities and low-quality PPE. In these cases, safety might not be considered significant in any type of project handled by these unqualified contractors (O’Faircheallaigh, 2015).

Van Heerden *et al.* (2018) illustrate that construction accidents are extensive, since clients and contractors concentrate more on profit maximization than safety implementation. This results in the poor organisation, reduction in productivity, programme delay, increased cost of

accidents, increase compensation, insurance claims, improved work performance, organisational performance, and reduction in a number of accidents, lost working days and harm done to the environment (Othman, 2012).

2.8.6 Time and its effect on safety management

Time, a resource within the life cycle of a project, is controlled by many categories of manager, but mainly by the client. The directive issued on planning supervisors and duties by the Construction Industry Research and Information Association (CIRIA) acknowledges the importance of considering the consequence of time in any activities executed. The capability to execute a plan and duties under the Construction (Design and Management) regulation 1994 duly is affected by the required time. If a plan is outweighed, the duty plan holders must demonstrate that they have the capacity to respond.

Manu *et al.* (2014), in carrying out a review on the factors that challenge safety, found lack of time was specified as one of the major factors on the respondent list. This study validates the reason for production to be placed ahead of safety based on the pressure mounted by time. Tender periods may fail to consider safety issues effectively, thereby affecting the efficient use of available time. As part of the findings deducted by Manu *et al.* (2014), it was understood that 50% of the site managers (respondents) affirmatively agreed that they sometimes decided to neglect certain safety measures or use specific equipment to save time or reduce cost.

Reason (2016) explains that production and protection are not equal, because stakeholders prefer productivity improvement over process productive skills. They rather ignore process productive skills since information concerning production is direct and constant. By contrast, effective safety is restrained by negative results. For this reason, line managers and supervisors boycott the right procedures to meet deadlines, a drastic act encouraging the high frequency of occupational accidents during construction activities. Lippel and Bittle, (2013) discuss similar opinions in their in-depth analysis of five accidents. The researchers discovered that numerous construction activities were executed illegitimately, with supervisors in many instances, ignoring such drastic acts in order to keep production moving along.

Manu *et al.* (2012) suggest that schedule pressures can persuade safety to be neglected. Even with tight budgets and time-scales, however, effective safety management can, and *must*, be exercised to ensure project completion within the allocated budget and time. Other effects of time pressure are working undue hours that may cause health issues, including stress. On the other hand, resource pressure causes an array of activities that are triggered by inadequate planning and risk assessment. The end of these effects will yield to accidents.

2.8.7 Integrating of safety into site planning management

Chen and Zorigt (2013) explain that the purpose of integrating safety into other management systems is the need to centralise the safety management, rather than as an add-on organisational objective. Some researchers have suggested the need to integrate safety management with strategic planning (Samy, Samy & Ammasaiappan, 2015; Boehm, 2016). This notion of incorporating safety management into other management systems has been examined by institutions: for example, the British Standards Institute offers relevant direction toward the attainment of an integrated management system. One of the end products of this integrating process is an environmental management system through the combination of the safety management and quality systems. The implementation of these factors is expected to benefit all groups involved in the construction industry.

Similarly, researchers like Lorenzi and Sørensen (2014) give clear understanding of the importance of considering the integration of an environmental, safety management system with the business activities and strategies to standardise the business environment around the globe. However, Yankah (2012) cautions businesses about the reason for implementing this integrating process, claiming that businesses are more into regulating compliance and client requirements than innovating and implementing integrated systems. In that case, the academic suggests the use of the situational management for safety integration to control the hazards and risks affecting individual company. Thus, Yankah (2012) declares that safety management is currently seen as an essential problem rather than a possible resource.

2.8.8 Client involvement in safety management on site

Clients are the persons, partnerships, establishments or public authorities for whom the construction is carried out. However, the majority of construction operation is carried out under the contractual arrangements (Rahman & Kumaraswamy, 2002; Cooke & Williams, 2009). The procurement technique used and clients' personal behaviours regarding safety can have a deep effect on the project's safety performance. Some clients encourage safety more than others. Petrochemical companies, to be precise, make it clear that contractor safety performance is a significant condition in the contract. Construction (Design and Management) regulation 1994 declared that regulations are developed to stimulate a strategic method in the management of safety risks in the construction, as this demonstrates the significance of clients in establishing quality of a project and making vital decisions that drive development. Effective implementation of construction design management would be advantageous to clients by attaining improved planning and project control, improved communication during project

implementation, improved welfare facilities to develop the working environment, instigating efficient management of future construction work, and advocating for zero tolerance for accident occurrence among construction workers to aid and abet improved risk management.

A report published by Sherratt (2012) cited a comprehensive report by Entec (2000) in accordance with the findings obtained from the UK consultation, that clients are struggling to harness their full potential in achieving a stable and standard construction safety. Therefore, the industry understands that many clients are not aware or properly informed about their position or role toward achieving a complete construction project free from any types of occupational accidents. Clients take an extensive variety of methods for safety. Some clients working in extremely regulated areas such as the chemical industry and prison services set high standards that could be understudied and incorporated into use by other construction companies in the construction chain.

The awareness of safety standards extends from the civil engineering sector to the building sector. The commitment level of clients varies, though, regarding safety standards. According to this, it is understood that most clients exercise little concern about safety importance while executing construction projects. Poor awareness of site problems suggests that clients do not take into consideration the multitude of potential problems are effect of a change in specification on project planning and implementation, effect of working excessive overtime and night shifts to meet project deadline, effect of adverse weather conditions, difficulties arising from the short time interval between award of project and starting work, and effect of poor standards of welfare facilities on the morale of the workforce.

2.9 Effective safety management techniques

The construction industry is globally acknowledged as one of the most dangerous industries due to the nature of its products and the difficulty of its practice within the systemic structure involving stakeholders. Accident reports in the industry cut across developed and developing nations, indicating this industry as one of the industries with an extremely high rate of accidents. Okoye (2016) buttresses that construction workers are predominantly exposed to accidents in this sector, since the industry is considered one of the leading unsafe industrial sectors due to safety inadequacy. Similarly, Mouleeswaran (2007) presents that construction contributes to the high number of occupational accidents on site as many workers are killed, in spite of the fact that many researchers have proffered solutions to the many erratic situations that persist on construction sites. Sousa *et al.* (2014) note that the rate of accidents in the construction industry is still very high regardless of the significant improvements in recent years.

Many researchers, however, have reported that several significant issues have influenced organisations to adopt a more organised safety management system in construction sites, citing reasons as follows:

- i. The models used in environmental and quality management have fortified the larger organisations to accept a comparable method to managing safety (Mohammadfam *et al.*, 2016; Bianchini *et al.*, 2017; Gopang *et al.*, 2017; Silaparasetti *et al.*, 2017).
- ii. The nature of safety legislation has encouraged the use of an organised method.
- iii. The response to major tragedies in the past focuses on a better role for managing safety rather than relegating safety to an insignificant function.

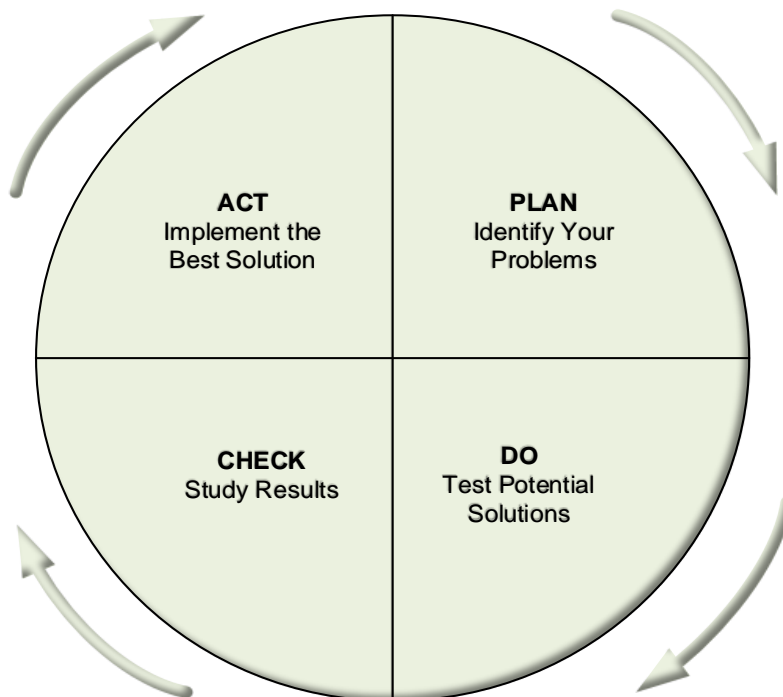


Figure 2.1: The plan-do-check-act-cycle (Moen & Norman, 2010); Jilcha *et al.* 2014)

Firms managing high-risk facilities that have influence on the public have a functioning system in place. Many construction companies manage the safety functions in their companies by executing safety activities designed to reduce or eliminate the risk of hazards on their construction sites. A growing number of construction companies, particularly larger ones, have tended to adopt safety management techniques that have their origin in Deming's Plan-Do-Check-Act model of continuous quality improvement (Jilcha *et al.*, 2014). Figure 2.1 presents continuous quality improvement while Figure 2.2 presents effective safety management.

Furthermore, safety executives have proposed that the comprehensive ethics of safety management systems are indistinguishable from the comprehensive management practices advocated by supporters of quality and business excellence. They offer a model that covers six significant basics for effective safety management, concisely described below:

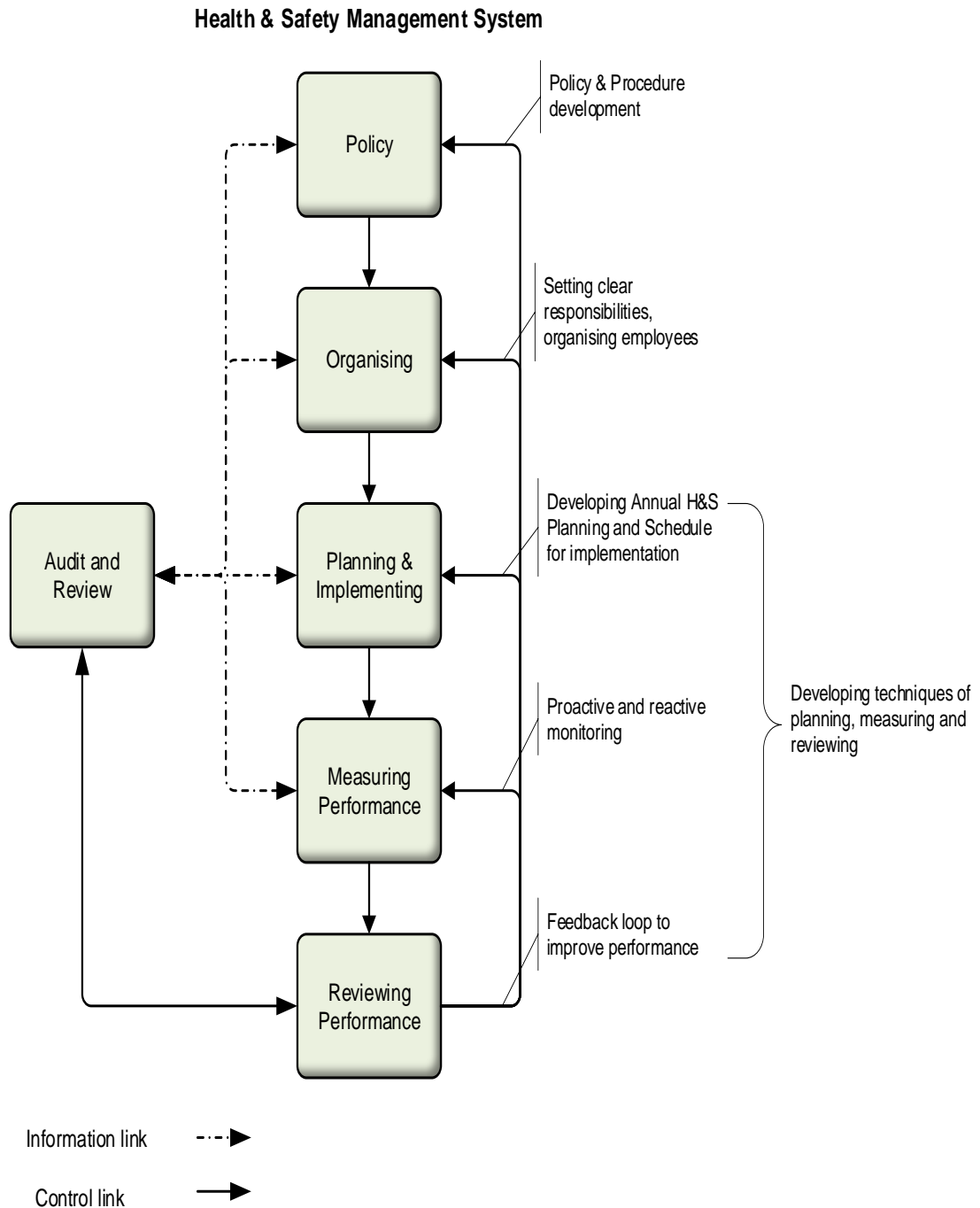


Figure 2.2: Sequential process of health and safety management system (Health and Safety Executive, 2008)

a. Policy	<p>Effective safety policies are adhered to by organisations in demonstrating their commitment toward continuous improvement, wherein legislative requirements are followed accordingly to ensure that responsibilities to personnel and their environment are attained (PMBOK, 2017). Cost-effective strategies are the basis for preserving and developing physical and human resources, thereby reducing financial losses and liabilities (Fisk, 1999).</p>
b. Organising	<p>According to Fisk (1999), implementation of an effective management structure will deliver a reliable policy, provided that staff are motivated and empowered to work safely and protected. In that case, effective communication interface involved between stakeholders should sustain a reliable safety programme (PMBOK, 2017).</p>
c. Planning & Implementing	<p>Planning is crucial in the realisation of any project, including the components of the project and safety. A well-planned operation involves a series of careful steps. This includes reviewing the records of successes and failures of all resources used in the past, and the practitioner forestalling the resources needed to meet those demands and make requests (PMBOK, 2017). A planned safety standard may require unusual demands, while a practitioner is expected to plan ahead of any possible future occurrence of incidents (Mohdashri, 2010). The procedure followed should accommodate the mission and objectives of the organisation to aid the decision of the safety practitioner towards performance of the safety programme. The attainment of these objectives propels the formulation of budgets and timetables to strengthen the relationship between the practitioners, management and organisation (Mohdashri, 2010).</p> <p>A systematic planning approach for safety policy should be implemented through an effective safety management technique to minimise risks (PMBOK, 2017). Based on this, risk assessment can determine the right priorities and relevant objectives required in eliminating hazards and reducing risks. Performance standards should be established as one of the priorities required in evaluating performance and specific actions identified to promote a safety culture across the construction company (Fisk, 1999).</p>

d. Controlling	Controlling occurs through a number of sub-functions. It monitors the occurrence of any events in the organisation and compares the results of the observations to establish standards. Therefore, it is necessary to take appropriate corrective measures. This usually occurs through inspections, audits, records reviewing, and interviews with employees and supervisors.
e. Measuring performance	This initiative is primarily for identifying where improvements are paramount, and for determining a verdict on any situation that requires urgent attention. Its application helps in determining any existing systems that accommodate failure. Reactive monitoring will uncover the causes of any possible failures.
f. Reviewing performance and auditing	The organisation learns from experiences, and applies the lesson learnt by undertaking systematic reviews of performance. In this way, it is in a position to improve on past performance and develop its policies, techniques and methods of risk control.

2.9.1 Safety training and induction

Ates *et al.* (2013) explain that safety training interprets the rules and provides information on potential hazards and ways to avoid them. However, poor training is the main cause of accidents at construction site. Training is vital as it teaches employees to realise a positive safety culture. Preventive training procedures in the workplace environment are important tools in preventing accidents at work. All new employees should receive a full induction about potential hazards and instructions for avoiding potential risks (Zhou *et al.*, 2015; Leonavičiūtė *et al.*, 2016). The induction should include several procedures are awareness on safety policy (of the company), habitual execution of safety responsibility (during construction activities), willingness to report any occurrence of accident (to the superiors in charge), readiness to participate in safety campaigns (toward a safe working environment), competence in accident reportage (to aid the safety management on how to tackle any feature occurrence of accident), and willingness to accept responsibility for involvement (in the cause of any accident).

Construction sites pose a large variety of risks, escalating the possibility of an accident because of factors such as variations of job responsibilities, new systems of work, and employment of more vulnerable persons; for example, young and disabled. Other varieties of risks are working with dangerous equipment, working around hazardous materials and fatigue from overwork (Mustapha, Aigbavboa & Thwala, 2018). However, OSHA (2007) declares that

a duty employer is allotted to ensure the safety, health and welfare of all the personnel in the workplace, incorporating the provision of instruction, information, training and supervision.

All employees must be cognizant of the risks associated with the use of new technologies, particularly while participating in the reviewing of safety measures. The safety commitment demonstrated by the management encourages the workforce from neglecting relevant safety measures. As such, participation of workforce in safety activities would be beneficial, such as safety inspections and audits, investigation of accidents and safety consultation meetings. Management training plays a significant role in deterring managerial failures that could instigate occurrence of accidents such as inadequate safety awareness, inadequate supervision, inadequate communication (between the management and employees) and inability to interpret one's responsibility.

Most activities on construction sites require specialist training, such as first aid, fire prevention, forklift truck driving, scaffolding inspection, overhead crane inspection and safety inspection. Job training safeguards employees to perform their obligations in the correct way to avoid occurrence of accidents. Skill training can be conducted 'on the job' or by 'toolbox training' to cover issues like emergency measures, correct use of protective personal equipment (PPE) and work activities that are hazardous. Safety training comprises training on personal protective equipment and emergency preparedness, as well as documentation of accident causes (Tudayekar & Kulkarni, 2014).

2.10 Management safety policy statement

A company should adopt a safety management policy statement that summarises the company's philosophy on safety, with the intention of setting the bar of quality for management's commitment to initiate the best safety procedures (Figure 2.3 below). Roberto and Peyton (1991) believe that policy must delineate simple, realistic, enforceable and concise statements of the assigned overall responsibilities for safety in all departments. The policy should be, at all times communicated to the departments either by company's chief executive officer or by a top project management representative to promote a safe workplace for workforce. According to Davies and Tomasin (1990), employees are expected to comprehend and duly follow the company policy statements as issued by the employers. By doing so, the employees will have a view of the organisational safety responsibilities of the management. And so the manager's roles and commitments on safety procedures should be continuously communicated to the employees to promote stability and collaboration in attaining a safe working environment for all. However, Wilson (2000) confirms that some companies only subject their employees to site experience instead of offering them proper safety training. And

this is likely to be inadequate for preventing occupational accidents. Nishgaki (1994) and Garza (1988) suggest a significant advantage of training employees on safety procedures: educating workers about all aspects of workplace safety will enhance their capacity and competency to protect themselves from any occupational risks. In addition, Davies and Tomasin (1990) advise construction management to give more attention to periodical safety improvement by being active and optimistic in reducing the number of injuries and fatalities.

2.10.1 Risk assessment and control measures

Armstrong and Taylor (2014) explain that risk assessment identifies specific hazards and quantifies the risks associated with them. Risk assessment, therefore, evaluates and predicts risks in quantitative and qualitative terms, focusing on predicting the probability of risk impacts of hazards on human and environmental resources. This approach will eliminate hazards through design improvement; process improvement; use of barriers; chemical replacements; use of personal protective materials; and use of warning signs, labels and instructions. Safety is the most crucial investment we can make. So the question is not what it costs, but what it saves (MacKee, 2013).

Several building contractors are profit-oriented by preferably maximising company's profits at the expense of avoiding safety control measures to reduce costs and endangering the lives of the workers and properties. The control of risks is important to secure and sustain a safe construction site. More so, Kibe (2016) says, safety is controlled through a combination of engineered measures which include avoidance of risks, elimination of hazards, safe systems of work, training and information, personal protective equipment, welfare and monitoring. For an effective and efficient safety management system, financial resources should be designated to ensure effective implementation of the measures and procedures to guarantee employees safety. The employment of a safety officer who will advise on various aspects concerning safety, include formulating safety policy with clear aims and objectives, safety measures of work and method statements, risk assessment, accident investigations, accident reporting, safety performance monitoring, review and audits is imperative.

First aid personnel should be employed at the construction site to deal with cases of accidents, injuries and emergencies, as they are equipped with necessary facilities to carry out these tasks effectively. Training is aimed at improving people's skills, knowledge and attitudes to be adequately competent in the safety aspects of their work. All construction sites are tasked to display safety signs and signals at the location where risks are paramount. Signs and signals should be positioned where there is a clear view and conveniently visible, portraying the correct warning symbols relevant to the hazard, easily understood, used as instructed or

required, durable, clean, water-resistant, effective and convey prohibitive statements or signs such no smoking.

Other important signs can indicate hazards such as a potential fire hazard area, falling objects areas, and chemical hazard, and provide a directive on the location of firefighting equipment and PPE such as helmets and hard hats, ears, eyes and face protections (safety goggles, masks, earmuffs), leg and foot protection (safety boots, gloves, hand guards, sleeve, cuffs and hand pads) and body protection (aprons, overall jackets, complete head-to-body protective suits) (Al-Buzz & Mostafa, 2015). Similarly, the provision of welfare facilities like safe drinking water, foods and accommodation is highly significant. Wells and Hawkins (2014) express that where safety costs are included in the contract tender document, and accepted by the client, loss of time due to accident occurrence is significantly reduced.

2.11 Different factors on safety management techniques

2.11.1 Resources factor on safety management

The resources factor, including hardware and software, are comprised of safety equipment, PPE, first aid equipment and many other additional requirements. These resources must be regularly provided with the required safety emergency shutdown (ESD) and fail-safe systems by the industry. Additionally, the regulatory requirements of the industry must be met, such as emergency response planning and recovery, internal control, programme evaluation, safety audits and safety process. The magnitude of an organisation determines the effectiveness of their systems (Goffee & Scase, 2015). These systems are influenced by the management skills, employer values and compliance with laws and regulations (Legg *et al.*, 2015; Zhou *et al.*, 2015), and the end products may be positive or negative depending on the activities executed.

2.11.2 Management factor on safety management

According to Ismail *et al.* (2012), the management factor includes leadership, vision, direction, statement of objectives, commitment, supervision, safety analysis and prevention planning. A correlation analysis performed by some researchers demonstrates that high levels of support at both the organisational and supervisor levels reflect maintenance concern for the welfare of the workers, engendering a reciprocal relationship in terms of increased safety citizenship behaviours (SCB) (Mearns & Reader, 2008; Ahmed & Musarrat Nawaz, 2015). Lu and Yang (2010) show that leadership and safety behaviour in container terminal operations are important factors for effective safety management, with results suggesting that safety motivation and safety concern positively affect self-reported safety behaviour. This should

include procedure and policy, safety codes and standards, clear goals and resources, rules and regulations and safety benchmarking including responsibility and supervision (Ismail *et al.*, 2012).

2.11.3 Personnel factor on safety management

The personnel factor includes awareness, good communication, personnel attitude, safety culture, and positive groups and personnel competency. Work culture results from personnel traditions, language, work attitudes and habits, and company practices (Ismail *et al.*, 2012). However, Hopkins (2006) explains that understanding the influence of organisational cultures requires a strategy referred to as the *perception survey*. Moreover, Guldenmund, (2007) points out that questionnaires have not been particularly successful in exposing the core of an organisational safety culture as questionnaires seem to expose only those attitudes that are shared throughout the entire organisation. But there are also individual differences concerning attitudes pertaining to organisational safety (Henning *et al.*, 2009). Bosak *et al.* (2013) disclose that the experience of work accidents is an important variable as a predictor of worker perceptions and behaviours.

2.11.4 Relationship factor on safety management

The relationship factor includes globalisation and interfaces with the stakeholders as well as internal personal relationships. Globalisation has thus impacted the growth of mental work, expansion of services sector, working hour changes, unemployment and industrial relations, managing changes in competency demands, flexibility in coping with diversity, and the definition and meaning of 'work' (Wilpert, 2008). According to Baram (2009), the introduction of hazardous technological activities to underdeveloped nations poses risks to health, safety and natural resources and most immediately endangers the worker involved. Koukoulaki (2010), for example, points out that countries have been subjected to large changes in terms of flexibility of work and labour in response to macro trends like globalisation thereby resulting in aggressive market competition. Manzey and Marold (2009) report that an average estimate of 350,000 fatal occupational accidents was recorded in 1998, with an average estimate of 264,000,000 non-fatal accidents. The variables examined were co-worker's knowledge, opener ability, team tenure, co-worker and supervisor support, group orientation and group unity.

2.11.5 Human resource factor on safety management

The human resource management factor includes remuneration, promotion, campaigns, motivation, appraisal, PPE, welfare, work conditions and safety rules (Flin *et al.*, 2000). It also includes safety practice, training expert staff and group meetings. Conducive working conditions contribute to safety (Prasad & Reghunath, 2010). Human resources plays a big role in sustaining the standard of safety management in the construction company. Workers are expected to comprehend the application of any equipment to avoid errors linked to triggering occurrences of occupational accidents (Scott & Renz, 2006; Dempsey & Mathiassen, 2006; Kirkeskov Jensen & Friche, 2007) (refer to Figure 2.3 below).

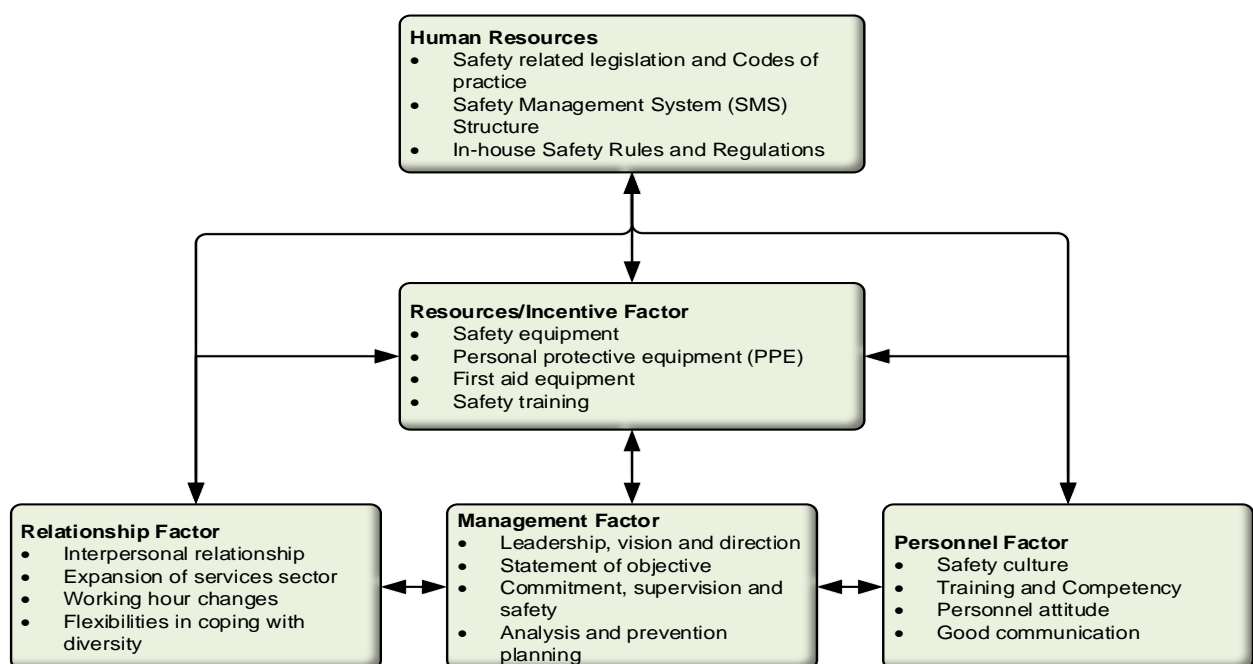


Figure 2.3: Flowchart depicting the management policy factors for effective safety implementation (Teo & Ling, 2006)

As part of most frequent incidents at the construction site, near misses must certainly not be ignored. Near misses, as reported by Borges Cambraia *et al.* (2010), show a drastic upsurge in numbers among most recorded incidents. It is understood that reports gathered on this particular occupational risk could assist the safety management team in preventing future occurrences of accidents. With the purpose of preventing near misses, Wu *et al.* (2010) developed a system that interrupts near misses to improve safety at construction sites. However, the practicality of introducing instructions on systems and procedures at the workplace needs to be reviewed (Cooper *et al.*, 1993; Li *et al.*, 2015).

2.12 Safety improvement through design

The safety performance improvement approaches described previously focused on improving specific and various parts of safety management. This aspect covers the enactment of laws or set of regulations that address the requirement for safety management to be taught in higher education. The argument is that this is the best view for long-term improvement across the entire industry (Chileshe & Dzisi, 2012).

Other safety management performance improvement techniques include prevention through design (Kidam *et al.*, 2015). Prevention through design is described as an approach applied by the designers to set the scene for the project by defining the specific work to be done. Designers are in a better position to eliminate hazards from the project, and to alter the design so that the risks can be tackled at the source (Smallwood & Goldswain, 2015). Hegarty *et al.* (2012) argue that appreciating 'designing-in' safety management is definitely achievable through using a conventional high dependability concept, even though history has exposed enormous failures of systems designed around these values. The researchers propose that it is, perhaps, time to re-think this viewpoint. This group further deals with accident model 'designing-in' safety as a seeming oxymoron; meanwhile, the act of developing high dependability, in fact, aggravated a system's tendency to fail (Hegarty *et al.*, 2012).

To accomplish an all-inclusive approach, regardless of the proposed technique, the involvement of key stakeholders in the course of safety management improvement performance is critical. According to Gibb *et al.* (2014), success in safety management can *only* be accomplished through teamwork among all construction stakeholders, namely designer, client and contractor. More so, Barrett *et al.* (2013) add that institutions, governments, clients and procurers of constructed facilities accelerate the momentum needed to improve the organisation.

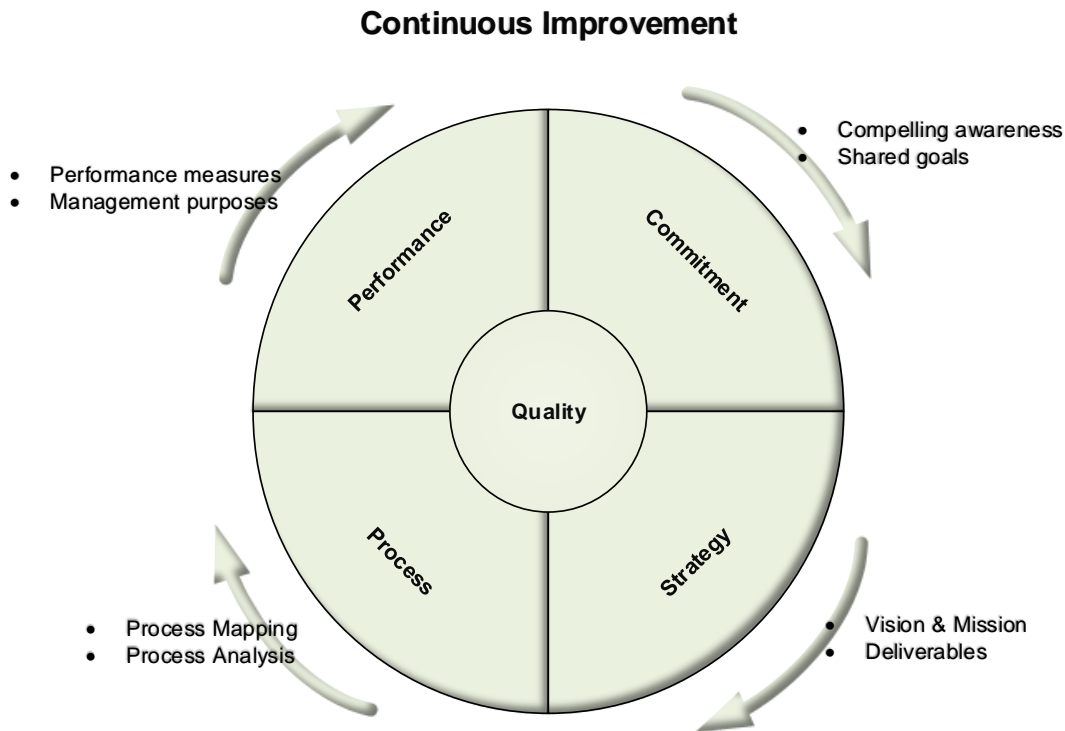


Figure 2.4: Continuous improvement performance (Creative Safety Supply, 2017)

To address safety management performance improvement holistically, measurement has to be conducted. Furthermore, the involvement of stakeholders in the construction industry has been identified as critical to safety management performance. While using a technique to improve safety management performance, it is necessary to consider attributes such as inclusivity in its approach to improvement, straightforwardness, ease of understanding, applicability to the construction industry, safety cultural changes, ability to be operationalised at both industrial and organisational levels, and the possibility of performance measurement to be done (refer to Figure 2.4).

2.13 Operational technique for safety management in construction site

There are no fixed rules on how safety risk assessment, communication, and control should be accomplished. Several researchers have developed risk assessment techniques to suit their requirements (Hughes & Ferrett, 2011). Regardless of the difference in the approaches or industries, most of the risk assessment techniques are similar in terms of basic principles as they include work analysis, hazard identification, risk estimation, risk evaluation and risk control. The complexity of risk assessment, risk communication and risk control depend on factors such as organisation size, the workplace situations with the organisation, and nature, complexity and significance of the risk to which the organisation is exposed (Rwamamara,

2007). It is understood that risk should be evaluated at every stage of a construction project, wherein the input of the key stakeholders and project contributors must be sought (Lingard *et al.*, 2013). In addition, the researcher explains further that involving designers in safety risk assessment exercises can provide opportunities to "design out" features of a project that poses a threat to the safety of the crews during the construction phase (Lingard *et al.*, 2013).

2.13.1 Influence network technique for safety management performance

Numerous techniques have been proposed to improve safety management performance in the construction site, such as an influence network technique (Li *et al.*, 2015). The influence network technique is operationalised by assessing the environmental factors, policy, organisational and direct levels that may have influenced an outcome of poor performance on safety. With the intention of improving safety management performance, the previously mentioned factors with ineligibility will be subjected to required standards.

The outcome events relative to the predefined categories – hardware, human and external events – are defined in accordance with the safety management system performance level such as deadly falls from height. The process must be recurrent for the successive levels of the organisation, policy and environment. The weighting and rating of the practice of each influence are determined and adjusted by a panel of experts or a focus group. Weighting is based on influenced scale, with a totalling unity from one influence level to another influence level. Then, the rating value is determined on a scale 1 to 10 to illustrate the safety management system performance status, from the worst level to the best level. A calculated risk level is obtained from the sum of all outcomes of rating and weighting accepted by the panel. Critical influences are identified for the topmost outcome event, and for the necessary control measure instituted for any presence of risk. After the implementation of the risk controls, the procedure is repeated for influences at various levels (Musonda *et al.*, 2013).

Application of the influence network technique in examining accident causes and poor management system performance with regard to safety yielded some illustrative results on the situational experience encountered by workers. Likewise, the incident investigation reports compiled by the Health and Safety Executive present some evidence on accidents. In addition to this, the experience encountered by these workers in this industry provides further complementary insight on the accident (Musonda *et al.*, 2013) though the data evaluated by Musonda *et al.* (2013) only provided evidence of what *has* occurred, not preferably indicating the countermeasures required to prevent any *future* occurrence of an accident. In that case, to find a way to combat this situational assessment of accident causes, it is significant for the management to involve a structure of the differences between the sources of evidence, with

the intent of developing a comprehensive model to determine accident causes along with an influence network technique.

From a fundamental perspective, the influence network technique, utilising past occurrences of events, uses results of poor safety management system performances to formulate appropriate improvement relevant to the attainment of topmost risks subject to the organisation, policy and environment level influences. The feasibility of this technique in the construction system is restricted due to its lack of usability regardless of the organisational level. However, if in any case, these tools are applied at an organisational level, and then it is dependent on the expertise, but difficulties render it unrealistic due to small contracting firms over an organisation (Mustapha *et al.*, 2017).

These firms have limited capacity to fully utilise its benefits. While this technique is proposed to be implemented at the government policy, organisation, and client levels, nonetheless it is better used as a contributor in the assessment of practice as best done by key shareholders (Ginsburg *et al.*, 2013). However, there have been improvements as regard to high dependence on past records, because more practical approaches are instituted basically on leading indicators toward causes or occurrence of accidents (Larsen & Whyte, 2013).

2.13.2 Perception surveys for safety management performance

Perception survey is one of the techniques for improving safety management system performance. Ginsburg *et al.* (2013) suggest that perception surveys can be applied as an indicator of a safety management system at a particular point in time. In a perception survey, members of an organisation are asked to give their view on safety management performance in their various organisations. A perception survey is an analytical methodology that could be better used in analysing the future safety management record than any other indicator, as it also aids the determination of what needs to be done to improve safety management systems in an organisation (Stewart, 2015). In a study of 160 organisations, in which questionnaires were administered to workers between 2000 and 2004, findings gathered disclose that after thorough comparison of workers' perceptions from the data analysed, an improved proportion of about 9% safety management system is determined.

Julnes *et al.* (2014) propose a similar technique based on a survey safety management system for measurement and improvement. In this study, involving a safety management system perception survey of over 6000 workers in 50 chemical company sites, Julnes *et al.* (2014) found that organisations that undertook a perception survey provide feedback to workers and convened focus groups to understand the results, then developed action plans that were

studied by senior management before implementation would decrease the likelihood of an accident of 25% to 50%.

The improvement level of 25% to 50%, however, may not necessarily be generalised to include the construction site, as the survey was conducted in chemical processing plants and industries (Julnes *et al.*, 2014). In addition, these findings assume that an organisation would have systems in place that are evaluated from time to time. The study technique was based on the philosophy that there had to be a measuring tool to determine current status in order to develop improvement actions on various elements that are determined as poor (Ginsburg *et al.*, 2013; Julnes *et al.*, 2014).

2.13.3 Behavioural audits for safety management performance

Another method that has been proposed for safety management system performance improvement is the use of safety management behaviour audit with set goals and feedback. Larsen and Whyte (2013), arguing that an intervention of management audit, goals and feedback could be used to improve safety management system performance, further stress that it is possible to implement a safety management system behavioural audit as a valid and reliable measure of safety management system performance in the construction industry. Set goals can improve management of safety performance. Nevertheless, Sparer and Dennerlein (2013) discovered a limitation of all behaviour based on safety management system programmes, wherein worker behaviour is only one factor affecting industrial safety management system performance. Safety behaviour can only be accomplished where basic safety infrastructures are implemented already. Sparer and Dennerlein's (2013) study was directed at workers while that of Larsen and Whyte's (2013) was directed at behaviour changes of managers after recognition that a behaviour based technique is unlikely to succeed without management commitment.

2.13.4 Conformance to safety management system

Safety performance can also be improved by emphasising conformance to the safety management system (Foster *et al.*, 2013; Li *et al.*, 2015; Saat *et al.*, 2016). Thus, in measuring the level of conformance to safety management requirements, risks can be determined *before* the occurrence of an injury. Therefore, an improving system based on identified deficiencies will reduce risks and generate improved statistical performance over time. Furthermore, determining the root causes of accidents for safety management deficiencies and implementing corrective measures will produce long-term improvements (Foster *et al.*, 2013; Li *et al.*, 2015; Saat *et al.*, 2016).

The assumption is that organisations will have a safety management system in place, and the systems must be effective: nevertheless, a system approach may not work, as claimed by Saat *et al.* (2016). It is only those organisations with basic safety management systems that can withstand operational dangers and still achieve objectives. A system approach is not adequate to prevent accidents and improve safety management performance (Altabbakh *et al.*, 2014). In high consistency organisations, those which are primary examples of a system approach, organisational culture is in fact of deep importance, suggested that best results are achieved with an improvement in the safety culture (Antonsen, 2017).

2.13.5 Developing a safety culture

Antonsen (2017) argues that only a safety culture is able to provide any degree of durable and reliable protection. Consequently, many researchers see cultural changes as a way to improve safety management performance (Santos *et al.*, 2013). If the safety management system performance can only be improved through cultural changes, then there has to be a way of measuring the baseline safety culture, together with the safety culture before baseline interventions (Desa *et al.*, 2013).

The assessment of the safety culture could be achieved by using climate assessment tools to measure the prevailing safety attitudes within organisations. A climate survey highlights the areas in which there are issues and establishes a basis for defining the imminent improvement plan. However, climate analysis is only an initial diagnosis step. To operationalise the culture change approach, a methodology has been proposed that measures climate through a perception survey, followed by a planning workshop with senior managers to develop action plans. The process is then repeated after the implementation of the action plans to assess the improvement (Desa *et al.*, 2013).

The aim of the model client framework is to facilitate the development of a positive safety culture (Hardison *et al.*, 2014). Furthermore, Hardison *et al.* (2014) explain that though the model client framework, the Australian Government, by whom the framework was developed, strives to ensure that the major stakeholders are involved in the planning, design, and execution of construction work. They will collaborate to allocate responsibility for safety management and integrate safety management considerations into all project decision making.

2.14 Safety planning on construction sites

Safety planning in the construction site begins with the identification of safety risk inherent in the project through a team meeting with the construction managers, safety managers and

other professional site managers (Leonavičiūtė *et al.*, 2016). At the meeting, distinctive information sources – drawings, accident cases and experimental knowledge – are frequently referred to in preparing preventive measures against predictable safety risks. The problems and limitations of using those information sources for construction safety planning were determined, which resulted from not yielding real field circumstances (Jeon & Park, 2005). Clearly, the professionals on construction sites need to be educated on the safety risks detected in the planning phase. For effective education and training, the educational material must reflect specific site project circumstances. Visser *et al.* (2007) maintain that the education and training sessions should focus on worker understanding of safety risks in term of ‘work location’, ‘type of work’, ‘type of risk’ and ‘behaviours risk exposure’. However, it is a time-consuming and costly task to develop project-specific safety educational material. But if it is possible, this will offer training and education on the right application of personal protective equipment (PPE) and generalised accident cases, with the periodic use of expensive pre-experience facility of fatal accidents (Eum & Woo, 2009).

2.15 Safety implementation in the construction industry

As previously mentioned in this study, accident occurrence at the construction site is perceived as high risk to the workers, rendering the construction environment risky. As a consequence, socio-economic improvement becomes impossible (Yean *et al.*, 2009; Ismail *et al.*, 2012). The rate of accidents is excessively high in the construction industry. Poor safety implementation has additional consequences on workers, industries, society and nations (Yean *et al.*, 2009; Ismail *et al.*, 2012). These consequences have affected the nation’s economy in the area of human capacity, industrialisation and health systems. There are two types of costs associated with these consequences, as previously discussed in Section 2.8.2: *direct cost* is associated with accident, injury, treatment, and compensation for injured workers including hospitalisation, sick leave, liability, death, property losses, impermanent incapacity payment and insurance premium for workers (Hughes & Ferrett, 2015; Heinrich, 1959); on the other hand, *indirect cost* includes delay cost, supervision cost, decline in productivity due to injured workers, untimely work completion, lost work days and cost of training newly employed personnel (Okorie & Smallwood, 2010). Costs of accidents are suppressed through the type of safety system implemented by a construction company.

According to Okorie and Smallwood (2010), safety implementation includes legislation, quality, late completion, fine and penalty, financial issues and reputation of the construction industry. More so, safety investment increases productivity, profitability and worker confidence (Muiruri & Mulinge, 2014). From another point, safety is considered a humanitarian and

economic concern required to accomplish appropriate results (Muiruri & Mulinge, 2014). The identification of hazards, rewards, risk control measures, increasing usage of information technology tools, integrating quality, safety incentive programmes, documenting method statements and safety induction, and training have been advocated as safety improvement tactics (Van Heerden *et al.*, 2018). Prevention of accident occurrence is countered through the determination of its root cause for non-implementation of safety management (Loiy, 2012; Hubner, 2016). Therefore, a constant investigation on the safety management implementation should be elemental.

2.15.1 Implementing a zero-injury construction site safety concept

According to Mwanaumo (2014), while safety was generally observed as the responsibility of the contractor, the goal of zero-injury is not compatible with this view. Clients, designers and many other parties in construction projects must become involved in the concept of zero-injury – from the start to the completion stage of a project – to ensure that hazards are eradicated and workers are protected. Construction Industry Institute (CII) instituted the zero-injury concept in 1993 to attain hazard eradication and worker protection. This institute carried out a study on how to achieve zero accidents in construction projects to convince clients, contractors and top managers of the significance of effective safety programmes (Construction Industry Institute, 1993). Based on the interviews with the clients, construction managers, construction superintendents and construction workers, five high impact techniques were determined to assist clients and contractors achieve zero accidents on their construction projects: 1) pre-project planning for safety; 2) safety training and induction; 3) safety incentive programmes; 4) accident/incident investigations; and 5) alcohol and substance abuse. Zero injuries are the desired end-product, a guarantee to eradicate injury from construction site (Construction Industry Institute, 1993; Mwanaumo, 2014).

Zero-injury signifies a position by management in the interests of the workers (Mining Safety, 2012). This stance of top leader sends the unflinching message to all employees that *any* injury is unacceptable. Therefore, all construction stakeholders and participants are expected to embrace the principle that they are liable to injuries during construction project execution. Pain and loss occurring by injury becomes a moral issue (Cullen *et al.*, 2006). Regardless of the cost, schedule and quality management, the goal is eradication of *all* accidents on job sites. The only acceptable number of injuries is ZERO.

2.15.2 Zero-injury concept

The zero-injury concept is based on the safety commitment demonstrated by senior management to eliminate injury. The zero-injury concept does not mean that another injury will never occur, but it means that workers are encouraged to ward off injuries during any activities (Mwanaumo, 2014). Once the participants or workers understand this, the extreme high prevalence and cost of a worker injury can be reduced to marginal numbers that were not deemed possible previously in the workplace (Mining Safety, 2012).

In the process of acknowledging zero as the ultimate goal, regulation and enforcement-enacted laws are made possible by the implementation of H & S. Companies are advised to realise the importance of initialising H & S policies, standards and guidelines to aid their safety management. Therefore, companies *must* invest time and energy in training, managing compliance through H & S audits and developing a caring culture (Aguilera-Vanderheyden, 2013; Mwanaumo, 2014). Once embraced, the greatest challenge facing any top manager, site supervisor or professional in a company is the coordination of employees in making wise decisions to execute any task appropriately (Mwanaumo, 2014).

2.15.3 Zero-injury achievement

The process followed by CII in developing zero-injury acknowledges nine best practices, wherein 170 specific safety techniques were listed in the companies surveyed. These practices were the ones deemed as the high impact, zero-injury techniques (Mwanaumo, 2014). The zero-injury techniques are highlighted below:

1. Demonstration management commitment
2. Staffing for safety
3. Worker involvement and participation
4. Recognition and rewards
5. Safety planning – pre-project/pre-task
6. Subcontractor management
7. Safety training and education
8. Drug and alcohol testing
9. Accident/incident reporting and investigation

These techniques are the types of activities that construction industry stakeholders and contractors need to adopt to promote H & S.

2.16 Compliance with safety legislations in construction sites

Zin and Ismail (2012) define *compliance* as the process of observing requirements set by the employers and employees to prevent occupational accidents, injuries, fatalities and diseases. Compliance assists in establishing efficient, effective safety during work performance (Zin & Ismail, 2012). Globally, the construction industry is alleged to be a poor executor of occupational safety from among other industries, a claim attributed to the industry's proneness to high injuries and fatal accidents with construction fatalities. In the UK, high injuries and fatal accidents recorded are five times higher than within other industries (Health and Safety Executive, 2013). Similarly, India's construction sector is largely characterised by an unorganised workforce, and neglects to adhere to standard regulations laid down by the government agencies (Beraha *et al.*, 2012).

The Southern African Development Community (SADC) and South Africa have general measures in place for the provision of OHS, including the demand for employers to report baseline risk assessments and OHS plans based on assessments related to the intended construction work. This is to ensure that precautions are in place and registration of all subcontractors for compensation according to the Compensation for Injuries and Diseases Act, Act No 130, 1993 as amended (Republic of South Africa, 1993). The result from the literature reviewed indicates that employer ignorance of the ILOs legal rules on occupational safety at workplaces exposes workers to the risk of occupational injuries (Gurcanli *et al.*, 2015). Furthermore, negative employer attitudes and ignorance of occupational safety practices also contribute to the high rates of accident occurrence at construction sites (Gurcanli *et al.*, 2015). According to Ale *et al.* (2008), construction workers in the Netherlands indicate that many occupational injuries and fatalities are caused either by the failure of the management to put safety measures in place or poor worker consideration to safety measures during construction work.

According to Aneziris *et al.* (2013), the supporters of occupational safety advocate for the occupational research and employment of professional at workplaces to identify the factors that compromise the safety of the employees. It is proposed that necessary legal outlines for operationalisation of occupational safety be established universally. The outlines – such as Health and Safety Executive (HSE) in the UK, Occupational Safety and Health Administration (OSHA) in the USA, and Japan Industrial Safety and Health Association (JISHE) – strengthen compliance with the safety legislation at the workplace and the Occupational Safety Acts in many developed nations (Zhou *et al.*, 2012b).

South Africa's Health and Safety Act, No. 85 of 1993 (Republic of South Africa, 1993) and the Construction Regulations, No. 84 of 2014 (Construction Regulations, 2014) govern the construction activities of the country to eliminate potential hazards during the design and construction stages. The intention is that this will reduce the negative consequences such as occupational injuries and fatalities (Republic of South Africa, 1993). Sometimes the construction site employers and employees do not adhere to the stipulated requirements, detrimentally increasing the number of accidents and fatalities in the construction industry (Smallwood & Geminiani, 2008; Zin & Ismail, 2012).

2.17 Chapter summary

This chapter has highlighted the essence of safety in the construction site, both locally and globally. From the discussion, safety clearly remains a serious issue for all construction stakeholders despite the existence of enabling safety legislation. As discussed in chapter, the primary causes of most occupational accidents in construction sites are attributed to management negligence.

CHAPTER THREE

3. Research Methodology and Design

3.1 Introduction

Subject to the relevant literature discussed in Chapter 2 of this study, an appropriate methodology was developed and applied to initiate data collection and exploration processes in generating feasible results required to validate the objectives presented in Chapter 1. Leedy and Ormrod (2010) define *research methodology* as a study segment that explains and guides the procedural steps for conducting research; that is, from data collection to data analysis and then conclusion. In essence, the research methodology is a sectional part of a study that guides the decision-making processes executed to attain the study objectives through the affirmative answers to the formulated research questions.

This chapter begins with a general overview of various types of research methodologies, followed by the specific research design adopted for this study. In the process of applying the research design, the research questions were developed from a determined research problem in validating the right methodology for this study. The methodology contains the design process, sampling techniques, data collection approach, process of analysis, rationale for these selections, and the test of validity and reliability of the research tool.

3.2 Research philosophies

A *research philosophy* is a term used to describe the evolution and nature of a specific knowledge (Bandaranay, 2012) that guides and validates researchers' decisions philosophically or theoretically (Greene, 2008). According to Biggam (2015), the pillars of the philosophical stance of research are below:

- Interpretivism
- Positivism

3.2.1 Interpretivism

An *interpretivism paradigm* of research is defined as a philosophical situation focusing on the interpreting and understanding of the theoretical content of data by implementing the principles of social sciences (Eriksson & Kovalainen, 2015). In addition, the Eriksson and Kovalainen state that the philosophical background of interpretivism research is based on hermeneutic and phenomenology to give subjective meanings to an objective phenomenon. Interpretivism

is concerned with the adoption of qualitative methods in data collection, which involves in-depth interviews with the participants (Punch, 2013). Furthermore, the primary focus of the researcher is to understand, interpret and give meanings to social realities from their perspective (Flowers, 2009). Therefore, interpretivism philosophy of research is based on four assumptions identified by Creswell and Poth (2017) are it presents critical scrutiny on unfathomable, forgotten and undiscovered knowledge, knowledge derived is sustained by qualitative methods relating to the participants, subjective knowledge, social processes and actions are relative, and language used for data interpretation is derived from social interaction with the participants in a particular place and time.

3.2.2 Positivism

Positivism is a word used to describe the quantitative nature of research (Biggam, 2015). Positivist research is characterised by the ability of researcher to test hypotheses derived from existing theories through the observations of social realities (Flowers, 2009). Blaxter (2013) defines *positivism* as a research paradigm based on experimental testing without the influence of human participation. Biggam (2015) adds that positivist research in sociology and history is influenced by human participation and observation based on the concept of obtaining quantifiable data for research. Therefore, this concept involves the use of quantitative methods, such as questionnaires, experiments, interviews and statistics that are dependent on human responses and experience. Consequently, human participation is inevitable (Pareta *et al.*, 2012). Eriksson and Kovalainen (2015) pose the basic philosophical positions of a positivist as follows knowledge is derived subject to results obtained from the application of a scientific approach to test observation and the hypothesis and research aims to find explanations and regularities on the causes and effects of a given phenomenon.

3.3 Research methodology

Research methodology is a holistic process of acquiring, analysing and interpreting data with the aim of reaching a conclusion that expands the view of a study (Leedy & Ormrod, 2010). According to Fapohunda (2014, as cited in Solanke, 2015), research methodology is the process of weighing advantages and disadvantages of various research methods, so as to identify the right method for research. Leedy and Ormrod (2010) additionally state the primary functions of research methodology:

- to set standard for data collection; and
- to collate the data after collection, and interpret them rightly.

Research is a repeated process of study in nature, involving several cyclical and logical

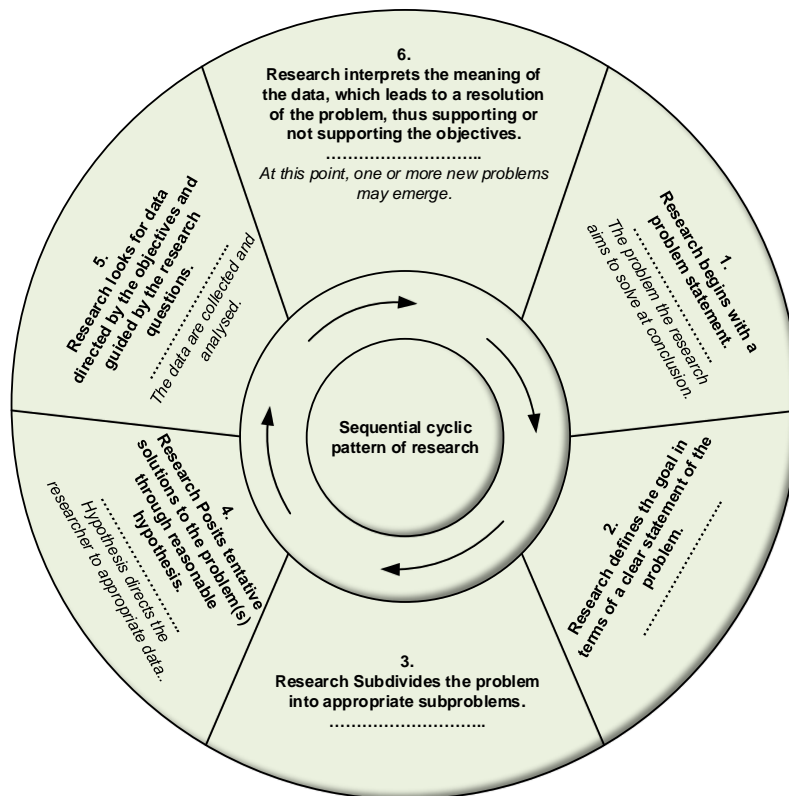


Figure 3.1: Research cycle (Solanke, 2015; Leedy & Ormrod, 2010)

steps in acquiring a complete solution for the research questions. These steps are illustrated in Figure 3.1 above. Additionally, Biggam (2015) highlights the significance of relationships between the research methodologies, data collection approach, and the techniques of data analysis. The author outlines the principal concerns thwarting the design of an appropriate methodology to solve research problems. These concerns are given below:

- Research concept – *What data is to be collected?*
- Significance – *Why is the data selected for the research?*
- Target population – *Where will the data will be collected?*
- Structure – *When will the data collection be coordinated?*
- Evaluation – *How will the data be collected and analysed?*

3.3.1 Quantitative research approach

A quantitative research approach, fundamentally the measurement of quantities and numbers (Kothari, 2004), is an orderly process of using numerical data from a selected sample group of a population to generalise findings to the population of study (Kuen-Shiou Yang, 2012). Therefore, this method uses a statistical approach of analysis and presents the results arithmetically (O’Leary, 2017). According to Thomas (2003), the quantitative research method

allows researchers to obtain generalisable and predictable results from population within a short period of time, and at a low cost. According to Flick (2015), a quantitative research approach is characterised by these three basic attributes, highlighted as follows: objectivity, arithmetical result (data), and generalisability.

An alternative description illustrates that a quantitative approach is a goal-oriented procedure of research that postulates inter-subjective realities as a standard for quality assurance (Kromre, 2006). As such, the data collection process for quantitative research involves the use of closed-ended questionnaires (Creswell & Clark, 2007). This process is guided by various methods such as theoretical studies, descriptive research, developmental studies (case studies and surveys) and correlational studies (Leedy & Ormrod, 2010) (refer to Table 3.1 below).

3.3.2 Qualitative research approach

This is an alternative research approach used widely in research processes with several adopted methods, techniques and philosophies (Leedy & Ormrod, 2005). The qualitative research approach comprises the collection and evaluation of various empirical data; for instance, observational, interviews, life stories and historical studies (Creswell & Clark, 2007). Moreover, a qualitative research approach involves an in-depth collection of descriptive data pertaining to a specific phenomenon with the aim of improving knowledge (O'Leary, 2017). Likewise, Flick (2015) posits that this approach is primarily about the acquisition of an intent of understanding social, cultural and behavioural patterns of people in an environment by interacting with the participants of the study. Significantly, the approach is an 'umbrella term' which houses and demonstrates the relationship between ranges of research paradigm (Creswell & Poth, 2017) (Table 3.1).

Table 3.1: Characteristic summary of qualitative and quantitative research approaches (Macdonald & Headlam, 2007)

Characteristics	Quantitative	Qualitative
Aim	The aim is to count things in an attempt to explain what is observed	The aim is a complete, detailed description of what is observed
Purpose	Generalisation, prediction, casual explanation	Contextualization, interpretation, understanding perspectives
Tools	Researchers uses tools, such as surveys, to collect arithmetical data	Researcher is the data-gathering instrument.
Data collection	Structured	Unstructured
Output	Data is in the form of numbers and statistics	Data is in the form of words, pictures or objects
Sample	Usually a large number of cases representing the population of interest, that is, randomly selected respondents	A small number of non-representative cases, so respondents are selected on their experience.
Objective/Subjective	Objective-seeks precise measurement and analysis	Subjective – individual's interpretation of events is important
Researcher role	Researcher tends to remain objectively separated from subject matter	Researcher tends to become subjectively immersed in the subject matter
Analysis	Statistical	Interpretive

3.3.3 Mixed method research

Mixed method research comprises the adoption of philosophical assumptions in the collection and analysis of both quantitative and qualitative data in a single research work (Creswell & Clark, 2007). This combination of both qualitative and quantitative approaches provides a better understanding on the research focus (Creswell & Clark, 2007). The mixed research approach gives the researcher an opportunity to increase the validity of the research, where one method covers-up for the lapses of the other, leaving no room for personal bias (Henn *et al.*, 2005). Thus, the mixed method enhances the integration of a variety of pragmatic and theoretical perspectives that have been perceived as a challenge to the quantitative and qualitative approaches separately (Fetters *et al.*, 2013). The advantages of integrating the qualitative and quantitative methods

postulated by Creswell and Clark (2007) are as follows mixed method research provides solutions to questions that qualitative or quantitative methods cannot solve unaided, mixed method research offers the researcher a wider and more complete perspective on the area of study, and mixed method research demands the use of various paradigms associated to qualitative and quantitative methods.

Equally, regardless of the merits of the mixed method research, researchers are confronted with some challenges in the course of using mixed research approach. These challenges, according to Creswell and Clark (2011), are highlighted as follow it complicates the process of data collection in research, it encourages long processing of multiple data collection and analysis, it requires multidisciplinary and specialised teamwork for data Interpretation, sampling size involves the design and data collection.

3.4 Research approach

3.4.1 Deductive research approach

The *deductive research method* involves processes such as the use of theory at the beginning of the study, generating a hypothesis from the theory and testing the hypothesis (Dahlberg & McCaig, 2010). This method, as described by Dahlberg and McCaig (2010), is a ‘top-down’ research method (Figure 3.2). The applicable theory is consulted purposely to guide the formulation of research questions (Punch, 2013). The factual content in conclusion of a deductive method is used principally in quantitative information research (Bryman, 2016).

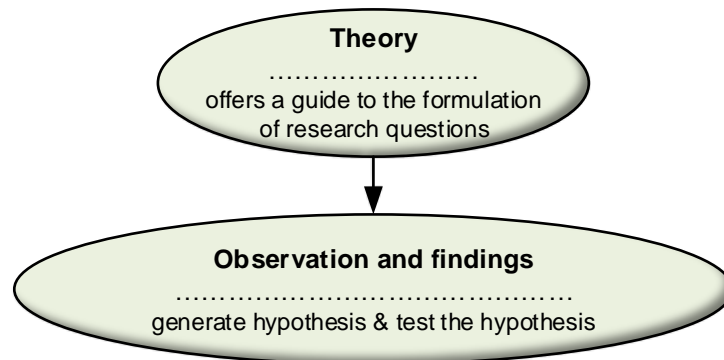


Figure 3.2: Deductive research method (Bryman, 2016)

3.4.2 Inductive research approach

The *inductive research method*, beginning with the collection of empirical data, allows change of questions, with the aim of introducing new questions at any point in the study (Dahlberg & McCaig, 2010). The approach is the opposite – a ‘bottom up’ research method that contributes to knowledge of reality and produces a theory (Figure 3.3). The evidence supporting the theory leads to a probable conclusion; that is, supporting statements steadily support the conclusion as reality becomes clearer (Baroni, 2009). Bryman (2016) argues that the inductive research method generates a theory, rather than testing the theory, and is mainly used in qualitative research. According to Punch (2013), researchers can begin the research process with an inductive investigative stage, and then generate a theory tested in a deductive descriptive stage.

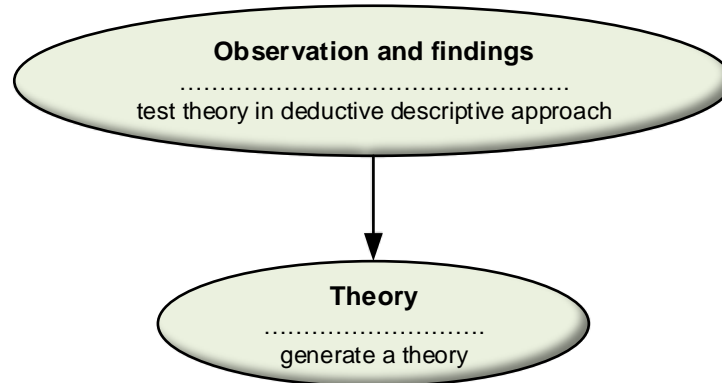


Figure 3.3: Inductive research method (Bryman, 2016)

3.5 Research strategies

3.5.1 Experimental designs

Research strategies, entailing a difficult and precise search for cause and effect, are considered a standard way of producing considerable confidence in the strength and credibility of causal findings (Bryman, 2016). Experimental designs require researchers to deliberately vary an independent variable. The design is comprised of goal-directed acts carried out on the study groups to analyse the impact of one on the other (Flick, 2015). Experimental design involves at least two experimental groups. Lewin (1946) enumerates a number of challenges that are paramount in the experimental design, as delineated as follow matching increase in difficulty – when carried out on more than one variable, variables with difficult determination such as attitude – pose a great challenge, and variable selection challenge – to serve as the basis of matching.

3.5.2 Survey research

Survey research is defined as the process of data collection through responses to questions posed to a range of individuals with regard to their characteristics, attitudes, ways of living or opinions through an administered questionnaire (O’Leary, 2017). The purpose of this form of research is to afford the researcher with statistical information, either on specific challenges that require improvement, or to test the strength of an existing theory (Punch, 2013). A survey researcher selects the kind of population that best suits an investigation of the topic, prepares appropriate research instruments and devises means of administering the instruments (Bryman, 2016). According to Dahlberg and McCaig (2010), response rate is an important factor in a survey exercise, allowing statistical efficiency and a generalised conclusion to the research population. Babbie (2013) specifies that survey research is the best method for collecting data from a study population that is too large to observe. Thus, survey research, according to Maree (2007), is characterised by the following large sample size, many variables measured to generate related hypothesis for testing, and results that can be generalised.

3.5.3 Historical research

Leedy and Ormrod (2010) define *historical research* as an effort undertaken by a researcher in interpreting historic events through the collection and analysis of historic documents or oral histories. Similarly, Walliman (2017) describes *historical research* as a systematic and objective process of locating, evaluating and integrating research findings to reach an accurate conclusion derived from past events. Tappen (2015) asserts that historical research is a systematic holistic process of describing, analysing and interpreting past events based on information derived from a selected population. Hill and Kerber (1967, as cited by Walliman, 2017), categorises the importance of a historic research to the researcher as follows it helps provide results to contemporary problems that occurred in the past, it stresses the relevance and defects of interfaces in the culture of a selected population (by asking ‘how’ and ‘why’ things happen), it creates room for the reassessment of the past-collated data supporting theories, hypothesis or generalised conclusion to bolster understanding of imminent trends.

Historic research requires a researcher to give critical, analytical scrutiny of minutes, reports or documents related to events or incidents (Broens *et al.*, 2007). Broens enumerates four types of historic research, applicable in general research, as follows primary source – archived document or original sources, secondary source – works of other scholars on focus of study, that is, literature

review, running records – documentaries maintained by organisations and recollection – oral histories and autobiographies.

3.5.4 Comparative research

According to Walliman (2017), *comparative research* is often used concurrently with its historical research. It is a systematic process of searching for the similarities and differences between occurrences over a specific period of time (Broens *et al.*, 2007). Comparative research involves the process of defining the research concepts, itemising them as operative variables, and generating the hypothetical relationships between the variables before performing a test on a hypothesis (Yanow, 2016). Therefore, a comparative researcher executes the comparison of the experiences of different people, with different backgrounds, based on conditions. Particularly, Broens *et al.* (2007) state that a comparative research offers a first-hand account of events that are usually reported by the observers, further explaining that the content of information derived from this strategy of research is validated, if not exaggerated facts.

3.5.5 Action research

Leedy and Ormrod (2010) describe *action research* as an applied research aimed at finding solutions to the indigenous problems of a specific group of people by using communal resource. Other researchers, Mcniff and Whitehead (2011) define *action research* as a form of analysis conducted by professional practitioners to evaluate and improve the existing work practices by resolving issues relating to their tasks. The fundamental aim of an action researcher, as a mediator, is to assist in planning and implementing effective solutions to problems suffered by the participants (Broens *et al.*, 2007). Though to successfully conduct an action research, it is required of a researcher to demonstrate the ability to understand and interpret the problems prior to proffering possible solutions (Coghlan, 2019). Coghlan (2019) highlights the following as characteristics of action research are it seeks to derive solutions to practical issues, it is aimed at affecting a change, it is an interactive strategy to knowledge development, it is a cyclic research process of planning, solution implementation and reasoning, and it requires the participation of the researchers and research sample.

3.6 Questionnaire design

According to Adler and Clark (2007), questionnaires are tools used for collection of data gathered based on the questions and statements organised, to obtain information from research respondents, without having to talk to them personally. Even so, questionnaires are designed as

simple yet robust enough to address relevant issues of research (Flick, 2015). The questionnaire design phase is a significant phase of research because it aids the realisation of the research objectives (De Vos *et al.*, 2011). Thus, the process of questionnaire design requires the researchers to consider with intensity the type of data to collect, and corresponding analytical methods for the data. Dahlberg and McCaig (2010) explain that, to the contrary, ineffective design of questionnaires aids inappropriate or inadequate realisation of right information in research. Therefore, designing an adequate questionnaire requires the following steps, as listed by Maree (2007) and Kuen-Shiou Yang (2012) are total appearance of the questionnaire – quality of paper used and font size, for example, question sequence – easy to answer questions, carefully named and thorough response categories and wording of questions – carefully selected clear words.

Kuen-Shiou Yang (2012) states that questionnaires are of various forms, mainly divided into two categories as open-ended questions and closed-ended questions.

3.6.1 Open-ended questions

The open-ended questions are questions asked without a specific guide for the patterns of answering the question. These forms of questions are typically designed with the participants' straight opinions in mind (De Vos *et al.*, 2011). Therefore, respondents are permitted to give comments and express their opinions (Kumar, 2012). Hopkins (2008) states that the other questions, closed-ended, are generally used to test research hypotheses, whereas the open-ended questions are most suitable in generating this research hypotheses. Hopkins adds that open-ended questions tend to explore and determine validity and reliability of the questionnaire. De Vos *et al.* (2011) and Leedy and Ormrod (2010) have compiled several advantages and disadvantages of open-ended questions.

3.6.1.1 Advantages of open-ended questions

- Participants respond to questions fairly with the guarantee of remaining anonymous.
- Respondents' views are revealed.
- Complex questions are answered accordingly with full justification.

3.6.1.2 Disadvantages of open-ended questions

- Data coding may be difficult.
- Time consuming for respondent to complete – thinking and writing.

- Answers are invariably different in content from the unstructured nature of the questions.
- Use of statistical analysis in this design has proven abortive.

3.6.2 Closed-ended question

Closed-ended questions are structured questions asked to obtain integrated responses from participants. De Vos *et al.* (2011) explain that closed-ended questionnaires provide a set of serial questions, requesting respondents to choose the most appropriate answers. Christensen *et al.* (2015) and Kumar (2012) affirm that the use of closed-ended questions in research gives the researchers the benefits of obtaining sufficient information to reach a more generalisable conclusion. Accordingly, Leedy and Ormrod (2010) agree that application of a closed-ended question in research yields several advantages and disadvantages.

3.6.2.1 Advantages of closed-ended questions

- Questions are short, precise and easy to answer.
- Coding and statistical analysis are easily done.

3.6.2.2 Disadvantages of closed-ended questions

- Answers are quite simple with no background details.
- Respondents may be persuaded to give answers they are unwilling to provide.
- As answering the questions is easy, answers given may misinform the researchers.
- Respondents' opinions might not be available as an option to choose from.
- Questionnaires are always too long.

3.7 Research design

Research design involves the planning and strategising of approaches required in conducting a research (Punch, 2013). In addition, research design is a holistic process that describes the general procedure of solving a research problem within a specific period of time – with data collection, data analysis and selection of relevant empirical materials (Leedy & Ormrod, 2010). Punch (2013) and Walliman (2017) identify the characteristics of a reliable research design as follows research design must aim at obtaining an assessable data: data derived should be statistically based, research design must be replicable within the same constraints by other researchers, and research design must state the suitable data analysis to be used and why.

The development or selection of a suitable research design for the current study is dependent on a number of factors: the phenomenon being studied, study participants, location of the survey and the researcher's survey experience (Kumar, 2012; Christensen *et al.*, 2015).

3.7.1 Research design for this study

Several research studies have been conducted over the years to evaluate factors that affect the effective operation of construction site worker safety, with the majority of the studies conducted to evaluate and improve the implementation of construction site worker safety; concentrating on the safety implementation requirements with the project objectives (Zhou *et al.*, 2015). This process will allow construction professionals to determine the effectiveness of safety implementation on sites.

This present study adopted a mixed method research approach to evaluate the effectiveness of site worker safety implementation. The mixed method approach was adopted for this research because it provides a more comprehensive perception of the phenomenon than either method separately (Leedy & Ormrod, 2010). Furthermore, the mixed research method aids the exploration of safety regulations and observations of construction professionals on the factors that affect the effective operation of construction site worker safety. Again, this research method was adopted specifically because it affords the opportunity to validate the data derived by using two or more research methods without favouritism. The qualitative method was applied to evaluate effective management techniques for site worker safety and evaluate the involvement of a construction management team on worker safety implementation on site. The quantitative method, alternatively, was used to collect data from the construction professionals (site managers, safety officers, quantity surveyors, architects and project managers) to elicit a comparative ranking of the effectiveness of the site worker safety implementation based on the level of importance, effectiveness and factors influence the effective operation of construction sites worker safety management. The research data was obtained with aid of a structured questionnaire survey (quantitative method), which was subsequently validated by conducting semi-structured interviews (qualitative method) shortly after the questionnaire survey. The quantitative method was adopted purposely to enable the researcher to identify the effectiveness of site worker safety implementation on construction sites. The results and conclusions of this study are thus reliable and generalisable.

3.7.2 Exploratory study

Exploratory study is an essential part of a research design that derives more knowledge on the research problem and provide solutions to the identified problems (Dahlberg & McCaig, 2010). Hence, Creswell (2011) recommends the pre-testing of a questionnaire, including groups within the larger group of possible participants. Piloting the research tool assists in determining the possibility of answering the research questions by using the data generated from the questionnaires, before proceeding to the main research study. The questionnaire used for the exploratory study was piloted amongst construction stakeholders, safety professionals and post-graduate students from Construction Management and Quantity Surveying department of Cape Peninsula University of Technology to certify the significance of the tool to the research. Similarly, Anderson *et al.* (1998) emphasise that the use of a pilot study questionnaire will improve the reliability of the research study. The retrieved questionnaires for the exploratory study were analysed using statistical package for social science (SPSS) package.

3.7.3 Research sampling technique

According to O'Leary (2017), the process of selecting elements of population to be included in a research is referred to as *sampling*. O'Leary (2017) further explains that a significant number of research samples are representative sample distributions and process characteristics that allow findings to be generalised to the entire population, as population samples make the research process manageable, the research adopts convenient and purposive sampling techniques. Considering the busy schedule of the project participants, questionnaires were administered to construction professionals in the Western Cape Province based on the accessibility to construction sites and availability of construction professionals and safety professionals on several sites. Marshall and Rossman (2014) express convenient sampling as a sampling technique adopted on the basis of availability and accessibility of respondents.

However, construction site supervisors and safety managers interviewed were purposively selected based on the direct working relationship between site supervisors, safety managers and construction labour. Participant site supervisors interviewed were experienced in construction, with adequate years of supervisory responsibilities in the construction sector. The experience of the site supervisors is arguably a helpful instrument to assess the validity of data obtained from construction professionals. Gubrium *et al.* (2012) describe *purposive sampling* as a sampling technique that enables researchers to select study participants with respect to their

characteristics, that is, participants with right information. Mertens (2014) argues that a purposive sampling strategy is a system where the researcher deliberately chooses a sample for a study, while having a purpose in mind. Similarly, O’Leary (2017) indicates that an adequate sample frame and large sample size prevent unbiased research, represent a population and present generalisable findings with respect to the population.

3.7.4 Data collection techniques

Data collection techniques entail the exploration of different sources of data for a research project. The framework presented in this research study is an outcome of secondary and primary data collected, as presented in the next chapter. Marshall and Rossman (2014) note that the two main forms of data collection in a research study are primary and secondary data. A triangulated data collection technique was adopted for this research. This study considers different types of data, and simultaneously determines the sources of data that best attain the aim of the research (McKim, 2017).

3.7.4.1 Secondary data collection

Secondary data, a set of data obtained from previous research conducted by any other researchers (Marshall & Rossman, 2014), can be gathered from a literature review based on information associated with the research. O’Leary (2017) stresses how vital access to past innovations for production of new knowledge is. Melville and Goddard (2004) illustrate that the secondary data (literature review) is obtainable in two different forms: a preliminary review (conducted in Chapter 1 to develop a framework); and a comprehensive review (conducted in Chapter 2 to evaluate and extend the views of other researchers on comparatively relevant topics).

Information derived from the previous studies determines the diverse factors that affect the effective operation of the construction site worker safety; specifically, the causal-effect of site accidents on construction site production. Other factors determined aided the design of the questionnaire. Comparatively, the majority of previous studies centred on the factors that affect the construction site worker safety efficiency and the causal-effect of site accidents on worker performance. However, expected criteria to adopt are the development of a framework that will enhance site worker safety during construction projects in South Africa. This process could be achieved through effective implementation of management techniques. Meanwhile, only an

insignificant amount of research has addressed the involvement of the construction management team on worker safety implementation on site. The sources of information for the literature review include textbooks, journals, articles, conference proceedings and theses.

3.7.4.2 Primary data collection

According to Leedy and Ormrod (2010), *primary data* is the most valid information obtained in a research as this method of data collection involves researchers ensuring that questions are designed for respondents in a clear and understandable manner, to produce thorough and fitting information (Piaw, 2012). Primary data for this study were collected through the administration of quantitative questionnaires to specifically selected survey respondents, as well as through face-to-face interviews conducted with site supervisors. The questionnaires were administered to respondents by hand and via the internet (survey monkey).

3.7.4.3 Interview

This method of data collection is qualitative in nature and commonly open-ended. However, Flick (2015) suggests that when conducting a qualitative interview, there should be dialogue between interviewer and interviewee. According to Leedy and Ormrod (2010), interviews in the survey are designed in two forms – structured and semi-structured – depending on the purpose of the survey.

Semi-structured qualitative interviews were chosen for the purpose of this research study due to its flexibility attribute. Furthermore, Piaw (2012) stresses that interviews offer a level of impulsiveness, flexibility, and authority to dialogue and interact with the survey respondents. Respondents were briefed about the relevance of the study prior to the commencement of the interview and given sufficient time to prepare in advance. The interview was tape-recorded with permission of the respondents. Three construction sites were selected for data validation. An interview was conducted with a safety officer on each construction site selected for data validation. Safety officers were selected because they are in the best position to disclose factors that affect the effective operation of the construction site worker safety management techniques. Emphatically, safety officers have relevant knowledge of the factors that affect the effective operation of construction site worker safety during construction projects.

3.7.4.4 Questionnaire design

The most significant aspect of any survey is the questionnaire design (Kumar, 2012; Piaw, 2012). This research questionnaire was designed in conformity with the study objectives and information derived from the reviewed literature as closed-ended questions. The questionnaire was structured in sections, with each section addressing a particular objective. Table 3.2 illustrates the relationship between the sections and study objectives. **The first section** of the questionnaire requests biographical details of survey participants. **The second section** of the questionnaire contains two subsections that address the first objective of this study, with the aim of evaluating the factors that affect the effective operation of construction site worker safety management techniques. This section considers barriers that frustrate the appropriate functioning of the operation of worker safety management on construction sites.

Table 3.2: Questionnaire design

Section	Section title	Section objective
1	Biographical information	
2	Barriers to the effective operation of construction site worker safety management techniques	Objective 1
3	Conditions that support effective management techniques for site worker safety	Objective 2
4	Condition that contributes to the following causal-effect of site accident on construction site production	Objective 3
5	Involvement of construction management team on worker safety implementation on site	Objective 4

The third section of the questionnaire is comprised of four subsections to ascertain the condition that support effective management system techniques for site worker safety in South Africa. This section contains questions such as the following: Does your company have a formal safety programme for employees? How frequently does your company undertake safety training for workers? How frequently does your company keep records of accidents on site? How frequently are incentives provided on site for good safety performance? **The fourth section** assesses the conditions that contribute to the following causal-effect of site accident on construction site production. **The fifth and final section** addresses the final objective of the research study, with

the intention of identifying the involvement of the construction management team on worker safety implementation on site.

3.7.5 Population and sample size

The space of units from which a sample is selected is called a *population* (Bryman, 2016). Sample population does not only refer to people being sampled in a study, but mainly depends on the nature of a researcher's study. O'Leary (2017) defines *population* as the total involvement of a defined class, objects or events. For the purpose of this research, as the poor implementation of a safety management system on construction sites is the determined problem that the research intends to address, the population for this study consists of construction workers, construction professionals and safety teams on South African construction sites.

In the simplest sample design, the sample frame is a list of elements comprising the population of a study (Babbie, 2013). Furthermore, Flick (2015) suggests that the sample of a study is to minimise representation of the population in terms of heterogeneity of the elements and representativeness of the variables. However, O'Leary (2017) discusses that the larger the sample in quantitative research project, the better the representation will be, and the more comprehensible the conclusions are. Thus, the sample frame for the research is an adequate representation of construction professionals, safety professionals and construction workers in South Africa.

The majority of survey participants are construction professionals, safety professionals with extensive construction knowledge, safety knowledge skills and formal educational background, with the exception of site supervisors with minimum formal education but adequate construction experience. Site managers, contract managers, project managers, site supervisors, architects, quantity surveyors, site engineers, safety managers and safety supervisors fulfil the selected sample to appropriately represent the population for the purpose of this study. Construction workers who constitute the sample for the research, as previously highlighted, are tasked with responsibilities on construction sites. Therefore, they are arguably a solid representation of the South African construction workforce.

3.7.6 Data analysis of the study

Data analysis includes tabulating, data testing, categorising, and examining results to address the purpose of a study (Yin, 2003). The quantitative and qualitative data gathered were using the

Statistical Package for Social Sciences (SPSS) software. Quantitative data obtained by questionnaires were analysed with descriptive statistics. Similarly, qualitative data were analysed technically by content analysis.

3.7.6.1 Descriptive statistics

Descriptive statistics in research analysis can be defined as the process of showing a set of quantitative data in clear formats; for example, tables and charts (Revelle, 2017). Marshall and Rossman (2014) suggest that the purpose of using statistical tools in data analysis is to display a straight, clear picture of a large amount of data. Leedy and Ormrod (2010) highlight three major terms used in descriptive statistical data analysis: central tendency measurements, dispersion measurements and frequency distributions. This study adopted the use of frequency distribution and central tendency measurement technique of analysing the quantitative data obtained in the survey using mean and standard deviations.

3.7.6.2 Content analysis

Content analysis primarily involves the coding and transcribing of human communication (oral or written) or other source of communication: internet blogs and videotape, for example (Leedy & Ormrod, 2010). Moreover, Flick (2015) adds that this method includes a summary of content, while omitting inappropriate words. In particular, content analysis is an effective method for answering a sizeable research question. When compared with the analysis of questionnaires, content analysis takes more time in terms of data processing and transcribing (Thomas, 2003) as content analysis adopts the inductive approach in exploring the advantages and disadvantages of a text or statement in order to support or oppose a theory in context. This study reports a summary of the relevant contents in the transcribed data obtained from the interviewees, while less important information was omitted in the reporting process.

3.8 Validity and reliability of the data

Validity and reliability of the research tool affect the genuineness of the research work. Marshall and Rossman (2014) clarify that the *validity* of a research tool indicates the degree to which the tool measures the reason for which it is designed, while the *reliability* offers certainty that there is steadiness and consistency in findings whenever it is regularly used. The principles of validity and reliability vary depending on the type of research conducted.

3.8.1 Validity

Validity of a research claims the originality of the survey tool and the research findings deducted (Marshall & Rossman, 2014). Leedy and Ormrod (2010) state that the validity of a research is the extent to which the instrument performs its application or task perfectly. Validity, then, refers to the credibility of a research finding (Marshall & Rossman, 2014). Validation test, such as the content analysis, were used to analyse the qualitative data collected and each interview was written out and checked for accuracy for respondent validation.

3.8.2 Reliability

Research *reliability* expresses the stability of a research result when used at different times or administered to different subjects from the population (Leedy & Ormrod, 2010). The major reason for ascertaining the reliability of a test is to reduce the inexactness and favourites in a survey (Srivastava & Thomson, 2009). The Cronbach's alpha test is one such statistical tool frequently used for evaluating the reliability of data (Girden & Kabacoff, 2010). Consequently, in the framework of this study, the reliability of the questionnaire was guaranteed by testing the questionnaire using Cronbach's coefficient alpha. It was well-known that the closer the coefficient is to 1, the more reliable the survey instrument is, with the best Cronbach's coefficient value above 0.7 (Cronbach, 1951).

3.9 Chapter summary

This chapter offers a comprehensive overview of the research methodology adopted in this present research study. A mixed research approach (quantitative and qualitative) was adopted to achieve the aim and objectives of the study. The quantitative research questionnaire was structured to elicit observations of construction professionals, safety officers and stakeholders to enhance site worker safety during construction projects in South Africa, through effective implementation of management techniques. Literature reviews, interviews and questionnaires were employed in collecting both primary and secondary data for this study. The distribution of the questionnaire included both 'online' and 'hand in' approaches. Subsequently, the reliability of the results was tested using Cronbach's alpha coefficient reliability test whilst validity was ensured, using content analysis to analyse the qualitative data collected to check for accuracy for respondent validation.

CHAPTER FOUR

4. Data Analysis

4.1 Introduction

This chapter presents the analysis of the data collected from the survey administered to construction professionals and safety officers. The questionnaire survey section illustrates the participant response rates in the variables defined as the characteristics of the respondents, exploratory studies undertaken in research instrument modification, and research instrument testing for reliability purposes. Alternatively, the interview section illustrates the summarised reports gathered during meeting with several selected participants, tabularising the structured analysis of the report in tables. The chapter subsequently presents the interpretation and discussion of findings with respect to the determination of problems that discourage the following:

- causes and effects of the site accident on the construction site production;
- effective management system techniques for site worker safety in South Africa;
- effective operation of construction site worker safety; and
- involvement of construction management team on worker safety implementation on site.

The results were properly interpreted and discussed prior to conclusions being drawn and recommendations made in Chapter 5 to confirm and validate the purpose of the study.

4.2 Pilot study

To substantiate the appropriateness and clarity of the questionnaires to be distributed, the research questionnaire was piloted among Master of Construction degree students in the department of Construction Management and Quantity Surveying, Cape Peninsula University of Technology. The students were requested to read the research instrument and make necessary comments. A total of 35 questionnaires were administered to construction professionals in Cape Town, South Africa. The respondents were requested to answer research questions and make comments where necessary. The input of the students and construction professionals were duly considered, and necessary adjustments were made in the formulation of the original questionnaire with respect to comments received and suggestions made.

4.3 Questionnaire survey for the main study

Quantitative data collection for this research was conducted through the use of questionnaire survey. A total of 220 questionnaires were administered to construction professionals, including project managers, site managers, safety officers, quantity surveyors and architects in the Western Cape Province of South Africa. During the exercise, 148 questionnaires were distributed to the selected respondents in total. Out of this number, only 72 questionnaires were appropriately completed and retrieved. As part of the process, electronic mail was used to distribute 72 questionnaires to other respondents, wherein only 13 questionnaires were completed and returned electronically. Eventually, 85 questionnaires were recovered, compiled and analysed.

4.4 Biographical information of respondents

4.4.1 Respondents' firms

The results in Table 4.1 illustrate the characteristics of the respondents from different work divisions, professions and organisations. The information was accumulated from the public and private sectors of the construction industry. The results demonstrate that an equal estimate of 43.5% respondents, as illustrated in the pie chart presented in Figure 4.1 below, were from *construction firms* and *government establishments*, respectively, whereas an estimate of 4.7% respondents were from *project management firms*, and 8.2% of the respondents were from *other construction firms*. The respondents were able to provide valid and reliable information based on the knowledge acquired from various firms.

With the illustrative chart below, it is clear that more respondents were involved from both *construction firms* and *government establishments*, more than any other firm that participated in the survey exercise. However, the smallest number of respondents was obtained from *project management firms*, showing that only a few of these respondents are not regularly on construction sites. This is perhaps due to their absence at the time of the researcher's visit to the construction site for the distribution survey questionnaires.

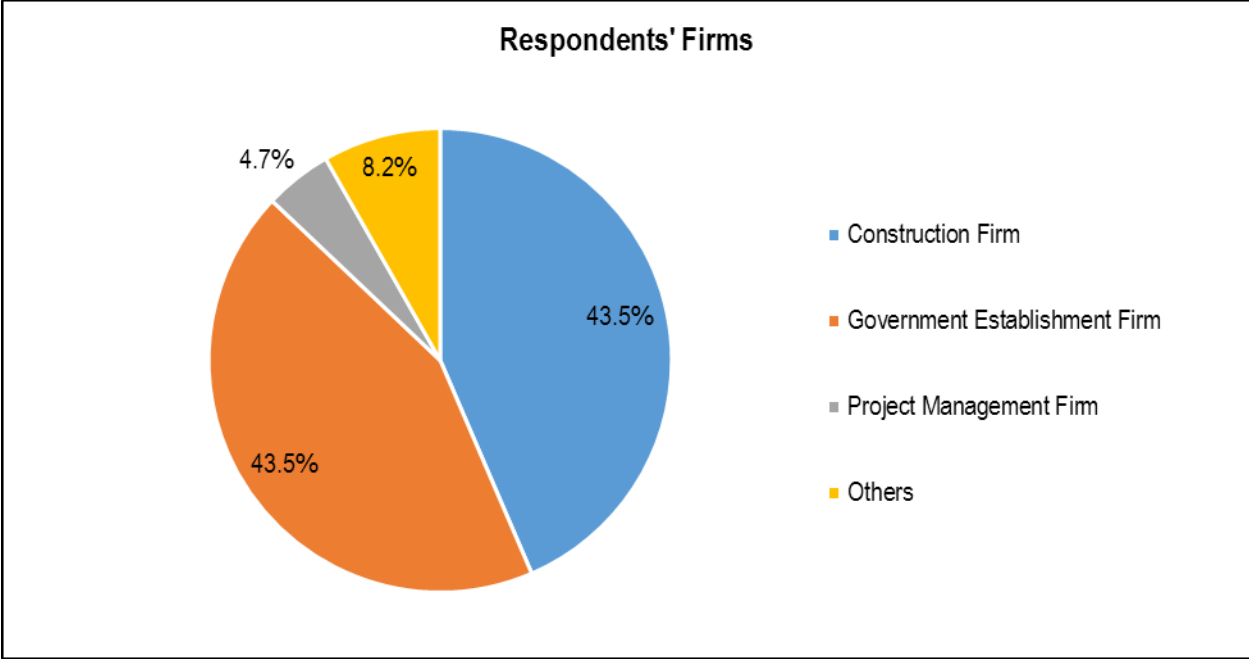


Figure 4.1: Chart illustrating the firms for which the respondents work

Table 4.1: Respondent details

Factors	Respondents	Percentage (%)
Respondents' firms	Construction Firm	43.5
	Government Establishment Firm	43.5
	Project Management Firm	4.7
	Others	8.2
Respondents' genders	Male	56.5
	Female	43.5
Respondents' ages	Below 26 Years	2.4
	26 – 30 Years	57.6
	31 – 40 Years	31.8
	41 – 50 Year	8.2
Respondents' qualifications	Diploma	68.2
	Bachelor's/Honour's Degree	31.8

Table 4.1 continued

Factors	Respondents	Percentage (%)
Respondents' jobs designation	Project Manager	23.5
	Site Manager	9.4
	Safety Officer	11.8
	Quantity Surveyor	8.2
	Architect	17.7
	Others	29.4
Respondents' years of experience	0 – 5 Years	15.3
	6 – 10 Years	18.7
	11 – 15 Years	45.9
	16 – 20 Years	5.1

4.4.2 Respondents' gender

As indicated in the chart below in regard to gender, 56.5% of the respondents were *male* respondents while the remaining percentage (43.5%) were *female* respondents; that is, the percentage of *male* respondents is higher than their *female* counterparts. However, information provided by respondents does not pose any gender discrimination for the purpose of the research. The information was presented based on closed-ended questions categorised under mixed methods, wherein no nepotism or inequality was encouraged during the survey exercise.

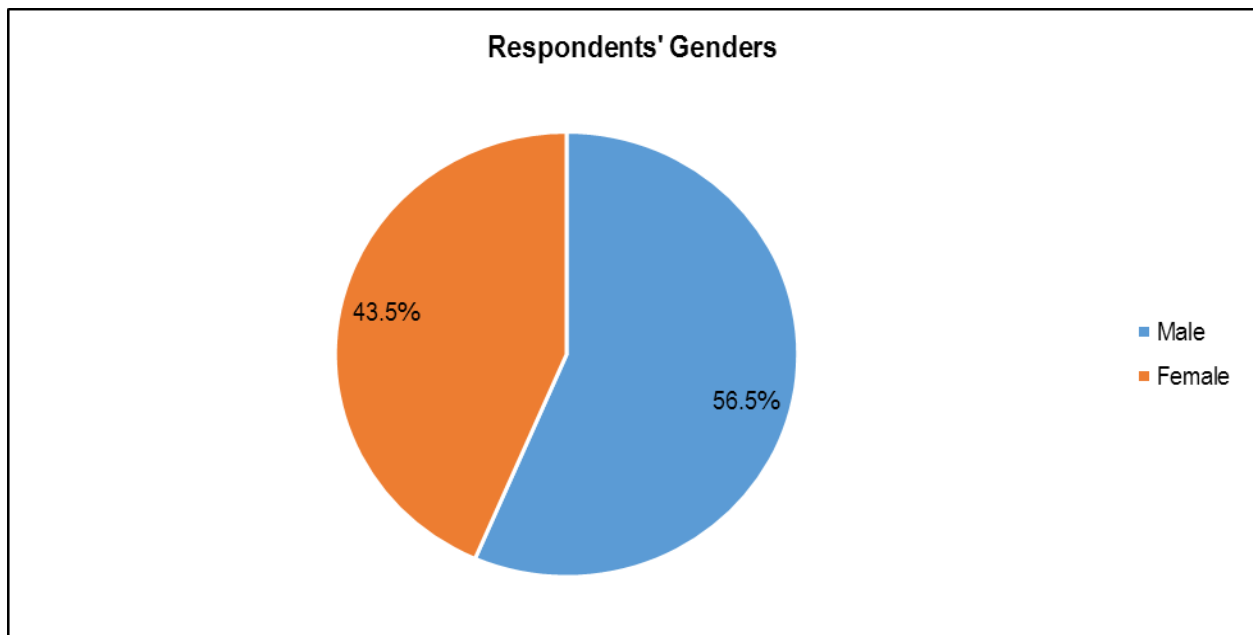


Figure 4.2: Chart illustrating gender of the respondents

4.4.3 Respondents' ages

Similarly, in the same table, the age of the respondents was distributed. It is observed that the age group with the lowest percentage falls below 26 years of age. The highest percentage of respondents' ages falls within the age group of 26 – 30 years old. The second highest percentage (31.8%) of respondents' ages falls within the age group of 31 – 40 years, while the second lowest percentage (8.2%) of respondents' ages falls within the age group of 41 – 50 years. The overview of the result indicates that 91.8% of respondents were not older than 40 years of age, while a nominal estimate of 8.2% were above 40 years of age. This deduction suggests that majority of the survey respondents are relatively young.

4.4.4 Respondents' qualifications

The qualification levels of the respondents were categorised into Diploma and Bachelor's/Honour's degrees. As presented in the table below, respondents holding a Diploma certificate represent 68.2% of the total participants, whereas respondents with a Bachelor's degree in their various fields represent 31.8%. This signifies that majority of the participants are Diploma certificate holders. With this indication, it is validated that respondents are knowledgeable and competent practitioners in the construction industry, wherein their judgement on issues surrounding construction safety are relevant and reliable.

4.4.5 Respondents' jobs designation

The current positions of the respondents in the industry were considered integral to the criteria necessary to validate their participation and competence for the survey exercise. As displayed in Figure 4.3 below, *project managers* were the largest group of respondents with an estimate of 23.5%, followed by *architects* and *safety officers*, with estimated percentages of 17.7% and 11.8%, respectively, while *site managers* and *quantity surveyors* have nominal estimates of 9.4% and 8.2%, correspondingly. *Other* titles held in the industry are estimated at 29.4%, constituting other construction professionals with various job designations. These estimates demonstrate the importance of seeking the opinion of these professionals in determining the problems causing inefficiency or frustrating construction site worker safety.

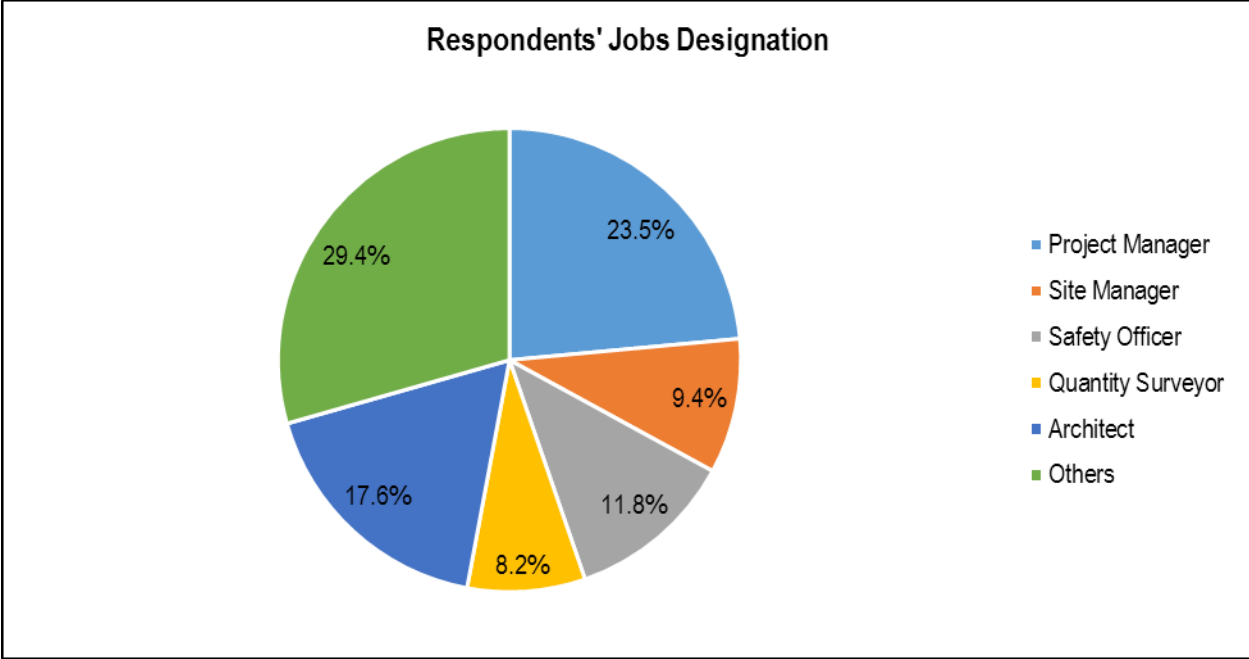


Figure 4.3: Chart illustrating job designations of the respondents

4.4.6 Respondents’ years of experience

The final section of the table illustrates the years of experience in the respondents’ current positions, with the interval categorised into four groups. According to the four groups, 45.9% of the respondents fall within 11 – 15 years of experience in their current positions, followed by 18.7% and 15.3% of the respondents who claim to be working in their current positions for 6 – 10 years and 0 – 5 years, respectively. A small percentage estimate of 5.1% is of respondents who have been occupying their current positions for a period of 16 – 20 years. These estimates reveal that the majority of respondents are currently occupying their positions not more than 16 years. However, this inference does not dispute the involvement of the respondents with work experience of 10 years or less in the survey exercise.

4.5 Testing the reliability of research instruments

The reliability of the questions used in the study were tested with Cronbach’s alpha coefficient, through the application of the SPSS software, to determine the reliability of research questions. The Cronbach’s alpha reliability test is an estimate of the internal consistency associated with the scores that can be derived from the scale or composite score (Cronbach, 1951; Tavakol & Dennick, 2011; Peterson & Kim, 2013).

Table 4.2: Testing for reliability of Likert scale questions

Questions No	Statement	Cronbach's Alpha coefficient
Section B1	Type of hazards	0.8
Section B2	Factors contributing to site accident	0.9
Section C1	Management techniques for workers safety	0.8
Section C2.1	Safety training for workers	0.7
Section C2.2	Record keeping	0.9
Section C2.3	Incentive for good safety performance	0.7
Section D1.1	Planning	0.7
Section D1.2	Organising	0.7
Section D1.3	Controlling	0.8
Section D1.4	Motivating	0.7
Section D2.1	Safety management related barrier	0.8
Section D2.2	Organisation related barrier	0.8
Section D2.3	Contractor related barrier	0.7
Section E1	Site manager factors	0.8
Section E2	Safety officer factors	0.9
Section E3	Contractor factors	0.9
Section E4	Client factors	0.7

Table 4.2 above presents the summary of reliability tests conducted on the scale questions. The Cronbach's alpha coefficient values are greater than 0.70. Tavakol and Dennick (2011) endorse that the score values between 0.75 – 0.95 are standardised values for proving the reliability of a test. Consequently, the results of the Cronbach's alpha coefficient tests were satisfactory in terms of reliability test requirements.

4.6 Presentation of findings

The study is designed to establish an effective implementation of management techniques in enhancing site worker safety in South Africa. From the findings, the factors that contribute to the causes and effects of site accidents on construction site production, effective management techniques for site worker safety, barriers to the effective management techniques of construction site worker safety, and involvement of construction teams on worker safety implementation on site, are presented.

4.6.1 Types of hazards on construction site

Table 4.3 below presents types of hazards on construction sites. Respondents were requested to indicate the level of their safety working on the each of the identified factors, following a four-point Likert scale of 1 = not safe, 2 = moderate, 3 = safe, and 4 = very safe. According to the affirmatives, as graphically demonstrated in Figure 4.4, an equal percentage estimate of 2.4% respondents claimed that *manual handling–carrying cement bags or bricks/block* and *working at height* posed a minimal hazard rate to construction site worker safety. On the contrary, as identified by respondents, *noise*, *handling heavy* and *overcrowded site* posed the highest hazard rates to construction site worker safety at estimates of 22.4%, 20.0% and 20.0% correspondingly.

Table 4.3: Types of hazards on the construction site

Type of hazard	Not safe		Moderate		Safe		Very Safe		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Manual handling–carrying cement bags or bricks/block	2	2.4	15	17.6	33	38.8	35	41.2	85	3.19	0.81	1
Working at height	2	2.4	14	16.5	37	43.5	32	37.6	85	3.16	0.78	2
Dust–mortal/cement	10	11.8	23	27.1	31	36.5	21	24.7	85	2.74	0.97	3
Overcrowded site	17	20.0	11	12.9	35	41.2	22	25.9	85	2.73	1.06	4
Handling heavy	17	20.0	22	25.9	21	24.7	25	29.4	85	2.64	1.11	5
Bending, twisting while laying block/bricks	8	9.4	31	36.5	30	35.3	16	18.8	85	2.64	0.90	6
Noise–using brick/block cutting machine	19	22.4	10	11.8	41	48.2	15	17.6	85	2.61	1.03	7

Based on the illustration above, it is deemed that a safer environment is ascertained for both *manual handling* and *working at height* than the other factors on construction sites. The distribution of the data analysed, as showed in the graph, demonstrates that more respondents indicated the ‘safe’ option more than any other option for the seven factors. In addition, for *manual handling* and *working at height*, having high mean values of 3.19 and 3.16, and lower standard deviation values of 0.81 and 0.78 show that the data analysed for these two factors concentrated on both ‘safe’ and ‘very safe’ options in the survey questionnaires. Although, in the case of *noise*, *handling heavy*, and *overcrowded site*, it is deduced that each of these factors have lower mean

values and higher standard deviation values that demonstrate a wide spread of data across the entirety of options in the survey questionnaire.

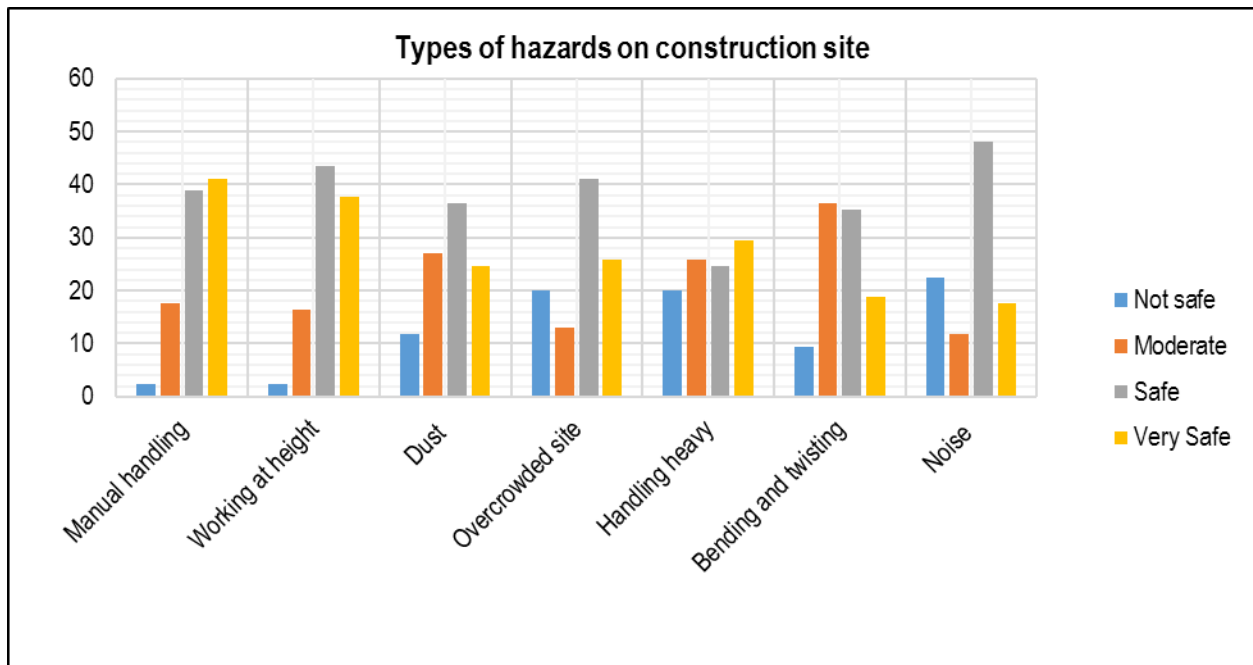


Figure 4.4: Graph illustrating types of hazards experienced on the construction site

In essence, a high number of respondents affirmed that such factors as *noise*, *handling heavy* and *overcrowded site* are highly hazardous. This determination requires urgent attention from the safety management group in charge of construction site project execution.

4.6.2 Factors affecting construction site production

The perceptions of the respondents pertaining to factors that affect construction site production are presented in Table 4.4 below. Respondents were requested to indicate the extent to which these factors affect production. A four-point scale option was presented, where 1 = to a little extent, 2 = to some extent, 3 = to a large extent, and 4 = to a very large extent.

From the tabularised figures, it is clear that a fewer numbers of respondents, with equal percentage estimates of 18.8%, affirm that two factors – namely *transporting mobile construction plant* and *ladders not properly placed* – have only a minimal effect on the construction site production: “to a little extent”; while substantial percentage estimates of 52.9% and 42.4% of the respondents, respectively, opposed that these two factors have a large effect on the construction site production: “to a very large extent”.

Table 4.4: Factors that affect construction site production

Factors	To a little extent		To some extent		To a large extent		To a very large extent		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Transporting mobile construction plant	16	18.8	6	7.1	18	21.2	45	52.9	85	3.08	1.17	1
Poorly maintained tools	10	11.8	10	11.8	36	42.4	29	34.1	85	2.99	0.97	2
Ladders not properly placed	16	18.8	10	11.8	23	27.1	36	42.4	85	2.93	1.14	3
Falling objects	16	18.8	12	14.1	27	31.8	30	35.3	85	2.84	1.11	4
Unguarded openings in floors and walls	16	18.8	16	18.8	21	24.7	32	37.6	85	2.81	1.14	5
Failure of platforms and scaffolds	16	18.8	16	18.8	25	29.4	28	32.9	85	2.76	1.11	6
Untidy construction site	16	18.8	25	29.4	11	12.9	33	38.8	85	2.72	1.17	7
Unguarded edges of platforms	22	25.9	16	18.8	15	17.6	32	37.6	85	2.67	1.23	8
Worker exposure to fumes	12	14.1	29	34.1	22	25.9	22	25.9	85	2.64	1.02	9
Untimbered trenches	28	32.9	0	0	33	38.8	24	28.2	85	2.62	1.22	10
Exposure to overhead live cable	23	27.1	14	16.5	20	23.5	28	32.9	85	2.62	1.21	11
Manual lifting of heavy weights	23	27.1	6	7.1	44	51.8	12	14.1	85	2.53	1.04	12
Exposure to underground cable	27	31.8	8	9.4	29	34.1	21	24.7	85	2.52	1.18	13
Exposure to high level of noise	18	21.1	23	27.1	26	30.6	18	21.2	85	2.52	1.05	14
Exposure to vibration	16	18.8	27	31.8	28	32.9	14	16.5	85	2.47	0.98	15
Exposure to dust on site	20	23.5	25	29.4	26	30.6	14	16.5	85	2.40	1.03	16

On the other hand, further findings reveal that two factors – namely *untimbered trenches* and *exposure to underground cables* – have a close variation in values with respect to their degree of extent in affecting the construction site production. The deduction illustrates the major variations in the factors that affect construction site production, as affirmed by the respondents. Numerically, it is determined that close percentage estimates of 32.9% and 31.8% of respondents accentuated that *untimbered trenches* and *exposure to underground cables* considerably affect the construction site production: “to a little extent”; while other close percentage estimates of 28.2% and 24.7% of respondents, correspondingly, oppose that the two factors affect the construction site production: “to a very large extent”.

From the same table, the above-discussed factors produced mean values of 3.08, 2.93, 2.62 and 2.52 respectively, while the standard deviation computed for these four factors are 1.17, 1.14, 1.22 and 1.18, respectively. Generally, these values signify that the distribution of the data analysed demonstrate minimal variations across the entire data set, from the highest mean values to the lowest mean values, and from the lowest standard deviation values to the highest standard deviation values.

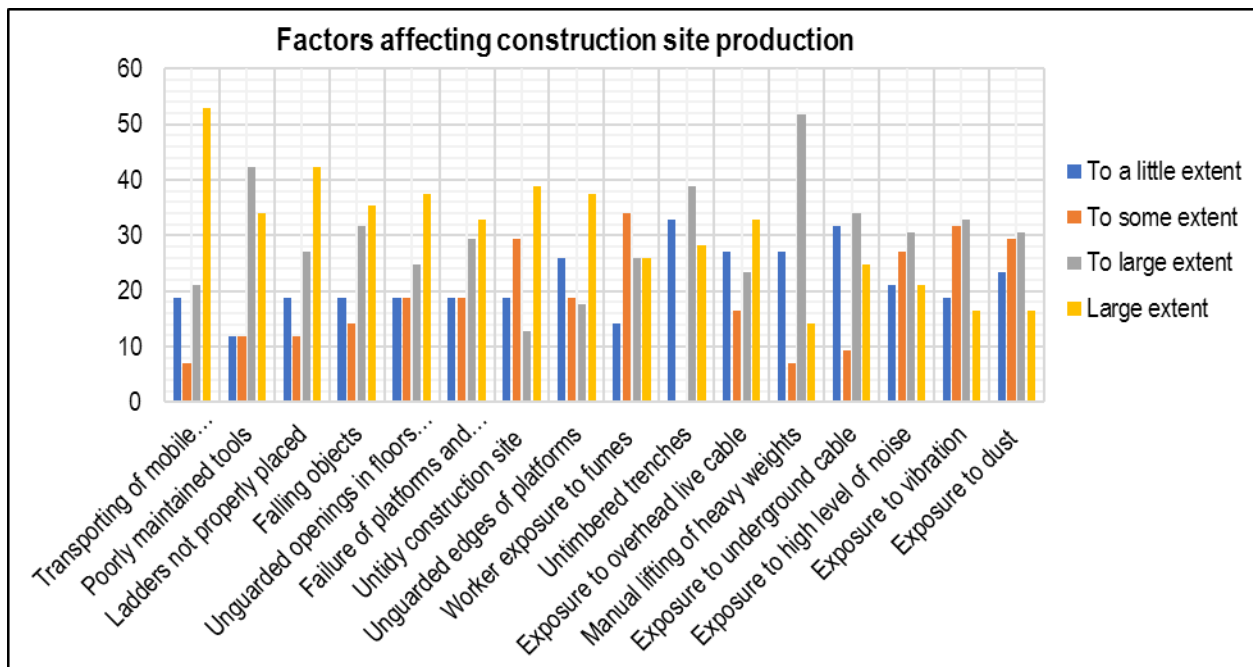


Figure 4.5: Graph illustrating factors that affect construction site production

Graphically, as displayed in **Figure 4.5**, data distribution for “to a little extent”, “to a large extent”, and “to a very large extent” across the entire realm of factors indicate more responses from the respondents. In the case of the fourth option (“to some extent”), fewer respondents indicated this particular option, illustrating that a large number of these factors do affect construction site production, whereas in some cases, they only minimally affect construction site production.

4.6.3 Measures for effective management techniques for site worker safety

Respondents were asked to evaluate ten factors for effective management techniques for site worker safety on construction sites. Data tabularised in Table 4.5 below illustrate the factors used to quantify the effective management technique for construction site worker safety. In the table, it is noted that “unimportant” scored zero responses across the ten factors. Observably, 76.5% respondents affirmed that effective management techniques applied in implementing safety for

site workers is predominantly “very important” in the *respond to employees’ complaints*, while 9.4% of the respondents claimed that effective management technique is “less important” in the *safe auditing*. Numerically, this result is the highest, followed by four other factors with equal percentage estimates of 8.2% responses.

Table 4.5: Effective management technique for site worker safety

Factors	Un important		Less important		Important		Very important		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Establishing safety training and orientation	0	0	0	0	23	27.1	62	72.9	85	3.73	0.43	1
Accident investigation and record keeping	0	0	6	7.1	18	21.2	61	71.8	85	3.65	0.61	2
Enforce safety guidelines	0	0	0	0	30	35.3	55	64.7	85	3.65	0.48	3
Fire prevention and fire fighting provision	0	0	0	0	31	36.5	54	63.5	85	3.64	0.48	4
Safety auditing	0	0	8	9.4	16	18.8	61	71.8	85	3.62	0.65	5
Respond to employees’ complaints	0	0	7	8.2	13	15.3	65	76.5	85	3.60	0.86	6
Management commitment to workers safety	0	0	0	0	34	40.0	51	60.0	85	3.60	0.49	7
Conduct toolbox meeting	0	0	7	8.2	21	24.7	57	67.1	85	3.59	0.64	8
Construction operatives’ appraisal	0	0	7	8.2	26	30.6	52	61.2	85	3.53	0.65	9
Assignment of safety responsibility	0	0	7	8.2	34	40.0	44	51.8	85	3.44	0.65	10

According to the distribution of data across the ten factors, as displayed in Figure 4.6 below, other observable results demonstrate that respondents largely affirm that all ten factors are either “very important” or “important” in terms of effective management techniques for site worker safety.

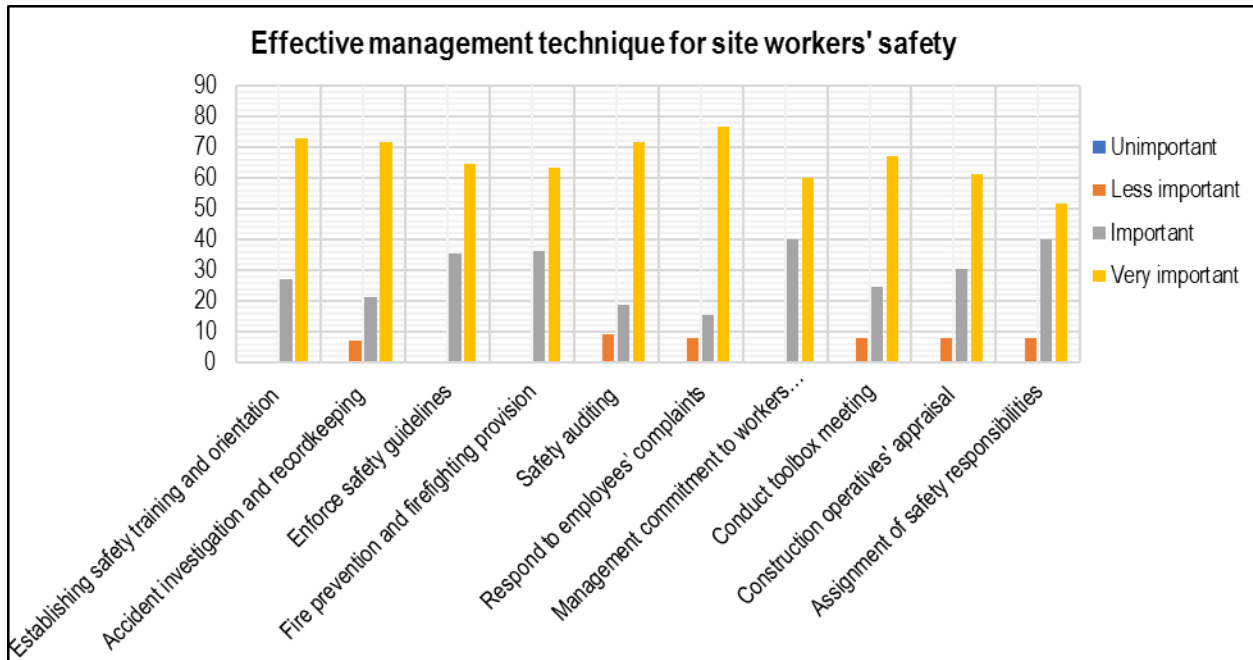


Figure 4.6: Graph illustrating effective management techniques available for site worker safety

To support the above statement, from the size of the mean values and standard deviations, the data distribution is lopsided because the factor with the highest mean value produced the smallest standard deviation, while the factor with the smallest mean value yielded the second highest standard deviation, thereby indicating high variation differences between the dataset categorised under each factor.

4.6.4 Companies' safety training undertaken for workers

The perceptions of respondents on companies' safety training undertaken for workers on site were quantified. A four-point evaluation scale was used, whereby respondents were requested to indicate the efficiency level of safety training implemented by companies for workers on site. The four-point evaluation scale included 1 = ineffective, 2 = less effective, 3 = effective, and 4 = very effective.

From Table 4.6 below, it is evident that equal numbers of respondents (81.2%) indicated that both *conducting safety training and meetings* and *safety induction for project inception* are "very effective" in the implementation of safety training exercises by construction companies.

Table 4.6: Safety training initiatives exercised by construction firms for site workers

Factors	Ineffective		Less effective		Effective		Very effective		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Conducting safety training and meeting	0	0	0	0	16	18.8	69	81.2	85	3.81	0.39	1
Training on the application of safety equipment	0	0	0	0	17	20.0	68	80.0	85	3.80	0.40	2
Safety induction for project inception	0	0	7	8.2	9	10.6	69	81.2	85	3.73	0.61	3
Training on the application of PPE	0	0	0	0	30	35.3	55	64.7	85	3.65	0.48	4
Safety induction for visitors	0	0	0	0	32	37.6	53	62.4	85	3.62	0.49	5
Issue of safety booklet or leaflet	0	0	4	4.7	59	69.4	22	25.9	85	3.21	0.51	6

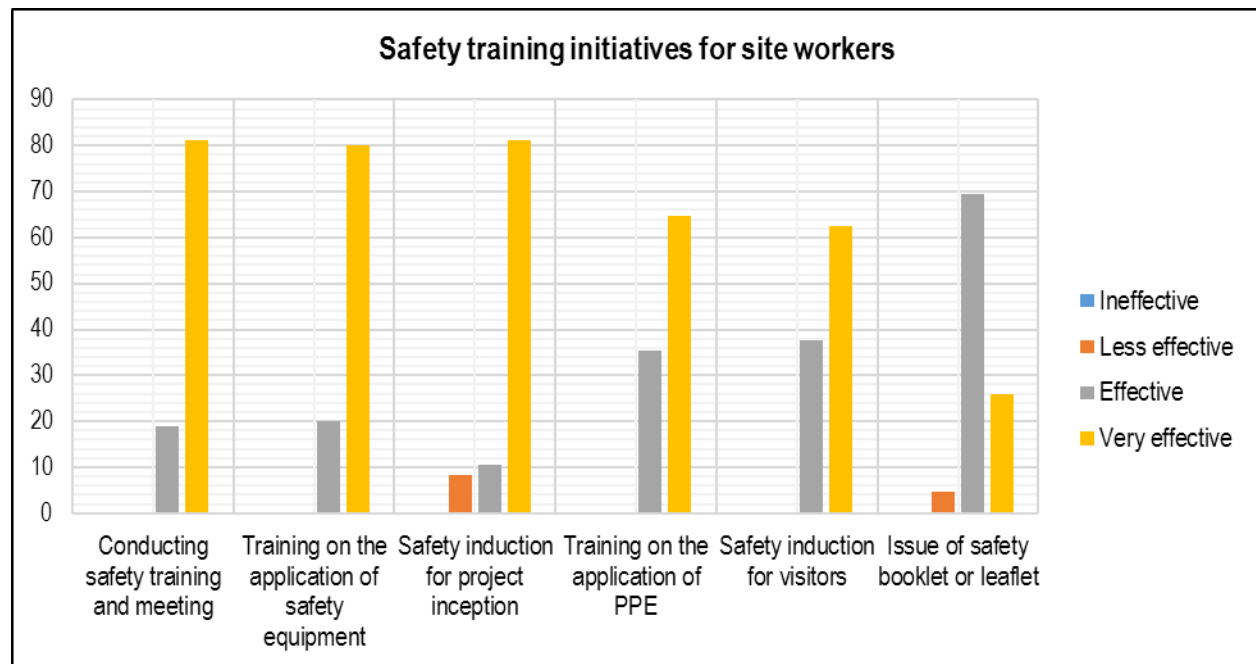


Figure 4.7: Graph illustrating safety training initiatives executed by construction firms for site workers

More so, only the factor of *issue of safety booklet or leaflet* was affirmed by 25.9% respondents to be minimally “very effective” as compared to the other factors. To the contrary, 8.2% of the

respondents claimed that *safety induction for project inception* is “less effective” in the implementation of safety training exercises by construction companies, followed by *issue of safety booklet or leaflet*, with an estimate of 4.7% respondents. Explicitly, as presented in Figure 4.7 above, the distribution of data demonstrates that more respondents affirmed that safety training initiatives implemented by construction companies are either “very effective” or “effective”.

In that case, mean values and standard deviations obtained indicate the spread of the data across the factors, wherein the data structure is lopsided with one of the options, “ineffective“, having zero responses throughout the factors, and “less effective” garnering only total estimates of 2.0% responses. This illustration shows that safety-training initiatives executed by construction companies are feasibly efficient toward the safety of the construction workers, having total estimates of 98.0% responses representing both “very effective” and “effective”.

4.6.5 Record keeping of accidents on site

The respondents’ perceptions were evaluated to determine the efficiency of record keeping of accidents on site to promote worker safety management. A four-point scale approach was used to evaluate the respondents’ perceptions regarding the effectiveness level of record keeping of accidents on site. The scale was dimensioned as 1 = ineffective, 2 = less effective, 3 = effective, and 4 = very effective.

Table 4.7: Recordkeeping of accidents on site

Factors	Ineffective		Less effective		Effective		Very effective		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Number of reportable injuries	7	8.2	0	0	35	41.2	43	50.6	85	3.34	0.85	1
Accident frequency rate	7	8.2	4	4.7	32	37.6	42	49.4	85	3.28	0.90	2
Number of dangerous occurrences	0	0	11	12.9	45	52.9	29	34.1	85	3.21	0.66	3
Number of minor injuries	7	8.2	17	20	13	15.3	48	56.5	85	3.20	1.03	4
Number of fatalities	0	0	23	27.1	29	34.1	33	38.8	85	3.12	0.81	5

Numerically, in Table 4.7, 56.5% of the respondents claimed that documentation of *number of minor injuries* is “very effective” on the construction site, followed by *number of reportable injuries*

with an estimate of 50.6% respondents. It is further observed that *number of dangerous occurrences* is the only factor with the smallest responses of 34.1% as “very effective” record keeping of accidents, but producing the highest responses of 52.9% is “effective” record keeping of accidents on the construction site.

Similarly, concerning the “less effective” and “ineffective” record keeping of accidents, 27.1% of the respondents indicated that *number of fatalities* are “less effectively” recorded on the construction site, followed by *number of injuries* with an estimate of 20.0% responses. Considering the “ineffective” record keeping of these factors on the construction site, an equal estimate of 8.2% of the respondents claimed that such factors as *number of reportable injuries*, *accident frequency rate*, and *number of minor injuries* are “ineffectively” recorded.

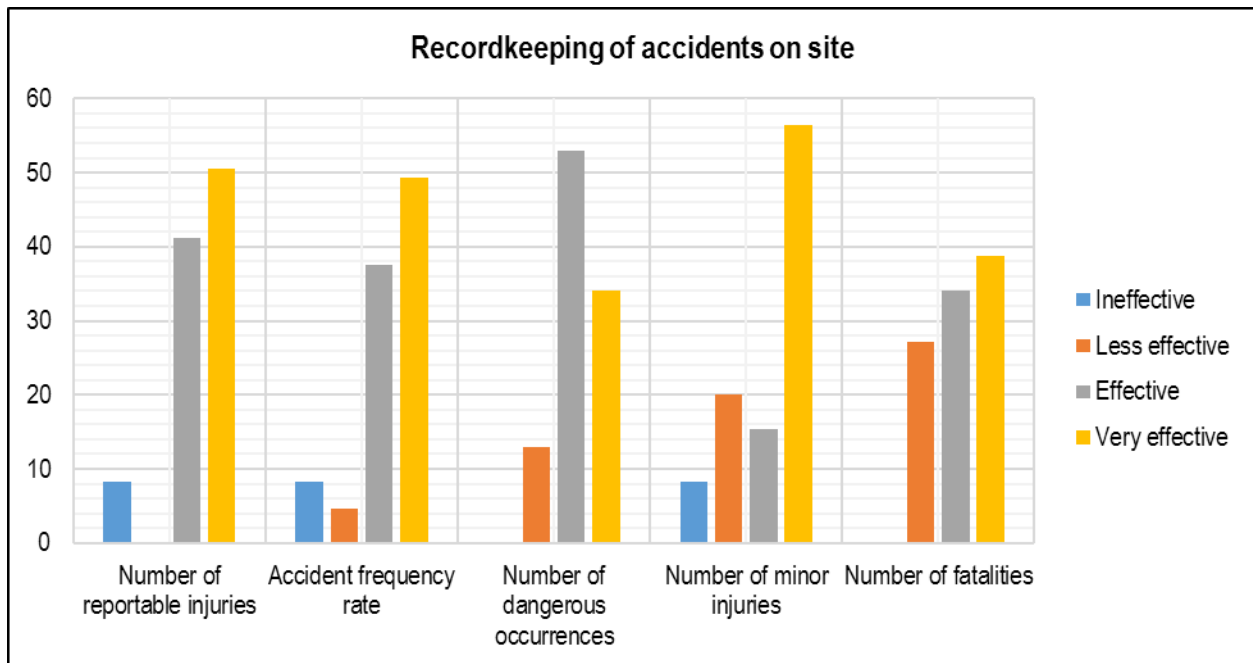


Figure 4.8: Graph illustrating documentation of accidents on construction sites

Graphically, as displayed in Figure 4.8, distribution of the data analysed across the entire realm of factors indicates that data mainly clustered around two options – namely “effective” and “very effective” – more than the other two options, with zero or few responses from the respondents. Both “very effective” and “effective” were represented by 82.0% of the data, while the remaining quota (18.0%) represents both “less effective” and “ineffective”. This implies that a large number of respondents have strong confidence in the accident record keeping procedures used on the construction site.

From the graph, further observations disclose that only two factors have the representation of the four options: *accident frequency rate* and *number of minor injuries*. This signifies that some respondents considered the procedures followed in documenting these two factors as either largely effective or minimally effective.

4.6.6 Provision of incentives for good safety performance

In this subsection, data distribution of provision of incentives for good safety performance is presented in the Table 4.8. Similar metrics used for the collection of data in the record keeping of accidents is appropriately applied in this section. The metrics are dimensioned as 1 = ineffective, 2 = less effective, 3 = effective, and 4 = very effective.

Table 4.8: Provision of incentives for good safety performance

Factors	Ineffective		Less effective		Effective		Very effective		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Provision of PPE	0	0	0	0	35	41.2	50	58.8	85	3.59	0.49	1
Provision of overtime allowance	2	2.4	21	24.7	17	20.0	45	52.2	85	3.24	0.91	2
Provision of bonus for workers	0	0	15	17.6	37	43.5	33	38.8	85	3.21	0.73	3
Construction operatives' appraisal	0	0	17	20.0	39	45.9	29	34.1	85	3.14	0.73	4

Tabled data clarify that 58.8% of the respondents specified that *provision of PPE* is “very effective” when providing incentives for safety performance on the construction site, followed by *provision of overtime allowance* with an estimate of 52.2% responses. The lowest of all is *construction operatives' appraisal*, with an estimate of 34.1% responses. Conversely, a total estimate of 27.1% of the respondents considered that *provision of overtime allowance*, among the four factors, lacks provision of incentives for good safety performance.

In addition, according to the respondent responses, only *provision of PPE* among all four factors demonstrated adequate provision of incentives for good safety performance. This necessitates safety management to realign their priority when it concerns safety improvement in providing primary incentives to sustain construction activities within a safe environment; that is, the safety of the workers should often be a company's priority in terms of physical health, performance improvement and overtime payment.



Figure 4.9: Graph illustrating provision of incentives for good safety performance

According to Figure 4.9, general observations validate that respondents largely indicated that these four factors are given thoroughly adequate provision to construction workers during any construction activities in South Africa, since numerical finding shows that options “very effective” and “effective” represent a total estimate of 88.8%, while the other two options, “less effective” and “ineffective”, represent the remaining quota (11.2%).

4.6.7 Influence of planning factors on the effective management techniques of construction site worker safety

Analysis performed on the influence of planning factors on effective management techniques for worker safety on construction sites presents results obtained through the application of evaluation metrics dimensioned as follows: not influential = 1, less influential = 2, influential = 3, and very influential = 4, as revealed in Table 4.9 below.

From the table, it is observed that respondents preferably affirmed that planning factors are very influential concerning effective management techniques for worker safety: 100% of all responses represent either “very influential” and “influential”, while zero responses represents either “less influential” and “not influential”. Numerically, 70.6% of the respondents asserted that *measures to control hazards and exposure* have great influence on the effective management techniques for worker safety, followed by *improving workplace safety*.

Table 4.9: Influence of planning factors on effective management techniques of construction site worker safety

Planning factors	Not influential		Less influential		Influential		Very influential		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Measures to control hazards and exposure	0	0	0	0	25	29.4	60	70.6	85	3.71	0.46	1
Improving workplace safety training programmes	0	0	0	0	32	37.6	53	62.4	85	3.62	0.49	2
Advocate for safety practices at levels	0	0	0	0	39	45.9	46	54.1	85	3.54	0.50	3
Improving near miss investigation and reportage	0	0	0	0	44	51.8	41	48.2	85	3.48	0.50	4

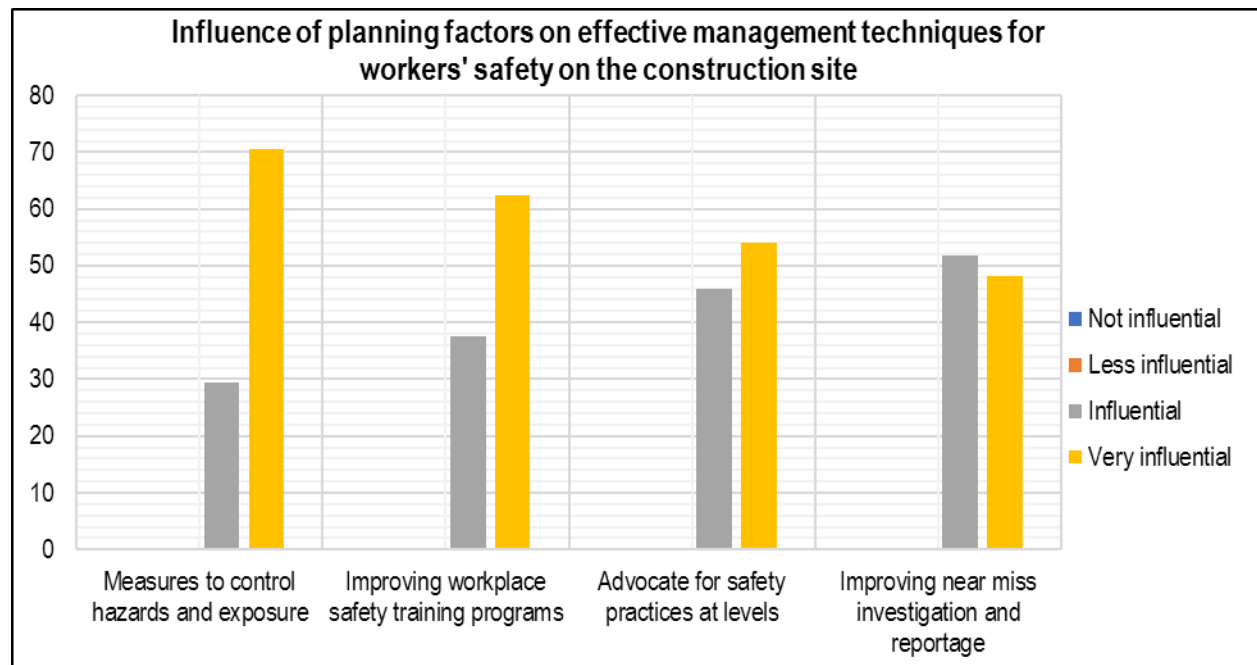


Figure 4.10: Graph illustrating impact of planning factors on effective management techniques

training with an estimate of 62.4% of the respondents. However, the factor with the smallest estimate of “very influential” regarding effective management techniques is *improving near miss investigation and reportage*, with an estimate of 48.2%. Other findings show that 51.8% of the

respondents still consider *improving near miss investigation and reportage* as an influential factor but not considerably affecting effective management technique toward worker safety. Figure 4.10 above reveals that distribution of data throughout the four planning factors is spread between two options, “very influential” and “influential”, an observation illustrating that construction management teams should be tasked to minimise the influence of these four planning factors on effective management techniques.

4.6.8 Influence of organising factors on effective management techniques of construction site worker safety

In this subsection, the influence of organising factors on effective management techniques is discussed to ascertain their level of impact on construction site worker safety. The data displayed in Table 4.10 contains the distribution obtained in the analysis of organising factors through application of metrics dimensioned as follows: not influential = 1, less influential = 2, influential = 3, and very influential = 4.

Table 4.10: Influence of organising factors on effective management techniques of construction site worker safety

Organising factors	Not influential		Less influential		Influential		Very influential		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Ensure effective company policy for safety	0	0	0	0	26	30.6	59	69.4	85	3.69	0.46	1
Awareness of individual responsibility for causal workers	0	0	0	0	29	34.1	56	65.9	85	3.66	0.48	2
Funds and facilities arrangement for company policy and legislation	0	0	2	2.4	30	35.3	53	62.4	85	3.60	0.54	3
Adequate and appropriate provision of training	0	0	6	7.1	23	27.1	56	65.9	85	3.59	0.62	4

The findings derived establish that only two factors out of the four organising factors are “less influential” on the effective management techniques for worker safety on construction sites. Statistically, *adequate and appropriate provision of training* was declared by an estimate of 7.1% of the respondents as a “less influential” factor in terms of effective management techniques for

worker safety, followed by *funds and facilities arrangement for company policy and legislation* with an estimate of 2.4% responses. Further understanding shows that *ensure effective company policy for safety* has the greatest influence on the effective management technique for worker safety, with an estimate of 69.4% of the respondents, followed by *awareness of individual responsibility for causal workers* with an estimate of 65.9% responses.

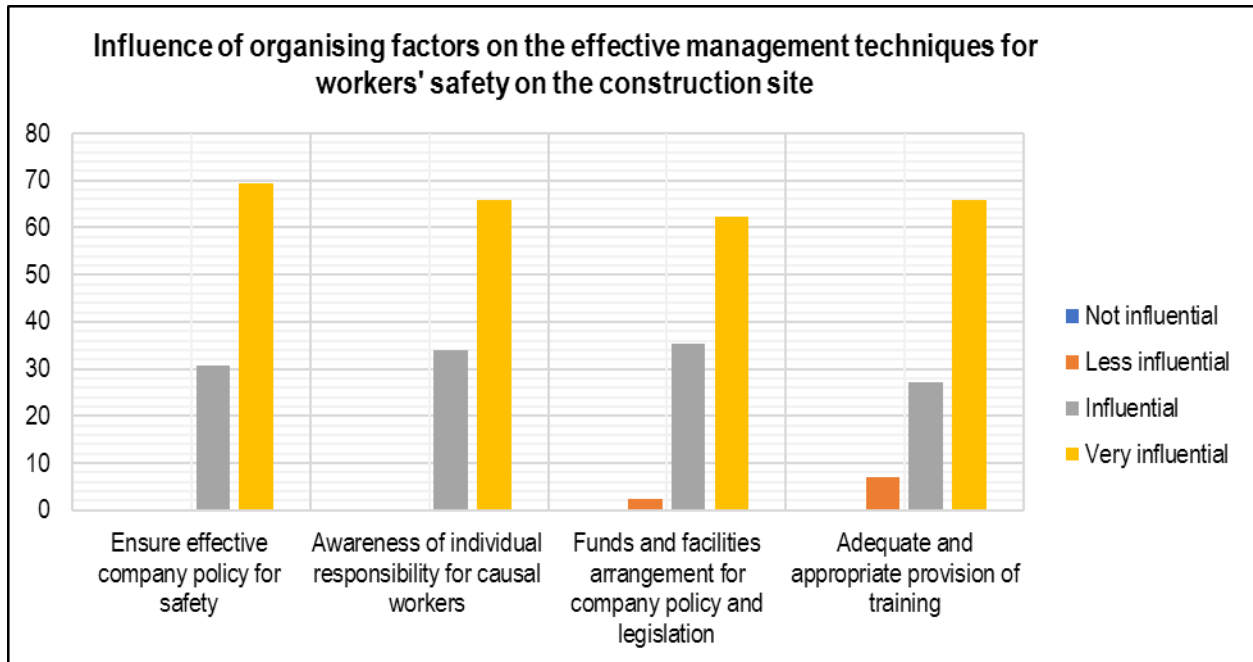


Figure 4.11: Graph illustrating impact of organising factors on effective management techniques

Graphically, as displayed in Figure 4.11, it is evident that the distribution of data across the four organising factors demonstrates little difference in values in the options “very influential” and “influential”, but options like “less influential” and “not influential” are sparsely represented.

4.6.9 Influence of controlling factors on effective management techniques of construction site worker safety

In this subsection, a scale of not influential = 1, less influential = 2, influential = 3, and very influential = 4 metrics was applied to quantify dimensionally each controlling factor’s influence level on effective management techniques for worker safety on the construction site.

Table 4.11 below shows that respondents perceived that all the three factors have an influence on the effective management techniques for worker safety on construction sites,

Table 4.11: Influence of controlling factors on effective management techniques of construction site worker safety

Controlling factors	Not influential		Less influential		Influential		Very influential		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Assign responsibilities for implementing the emergency plan	0	0	0	0	25	29.4	60	70.6	85	3.71	0.49	1
Develop plans to control hazards in emergency situations	0	0	0	0	31	36.5	54	63.5	85	3.64	0.84	2
Conducting emergency drills to control emergency situations	0	0	0	0	43	50.6	42	49.4	85	3.49	0.50	3

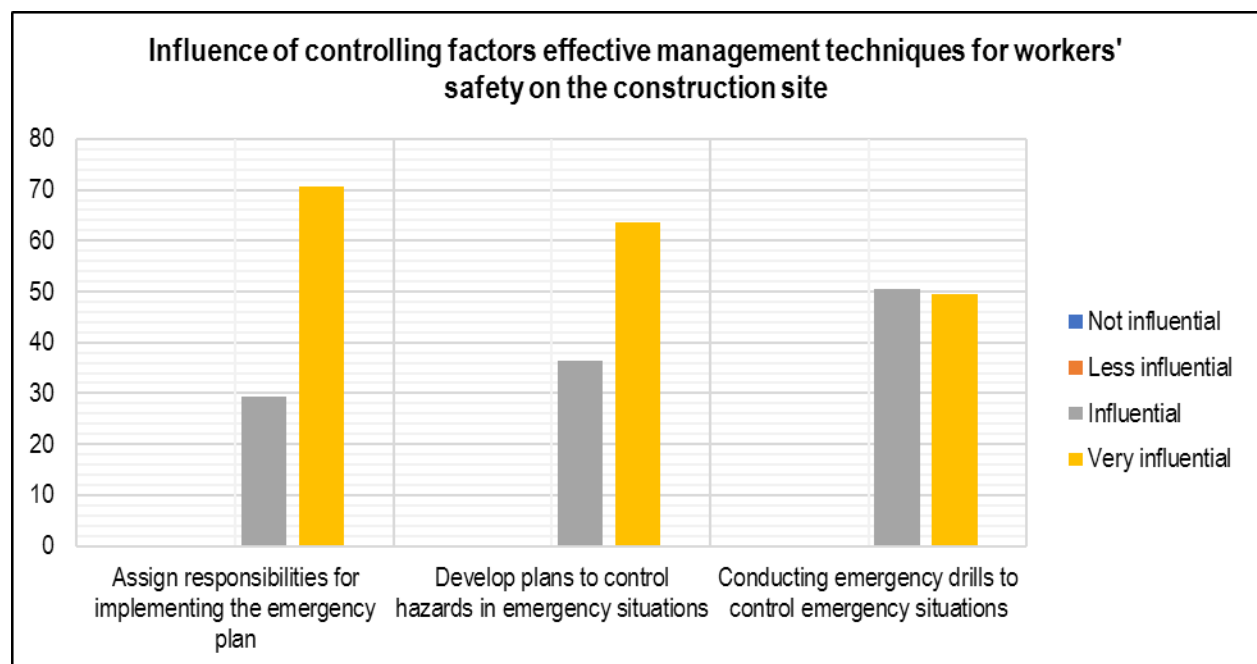


Figure 4.12: Graph illustrating impact of controlling factors on effective management techniques whether high or low influence. Numerical analysis demonstrates that *assign responsibilities for implementing the emergency plan* is indicated as a controlling factor with a “very influential” impact of 70.6%, as claimed by the respondents, followed by *develop plans to control hazards in emergency situations* with an estimate of 63.5% responses. From another perspective, *conducting*

emergency drills to control emergency situations was considered as a controlling factor with less influence on effective management techniques for worker safety on the construction sites.

From the graph presented in Figure 4.12 above, close estimate values of “very influential” (49.4%) and “influential” (50.6%) for *conducting emergency drills to control emergency situations* demonstrate the situational responses of the respondents towards that question. Literally, it implies that this particular factor is not considered as a controlling factor with a high degree of influence on effective management techniques for worker safety on construction sites.

4.6.10 Influence of motivational factors on effective management techniques of construction site worker safety

Evaluation of the influence of motivational factors pertaining to effective management techniques of construction site worker safety is discussed in this subsection. The evaluation was achieved through the application of the four-point Likert scale as executed in the preceding subsection. The scale was dimensioned as follows: not influential = 1, less influential = 2, influential = 3, and very influential = 4.

Table 4.12: Tabularised illustration of the influence of motivational factors on effective management techniques of construction site worker safety

Motivational factor	Not influential		Less influential		Influential		Very influential		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Provision of bonus for workers	1	1.2	6	7.1	30	35.3	48	56.5	85	3.47	0.68	1
Construction operatives' appraisal	0	0	7	8.2	31	36.5	47	55.3	85	3.47	0.65	2
Provision of PPE	7	8.2	6	7.1	27	31.8	45	52.9	85	3.29	0.92	3
Provision of overtime allowance	3	3.5	12	14.1	35	41.2	35	41.2	85	3.20	0.81	4

Table 4.12 displays the numerical results derived from the analysis of the data set collected for the influence of motivational factors on effective management techniques of construction site worker safety. The results indicate that *provision of overtime allowance* is the only motivational factor with the lowest level of influential on effective management techniques for worker safety on the construction site. In addition, *provision of bonus for workers* is indicated by the respondents as the highest influential motivational factor, with an estimate of 56.5% followed by

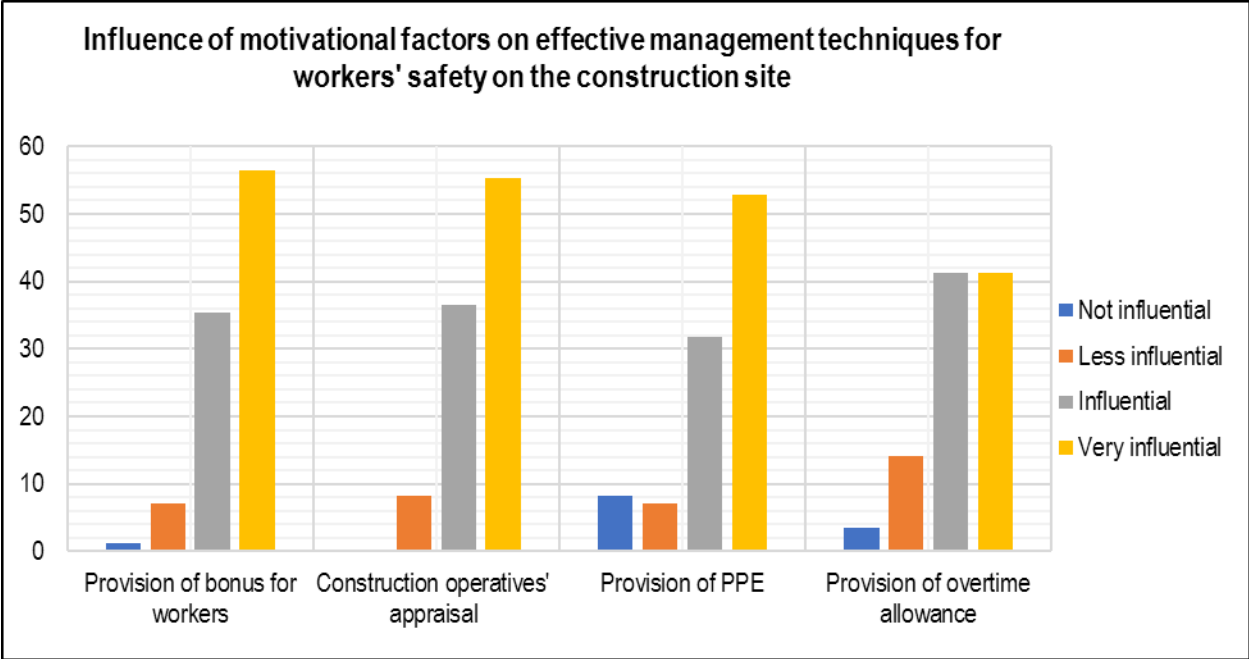


Figure 4.13: Graph illustrating influence of motivating factors on effective management techniques

construction operatives' appraisal and *provision of PPE*, with percentage estimates of 55.3% and 52.9% of the respondents, correspondingly. Graphically in Figure 4.13, these three motivational factors demonstrate close intervals between them, suggesting that respondents are more confident about their high influential effect on effective management techniques for worker safety on construction site. The graph further discloses the distribution shape of the data, wherein it is observed that only three out of four motivational factors demonstrate their complete effect through the four selected options.

4.6.11 Safety management techniques related barriers

Data acquired from the analysis of the safety management techniques related barriers are tabulated in Table 4.13 below. With the objective of determining the barriers responsible for the unattainable improvement in safety management techniques for construction workers, possible related barriers were constructed to foster the appropriate collection and evaluation of data. Hence, to initialise this collection and evaluation process, a four-point Likert scale was utilised as metrics dimensioned as follows: not influential = 1, less influential = 2, influential = 3, and very influential = 4.

Table 4.13: Safety management techniques related barriers

Barriers	Not influential		Less influential		Influential		Very influential		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Off-the-shelf system imposed without modification	0	0	8	9.4	39	45.9	38	44.7	85	3.35	0.65	1
Workers – management relationship	0	0	7	8.2	44	51.8	34	40.0	85	3.32	0.62	2
System-imposed by senior management without consultation	0	0	8	9.4	51	60.0	26	30.6	85	3.21	0.60	3
Trade union involvement	4	4.7	27	31.8	42	49.4	12	14.1	85	2.73	0.76	4

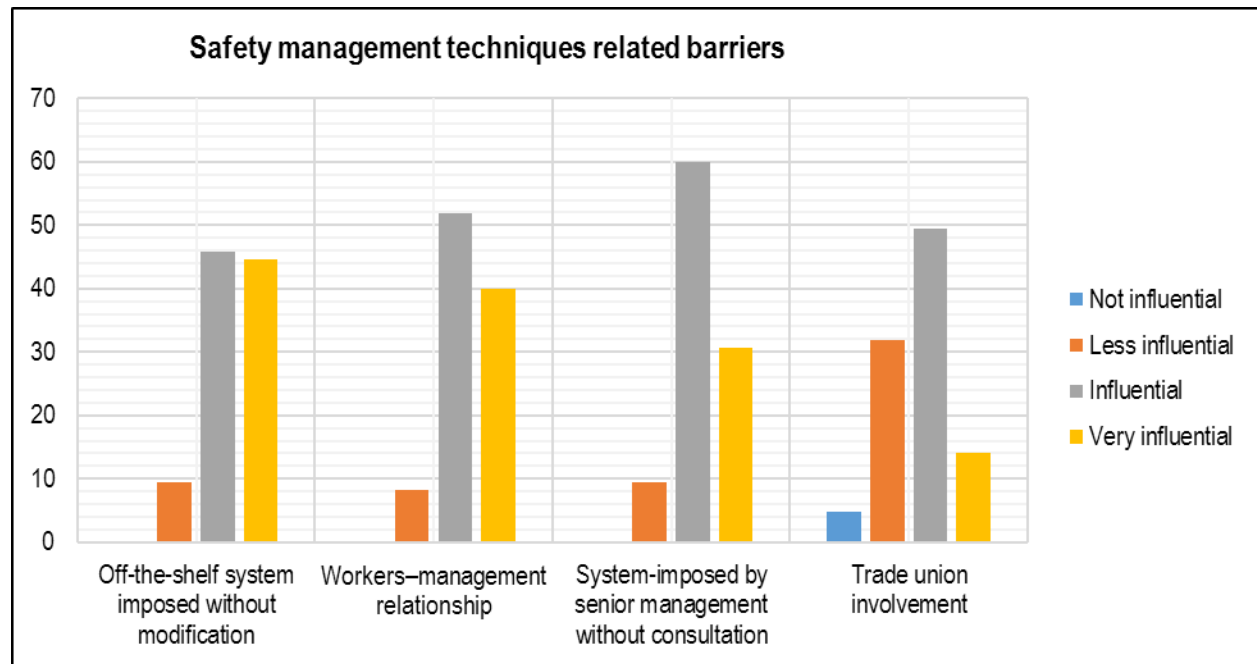


Figure 4.14: Graph illustrating safety management techniques related barriers

According to respondent responses, *trade union involvement* is denoted as the only related barrier affecting safety management techniques at a very low estimate of 14.1% of the responses for “very influential”, and a second lower estimate of 49.4% responses for “influential” as preceded

by *off-the-shelf system imposed without modification*, with an estimate of 45.9% responses for “influential”. Figure 4.14 above illustrates that three related barriers are considerably “very influential” and “influential” on the implementation of safety management techniques, with an equal estimate of 90.6% responses for both *off-the-shelf system imposed without modification* and *system-imposed by senior management without consultation*, and an estimate of 91.8% of the responses for *workers-management relationship*.

In addition, in terms of options indicated, observation discloses that both “very influential” and “influential” represent a total estimate of 84.1% across the four related barriers, while the remaining quota (15.9%) represents both “less influential” and “not influential”. Generally, this illustration signifies that over 70% of the respondents considerably agreed that these four related barriers have an extreme impact on the improvement of safety management technique initiatives toward worker safety.

4.6.12 Organisation related barriers

Data analysed with regard to the evaluation of organisation related barriers affecting the improvement of safety management techniques are tabularised in Table 4.14 below. A four-point Likert scale was considered in quantifying the eight related barriers defined accordingly to foster an appropriate collection and evaluation of data as in the preceding subsections.

In the table, the distribution of data analysed appeared asymmetrical in terms of the mean values and standard deviation value structures because the standard deviation of a barrier with the smallest mean value does not produce the highest standard deviation to centre the distribution of the data around the mean. Observably, *inadequate resources* is indicated by an estimate of 58.8% of respondents as the most influential organisation related barriers affecting the improvement of safety management techniques toward worker safety, followed by *health and safety consultation inadequate training* with an estimate of 57.6% responses.

Considering the barrier with the lowest percentage of “very influential”, *high labour turnover leads to fatigue of workers* yielded the lowest percentage estimate of 23.5% of the responses.

Table 4.14: Organisation related barriers

Barriers	Not influential		Less influential		Influential		Very influential		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Health and safety consultation inadequate training	0	0	4	4.8	32	37.6	49	57.6	85	3.53	0.59	1
Inadequate resources	2	2.4	12	14.1	21	24.7	50	58.8	85	3.40	0.82	2
Inappropriate hiring labour workers	0	0	7	8.2	45	52.9	33	38.8	85	3.31	0.62	3
Inadequate of work associated with hiring of workers/contractors	0	0	18	21.2	27	31.8	40	47.1	85	3.26	0.79	4
Limited accountability mechanisms	7	8.2	10	11.8	32	37.6	36	42.4	85	3.14	0.93	5
Small firm with limited resources and unfamiliar system concept	0	0	17	20.0	40	47.1	28	32.9	85	3.13	0.72	6
Safety activities restricted to technical experts	0	0	13	15.3	50	58.8	22	25.9	85	3.11	0.64	7
High labour turnover leads to fatigue of workers	0	0	12	14.1	53	62.4	20	23.5	85	3.09	0.61	8

On the other hand, only two related barriers, *limited accountability mechanisms* and *inadequate resources*, are represented with nominal estimates of 8.2% and 2.4% responses for “not influential”. This estimate indicates that very few respondents agree that the two organisation related barriers are not influential for the improvement of safety management techniques toward worker safety.

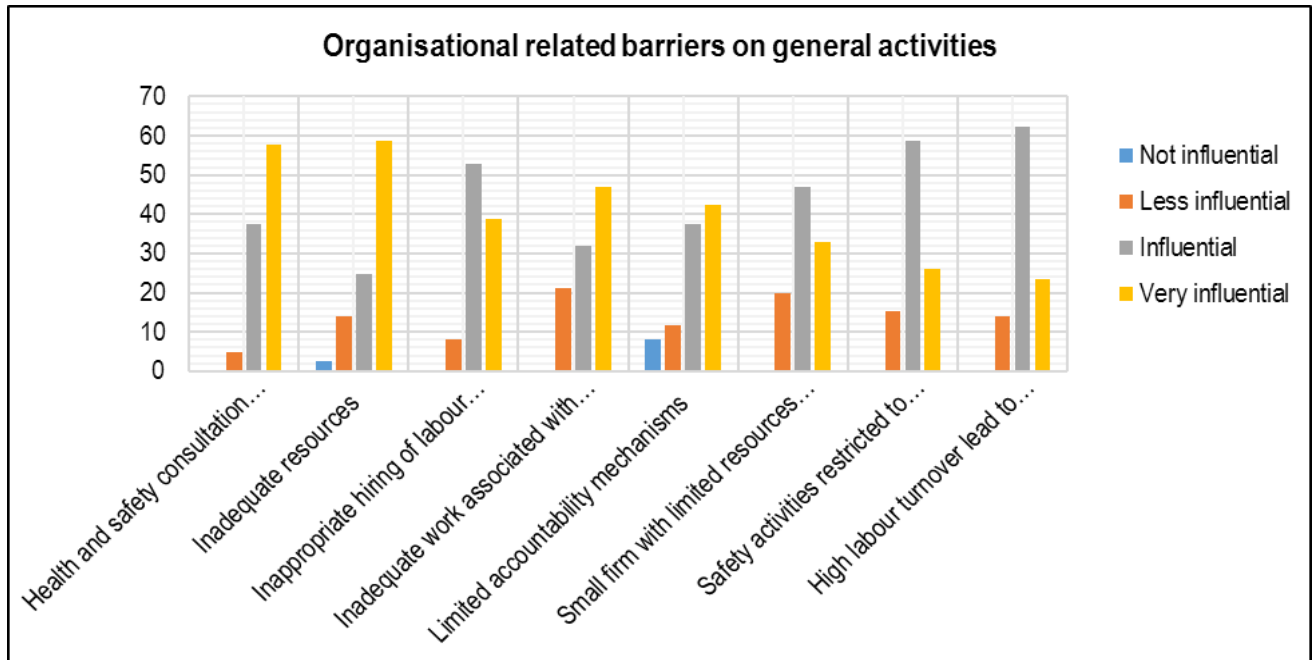


Figure 4.15: Graph illustrating organisational related barriers on general activities

Details from the graph in Figure 4.15 reveal that all eight organisation related barriers have a potential influence on the improvement of safety management techniques toward worker safety at a percentage estimate of 98.0%, whereas a nominal percentage estimate of 2.0% of the respondents claimed that the eight organisation related barriers have no influence on the improvement of safety management techniques toward worker safety. This above illustration tasks the safety management group to investigate the possibility of limiting or even decimating the negative impact of these organisation related barriers on the improvement of safety management techniques toward worker safety across entire departments of any construction firms in South Africa. If this could be attained, without any doubt, lives and properties will be protected and safe construction environments will be provided and sustained, accelerating the production and service delivery rate for project completion without any occupational accidents.

4.6.13 Contractor related barrier

The distribution of data in the Table 4.15 demonstrates a small difference between the mean values and the structure of the standard deviations. This illustrates that the data structure is centred on the mean, and explains better distribution of data around some options for different related barriers: the highest mean value of 3.46 yielded the smallest standard deviation value of 0.52, accordingly in ascending-descending order. A four-point Likert scale was adopted to

enhance the possibility of defining appropriate metrics dimensioned into the following: not influential = 1, less influential = 2, influential = 3, and very influential = 4.

Additionally, analysis of the contractor related barriers is centred only on three related barriers, primarily concentrating on the operational relationship between principal contractors and subcontractors with the purpose of determining their impact with regard to the occupational safety of workers during project execution on construction sites.

Table 4.15: Contractor related barriers

Barriers	Not influential		Less influential		Influential		Very influential		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Imposes safety management techniques on subcontractor	0	0	1	1.2	44	51.7	40	47.1	85	3.46	0.52	1
Imposes safety management techniques responsibility on subcontractor	0	0	6	7.1	42	49.4	37	43.5	85	3.36	0.61	2
Safety management techniques inconsistency between subcontractors and principal contractors	7	8.2	10	11.8	25	29.4	43	50.6	85	3.22	0.96	3

Statistically, as presented in Table 4.15, 8.2% of the respondents claimed that *safety management techniques inconsistency between subcontractors and principal contractors* is not identified as an influential barrier in attaining improved management techniques toward worker safety on the construction site. To the contrary, 91.8% of the respondents affirmed that this particular barrier is potentially influential on the occupational safety of workers, with 11.8% respondents out of this sum estimate confirming that the barrier has a “less influential” impact on the occupational safety of the workers. In essence, this barrier demonstrates the highest percentage estimated.

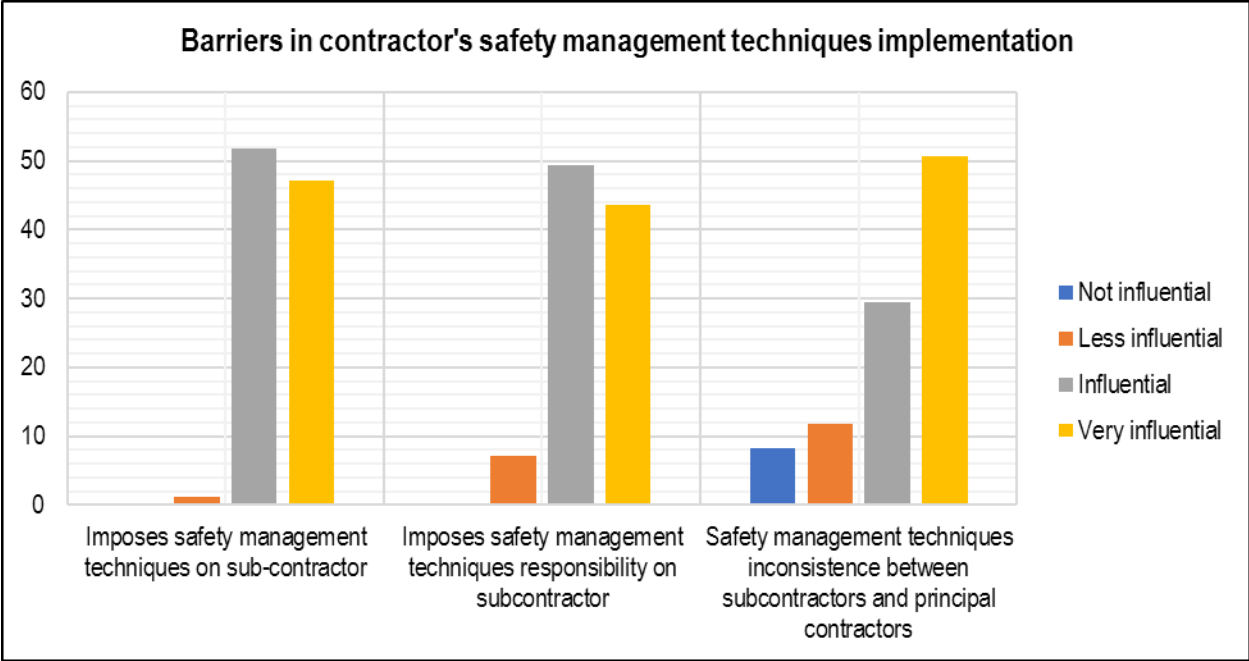


Figure 4.16: Graph illustrating barriers affecting contractor safety management techniques implementation

As graphically illustrated in Figure 4.16, only one barrier is represented in the four options, while the other two barriers are represented in only three out of the four options. More so, overall the illustration shows that “very influential” and “influential” represent a total estimate of 90.6% of the responses across the three contractor related barriers, while the other options like “less influential” and “not influential” represent a total estimate of 9.4% of the responses. Understandably, the highest quota expresses the opinion of the respondents in terms of the impact of the three related barriers on the improvement of occupational safety for construction workers.

4.6.14 Site manager factors

In this subsection, another form of four-point Likert scale was introduced to evaluate respondent opinions concerning the importance of the site managers’ impact in improving the occupational safety of workers on the construction site. In Table 4.16 below, the mean values are arranged in descending order corresponding to each factor, although, the standard deviation values were not aligned in ascending order.

This means that some factors have more representation of data across the four options. Observably, *involve workers in safety planning* is the only factor represented with a nominal estimate of 7.1%, which rates it as an unimportant factor in ascertaining the obligations of the site.

Table 4.16: Site manager factors

Factor	Not important		Less important		Important		Very important		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Give safety policy statement on projects	0	0	0	0	22	25.9	63	74.1	85	3.74	0.44	1
Communicates risk findings	0	0	6	7.1	20	23.5	59	69.4	85	3.55	0.82	2
Provide incentives for good safety behaviours	0	0	5	5.9	29	34.1	51	60.0	85	3.54	0.61	3
Constant safety meetings attendance	0	0	4	4.7	34	40.0	47	55.3	85	3.51	0.60	4
Adequate provision of safety resources	0	0	13	15.3	20	23.5	52	61.2	85	3.46	0.75	5
Routine safety evaluation in work schedules	0	0	7	8.2	33	38.8	45	52.9	85	3.45	0.65	6
Set safety as priority in project meetings	0	0	0	0	49	57.6	36	42.4	85	3.42	0.50	7
Provide information on risk control	0	0	16	18.8	19	22.4	50	58.8	85	3.40	0.79	8
Actively monitors safety programmes on the project	0	0	6	7.1	46	54.1	33	38.8	85	3.32	0.60	9
Involve workers in safety planning	6	7.1	6	7.1	32	37.6	41	48.2	85	3.27	0.88	10

manager in ensuring improved occupational safety for construction workers. Further observations indicate that an equal estimate of 100% respondents represents both *give safety policy statement on the project* and *set safety as priority in project meetings* as the most important obligations to be executed by the site manager in promoting occupational safety for construction workers.

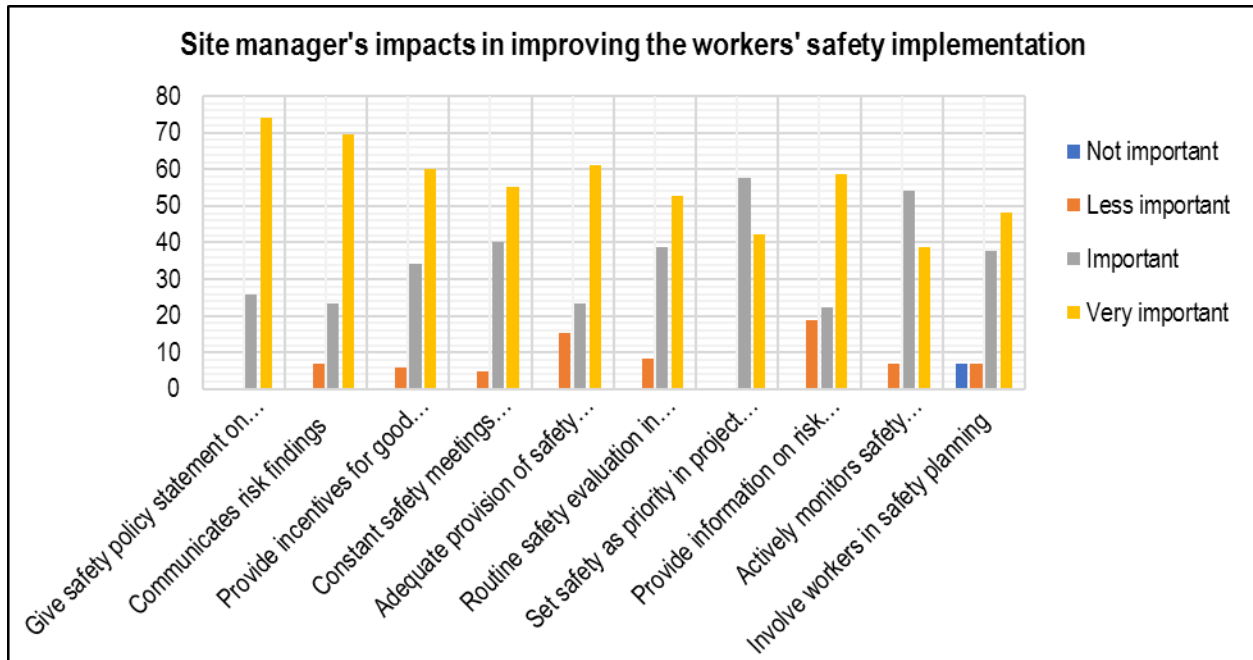


Figure 4.17: Graph illustrating impact of site managers in improving the implementation of worker safety

Graphical presentation shows 91.9% of the responses represent both options “very important” and “important” across the ten important factors expected to be executed by the site manager, while 8.1% of the responses represent both “less important” and “not important”. This means, quite literally, that a huge number of respondents consider *all* these factors crucial to the potential of seeing site managers promote occupational safety for construction workers. From the same graph, the “very important” option is the most predominantly selected factor across the ten site manager factors.

4.6.15 Safety officer factors

Statistical results derived from the analysis show respondent opinions on the importance of the safety officer’s obligations toward stimulating the occupational safety for workers. In other words, analysing the opinions of the respondents demonstrates the purpose of determining or assessing the degree of importance for the safety officer to perform these factors in ensuring improved safety procedures for the construction worker safety. To collect and interpret data, a four-point Likert option was utilised to measure the opinions of the respondents. According to the structure of the mean values, as displayed in Table 4.17, the highest mean value does not have a corresponding lowest standard deviation value, implying that the distribution of the data analysed in terms of safety officer factors is not centred around the mean for each factor analysed in this subsection.

Table 4.17: Safety officer factors

Factors	Not important		Less important		Important		Very important		Total	Mean value (MV)	Std. Dev.
	N	%	N	%	N	%	N	%			
Performs emergency response drills	0	0	7	8.2	16	18.8	62	72.9	85	3.65	0.63
Hazard identification & risk assessment	0	0	6	7.1	19	22.4	60	70.6	85	3.64	0.61
Safety audit & inspections	0	0	0	0	33	38.8	52	61.2	85	3.61	0.49
Regularly makes safety briefs	0	0	4	4.7	27	31.8	54	63.5	85	3.59	0.58
Conducts toolbox meetings	0	0	6	7.1	27	31.8	52	61.2	85	3.54	0.63
Enforces safety guidelines	0	0	6	7.1	28	32.9	51	60.0	85	3.53	0.63
Executes hazard-free environment inspection	0	0	6	7.1	32	37.6	47	55.3	85	3.48	0.63
Accident investigation and record keeping	0	0	6	7.1	33	38.8	46	54.1	85	3.47	0.63
Promotes safe practices at the job site	0	0	6	7.1	29	34.1	50	58.8	85	3.45	0.82
Ensures tools and equipment adequacy and safe to use	0	0	12	14.1	26	30.6	47	55.3	85	3.41	0.73

In the process, findings indicate that none of the ten factors is indicated by the respondents as “not important” in the improvement of worker safety on the construction site. In addition, 14.1% of the respondents claim that *ensure tools and equipment adequacy and safe to use* is “less important” in aiding the improvement in the occupational safety of workers on the construction site, followed by *performs emergency response drills* with an estimate of 8.2%.

On the contrary, 72.9 % respondents indicated that *performs emergency response drills* is “very important” for the safety officer to execute in attaining reliable occupational safety of workers on the construction site. Similar interpretation reveals that 55.3% of the respondents affirmed that *ensures tools and equipment adequacy and safe to use* is “very important” in the attainment of reliable occupational safety of workers.

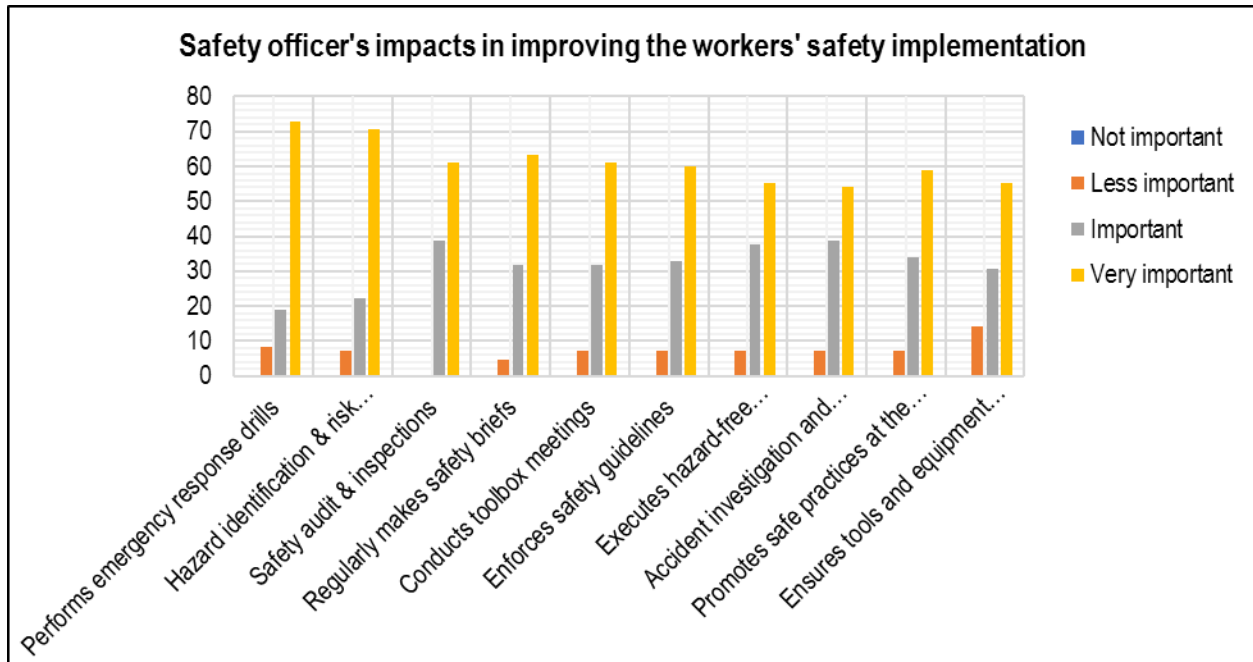


Figure 4.18: Graph illustrating impact of safety officers improving the implementation of worker safety

Figure 4.18 data denotes that “very important” and “important” options represent 93.0% of the respondent responses across the ten factors with regard to the occupational safety of the workers, while 7.0% of the respondent responses represent “less important”. The illustration demonstrates the overall interpretation of respondent opinions on the appropriate implementation of worker safety. Literally, the findings reveal that a large portion of respondents considers these factors critical in the attainment of appropriate implementation of worker safety.

4.6.16 Contractor factors

The impact of a contractor in attaining appropriate implementation of worker safety on the construction site is invaluable. In evaluating this factor, sub-factors were formulated and quantified with the application of four-point Likert scale dimensioned as follows: not important = 1, less important = 2, important = 3, and very important = 4. The distribution of data in Table 4.18 below is not centred around the mean for each factor analysed because the highest mean

Table 4.18: Contractor factors

Factors	Not important		Less important		Important		Very important		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Document safety induction training and make file available for inspection	0	0	6	7.1	20	23.5	59	69.4	85	3.62	0.62	2
Consult and communicate safety information	0	0	0	0	32	37.6	53	62.4	85	3.62	0.49	3
Establish safety regulations among subcontractors	2	2.4	6	7.0	24	28.2	53	62.4	85	3.51	0.73	4
Giving safety orientation to all employees on site	6	7.1	8	9.4	15	17.6	56	65.9	85	3.42	0.93	6
Appoint competent subcontractors to ensure safe workplace	0	0	2	2.4	45	52.9	38	44.7	85	3.42	0.54	7
Provide safety equipment for visitors during safety induction training	0	0	12	14.1	28	32.9	45	52.9	85	3.39	0.73	8

values of equal estimates of 3.62, produced by two factors in the table, do not yield equal lowest standard deviation values of 0.49, correspondingly. This shows that the opinions or responses of the respondents vary across the six factors grouped under contractor factors.

According to the table above, no responses represent *consult and communicate safety information* as “not important” or “less important” toward the attainment of appropriate implementation of worker safety on the construction site. Similar observation was noted for three other factors that are not represented as “not important” to the appropriate implementation of worker safety. In contrast, two other factors, *giving safety orientation to all employees on site* and *establish safety regulations among subcontractors* are represented as “not important”, with minimal corresponding estimates of 7.1% and 2.4% of the responses.

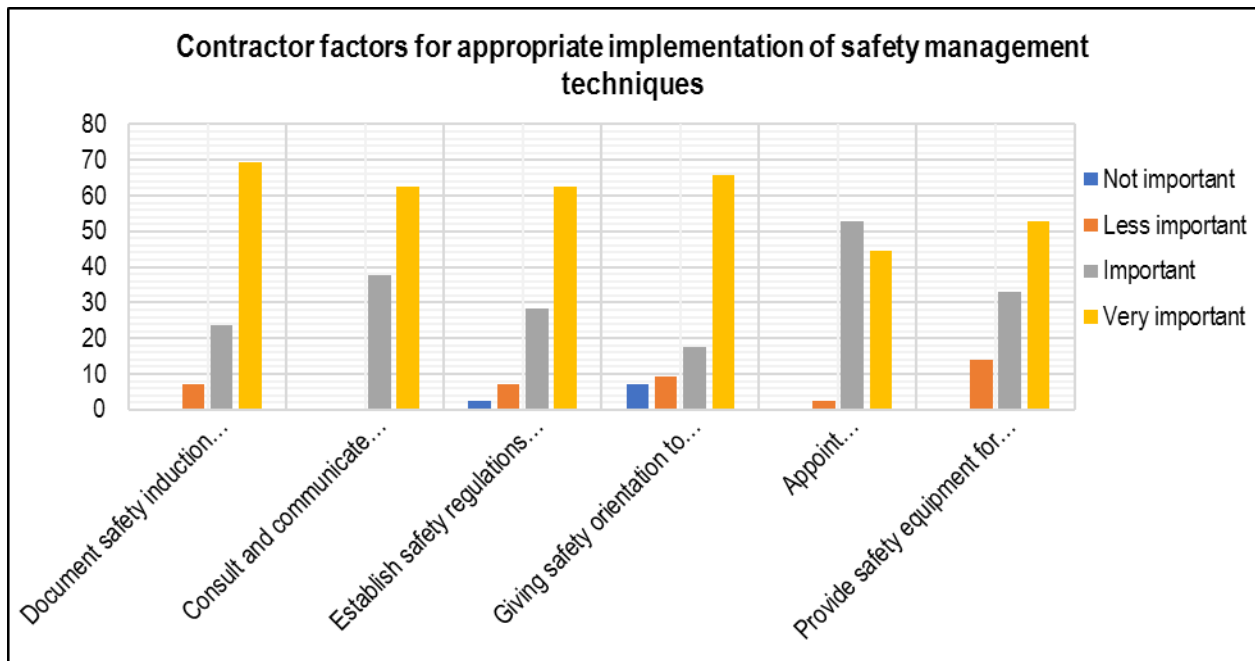


Figure 4.19: Graph illustrating contractor impact in ensuring appropriate implementation of safety management techniques

Further observations reveal that 69.4% of the respondents considered *document safety induction training and make file available for inspection* as the most important factor, followed by *giving safety orientation to all employees on site* with an estimate of 65.9% responses. *Appoint competent subcontractors to ensure safe workplace* is represented with the lowest estimated percentage of 44.7% of the responses as the least “very important” factor in attaining appropriate implementation of worker safety.

From a graphical perspective, as displayed in Figure 4.19 above, both “very important” and “important” represent 91.7% of the respondent responses across the six factors, while “less important” and “not important” represent only 8.3% of respondent responses. In addition, only two factors, *establish safety regulations among subcontractors* and *giving safety orientation to all employees on site*, were entirely represented across the four options. The structure of the graph validates the data variation explained in the first paragraph of this discussion. The illustration given in this paragraph signifies that more than 80% of the respondents considered the six factors crucial in attaining the appropriate implementation of worker safety on the construction site.

4.6.17 Client factors

Clients are regarded as important stakeholders in the construction industry, particularly concerning the allocation of contractors to corresponding projects in construction management. With the purpose of deriving greater understanding of the importance of client factors in the attainment of appropriate implementation of worker safety on the construction site, data collected with a four-point Likert scale were analysed to demonstrate the importance of the sub factors developed (see Table 4.19 below).

In the table, five factors are not represented in the options of “less important” and “not important”, and the other remaining four factors, likewise, are not represented in the option of “not important”. Therefore, having the option of “not important” common in the two findings, it is evident that respondents perceive that the nine factors are either minimally “less important” or significantly “very important” across the entire factors. The illustration demonstrates the relevance of these factors in reforming the safety issues frustrating construction industry activities in South Africa.

The contribution of these sub factors, if executed by clients, was numerically discussed. From the table, it is evident that the distribution of the data analysed displays a lack of corresponding structure in the mean values and standard deviations, suggesting that the data distribution is not centred around the mean, as similarly discussed in the preceding subsection, because response representation varies across the nine factors.

Further deductions show that 83.5% of the respondents affirmed that *ensure non-violation of safety regulations by the contractors* is “very important” in fostering the improvement of occupational safety in the construction companies, followed by *prevent execution of projects with hazard intent* with an estimate of 78.8% responses. On the other hand, 58.8% of the respondents affirmed that *provide resources for safety improvement* is the least “very important” factor among

the nine factors. Regarding the “less important” factors, only three factors were represented by the respondents, wherein 14.1% of the respondents agreed that *provide resources for safety improvement* is the most “less important”, followed by two other factors with an equal estimate of 7.1% responses.

Table 4.19: Client factors

Client factors	Not important		Less important		Important		Very important		Total	Mean value (MV)	Std. Dev.	Rank
	N	%	N	%	N	%	N	%				
Ensure non-violation of safety regulations by the contractors	0	0	0	0	14	16.5	71	83.5	85	3.84	0.37	1
Prevent execution of projects with hazard intent	0	0	6	7.1	12	14.1	67	78.8	85	3.72	0.59	2
Partake in construction site safety meeting	0	0	0	0	25	29.4	60	70.6	85	3.71	0.46	3
Appointment of safety agent	0	0	0	0	27	31.8	58	68.2	85	3.68	0.47	4
Ensure availability of safety plan for contractors	0	0	0	0	28	32.9	57	67.1	85	3.67	0.47	5
Execute periodic safety audits on contractors	0	0	0	0	29	34.1	56	65.9	85	3.66	0.48	6
Involve in project design	0	0	0	0	31	36.5	54	63.5	85	3.64	0.48	7
Employ contractors with safety measures knowledge	0	0	6	7.1	27	31.8	52	61.2	85	3.47	0.83	8
Provide resources for safety improvement	0	0	12	14.1	23	27.1	50	58.8	85	3.45	0.73	9

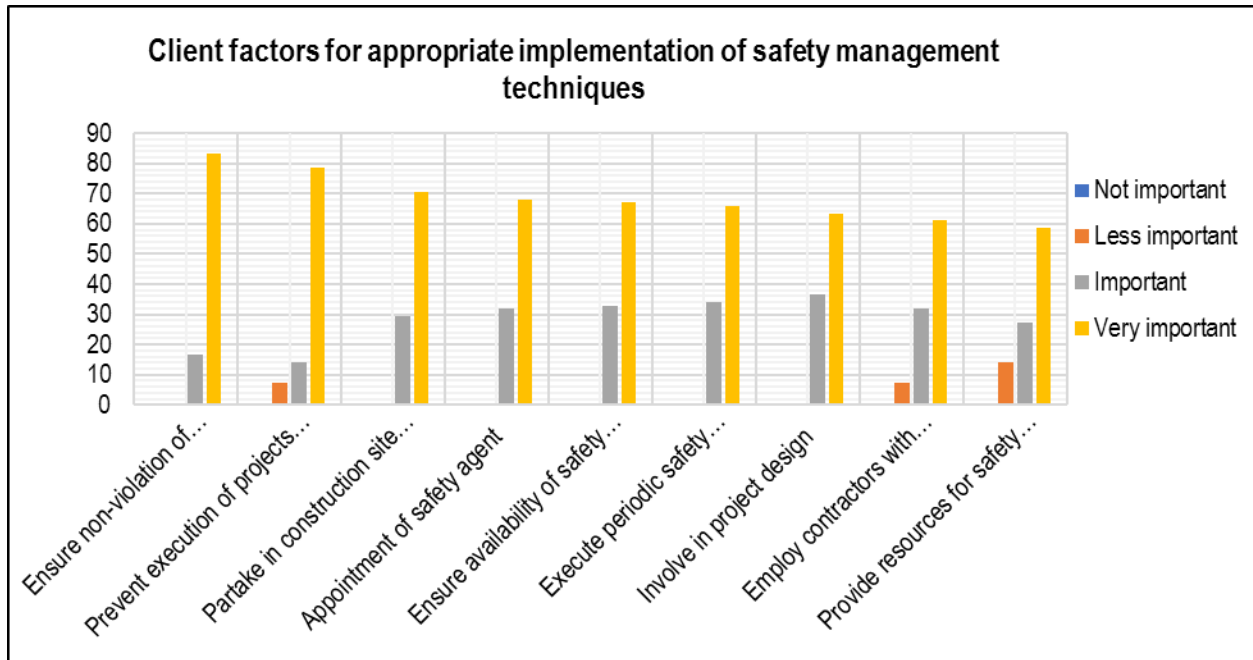


Figure 4.20: Graph illustrating client impact in ensuring appropriate implementation of safety management techniques

The graph in Figure 4.20 displays the distribution of data for option “very important” skewed to the right of the graph, while the pattern produced by the option “important” is more concave, while the data distribution patterns for both “less important” and “not important” are insignificantly expressible because only three factors were represented. An overall interpretation demonstrates that 96.9% of the responses represent both “very important” and “important” across the nine factors, while a minimal percentage estimate of 3.1% represents only “less important”. This shows that respondents affirmed that all nine factors are important with over 90.0% of responses, if carried out by the client, in attaining occupational safety for construction workers.

4.7 Qualitative interview

The purpose of conducting the interviews was to validate the quantitative data obtained from construction professionals and safety officers in construction sites. Four construction sites were chosen and suitable locations for conducting the interviews, and then a safety officer was interviewed on each construction site. The interview was semi-structured, with interview questions formulated based on the results of quantitative data. The interviews were initially conducted with a recording device and afterwards transcribed. Four safety officers were interviewed, each one given the opportunity to identify any other factors for effective management techniques for site worker safety. A copy of the interview questions can be found in Appendix B. Meanwhile, the

interviews each started with the introduction of the researcher to the respondents. The researcher subsequently introduced the research topic to the respondents.

4.7.1 Interview performed with four selected respondents

The interviews carried out with the selected respondents were conducted on different dates and at different times. The interview conducted with Respondent A (safety officer) was carried out on May 16, 2019, at 09h30min in the construction site office. The respondent presently has 13 years of experience as a safety officer. The site manager is categorised as Respondent B, who was interviewed the following day on May 17, 2019, at 10h35min in the construction site office. This respondent has 10 years' experience. Respondent C is another safety officer interviewed on May 23, 2019, at 11h28min, a few days after the interview with Respondent B was completed. This respondent has an equivalent number of years' experience (13 years) as Respondent A, a safety officer. The final respondent, Respondent D, is a quantity surveyor who was interviewed on May 24, 2019, at 12h28min in the construction site office. This respondent has 11 years' experience in the construction industry. The entire interview period lasted for 30 minutes with each respondent.

In each interview, similar questions were asked of the respondents based on the content of the exercise. The respondents affirmed that each project contains its own hazards affecting workers in different sections of the construction site, such as working at a height, manual lifting, bending and lifting. As claimed, the respondents stressed that all these activities expose workers to various types of hazards that affect their physical abilities and health. In such cases, these activities caused the firm to lose time and money. According to the respondents, these factors usually cause site accidents, and this in turn hinders construction site production.

They emphasised that top management demonstrate commitment towards worker safety by establishing safety training and orientation for site operatives. Other obligations executed include assigning safety responsibilities to all levels of workers, accident investigations and careful record keeping on construction sites, safety auditing by safety committees, conducting toolbox meeting, and finally, enforcement of safety guidelines. In addition, construction operatives are motivated by the institution of safety awards for effective management techniques for site worker safety. Further addition is by reviewing the implementation of new measures to control hazards and exposure every six months.

As part of the responses, each company has training and staff analysis of required items or strategies to improve workplace safety training programmes which advocate for safety implementation at all levels of the company. It was discovered that there are different levels of communication dealing with safety consciousness within the organisation. Another factor considered is safety culture, as safety culture aids in the avoidance of a 'near miss' during any construction activity. This is implemented by communicating to the workers about what needs to be done and what they need not be doing.

As pointed out during the interview, plans are expected to be put in place to control hazards that may arise in the emergency situations. These plans are executed properly by assigning the right person to the right position, for example, assigning a trained fire fighter to the operation of the fire fighting equipment. Another important activity to assign is conducting emergency drills to ensure proper functioning of the procedures and equipment at their disposal. Systems cannot be imposed by senior management without modification with the new ISO, the international standard that specifies requirements for an effective environmental management system (EMS).

The responses gathered further indicated that a framework developed for the organisation will establish environmental performance requirements and accreditation that will occur annually. This effect discourages system imposition in this company. Other important factor identified is inadequate resources, which has a significant effect on the performance of the safety management team. The absence, or ineffectiveness, of this factor will lead to such issues as a limited accountability mechanism and inadequate training of employees in health and safety. In this situation, the sub-contractor is advised to work in accordance with the small firm with limited resources and unfamiliarity with the concept of the company system.

Another area to consider is to improve worker appraisal programmes to intensify the commitment of the workers to their assigned duties. In this case, workers will be keen to be more actively involved in many important activities occurring within the organisation, such as regular safety meetings on the construction site.

Table 4.20: Summary of qualitative interviews

Factors	Respondent A	Respondent B	Respondent C	Respondent D
Safety training for effective production	Every employee involves in safety training every morning	Every employee involves in safety training every day	Every employee involves in safety training every morning and when there is accident on site	Every employee involves in safety training every morning
Incentives for good safety performance	Instituting safety award and bonus for workers	Safety bonus to workers	Giving safety award to department hazard free	Safety award and bonus for workers
Causes of accidents and injuries in construction site	Arrogant and not taking to instruction	Overconfident	Negligent	Overconfident
Effect of accidents and injuries mention above	Loss time and production	Loss time and production	Loss time and production	Loss time and production
Management commitment to safety implementation	No work commences without safety	Safety must guarantee before the commencement of any project	Construction site safety must assure before implementation of any project	Construction site safety must guarantee before of any project can executed
Organising and controlling activities within the site to address hazard	Before the commencement of any job the management has funds budgeted to address any hazard	Before the beginning of any project management has planned to address any hazard	Management has budgeted to address any hazard before the start of a project	Before commencing a project, the management has set some aside to take care of any hazard

As part of the discussion, a dialogue focussed on the importance of setting safety as a major agenda item in all project meetings was carried out. In the process, it was pointed out that during such a meeting, a clear safety policy statement on any existing project is expected to be communicated to declare the importance of determining risk inherent in every aspect of construction activities. This can be substantiated by providing necessary and adequate resources to support the effective implementation of safety in every aspect of the organisation, such as regular safety briefs, safety audits and inspections, hazard identification and risk assessment, and accident investigation and record keeping on construction sites. In addition, the organisation is advised to brief the appointed sub-contractors on strict adherence of proper implementation of safety. Summaries of the interviews conducted with the four selected respondents are presented in Table 4.20 above.

4.8 Discussion of findings

This section presents the findings obtained from the study to identify the causes and effects of site accidents on construction site production, to acknowledge factors that affect the effective operation of construction site worker safety, to assess the involvement of construction management team on worker safety implementation on site, and to determine effective management system techniques for site worker safety.

4.8.1 Type of hazard on construction site

Based on the findings gathered from the analysis of the type of hazard taken place on the construction site, it is understood that safer environment is attained for some operations that are perceived to be hazardous to the construction site workers, such operations as manual handling and working at height with a total estimate of 78.8%. However, overall findings indicated that respondents fairly perceived that operations such as noise, handling heavy and overcrowded site are highly dangerous to the wellbeing of the construction site workers with a total estimate of 64.4% (Table 4.3 & Figure 4.4). Therefore, these aforementioned operations demand urgent improvement to discard any future occupational accident that may endanger the lives of the construction workers (Hughes & Ferrett, 2011). In addition, according to some literatures studied, along with the personal interviews conducted, findings show that huge number of construction site workers are suffering from back ache due to the unsafe way of performing some operations on the construction site. Generally speaking, some of the operations, irrespective of their degree of hazard intensity, have long term effects on the health of the construction workers across every

department on the construction site (ILO, 1999; Holt & Allen, 2015). According to findings, order of less to high types of operational hazards is structured as manual handling, working at height, dust, overcrowded site, handling heavy, bending and twisting, and noise.

4.8.2 Factors that affect construction site production

Analytical results demonstrate that unwarranted movement of mobile construction plant on a construction site is the most significant factor affecting construction site production (Table 4.4 & **Figure 4.5**). The capability and effectiveness of management techniques for construction site worker safety, when planning construction operations, will unarguably facilitate construction operations and prevent unnecessary site accidents and unanticipated delays during construction site production (Adebowale, 2014; Imimole, 2018).

Safety management generally minimises the likelihood of accidents in the working arena by enforcing standards and regulations while simultaneously protecting employees from the risk of workplace injury or even death (Mohammed, 2014). Furthermore, poorly maintained tools are regarded as the second most problematic factor in construction site production, as presented in the same table. In addition, the study and interviews carried out specified that schedule pressures can cause safety measures to be disregarded (Saurin, Formoso, and Cambraia, 2008).

4.8.3 Measures for effective management techniques for site worker safety

Establishing safety training and orientation for site operative is indicated as the number one significant factor for effective management techniques for site worker safety (Table 4.5 & Figure 4.6). According to Langford *et al.* (2000), the establishment of good relationships, training and orientation for site operatives are essential. The ability of a safety officer to manage worker safety on a construction site is significant to construction production. Another major finding included *accident investigation and record keeping* on construction sites, as indicated in Table 4.5. Accident/incident recordkeeping is essential to identify and resolve deficiencies and future occurrences of ineffective management techniques for site worker safety (Awwad *et al.*, 2016).

Other important factors determined are enforcing safety guidelines, providing for fire prevention and fire fighting during construction of facility, safety auditing by safety committees, responding to employees, top management commitment to workers safety, conducting toolbox meeting, motivating construction operatives by instituting safety award, and assigning safety responsibility

to all levels of management and workers. The nominal number of respondents believed that all factors were less important or not important. This implies that improving these factors will enhance management techniques towards a better or effective workers safety.

4.8.4 Company undertaking safety training for workers

As part of the findings attained, it is necessary to consider special training on such activities as first aid, fire prevention, forklift truck driving, scaffolding inspection, overhead crane inspection and safety inspection. This is because safety training spells out the rules and provides information on potential hazards and ways to avoid them. However, lack of experience and poor training are the main causes of accidents at work. Training in construction site workplace helps inculcate in employees a positive safety culture (De Silva and Wimalaratne, 2012).

Preventive training procedures in workplace environment are important tools in preventing accidents at work. As advised, newly employed employees should receive a full induction ahead of their full resumption, with the purpose of alerting them on the potential hazards (Zhou *et al.*, 2015). Conducting safety training and meeting on construction site is agreed upon as a significant factor to the effective techniques for construction site worker safety management (Table 4.6 & Figure 4.7).

4.8.5 Record keeping of accidents on site

From more findings, monthly review of the project safety record including accident statistics, number of reportable injuries, accident frequency rate, number of dangerous, number of minor injuries, and number of fatalities is a valuable safety tool in the construction company. It is significant to know the causes of accidents on construction site, in order to galvanise necessary countermeasure to controlling them (Kartam *et al.*, 2000; Yankah, 2012). Respondents were asked to indicate how effective record keeping of accident is with regard to on the activities executed on the construction sites as presented in Table 4.7 and Figure 4.8.

4.8.6 Provision of incentives for good safety performance

As agreed by respondent responses, incentives motivate workers to work harder. Therefore, it is expected that employees be provided with incentives in various form, such as personal protective equipment, overtime allowance, bonus for workers, and motivation of construction operatives by awarding good safety performance, as presented in Table 4.8 & Figure 4.9. In addition, the

interview reports further stressed that provision of incentive aids good safety performance. In addition, it renders safety management techniques effective (Hasan and Jha, 2013).

4.8.7 Influence of planning factor on effective management techniques of construction site worker safety

Planning factor, as indicated by the respondents, is important to the success of any project and its components, along with safety. A well-planned operation involves a series of careful steps, including implementing new measures to control hazards and exposure, improving workplace safety training programmes, encouraging engagement in safety at all levels of the organisation and improving the reporting and investigation of near misses (Table 4.9 & Figure 4.10).

Reports garnered from the interview demonstrated that reviewing the records of successes and failures of a plethora of resources used in the past is critical to sustaining a better safety environment in the construction company. In that case, practitioners must forestall the resources needed to meet those demands and make requests based on that (PMBOK, 2017). Actually, a practitioner must not wait for an incident to occur, but rather forestalls and plans to deal with the problem before it occurrence (Mohdashri, 2010). For this, the mission and objectives of the organisation must be reviewed. Once safety objectives are written and procedures by which those objectives can be accomplished are laid out, then budgets and timetables can be formulated by a safety practitioner (Mohdashri, 2010).

4.8.8 Influence of organising factor on effective management techniques of construction site worker safety

Organising factors include ensuring effective company policy for safety of all employees and contractors, in the aspects such as causal workers are made aware of their individual responsibility, arrangement of funds and facilities to meet the requirements of company policy and legislation, and provision for adequate and appropriate training to all workers (Table 4.10 & Figure 4.11). Effective management structures and arrangements should be established to deliver the policy, with staff motivated and empowered to work safely and well protected. Such arrangements must be underpinned by effective staff involvement and participation, and sustained by effective communication about safety efforts (PMBOK, 2017).

4.8.9 Influence of controlling factor on effective management techniques of construction site worker safety

Observations deduced from the responses of the respondents illustrate that implementing the emergency plan, developing plans to control hazards and conducting emergency drills are influential for attaining effective management techniques of construction site worker safety (Feng, 2013). Interview reports support these observations stating that controlling occurs through a number of sub-functions. It involves monitoring what happens in the organisation, comparing the results of the observations, generating standards and then taking appropriate corrective actions. This usually occurs through inspections, audits, records reviews and interviews with employees and supervisors.

4.8.10 Influence of motivational factor on effective management techniques of construction site worker safety

As part of the findings, indicated by the respondents, provision of bonus for workers and motivation of construction operatives are regarded as highly influential attributes of the motivational factor for effective management techniques of construction site worker safety. In addition, interview reports suggest that motivation plays an imperative role in improving productivity. It is clear that money aids motivation (Adebowale, 2014), with the financial strength of a company determining the right motivational approach, as quality performance of workers undeniably depends on motivation (Adebowale, 2014).

4.8.11 Safety management technique related barriers

Findings obtained show that occupational safety barriers are integral to safety management techniques on construction sites. Furthermore, the results show that an off-the-shelf system imposed without modification, a worker–management relationship, a system imposed by senior management without consultation, and trade union involvement are the occupational safety management technique related barriers that influence the operation of safety management techniques on construction sites sites (Robson, Clarke, Cullen, Bielecky, Severin, Bigelow, Irvin, Culyer, & Mahood, 2007).

4.8.12 Organisation related barriers

Under organisational related barriers, response results illustrated that large number of respondents indicated that inadequate training of employees in health and safety consultation is a barrier to the effective operation of construction sites workers. On the other hand, a nominal

number of respondents indicated that this particular factor is not a barrier. Also, inadequate resources were indicated as a barrier to the effective operation of construction sites workers' safety (Robson *et al.*, 2007). (Table 4.14 & Figure 4.16).

4.8.13 Contractor related barrier

According to the responses indicated by the respondents, principal contractor is considered as a huge gap in the effective operation of construction sites workers' safety are presented in Table 4.15 & Figure 4.17 by a large number of respondents, while a nominal amount of respondents believed that the factors is not problematic to the effective operation of construction sites workers' safety (Robson *et al.*, 2007).

4.8.14 Site manager factors

Site managers, important in encouraging safety at construction sites as they work closely with employees, play a major role in construction safety management. Construction regulations have a list of responsibilities that are intended for implementation by site managers in pursuit of the safety of employees and visitors. Respondents advised the site managers to make a clear safety police statement on the project. They further suggested that communication goes a long way in deterring risk facing all workers, as does the provision of incentives for good safety behaviours, and regular attendance at safety meetings on the construction site.

Other important activities are provision of adequate resources for safety implementation, routine evaluation in all safety work schedules, set agenda item in all project meetings, provide information on risk control, actively monitor safety programmes on the project, and involve workers in safety planning (Zhou, Goh, & Li, 2015). Only a small percentage of the respondents believe this is "not important" or "less important". Thus, it can be concluded that the majority of contractors in the Western Cape Province of South Africa are managing to meet the safety requirements of clients as stipulated in the Construction Regulations.

4.8.15 Safety officer factors

According to the safety regulations, safety officers incur some responsibility ensuring compliance with safety regulations. In fact, safety officers play a significant role in construction safety management (Health and Safety Executive, 2013). Respondents largely indicated that the safety officer should be intricately involved in performing emergency response drills, hazard identification and risk assessment, safety audits and inspections, regular safety briefs, toolbox meetings, safety

guideline enforcement, and site inspection to ensure it is a hazard-free environment. In addition, other activities to be considered are accident investigation and record keeping on construction sites, promotion of safe practices at the job site, and verification that all tools and equipment are adequate, safe and ready for use (Aksorn & Hadikusumo, 2008). On the other hand, a minimal number of respondents indicated this factor as “less important”. It is evident that the majority of safety officers in the Western Cape ensure that the appointed contractor and employees are cooperating and complying with safety regulations. This is essential in reducing or hopefully even eliminating the occurrence of accidents at construction sites.

4.8.16 Contractor factors

Contractors, important in encouraging safety in all aspects of construction sites as they work carefully with employees (Zin & Ismail, 2012), play a significant role in construction safety management. Contractors, for example, keep records of all safety induction training conducted on site; make files available for inspection by an inspector, client or his agent; and ensure all sub-contractors cooperate with one another in complying with safety regulations.

The largest proportion of the respondents agree that it is “important” and “very important” that contractors keep records of all safety induction training conducted on site, make files available for inspection by an inspector, client or his agent, and ensure all sub-contractors cooperate with each other in complying with safety regulations. While only a small percentage of respondents regard this as “not important” and “less important”. Therefore, it can be concluded that the majority of contractors in the Western Cape of South Africa are managing to meet the safety requirements of clients as stipulated in the Construction Regulations.

Table 4.21: Summary of findings of qualitative data

Concepts	Issued Addressed	Findings		
To identify the causes and effect of site accident on construction site production	Type of hazard	Manual handling (carrying cement bags or bricks/block)	Working at height	
		Dust (mortal/cement)	Overcrowded site	
		Handling heavy	Bending, twisting while laying block/bricks	
		Noise (carrying cement bags or brick/block)		
	Factors that affect construction site production	Unwarranted movement of mobile construction plant on construction site	Poorly maintained tools	
		Ladders not properly placed	Falling objects from the working platform, hoist and scaffolds	
		Unguarded openings in floors, walls	Failure of platforms and scaffolds due to lack of proper inspection	
		Untidy construction site due to waste materials littered on construction site	Unguarded edges of platforms	
		Worker exposure to fumes on site	Untimbered trenches that are more than 1.2m deep	

Table 4.21 continued

Concepts	Issued Addressed	Findings	
1. To ascertain effective management techniques for site worker safety in South Africa	2.1 Effective management techniques for site worker safety	1. Establishing safety training and orientation for site operative	2. Accident investigation and record keeping on construction sites
		3. Enforce safety guidelines	4. Providing for fire prevention and fire fighting during construction of facility
		5. Safety auditing by safety committees	6. Responds to employees'
		7. Top management commitment to workers safety	8. Conduct toolbox meeting
		9. Motivation of construction operatives by instituting safety award	10. Assignment of safety responsibility to all level of management and workers
	2.2 Company undertake safety training for workers	1. Conducting safety training and meeting	2. Training on the safety equipment on site
		3. Safety induction at the beginning of project	4. Training on the use of personal protective equipment
		5. Safety induction for visitors	6. Issue of safety booklet or leaflet

Table 4.21 continued

Concepts	Issued Addressed	Findings	
	2.3 Record keeping of accidents on site	1. Number of reportable injuries	2. Accident frequency rate
		3. Number of dangerous occurrences	4. Number of minor injuries
		5. Number of fatalities	
	2.4 Provision of incentives for good safety performance	1. Provision of personal protective equipment	2. Provision of overtime allowance
3. Provision of bonus for workers		4. Motivation of construction operatives by instituting safety award	
2. To evaluate the factors that affect the effective operation of the construction site worker safety	3.1 Influence of planning on effective management techniques of construction site worker safety	1. Implementing new measures to control hazards and exposure	2. Improving workplace safety training programmes
		3. Improving the reporting and investigation of near misses	
	3.2 Influence of organising on effective management techniques of construction site worker safety	1. Ensure there is an effective company policy for safety for all employees and contractors	2. Causal workers are made aware of their individual responsibility
		3. Arrangement of funds and facilities to meet the requirements of company policy and legislation	4. Provision for adequate and appropriate training to all workers

Table 4.21 continued

Concepts	Issued Addressed	Findings	
	3.3 Influence of control on effective management techniques of construction site worker safety	1. Assign responsibilities for implementing the emergency plan	2. Develop plans to control hazards that may arise in emergency situations
		3. Conducting emergency drills to ensure that procedures and equipment provides adequate protection during emergency situations	
	3.4 Influence of motivational on effective management techniques of construction site worker safety	1. Provision of bonus for workers	2. Motivation of construction operatives by instituting safety award
		3. Provision of personal protective equipment	4. Provision of overtime allowance
	3.5 Safety management technique related barriers	1. Off-the-shelf system imposed without modification	2. Workers – management relationship
		3. System-imposed by senior management without consultation	4. Trade union involvement
	3.6 Organisation related barriers	1. Inadequate training of employees in health and safety consultation	2. Inadequate resources
		3. Labour hire company with employees working between multiple client sites	4. Inadequacy of work associated with the incidence of hire employees and contractors

Table 4.21 continued

Concepts	Issued Addressed	Findings	
		5. Limited accountability mechanisms	6. Small firm with limited resources and unfamiliar with the system concept
		7. Safety activities restricted to technical experts	8. High labour turnover lead to fatigue of workers
	3.7 Contractor related barrier	1. Principal contractor simply imposes safety management technique on sub-contractor	2. Principal contractor imposing the responsibility on sub-contractor to have a safety management technique
		3. Subcontractor's safety management techniques inconsistent with the principal contractors	
3. To assess the involvement of construction management team on worker safety implementation on site	4.1 Site manager factors	1. Made a clear safety policy statement on the project	2. Always communicates risk findings to all workers
		3. Provide incentives for good safety behaviours	4. Always attends safety meetings on the construction site
		5. Provision of adequate resources for safety implementation	6. Routine safety evaluation in all work schedules

Table 4.21 continued

Concepts	Issued Addressed	Findings	
		7. Set safety as a major agenda item in all project meetings	8. Provides information on risk control
		9. Actively monitors safety programmes on the project	10. Involve workers in safety planning
	4.2 Safety officer factors	1. Performs emergency response drills	2. Hazard identification & risk assessment
		3. Safety audit & inspections	4. Regularly makes safety briefs
		5. Conducts toolbox meetings	6. Enforces safety guidelines
		7. Inspects the site to ensure it is a hazard-free environment	8. Accident investigation & record keeping on construction sites
		9. Promotes safe practices at the job site	10. Verifies that all tools and equipment are adequate and safe for use

Table 4.21 continued

Concepts	Issued Addressed	Findings	
	4.3 Contractor factors	1. Keeps records of all safety induction training conducted on site and make file available for inspection by an inspector, client or his agent	2. Consult & communicate safety information
3. Ensures all sub-contractors cooperate with each other in complying with safety regulations		4. Provision of safety orientation to all employees on construction site	
5. Appoints sub-contractors with necessary competences and resources to execute work safely		6. Ensures visitors undergo safety induction training relating to hazards prevalent on construction site and provides them with personal protective equipment	

Table 4.21 continued

Concepts	Issued Addressed	Findings	
	4.4 Client factors	1. Ensures all appointed contractors are cooperating and complying with the safety regulations	2. Stops contractors from executing a project that poses a threat to the safety of persons on site
		3. Participation in construction site safety meeting	4. Endures the appointed contractors have the necessary safety plan
		5. Ensures periodic safety audits are conducted on contractors	6. Involvement in project design
		7. Appoints contractors with necessary competences and safety measures	8. Provision of finance for safety

4.8.17 Client factors

Finding obtained from the analysis presented in Table 4.19 and Figure 4.20 according to the construction regulations suggest that clients have certain involvements in ensuring compliance with regulations. Clients, in fact, play a major role in construction safety management (Smallwood, 2002). Respondents were asked if the factors mentioned in the table and graph were carried out according to regulations.

The larger percentage of the respondents strongly agreed that it is “important” and “very important” for involvement of clients to ensure all appointed contractors are cooperating and complying with safety regulations, stopping contractors from executing a project that poses a threat to the safety of persons on site.

Furthermore, participation in construction site safety meetings endures that the appointed contractors have access to the safety plan through periodic safety audits by the contractors. As for the involvement of a project designer, the appointing of contractors with necessary competences and safety measures, and the provision of finance for safety, only a small percentage of respondents believed these to be “less important”. It can therefore be concluded that majority of the clients in the Western Cape of South Africa are ensuring that the appointed contractor is cooperating and complying with safety regulations. This is essential in eliminating or reducing the occurrence of accidents at construction sites (Smallwood, 2002).

4.9 Validity assurance of the research outcome

Validity assurance, the process for checking that a research instrument measures what it claims to measure, is critical for a study so that the results obtained will be accurately applied and interpreted. Teddlie and Tashakkori (2009) confirm that validity is the level to which the data accurately measures what they were intended to measure. *Validity* is hereby defined as authenticity of data collected to produce a desired result (Teddlie & Tashakkori, 2009). The following were considered to ensure validity:

- *Research population:* The population sampled for this study was comprised of construction professionals in the construction industry in the Western Cape Province of South Africa. This population was identified for achieving reliable results (Section 4.4).
- *Expected participants:* Experienced construction professionals within the industry were targeted (Section 4.4 & Table 4.1).
- *Sampling technique:* The research adopted convenient and purposive sampling techniques. Considering the busy schedule of the project participants, questionnaires were administered to construction professionals based on their accessibility to construction sites

and availability of construction professionals and safety professionals on sites. Gubrium *et al.* (2012) describes purposive sampling as a sampling technique that enables researchers to select study participants with respect to their characteristics, that is, participants with right information. Mertens (2014) argues that a purposive sampling strategy is a system whereby the researcher deliberately chooses a sample for a study, while having a purpose in mind. O'Leary (2017) indicates that an adequate sample frame and large sample size prevent unbiased research, represent a population and present a generalisable finding with respect to the population (Section 3.7.5).

- *Time*: The data were collected in considerable time limit.
- *Data collection instrument*: The most accurate data collection tool was adopted for each phase of collection (Section 3.7.4 & Section 4.1).
- *Pilot study*: A pilot study was conducted to determine the reliability and accuracy of the data collection (Section 4.2).
- *Cronbach's alpha co-efficient analysis*: The Cronbach's alpha co-efficient analysis was conducted to test the reliability of the quantitative research question (Section 4.5).

4.10 Achieving the objectives of the research study

4.10.1 The first objective of the research study was to identify the causes and effects of site accidents on construction site production

In achieving the objective, the data collected were analysed and major findings centred on types of hazard and factors affecting construction site production. manual handling, working at height, noise, handling heavy, overcrowded site, transporting mobile construction plant and ladders not properly placed, untimbered trenches, exposure to underground cable, untimbered trenches and exposure to underground cable are the major causes and effects of site accident on construction site production, as presented in Table 4.3 & Figure 4.4, and Table 4.4 & Figure 4.5.

4.10.2 The second objective of this research study was to ascertain effective management techniques for site worker safety in South Africa

In achieving this objective, the data collected were analysed and the important findings centred on the effective management techniques for site worker safety. These included: establishing safety training and orientation for site operative, accident investigation and record keeping on construction sites, motivation of construction operatives by instituting safety award, assignment of safety responsibility to all level of management and workers, conducting safety training and meeting and safety induction for project inception, issue of safety booklet or

leaflet, number of minor injuries, number of reportable injuries number of dangerous occurrences, number of fatalities, accident frequency rate, provision of PPE, provision of overtime allowance, and construction operatives' appraisal, in the construction industry for effective management techniques for site workers' safety were the factors findings obtained after data analysis, as presented in Table 4.5 & Figure 4.6, Table 4.6 & Figure 4.7, Table 4.7 & Figure 4.8, and **Error! Reference source not found.** & Figure 4.9.

4.10.3 The third objective of this research study was to evaluate the factors that affect the effective operation of the construction site worker safety

In achieving this objective, the data collected were analysed and the important findings were centred on the influence of planning, organising, controlling, and motivating for effective management techniques of construction site worker safety. Achieving the objective, the findings obtained after data analysis (as presented in Table 4.9 & Figure 4.10, Table 4.10 & Figure 4.11, Table 4.11 & Figure 4.12, Table 4.12 & Figure 4.13) included: are measures to control hazards and exposure, improving workplace safety training, improving near miss investigation and reportage, adequate and appropriate provision of training funds and facilities arrangement for company policy and legislation, ensure effective company policy for safety, awareness of individual responsibility for causal workers, assign responsibilities for implementing the emergency plan, develop plans to control hazards in emergency situations and conducting emergency drills to control emergency situations responses, conducting emergency drills to control emergency situations, provision of overtime allowance, provision of bonus for workers, construction operatives' appraisal and provision of PPE to enhance the effective operation of the construction site worker safety.

However, the findings also show the barriers for effective operation of construction site worker safety. This is comprised of three sub-questions under barrier for the effective operation of the construction site worker safety. In achieving this objective, the data collected were analysed and the important findings were centred on the safety management technique related barriers, organisation related barriers, and contractor related barrier. Achieving the objective, the findings obtained after data analysis (as presented in Table 4.13 & Figure 4.14, Table 4.14 & Figure 4.15, Table 4.15 & Figure 4.16) were the following: off-the-shelf system imposed without modification, workers-management relationship, system-imposed by senior management without consultation, trade union involvement, inadequate training of employees in health and safety consultation, inadequate resources, labour hire company with employees working between multiple client sites, inadequacy of work associated with the incidence of hire employees and contractors, limited accountability mechanism, small firm with limited

resources and unfamiliar with the system concept, safety activities restricted to technical experts, high labour turnover lead to fatigue of workers, principal contractor simply imposes safety management technique on sub-contractor, principal contractor imposing the responsibility on sub-contractor to have a safety management technique, and subcontractor safety management techniques inconsistent with the principal contractors. These are all the main factors considered for effective operation of the construction site worker safety.

4.10.4 The fourth objective of this research study was to assess the involvement of construction management team on workers safety implementation on site

In achieving this objective, the data collected were analysed and major findings centred on involvement of construction management team on worker safety implementation. The findings in Table 4.16 & Figure 4.17, Table 4.17 & Figure 4.18, Table 4.18 & Figure 4.19, and Table 4.19 & Figure 4.20 show that site manager, safety officer, contractor, and client are the management team shouldering significant involvement on worker safety implementation on site, with findings as follows: involve workers in safety planning, give safety policy statement on the project, priority in project meetings, performs emergency response drills, ensure tools and equipment adequacy and safe to use, consult and communicate safety information, giving safety orientation to all employees on site, establish safety regulations among subcontractors, document safety induction training and make file available for inspection, appoint competent subcontractors to ensure safe workplace, establish safety regulations among subcontractors and giving safety orientation to all employees on site, ensure non-violation of safety regulations by the contractors, prevent execution of projects with hazard intent, provide resources for safety improvement for safety involvement of construction management team on workers safety implementation on site.

4.11 Operational framework

Figure 4.21 below presents an operational framework for the management of construction site worker safety for effective production. Adequate application of the recommendations presented in this study will significantly reduce accidents on site and improve construction production.

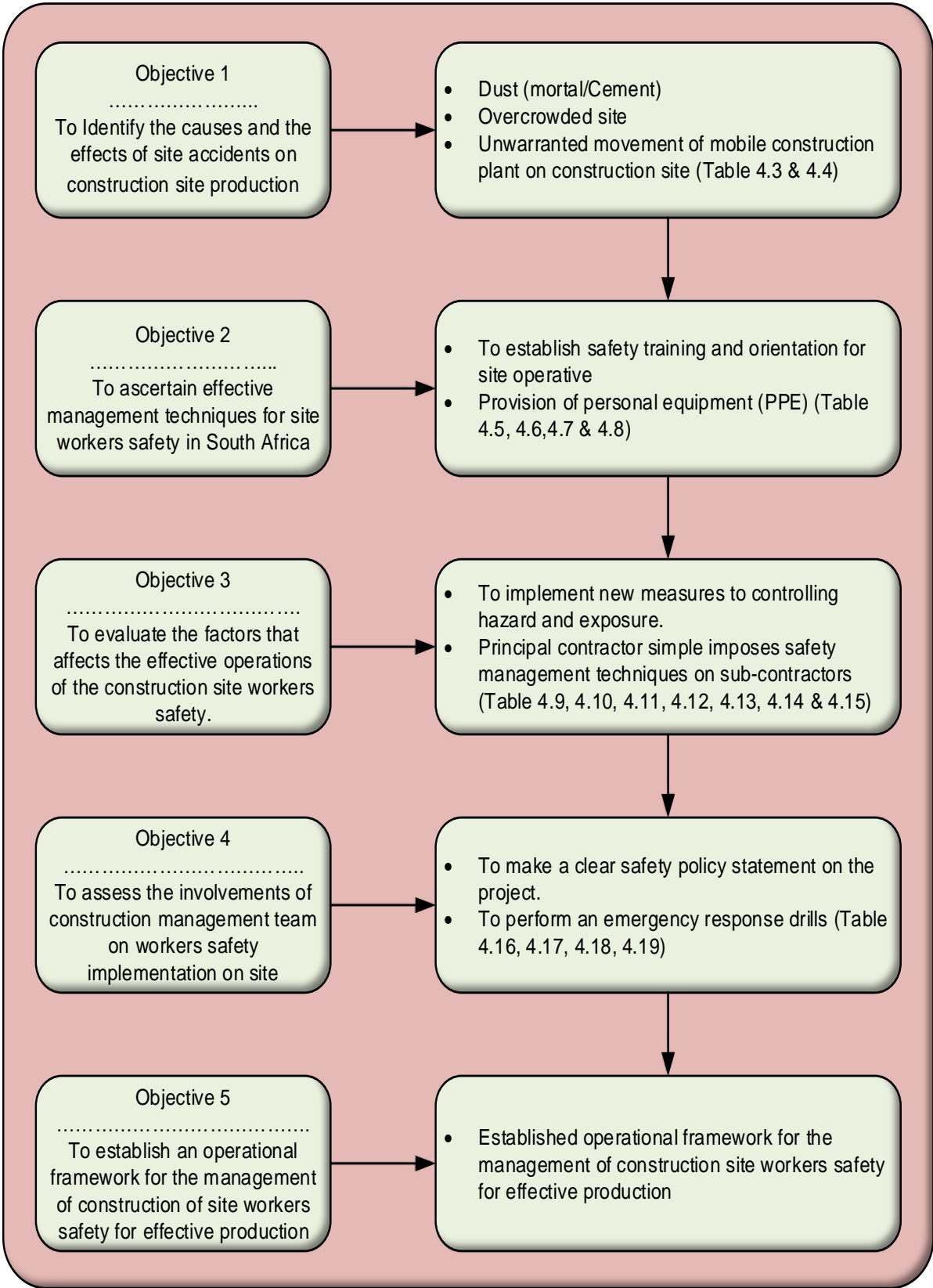


Figure 4.21: Summary of key findings

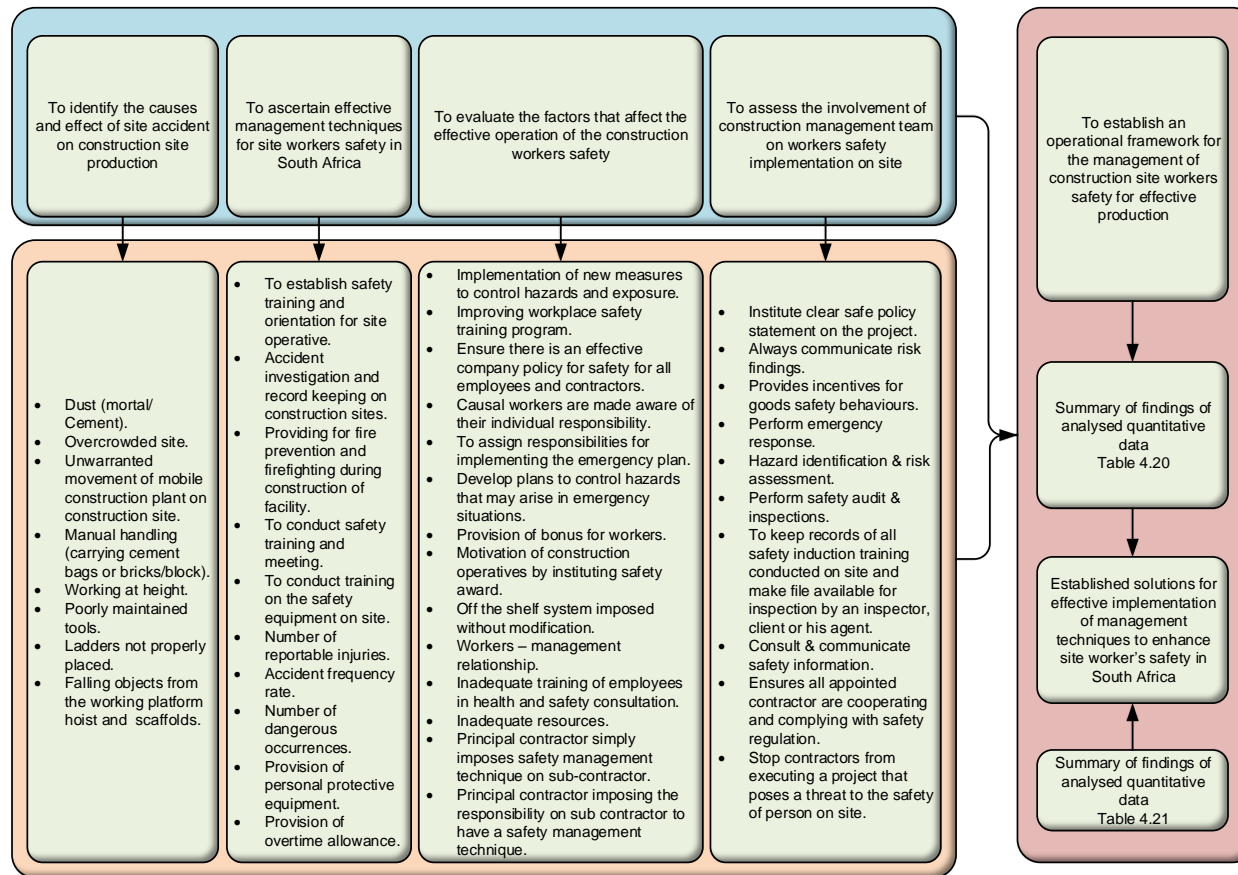


Figure 4.22: Operational framework for management of construction site worker safety for effective production

4.12 Chapter summary

This chapter presented results of the research from quantitative and qualitative analysis. SPSS software (version 25) was used to analyse the data obtained. Descriptive statistical analysis was employed in the research to make sense of data collected. The results were discussed and interpreted in the context of existing literature. The research findings were discussed in five categories: biographic information of respondents; factors that contribute to the following causes and effect of site accidents on construction site production; effective management techniques for site worker safety; barriers to the effective management techniques of construction site worker safety; and involvement of the construction team on worker safety implementation on site. The next and final chapter of the research presents the conclusions and recommendations.

CHAPTER FIVE

5. Summary, Conclusions and Recommendations

5.1 Introduction

The data derived from the quantitative and qualitative survey on the effective implementation of management techniques to enhance site worker safety in South Africa were analysed and discussed. Conclusions were drawn and recommendations were made based on the results attained. The study's aim was to develop a framework for effective implementation of management techniques to enhance site worker safety in South Africa. The completed objectives in this study were as follows:

1. to identify the causes and effects of site accident on construction site production;
2. to ascertain effective management techniques for site worker safety in South Africa;
3. to evaluate factors affecting the effective operation of construction site worker safety;
4. to assess the involvement of a construction management team on worker safety implementation on site; and
5. to establish an operational framework for the management of construction site worker safety for effective production.

5.2 Summary

Literature reviewed and findings were obtained through mixed methods of data collection.

Table 5.1: Summary of research outcomes

S/N	Concept	Reference	Page
1.	Conceptual framework	Figure 1.1	3
2.	Research methodology	Figure 1.2	9
3.	Summary findings of qualitative study	Table 4.20	111
4.	Summary findings of quantitative study	Table 4.21	119
5.	Operational framework for the study	Figure 4.21	132

5.3 Conclusion

The safety of construction site workers to the construction management of any construction company is imperative during and after the execution of any construction project. Many incidents of occupational hazards during and after construction activities have been recorded, but some of them are yet to be investigated to quantify their cause and effect, with the objective

of clarifying the effective operation of the construction site worker safety management system to validate the effective management system techniques that could be established for site worker safety. In the process of validating these techniques, analyses were done and valid findings were attained and discussed, wherein appropriate recommendations were formulated and an operational framework was developed to ameliorate ways of improving the occupational safety of workers in efforts to raise the production level. If this framework could be implemented accordingly by South African construction professionals, it will improve construction site worker safety across their various activities while enhancing construction production levels in South Africa because of the drastic reduction in occupational hazards.

5.3.1 Causes and effects of site accidents on construction site production

This objective aided the determination of the causes and effects of site accidents on construction site production by a thorough study of literature relevant to the investigation, a distribution of survey questionnaires to gather valid information on possible factors triggering causes and effects, and semi-structured interviews sectionalised and appropriately scheduled with construction professionals and safety officers to validate findings and implications deduced from numerical analysis of the data.

Findings reveal that over 70% of the respondents, as defined in accordance with each factor, agreed that *all* identified hazard-purported factors that affect construction site production are critical to the improvement of occupational safety of workers, provided that appropriate implementation of management techniques are enforced to facilitate a reliable approach to the safety of the construction site workers.

5.3.2 Effective management techniques for site worker safety in South Africa

This objective determined the effective management techniques required to improve the safety of construction site workers in South Africa. A study of the relevant literature, along with the execution of a pilot study to ascertain the integrity of the investigation, followed by the distribution of survey questionnaires to the respective construction professionals, including the semi-interviews sectionalised and properly scheduled with the safety officers.

From the findings obtained after a thorough numerical analysis integrated with the interview conclusions, it is categorically confirmed that the majority of respondents agreed that *all* the factors investigated and determined are crucial to effective management techniques for the safety of construction site workers, while in only a few cases, an insignificant number of respondents disagreed.

5.3.3 To evaluate the factors that affect the effective operation of the construction site worker safety

This objective facilitated the assessment of the factors that affect the effective operation of the construction site worker safety. This was initiated by reviewing the related literature, executing a pilot study and appropriate distribution of the survey questionnaires to the construction professionals, with a sectionalised and proper semi-structured scheduled interviews with the respective safety officers. After careful assessment and exploration of the data analysed, it is concluded that more than 70% of the respondents agreed that all the factors assessed in the process of determining the problems affecting the effective operation of the construction site worker safety are crucial in attaining effective operation of the construction site worker safety. Therefore, a four-word management approach – such as planning, organising, controlling and motivating – in construction management organisation will be appropriate in fostering effective implementation of management techniques for construction site worker safety.

5.3.4 To assess the involvement of construction management team on worker safety implementation on site

This is the last of the four objectives determined in this study. This objective aided the assessment of the involvement of construction management team on worker safety implementation on site. In the process, 35 factors were formulated and assessed with the aid of relevant literature, executing a pilot study to determine the reliability of the factors formulated in attaining desire results or findings, and distributing survey questionnaires to construction professionals, along with conducting semi-structured interviews pertaining to the involvement of construction management team on worker safety implementation on site.

The findings gathered reveal that site managers are tasked to exercise more commitment to consistently execute a safety policy statement to other construction site workers emphasising the importance of occupational safety while performing *any* construction activities. Similarly, safety officers are advised to consistently perform emergency response drills to foster occupational safety among the construction workers. More so, contractors are tasked with consistently keeping record of safety induction training conduct on the site, and by doing so, the client or appointed agent will be able to access and inspect the records. Moreover, clients are tasked with ensuring that appointed contractors are cooperating, while simultaneously complying with safety regulations to boost the improvement of the occupational safety among the construction workers.

If the above-discussed tasks can be exercised, a goal of zero occupational hazards will be attained.

5.4 Limitations of the research

This research was conducted in the Western Cape Province of South Africa. The collection of data from construction professionals was a challenging task in the course of the research as a result of the busy schedules of the respondents. The majority of the respondents complained about their tight time schedules on the construction site, attending safety meetings, and the pressure on them to meet project completion time. Some construction professional on site complained of being devoid of time to answer questions; such refusal to assist with this project tended to produce similar responses from their colleagues working in the same office. Due to their busy time, a significant number of the questionnaires were returned incomplete and therefore discarded by the researcher. As a result, findings derived from this research are only applicable to construction site safety to reduce the construction accident rate in Western Cape construction industries in particular and South Africa in general.

5.5 Recommendations

In view of the findings and conclusion, the study for effective implementation of management techniques for construction sites worker safety is essential for all construction sites to ensure that accidents and hazards are reduced or eradicated. To improve the operation of safety management techniques in the construction industry, the following recommendation have been developed:

- Top management should commit to worker safety by establishing safety training and orientation for site operatives.
- Management should enforce safety guidelines on accident investigations and record keeping on construction sites, must schedule safety auditing by safety committees, and must conduct toolbox meetings.
- The existing legislation should be modified to place higher importance on management's role to enhance management techniques for worker safety on site.
- Provision should be made to make safety management programmes on site a constitutional responsibility for each and every contractor.
- Management should respond to employees by assigning safety responsibilities to all levels of management and workers, and motivate construction operatives by instituting safety awards.

The study concluded that adequate consideration of these findings achieved in the study will render the framework developed in Figure 4.21 above as an advantageous model to operationalise on South Africa construction sites. Effective implementation of the

recommendations presented in the study will enhance management techniques for construction site worker safety and reduce or eliminate potential hazards on site.

5.6 Suggestions for further study

Further research should focus on construction site accident investigation and record keeping in order to advise construction professional and government on policy improvement, and implementation of management techniques for site worker safety on South African construction sites.

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Appendix I: Ethics approval for data collection



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Tel: +27 21 959 6666 E-Mail: greent@cput.ac.za

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

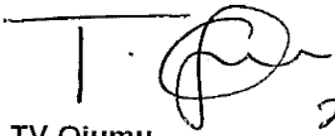
On 21 June 2019, the Chairperson of the Engineering Ethics Committee of the Cape Peninsula University of Technology granted ethics approval **AYODELE OLAJIRE FATOBA: 216296471** for research activities related to his **MASTER OF CONSTRUCTION** studies at the Cape Peninsula University of Technology.

Title of thesis:

Effective implementation of management techniques to enhance site workers' safety in South Africa

Comments:

Data collection is required – permission to collect data attached


21/06/2019
Prof. TV Ojumu
Research Coordinator (Acting)
Faculty of Engineering and the Built Environment

2019FEREC-STD-37

FACULTY OF ENGINEERING
DEPARTMENT OF COSTRUCTION MANAGEMENT & QUANTITY SURVEYING

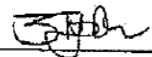
Research Data Collection Permission

Student: *(insert)* FATOBA AYODELE OLAJIRE

Student Number: *(insert)* 216296471

Topic: *(insert)* Framework to Enhance Site Workers Safety during Construction Project in South Africa
through effective Implementation of Management Techniques

In support of the ethical clearance for the above student, this letter confirms that permission has been requested and granted from this organisation where data will be collected for research.

Personnel Signature: 

Date: 14.09.2018

Personnel Capacity: PRINCIPAL TECHNICIAN (021 444 3384)

Name of Organisation/Official Stamp:



Appendix II: Survey participation invitation letter

QUESTIONNAIRE SURVEY



Effective Implementation of Management Techniques to enhance Site Worker Safety in South Africa

Dear Sir/Madam,

PARTICIPATION IN A SURVEY

You are cordially invited to participate in this research survey that aims to develop a framework for Effective Implementation of Management Techniques to enhance Site Worker's Safety in South Africa. This study is primarily undertaken for academic purposes for a Master of Construction degree in Construction Management Department, Cape Peninsula University of Technology.

All information provided in this study will be kept strictly **CONFIDENTIAL**.

Kindly complete the survey and return to:

Ayodele Olajire Fatoba,

E-mail: fatobaayodele1@gmail.com

Department of Construction Management and Quantity Surveying

Mobile: +27 (0) 731566408

Thanks for your cooperation and readiness to assist always.

Appendix III: Questionnaires

Section A: Biographic information of participants/ respondents

Please, cross or tick as appropriate (**x or √**) to indicate your opinion.

1. Kindly indicate which best describes your company:

Quantity surveying firm	
Construction firm	
Government establishment firm	
Project management firm	
Others (Specify)	

If other, please specify.....

2. Please indicate your gender:

Male	
Female	
others	

3. Please indicate your age group:

Below 26	26 - 30	31- 40	41 - 50	51 – 60	60 Above

4. Please indicate your highest formal qualification:

Matric Certificate	Diploma	Bachelor's/ Honour's degree	Master's degree	Doctorate degree	Other

If other, please specify.....

5. Kindly indicate your present position in your firm

Project manager	
Site manager	
Safety officer	
Quantity Surveyor	
Architect	
Other	

If other, please specify.....

6. How long have you been working in this position?

0 –5yrs	6 – 10yrs	11 – 15yrs	16 – 20yrs	Above 20yrs

Section B: Factors that contribute to the following causes and effect of site accident on construction site production

7. How safe are you when you are working on the following? **Please indicate your answer using the following 4 – 1 scale: Where 4 = very safe, 3 = safe, 2 = moderate, 1= not safe**

Type of hazard	4	3	2	1
Working at height				
Manual handling				
Overcrowded site				
Handling heavy				
Manual handling (carrying cement bags or bricks/blocks)				
Noise (using block/brick cutting machine)				
Dust (mortar/cement)				
Bending, twisting while laying blocks/bricks				

8. To what extent do you agree that the following factors will affect construction site productivity? **Please indicate your answer using the following 4 – 1 scale: Where 4=Very Large extent, 3= To a large extent, 2= To some extent, 1= To a little extent**

Factor	4	3	2	1
Worker exposure to dust on site				
Worker exposure to fumes on site				
Worker exposure to vibration during construction				
Exposure to high level of noise				
Exposure to underground cable				
Exposure to overhead live cable				
Manual lifting of heavy weights				
Untidy construction site due to waste materials littered on construction site				
Poorly maintained tools				
Falling objects from the working platform, hoist and scaffolds				
Failure of platforms and scaffolds due to lack of proper inspection				
Unguarded edges of platforms				

Unguarded openings in floors, walls				
Untimbered trenches that are more than 1.2m deep				
Ladders not properly placed				
Unwarranted movement of mobile construction plant on construction site.				

Section C: Effective management techniques for site worker safety

9. The following are management techniques for site worker safety. Kindly rank their level of importance, **Please indicate your answer using the following 4 – 1 scale: where; 4 = very important, 3 = Important, 2 = less important, 1= Unimportant**

Factors	4	3	2	1
Establishing safety training and orientation for site operative				
Assignment of safety responsibility to all level of management and workers				
Top management commitment to workers safety				
Accident investigation and record keeping on construction sites				
Safety auditing by safety committees				
Conduct toolbox meeting				
Enforce safety guidelines				
Responds to employees				
Motivation of construction operatives by instituting safety award				
Providing for fire prevention and fire fighting during construction of facility				

10. How effective are these management techniques for site worker safety. Kindly rank their level of effectiveness, **Please indicate your answer using the following 4 – 1 scale: where; 4 = very effective, 3 = effective, 2 = less effective, 1= ineffective**

Factors				
Company undertake safety training for workers	4	3	2	1
Training on the safety equipment on site				
Training on the use of personal protective equipment				
Issue of safety booklet or leaflet				
Safety instruction at work site				
Safety induction at the beginning of project				
Conducting safety training and meeting				
Safety induction for visitors				
Record keeping of accidents on site				
Accident frequency rate				
Number of fatalities				
Number of dangerous occurrence				
Number of reportable injury				

Number of minor injury				
Provision of incentives for good safety performance				
Provision of personal protective equipment				
Provision of overtime allowance				
Provision of bonus for workers				
Motivation of construction operatives by instituting safety award				

Section D: Barriers to the effective management techniques of construction site worker safety

11. How does the following influence the effective management techniques of construction sites workers safety? **Please**, kindly rank their level of influence for each of the listed management techniques, **Where: 4= Very influential, 3= Influential, 2= Less influential, 1 = Not influential**

Planning	4	3	2	1
Implementing new measures to control hazards and exposure				
Improving workplace safety training programmes				
Encouraging engagement in safety at all levels of the organisation				
Improving the reporting and investigation of near misses				
Organising				
Ensure there is an effective company policy for safety for all employees and contractors				
Causal workers are made aware of their individual responsibility				
Provision for adequate and appropriate training to all workers				
Arrangement of funds and facilities to meet the requirements of company policy and legislation				
Controlling				
Develop plans to control hazards that may arise in emergency situations				
Conducting emergency drills to ensure that procedures and equipment provides adequate protection during emergency situations				
Assign responsibilities for implementing the emergency plan				
Motivating				
Provision of bonus for workers				

Motivation of construction operatives by instituting safety award				
Provision of overtime allowance				
Provision of personal protective equipment				

12. The following are the barrier that influence the effective operation of construction sites workers safety management, **Please indicate your answer using the following 4 – 1 scale: Where 4= Very influential, 3= Influential, 2= Less influential, 1 = Not influential**

Barrier	4	3	2	1
Safety Management Related Barriers				
Off-the-shelf system imposed without modification	4	3	2	1
System-imposed by senior management without consultation	4	3	2	1
Workers – management relationship	4	3	2	1
Trade union involvement	4	3	2	1
Organisation Related Barriers				
Inadequate resources	4	3	2	1
Limited accountability mechanisms	4	3	2	1
Safety activities restricted to technical experts	4	3	2	1
Inadequate training of employees in health and safety consultation	4	3	2	1
High labour turnover lead to fatigue of workers	4	3	2	1
Small firm with limited resources and unfamiliar with the system concept	4	3	2	1
Labour hire company with employees working between multiple client sites	4	3	2	1
Inadequacy of work associated with the incidence of hire employees and contractors	4	3	2	1
Contractor Related Barriers				
Principal contractor imposing the responsibility on sub-contractor to have a safety management technique	4	3	2	1
Principal contractor simply imposes safety management technique on sub-contractor	4	3	2	1
Subcontractor's safety management techniques inconsistent with the principal contractor's	4	3	2	1

Section E: Involvement of construction team on workers' safety implementation on site

13. The following are the involvement of construction management team on workers safety implementation on site. Kindly use the scale below to 'tick as appropriate' where; **4= very important, 3= important, 2= Less important, 1= Not important**

Site manager factors	4	3	2	1
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Provide incentives for good safety behaviours				
Routine safety evaluation in all work schedules				
Actively monitors safety programmes on the project				
Always attends safety meetings on the construction site				
Provision of adequate resources for safety implementation				
Set safety as a major agenda item in all project meetings				
Made a clear safety policy statement on the project				
Involve workers in safety planning				
Always communicates risk findings to all workers				
Provides information on risk control				
Safety officer factors				
Regularly makes safety briefs				
Safety audit & inspections				
Hazard identification & risk assessment				
Inspects the site to ensure it is a hazard-free environment				
Accident investigation & record keeping on construction sites				
Enforces safety guidelines				
Verifies that all tools and equipment are adequate and safe for use				
Conducts toolbox meetings				
Performs emergency response drills				
Promotes safe practices at the job site				
Contractors factors				
Safety staffing				
Consult & communicate safety information				
Top management commitment				
Appoints sub-contractors with necessary competences and resources to execute work safely				
Ensures all sub-contractors cooperate with each other in complying with safety regulations				
Keeps records of all safety induction training conducted on site and make file available for inspection by an inspector, client or his agent				
Ensures visitors undergo safety induction training relating to hazards prevalent on construction site and provides them with personal protective equipment				
Provision of safety orientation to all employees on construction site				
Client factors				
Appointment of safety agent				
Involvement in project design				
Provision of finance for safety				
Appoints contractors with necessary competences and safety measures				
Endures the appointed contractors have the necessary safety plan				
Ensures periodic safety audits are conducted on contractors				
Stops contractors from executing a project that poses a threat to the safety of persons on site				

Ensures all appointed contractors are cooperating and complying with the safety regulations				
Participation in construction site safety meeting				

THANKS FOR YOUR PARTICIPATION AND COOPERATION

Appendix IV: Interview

Interview guide

1. What are the factors that are influencing implementation of safety on construction site?
2. How often does the employee attend safety training for effective production?
3. How frequently are incentives provided on site for good safety performance?
4. What are the kinds and likely causes of accidents and injuries on construction sites?
5. What are the effects of accidents and injuries mention above?
6. What is the level of the management commitment on safety implementation?
7. How does the management allocate resources for organizing and controlling activities within the site to address hazards?