DEVELOPMENT OF A CLIENT-DRIVEN HEALTH AND SAFETY MODEL FOR MEASURING HEALTH AND SAFETY PERFORMANCE OF CONSTRUCTION PROJECTS IN SOUTH AFRICA

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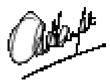
PREFACE

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

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



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I, Joseph D. Khoza, declare that:

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

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

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a) their words have been rewritten but the general information attributed to them has been referenced

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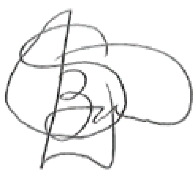

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Signed: Joseph D. Khoza

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ABSTRACT

The construction industry plays a vital role in the world economy. A labour-intensive sector creates the most employment opportunities for unskilled and semi-skilled workers from impoverished local communities. The activities of the construction industry affect all aspects of the economy and drive the economic growth of many countries; it makes use of materials procured from other industries – making it one of the sectors indirectly contributing to employment creation in other sectors.

Despite its vital role and contribution to economic growth, the construction industry remains a hazardous sector where the most vulnerable (unskilled and semi-skilled) workers are continually involved in serious construction accidents. Although there have been interventions by various stakeholders to deal with this problem, the results remain unacceptable with accidents persisting in the industry. Notwithstanding significant effort by business associations, researchers, construction clients and contractors to deal with the unsatisfactory health and safety (H&S) performance in the construction industry, the situation has not improved.

There is consensus amongst researchers that the involvement by clients throughout all of the project phases can lead to improvement in the health and safety performance of construction projects. Over the past few years various studies dealing with client influence in construction project health and safety performance have reported several methods in which construction clients can improve this aspect on project sites; however, very few studies have developed models to assist the industry in improving health and safety of these projects. Lack of effective involvement by clients has contributed to the construction industry's extremely high number of accidents that occur on a daily basis, resulting in medical treatment cases, lost time incidents, fatalities and damage to property.

The objective of this study was to develop a client-driven health and safety rating model (CHSRM) for the measurement of health and safety performance that can be used by construction clients to improve project health and safety performance. The relationship between involvement of clients in construction projects and health and safety performance was investigated and the extent to which South African construction clients are involved in projects was examined. Results from the literature reviewed identified the attitudes by clients towards health and safety overall, the communication attitudes by clients towards health and safety, the selection of contractors, the involvement of clients before and during construction, contractual health and safety arrangement and monitoring of health and safety performance by contractors, as critical factors associated with involvement of clients in construction

projects and health and safety improvements. It was conceptualised that these critical factors can be used as building blocks for the CHSRM.

Using the framework of factors from previous studies, a survey method was adopted for this study. A questionnaire was designed for respondents to assess the extent to which construction clients were involved in construction project health and safety in projects they had managed and to evaluate the health and safety performance of those projects. Results from data collected across 135 large-size construction projects in South Africa were analysed using descriptive statistics. The first results from the questionnaire relate to the degree to which construction clients are involved in the project health and safety. They show that the attitudes of clients and their communication attitudes towards health and safety, selection of contractors, contractual health and safety arrangement and the monitoring of health and safety performance of contractors were found to be satisfactory and common in the construction industry. However, involvement by clients before and during construction was found to be unsatisfactory.

The second results relate to whether there is a relationship between client involvement and project health and safety performance. A survey was designed for respondents to assess the performance of projects they had participated in and to evaluate their performance by providing data using lagging indicators. The relationship between the six constructs with each of the project health and safety performance indicators was tested using correlation analysis. The results show that all of the constructs have a high significant positive correlation at $p<0.001$. Furthermore, they show that the first aid incident rate and all incident frequency rate indicators of project health and safety performance are not influenced by any of the research variables. The medical treatment incident frequency rate, lost time incident frequency rate and recordable case rate indicators of project performance are all influenced by selection of contractors and contractual health and safety arrangement. Based on the results of the study, the client-driven occupational health and safety measurement model seemed to be justifiable.

The results from previous studies provided a theoretical basis to construct a model for this study using the critical health and safety factors. It was hypothesised that attitude of clients towards health and safety, their communication attitude towards health and safety, their involvement before and during construction, selection of contractors, contractual health and safety arrangement and the monitoring of health and safety performance of contractors, have a direct influence on project health and safety performance. These hypotheses were tested and verified using Covariance-Based Structural Equation Modelling (CB-SEM). Contrary to the findings of the previous studies, the final CB-SEM results

suggested that the contractual health and safety arrangement is the only construct which has a direct effect on project health and safety performance.

Mediation hypothesis was performed revealing that the attitude, communication and selection of contractors based on their historical health and safety performance have an indirect effect of project health and safety performance. The final model was validated by CHS experts who were asked to review the proposed model and to rate the extent to which they agree/disagree with the statements that described the model in terms of its applicability, effectiveness and adaptability in the construction industry. The key finding was that CHSRM was acceptable.

The study has contributed to knowledge by deepening the understanding of the critical elements to health and safety beyond those considered in previous studies. The significance of the study was that construction clients could use CHSRM before and during the construction process. It has also highlighted the urgent need for construction clients to change the traditional mind-set that health and safety is only the responsibility of construction contractors. The results of the study have confirmed that involvement by clients throughout the phases of the project could lead to improvement in project health and safety. Future studies should be conducted using a larger sample size to improve the application of the model in the construction industry. The survey instrument indicator variables may be refined to suit specific project environments.

Keywords: construction clients; health and safety; project performance; structural equation model

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
ACEC/MA	American Council of Engineering Companies of Massachusetts
AGFI	Adjusted Goodness-Of-Fit Index
AIFR	All Incident Frequency Rate
ASM1	Alternative Model 1
ASM2	Alternative Model 2
AVE	Average Variance Extracted
BLR	Business and Legal Resources
CB-SEM	Covariance-Based Structural Equation Modelling
CDM	Construction Design and Management
CIDB	Construction Industry Development Board
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CIH	Certified Industrial Hygienist
CR	Construction Regulation
CSP	Certified Safety Professional
CHSA	Construction Health and Safety Agent
CHS	Construction Health and Safety
CHSRM	Client-Driven Health and Safety Rating Model
CTE	Critical to Expectation
CTHS	Critical to Health and Safety
CTS	Critical to Safety
DoL	Department of Labour
EFA	Exploratory Factor Analysis
EJCDC	Engineers Joint Contract Documents Committee
EPC	Engineering, Procurement and Construction
FAI	First Aid Injury
FAIFR	First Aid Incident Frequency Rate

FEMA	Federated Employers Mutual Assurance
FIDIC	The International Federation of Consulting Engineers (Fédération Internationale Des Ingénieurs-Conseils)
GCC	General Conditions of Contract
GDP	Gross Domestic Product
GFI	Goodness-Of-Fit Index
H&S	Health and Safety
HSE	Health, Safety and Environment
IFI	Incremental Fit Index
LISREL	Software for Structural Equation Modelling
JBCC	The Joint Building Contracts Committee
JCT	Joint Contracts Tribunal Forms of Contract
KMO	Kaiser-Meyer-Olkin
KPIs	Key Performance Indicators
LTIFR	Lost Time Incident Frequency Rate
MANOVA	Multivariate Analysis of Variance
MSA	Measure of Sampling Adequacy
MSV	Maximum Shared Variance
MTI	Medical Treatment Injury
MTIFR	Medical Treatment Incident Frequency Rate
NEC	Engineering and Construction Contract
NFI	Normed Fit Index
OHS	Occupational Health and Safety
ORRM	Owner's Role Rating Model
OSHA	Occupational Safety and Health Administration
PAF	Principal Axis Factoring
PARAFAC	Parallel Factor Analysis
PCA	Principal Components Analysis
PCFI	Parsimony Adjusted Comparative Fit Index
PM	Project Management
PNFI	Parsimony Adjusted Normed Fit Index

PPE	Personal Protective Equipment
Q3	Quarter Three
RCR	Recordable Case Rate
RFI	Relative Fit Index
RMSEA	Random Measures of Sample Error Approximation
RIFR	Recordable Incident Frequency Rate
SACPCMP	South African Council for Project and Construction Management Professions
SAS	Statistical Analysis System
SEM	Structural Equation Model
S/M	Specification/Measurement
SHEQ	Safety, Health, Environment and Quality
SMEIPP	Structural Steel, Mechanical, Electrical, Instrumentation, Piping and Platework
SPSS	Statistical Package for The Social Sciences Version 25
SPSS AMOS	Statistical Package for the Social Sciences Analysis of Moment Structures Version 25
SRMR	Standard Root Mean Square Residual
STD. ERROR	Standard Error
TLI	Tucker Lewis Index
TRIR	Total Recordable Incident Rate
UK	United Kingdom
USA	United States of America
VB-SEM	Variable-based Structural Equation Modelling

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CHAPTER 1 : RESEARCH BACKGROUND

1.1 Introduction

1.1.1 Challenges in the Construction Industry

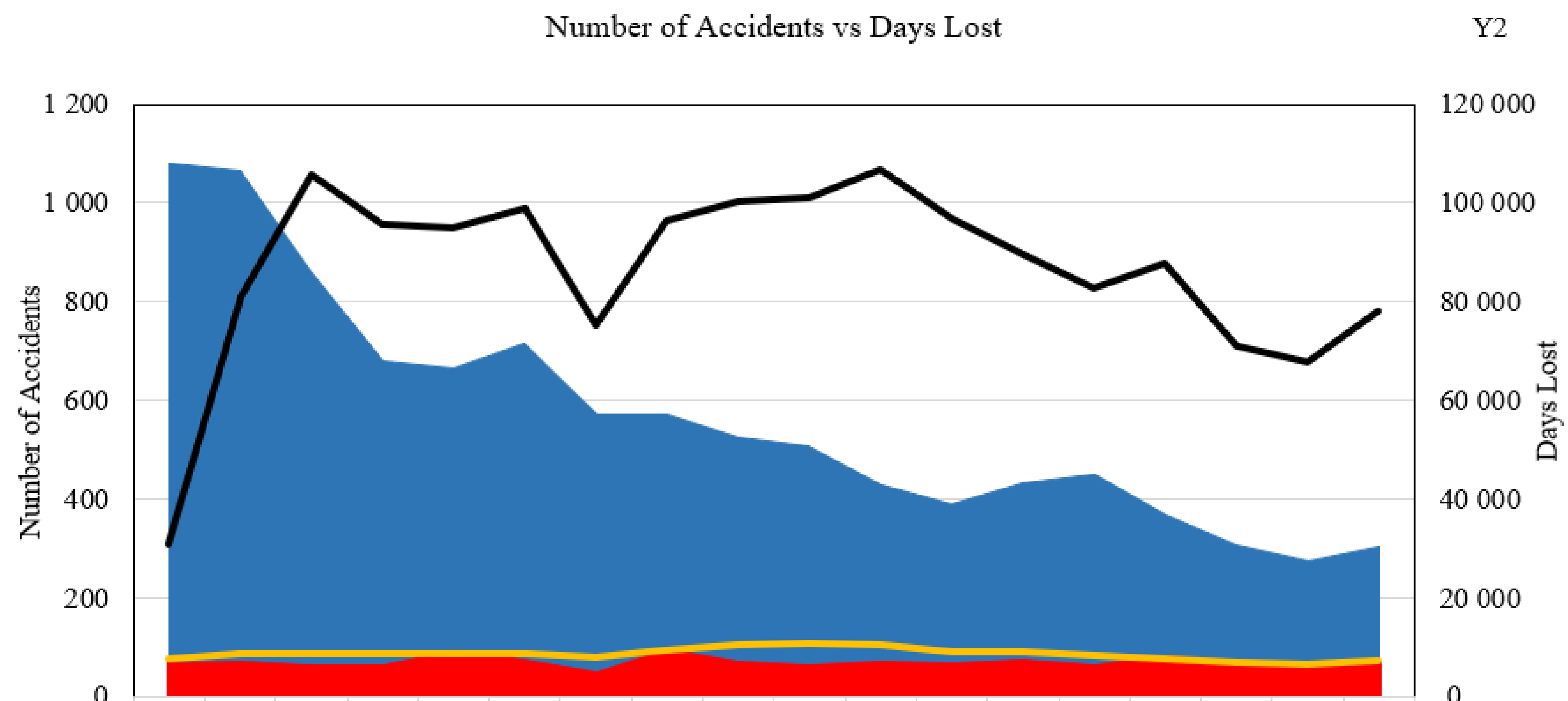
The construction industry plays a vital role in the world economy and offers employment to approximately seven per cent of the global work force. According to Nieuwenkamp (2016), construction is estimated to account for approximately thirteen per cent of gross domestic product by 2020. The Construction Industry Development Board (CIDB) Employment Quarter Three Report (Construction Monitor, 2017) states that the construction industry in South Africa accounts for eight per cent of total formal employment and sixteen per cent of total informal employment. The Global Construction 2030 study (Global Construction Perspectives and Oxford Economics, 2015) estimates that the volume of construction output will grow by eighty-five per cent to $15.5 trillion worldwide by 2030 – with three countries(China, the United States of America (USA) and India) – leading the way and accounting for fifty-seven per cent of all global growth. This indicates an average global construction growth of approximately four per cent per annum to 2030.

The construction industry is one of the sectors that creates the most employment opportunities for unskilled and semi-skilled workers from impoverished local communities due to its relatively labour-intensive nature (Phoya, 2012). According to the Construction Industry Development Board (CIDB) Employment Quarter Three Report (Construction Monitor, 2017), around seventy per cent of labour employed in the industry in South Africa, is unskilled or semi-skilled. The construction industry is the driving force behind the economic growth due to its operations having an impact on most sectors of the economy (Oladinrin, Ogunsemi and Aje, 2012). In addition, it contributes indirectly to employment creation in other sectors as most materials used are sourced from these sectors of the economy (Ngandu, Garcia and Arndt, 2010).

Notwithstanding its important role and contribution to economic growth, the construction industry remains a risky sector where the most vulnerable (unskilled and semi-skilled) workers are continually involved in serious construction accidents. Although there were interventions by various stakeholders to deal with this problem, the results remain unacceptable as accidents continue to persist in the construction industry.

Despite the programmes implemented by government authorities and other relevant stakeholders to improve the standard of health and safety (H&S) at construction project sites, the construction industry in South Africa still has an unacceptably high level of incident rates. This causes extensive human suffering – and despite measures introduced by the contractors themselves, construction workers continue to be fatally injured and exposed to occupational health hazards (Lopes, Haupt and Fester, 2011). A study by Saïdani (2012) has found that developing countries have a very high number of construction-related fatalities and the construction industry in these countries continues to lag behind most other industries in this regard.

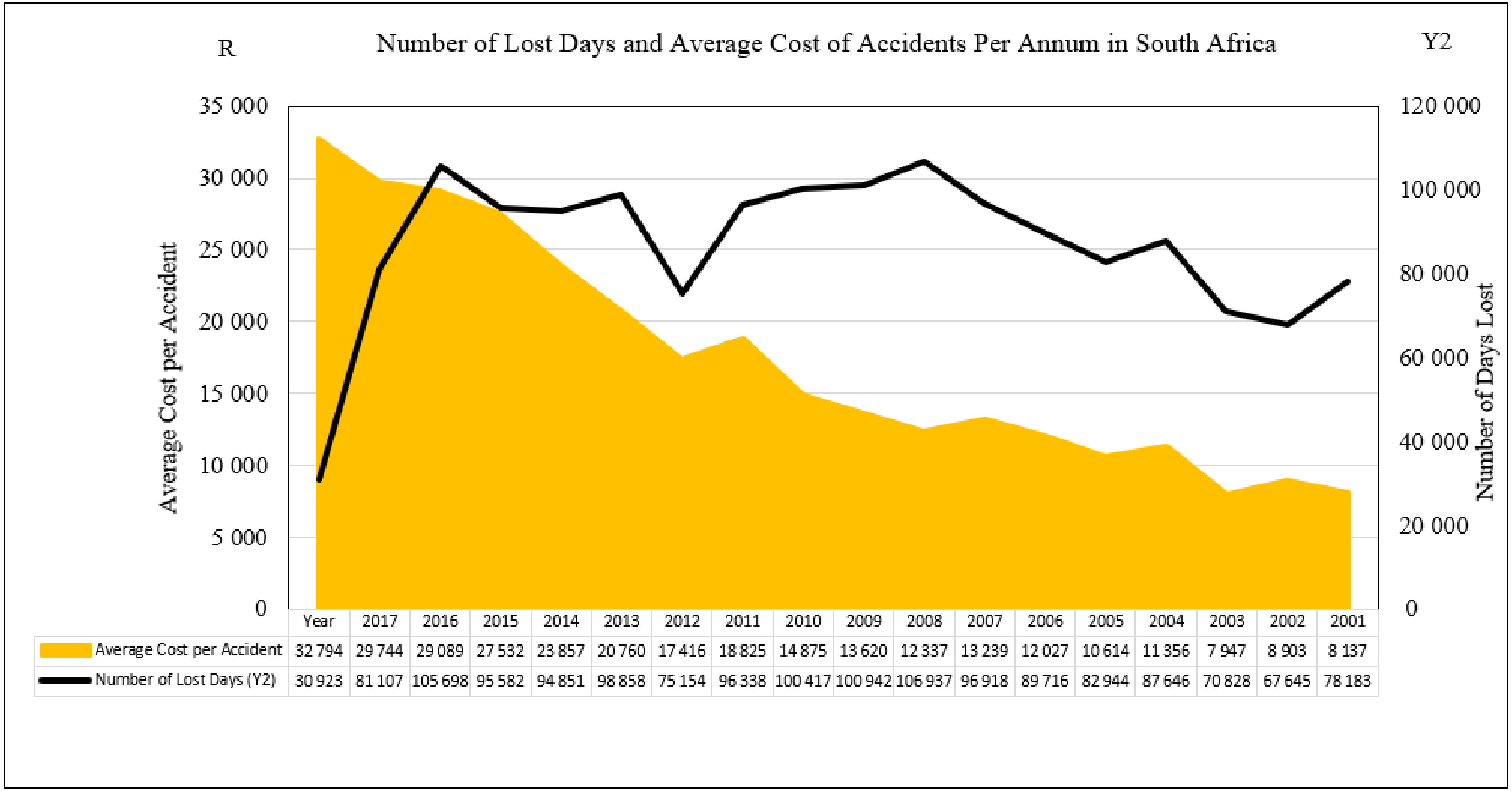
In South Africa, between 2007 and 2017, the records of the Federated Employers Mutual Assurance (FEMA) indicated that 153,780 incidents occurred. These incidents resulted in 1 316 fatalities, 8 870 permanent disabilities not resulting in a pension, 650 permanent disabilities resulting in a pension and 1 560 687 lost workdays (Figure 1.1). On average, this indicates an accident frequency rate of 3.9 and seventy-three fatal incidents per annum. In the same period, the average cost of accidents per year increased from R8 137 in 2000 to R32 794 in 2017 (Figure 1.2). It must be noted, however, that the accuracy of these statistics remains questionable, as it does not include the construction sector covered by the Department of Labour (DoL) Compensation Commissioner.



Year	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Permanent Disabilities not resulting in Pensions	1 010	991	795	613	572	640	519	474	453	441	356	318	355	384	283	233	198	235
Fatal Accidents	69	74	67	66	94	76	51	97	73	67	72	70	76	66	83	72	75	68
Number of Accidents (Y2)	7 560	8 455	8 514	8 709	8 720	8 439	8 042	9 213	10 404	10 936	10 504	9 058	8 944	8 146	7 377	6 887	6 524	7 348
Lost Days (Y2)	30 923	81 107	105 69	95 582	94 851	98 858	75 154	96 338	100 41	100 94	106 93	96 918	89 716	82 944	87 646	70 828	67 645	78 183

Figure 1.1 Number of Accidents and Lost Time in South Africa Between 2007 and 2017

Source: Data provided by FEMA



Year	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Average Cost per Accident	32 794	29 744	29 089	27 532	23 857	20 760	17 416	18 825	14 875	13 620	12 337	13 239	12 027	10 614	11 356	7 947	8 903	8 137
Number of Lost Days (Y2)	30 923	81 107	105 698	95 582	94 851	98 858	75 154	96 338	100 417	100 942	106 937	96 918	89 716	82 944	87 646	70 828	67 645	78 183

Figure 1.2 Number of Lost Days and Average Cost of Accidents Per Annum in South Africa

Source: Data provided by FEMA

1.1.2 Efforts to Improve Health and Safety in the Construction Industry

Despite significant efforts by industry associations, researchers, construction clients and contractors to improve H&S in the construction industry, overall construction H&S performance has not improved and continues to contribute an unacceptably high level of injuries and fatalities. The construction industry continually fails to comply with construction regulations (CR 2014) in South Africa. To address the unacceptably high level of incident rates in the construction industry, many countries have developed laws and regulations that govern the processes in which construction clients must manage H&S on construction sites. Client influence in construction projects has been cited by numerous researchers as a lasting solution for reducing the number of H&S accidents on sites.

Huang (2003) stated that there is a legal and moral responsibility on owners to ensure that their contractors comply with H&S requirements. From the construction process perspective, there are three key issues that affect the project owner (The Hartford Loss Control Department, 2002) namely, moral obligation, legal obligation and potential cost savings. In terms moral obligation, employers are generally expected to provide and maintain a safe working environment that is without risk to the health of employees. This moral obligation goes beyond the employees of contractors and includes other stakeholders. In terms of legal obligation employers have a duty to inform and warn their employees, contractors and other stakeholders about any potential hazardous situation on sites. The clients could be held liable for injuries to any of the project stakeholders caused by their failure to enforce strict H&S requirements on a site that is under their control. In terms of potential cost savings, any effort shown by clients for H&S on site has the potential to bring down construction costs as the number of injuries reduce.

1.1.3 Legislative Framework

Globally, health and safety regulations have been developed to be observed by employers and contractors. Construction clients are required by labour departments to enforce H&S requirements in respect of contractors; therefore, contractors persevere in implementing H&S measures on site to avoid being liable for injuries arising from failure to adhere to legal and other requirements (van Heerden, Musonda and Okoro, 2018).

In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation on all stakeholders. According to Smallwood, Haupt and Shakantu (2009), the CR 2014 has redirected the duties for H&S from the contractors only, to include all stakeholders (including the end user). In the United Kingdom

(UK), Construction Design and Management (CDM) 2015 identifies the client as a major influencer over the way a project is procured and managed. In terms of CDM 2015, it requires clients to appoint contractors and designers that can demonstrate capability in term skills, experience and knowledge of the work that they are being employed to execute. In terms of the process, safety standards the USA, construction clients are obligated to be more involved in H&S on project sites (Hartford Loss Control Department, 2002). According to Lurie, Ilchert, MacDonnell and Ryan (2017), New York's workplace safety laws require construction clients and contractors to follow H&S regulations and to provide workers with Personal Protective Equipment (PPE).

Throughout the world, most countries have adopted standard forms of contract – for engineering and construction works contracts – as a standard uniformity for construction procurement. In this country, although these standard forms of contract make explicit (or implicit) reference to the fact that the forms of contract are subject to the laws of the land and therefore to South African legislation impacting on construction H&S, they lack direct references to CR 2014 (Smallwood et al., 2009).

Smallwood et al. (2009) argue that there is scope for the standard form contracts to include a more direct reference to construction H&S, construction regulations and the obligations of contractors, as well as providing for additional client-driven H&S requirements. Mzyece, Ndekugri, Ankrah and Hammond (2012) examined H&S contractual provisions in four standard form contracts that are widely used in the UK construction industry. Mzyece et al., (2012) compared the H&S contractual provisions with key features of the Construction (Design and Management) Regulations 2007 (CDM 2007) with a standard form of contracts, and concluded that there is a need for greater clarity and uniformity in standard form contracts – particularly in the area of H&S.

Haywood (2004) noted that H&S culture starts when the client decides to embark on a construction project. H&S performance can only be realised by the active involvement of construction clients throughout all of the project phases (Haywood, 2004) Client influences in driving H&S is important when compared to legal and regulatory influences (Diugwu and Baba, 2014). Diugwu and Baba (2014) point out that if construction clients assume the responsibility of controlling and coordinating H&S improvement programmes, the potential of achieving effective H&S programmes on sites can be realised. This is due to the clients being the final decision-makers in the supply chain process.

1.1.4 Influence of Clients on Project Health and Safety Performance

Jazayeri and Dadi (2017) revealed that various researchers have conducted studies in the construction industry on client influence on construction project H&S performance, identifying factors causing poor performance in construction projects and critical success factors influencing safe programme implementation.

Musonda, Pretorius and Haupt (2012) investigated the influence of clients on construction project H&S performance in Botswana and South Africa. The findings of the study were that H&S performance was better when factors associated with client health and safety culture were observed. Musonda et al., (2012) argued that in most instances the role of construction clients is ignored by researchers as they place most of the emphasis on contractors. A study by Huang and Hinze (2006: 171) found that H&S performance is improved when construction clients strictly enforce H&S compliance for contractors.

Liu, Jazayeri and Dadi (2017) conducted a study to evaluate the degree to which owners are involved in site safety issues. They developed a model – Owner's Role Rating Model (ORRM) – to test the extent to which construction clients participate in health and safety and presented a survey instrument to assess the level of participation by owners in site safety management. Liu et al., (2017) conducted an evaluation of twenty projects by using ORRM to verify its applicability in the construction environment; the study concluded that owners with little involvement in construction projects could use the ORRM to identify the critical points for better performance.

1.2 Problem Statement

Although there is consensus amongst researchers that client participation throughout the phases of construction projects can lead to improvements in the H&S performance of these projects, very few studies have developed models to assist the industry to improve health and safety in this area. Lack of effective participation of clients in health and safety has left the construction industry with a very high number of accidents every day, resulting in medical treatment cases, lost time incidents, fatalities and damage to property that occur on construction sites.

While previous studies provided various ways on how construction clients could improve the H&S performance of construction projects, few studies have produced models that can be used as a framework to assess clients overall performance and which could help identify gaps that construction clients can focus on to improve performance in health and safety.

This study builds on Liu et al., (2017) and uses an alternative method to develop a model, the Client-Driven Health and Safety Rating Model (CHSRM), aimed at assisting clients to influence contractors in improving the health and safety performance of construction projects effectively. Contrary to Liu et al., (2017), the study was conducted in a developing country where the maturity of the health and safety culture lags when compared to the developed country where the survey was conducted. Structural Equation Modelling (SEM) was applied in displaying how clients could assist contractors to improve H&S performance on project sites.

To avoid compromising (and to verify the effectiveness and efficiency of the model), a sample size of 135 construction projects was used to represent the general situation in the construction industry. Additional Critical to Expectations (CTE) elements were added to ensure that the model covers all legal requirements and does not produce inaccurate results. Further, the study included all types of construction projects so that a comparative analysis between different project categories could generate constructive and insightful results.

Contrary to Liu et al., (2017), the study used various H&S performance indicators, including First Aid Incident Frequency Rate (FAIFR), Medical Treatment Incident Frequency Rate (MTIFR), lost time Incident Frequency Rate (LTIFR) and Recordable Case Rate (RCR) (also known as Recordable Incident Frequency Rate (RIFR). Furthermore, this study analysed the extent to which construction clients use leading indicators to prevent unfavourable events before they occur.

1.3 Research Questions

To address the purpose of the study, the following research questions were developed:

- Does the attitude of construction clients towards health and safety influence project health and safety performance?
- To what extent do communication attitudes of construction clients towards health and safety lead to improvements in health and safety performance?
- To what extent do construction clients select contractors based on a proven health and safety track record?
- To what extent do health and safety arrangements of construction clients stipulate the health and safety duties for all participants on the construction project?
- How involved are construction clients in health and safety before construction?
- To what extent do construction clients monitor contractor health and safety compliance?

- Is there a relationship between involvement of clients in construction health and safety processes and overall project health and safety performance?

1.4 Research Objectives

The key objectives of this study were to provide answers to the research questions and to the hypothesis. Study objectives are to:

- investigate the impact of the attitude of clients towards H&S and project H&S performance
- to establish whether the ability of clients to communicate H&S requirements lead to better project H&S performance
- establish if there is a relationship between selecting contractors based on their historical H&S performance and improvement in project H&S
- establish whether stipulating H&S requirements in the contract enhances compliance to H&S by contractors
- establish whether client involvement before and during construction leads to better project H&S performance
- establish whether the extent to which clients monitor the H&S compliance of contractors leads to improvement project H&S
- develop, verify and validate a client-driven H&S model for measuring health and safety performance of construction projects in South Africa

1.5 Hypotheses

Based on the conclusions made by previous studies (that client involvement in all phases of the construction project could lead to improvements in the health and safety performance of construction projects), the following hypotheses were tested by this study:

H_1: The attitude of construction clients towards H&S has direct influence on project H&S performance.

H_2: The ability of clients to communicate their H&S requirements could directly improve project H&S performance.

H_3: Selection of contractors by construction clients based on proven H&S track records could lead to improved project H&S performance.

H_4: Stipulation of H&S duties for all participants on the construction project by construction clients in the contractual arrangement could improve project H&S performance.

H_5: Involvement of construction clients before and during construction directly improves project H&S performance.

H_6: Monitoring of contractor H&S compliance by construction clients could directly improve the project H&S.

1.6 Research Methodology

For the purpose of this study, the target population includes construction clients of building, housing, civil construction, petrochemicals, roads and earthworks, and structural, mechanical, electrical, instrumentation, piping and platework (SMEIPP). The data was gathered directly from clients, professionals representing client health and safety agents, construction managers, construction health and safety managers and officers.

A thorough and extensive literature review was conducted to identify critical health and safety elements that could be applied by construction clients to improve project health and safety performance. A list of Critical to Safety (CTS) factors, Critical to Expectation (CTE) elements and measurements were developed from previous studies. SEM was used to analyse the structural relationship between measured variables (CTEs) and latent constructs (CTS). Statistical Package for the Social Sciences Analysis of Moment Structures Version 25 (SPSS AMOS) was used in the structural equation modelling and path analysis and in the confirmatory factor analysis of the study.

A survey instrument adapted from the ORRM developed by Liu et al., (2017) was adopted to measure the extent to which construction clients are involved in their own construction projects. A total of 135 projects, with a value of more than R40 million, were targeted for this study.

The study was limited to construction projects that started during the period 2014 – 2017 and excluded projects that involve maintenance work. Descriptive statistical methods (SPSS AMOS) of analysis were used to analyse the collected data to achieve the objectives of the study. Data from the 135 construction projects was used to validate the effectiveness and efficiency of the proposed model.

1.7 Research Scope and Limitations

The scope of data gathering for the study was limited to the Republic of South Africa (RSA). The study was limited to a sample size of 135 construction clients and 135 large construction projects that were implemented from 2014 – 2017. For the construction project to be considered, its value needed to be R40 million or more and was not to be managed by the same health and safety agent. Construction projects performed in the mining sector were excluded from the study. (The mining sector operates under the Mining Act and construction projects outside of the mining environment operate under the Construction Regulation (CR 2014)).

The study focussed on the extent to which construction clients were involved in the health and safety of construction projects. An analysis between the variables, involvement of construction clients in the projects, and health and safety performance was established through structural equation modelling using SPSS AMOS software.

1.8 Assumptions

The following assumptions were made:

- The selected projects used for the study were not managed by the same client or client health and safety agent.
- All parties involved in the selected projects were construction professionals who were aware of all project procedures, processes, and had full access to the project information for the project that they were working on.
- All construction professionals were knowledgeable and capable of answering the questionnaire without any difficulty, using the survey instrument provided.
- All questionnaires were completed honestly and were a true reflection of what was happening on site.
- Clients were actively involved in the health and safety of construction projects.
- Project health and safety performance influenced the active involvement of construction clients.

1.9 Contributions of the Findings to Knowledge

Few studies have developed models to assist the construction industry in improving health and safety of construction projects. The study provides a framework for gaining a deeper understanding of factors that influence the health and safety performance of construction projects. It identified key areas of improvements that can only be influenced by effective involvement of construction clients. It was hypothesised that the attitude of clients towards health and safety, their communication attitude towards health and safety, selection of contractors, involvement of clients before and during construction, contractual health and safety arrangement and monitoring of health and safety performance of contractors have a direct influence on project health and safety performance. These hypotheses were tested and verified using CB-SEM. Contrary to the findings of previous studies, the final CB-SEM results suggested that the contractual health and safety arrangement is the only construct that has a direct effect on project H&S performance.

Mediation hypotheses was performed and revealed that the attitude, communication and selection of contractors based on their historical health and safety have an indirect effect of project H&S performance. The final model was validated by CHS experts, who were asked to review the proposed model and to rate the degree to which they agreed/disagreed with the statements that described the proposed model in terms of its applicability, effectiveness and adaptability in the construction industry. The key finding was that CHSRM was acceptable.

The study highlighted the urgent need for all stakeholders to work together in the interest of improving health and safety performance on construction sites. The research contributed to knowledge by deepening the understanding of the critical elements to H&S beyond those considered in previous studies. The significance of this is that critical H&S factors that must be taken into consideration by construction clients during the construction process have been identified. It has highlighted to construction the urgent need to change the traditional mind-set that health and safety is the responsibility of construction contractors only.

1.10 Ethical Considerations during the Study

Strict ethical principles were observed in this study by ensuring that respondents understood that they would withdraw from participation if they felt that they were not in agreement with the direction of the study. Participants were informed of their rights to withdraw from the study at any stage. The participants were asked to participate voluntarily in the study, and they were assured that their participation or information they provided was not going be used against them. Names of participants were not included so that anonymity was maintained. Confidentiality was ensured by excluding the names of companies, project names, project-specific locations and project price.

1.11 Structure of the Study

The structure of this dissertation consists of nine chapters. The establishment of the CHSRM and the empirical validation are both presented in a structured manner.

1.11.1 Chapter 1: Research Background

This chapter introduces the background, problem statement and overview of this research – including research motivations, purposes, scope and methodology.

1.11.2 Chapter 2: Literature Review

This chapter presents the preparation work for the in-depth exploration of the main research objective – that primarily includes the collection and summary of previous relevant studies through an extensive literature review of existing client-related H&S models. A comparative analysis of a client-driven health and safety model is conducted, and theoretical issues related to H&S models are discussed.

1.11.3 Chapter 3: Conceptual Framework

This chapter presents the conceptual model of the research. The conceptual model is described and the key concepts that constitute the building blocks of the conceptual model are explored.

1.11.4 Chapter 4: Research Methodology

This chapter presents a methodology that explains the data-collection process, analysis procedures and methods that were applied during the research.

1.11.5 Chapter 5: Client-Driven Health and Safety Model Development

This chapter presents a detailed description of the model development process. The process followed in developing the measurement instrument used to assess the constructs is presented. A description of the measurement instruments, measurement items, and the choice of the selected measurement scale are presented. The Critical to Health and Safety (CTHS) factors and their attributes/indicators are explained. The final CHSRM is presented.

1.11.6 Chapter 6: Survey Questionnaire Results

This chapter presents the research findings. The research findings and analysis of the extent to which hypothesised multiple factors driven by a client are acting concurrently, and by their combined influence lead to improvement in the project H&S performance are discussed.

1.11.7 Chapter 7: Model Validation Results

This chapter presents the results, analysis and empirical validation of the proposed model by H&S experts. The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it meets the actual requirements of the construction industry.

1.11.8 Chapter 8: Discussion of the Overall Research Results

This chapter discusses the research results and the extent to which research objectives and hypotheses have been met. The validity of the developed client-driven occupational health and safety measurement model is presented.

1.11.9 Chapter 9: Conclusion and Recommendation

This chapter discusses the research findings in detail and presents the overall conclusion of the study, recommendations, contribution to knowledge and suggestions for future research.

1.12 Chapter Summary

This chapter outlines the research background, problem statement, research questions and objectives. The role played by the construction industry in the world economy and the challenges facing the construction industry are discussed. The scope and limitations of the study are outlined. The contribution and justification of the study are also explained. The chapter concludes by summarising the structure of the dissertation report. The next chapter discusses the review of literature.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter presents the preparatory work for the in-depth exploration of the main research objective; it primarily includes the collection and summary of previous relevant studies through an extensive literature review of existing models. The health and safety roles and responsibilities of major participants in construction projects and theoretical issues related to the H&S client improvement models are discussed. A comparative analysis of client-related health and safety studies is conducted.

2.2 Health and Safety Roles and Responsibilities

The construction industry plays an important role in the development of the South African economy. Regardless of its vital role and contribution to economic growth, the level of incident rates in the South Africa construction industry remain unsatisfactory, requiring the participation of all stakeholders to improve health and safety performance (Smallwood, 1999). The lack of H&S compliance does not only affect contractors, but the sustainability of the country as whole (Smallwood, 1999). According Smallwood (2004) the negative health and safety performance by contractors also has an impact on customer satisfaction.

Various stakeholders (including clients, designers, principal contractors, subcontractors, suppliers, employees and government agencies), participate during the construction phases of the project (Xiaohua et al., 2017). According to Xiaohua et al., (2017), although they may have different approaches of how to mitigate health and safety risks, these stakeholders have the ability to ensure that improvement in this area is not compromised on site. A study by Heravi, Coffey and Trigunarsyah (2015) found that clients, designers and project managers were the only stakeholders that were heavily involved with project planning while contractors were left out. An earlier study by Kumaraswamy and Wong (2014), also found contractors, subcontractors and suppliers only focussed on project completion to satisfy the clients.

Donkoh and Aboagye-Nimo (2017) explored the role of stakeholders in improving Ghana's construction safety through a qualitative study. The study uncovered lapses in regulations currently being used in Ghana regarding workplace health and safety – particularly in construction. It was found that the current laws do not adequately ensure effective health and safety in the construction industry. Donkoh and Aboagye-Nimo (2017) argue that collaboration between all parties involved in the process is essential;

and that potential contractors must be encouraged to participate and contribute during the design phase to improve overall project safety.

In South Africa, a clear obligation to all parties is imposed by the Construction Regulation 2014 on construction projects and owners of assets – clients, their agent, the designers, the principal contractors, contractors, and owners of the structure. According to Smallwood, Haupt and Shakantu (2009), CR 2014 has redistributed responsibility for construction health and safety away from the contractor (who was previously solely responsible) to include all participants in the construction process – from the client through to the final end user. Table 2.1 (below) provides a summary of the duties of the key participants in construction projects:

Table 2.1 Duties of Construction Stakeholders under the Construction Regulations 2014

Construction Stakeholder	**Duties**
Client	• prepare a baseline risk assessment for the intended construction project • prepare suitable, sufficiently documented and coherent site-specific health and safety specifications based on the baseline risk assessment • provide the designer with the health and safety specification • ensure that the designer takes safety specification into consideration during the design stage • ensure that the designer carries out all responsibilities in construction regulation six • include the safety specification in the tender documents • inspect the site at least once in every thirty days • issue a copy of the safety audit report to the principal contractor within seven days of the audit • ensure that the contractor reports any on site fatality or permanent disabling injury to DoL and that the report includes measures taken by the contractor to make the site safer • where more than one principal contractor is appointed, the client must ensure cooperation between contractors

	• The client may appoint a competent person as the agent where notification other than the Construction Work Permit application to DoL is required (i.e. under CR 4(1).
Client Health and Safety Agent	• assume responsibility for legal safety obligations of the client • agent must manage on site health and safety for the client • agent must be registered with the South African Council for Project and Construction Management Professions (SACPCMP)
Designer	• incorporate all applicable safety standards into design • take health and safety specifications into consideration • in a report and before a tender, make available to the client: ➢ all health and safety information of the design that may affect pricing of the construction work ➢ the geotechnical-science aspects ➢ the loading that the structure can withstand • inform the client in writing of any anticipated dangers or hazards relating to construction, and make available all information for safe execution of work during design or during design alterations • exclude dangerous procedures or materials which are hazardous to people **When mandated by the client:** • carry out inspections at appropriate stages to verify construction is carried out, as per design • stop works not in accordance with health and safety aspects of design • in final inspection of completed structure, include health and safety aspects, declare structure safe for use, and issue completion certificate • take ergonomic-related hazards into account in the design
Designer of Temporary Works	• ensure all temporary works are adequately designed so that they are capable of supporting all of the anticipated vertical and lateral loads that may be applied • the designs of temporary works are done with close reference to the structural design drawings issued by the contractor – and in the event of uncertainty the contractor is consulted

	• all drawings and calculations pertaining to the design of temporary works are kept at the office of the temporary works designer and are made available on request by an inspector • the loads caused by the temporary works and any imposed loads are clearly indicated in the design
Principal Contractor	• provide and demonstrate to the client a suitable, sufficiently documented and coherent site-specific health and safety plan • a health and safety file opened and kept on site • on appointing any other contractor, to ensure compliance with the provisions of the Act No 85 of 1993: ➢ provide those contractors who tender to perform construction work for the principal contractor with relevant sections of the health and safety specifications contemplated in regulation 5(1)(b) pertaining to the construction work required ➢ ensure that potential contractors submitting tenders have made sufficient provision for health and safety measures during the construction process ➢ ensure that no contractor is appointed to perform construction work unless the principal contractor is reasonably satisfied that the contractor to be appointed has the necessary competencies and resources to perform the construction work safely ➢ prior to work commencing on the site, ensure that every contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer as contemplated in the Compensation for Occupational Injuries and Diseases Act, 1993 ➢ appoint each contractor in writing for the part of the project for the contractors are that he will be working in the construction site ➢ take reasonable steps to ensure that the health and safety plan of each contractor contemplated in sub-regulation (2)(a) is implemented and maintained on the construction site ➢ ensure that the periodic site audits and document verification are conducted at intervals mutually agreed on between the principal contractor and any contractor – and at least once in every thirty days

	➢ stop any contractor from executing construction work that is not in accordance with the health and safety specifications of the client and the health and safety plan of the principal contractor for the site, or which poses a threat to the health and safety of persons ➢ where changes are brought about to the design and construction, make available sufficient health and safety information and appropriate resources to the contractor to execute the work safely ➢ discuss and negotiate with the contractor the contents of the health and safety plan contemplated in sub-regulation 7(1)
Contractor	• provide and demonstrate a suitable and sufficiently documented health and safety plan to the principal contractor • review and update the health and safety plan as the work progresses • open and keep a health and safety file (which must include all documentation required in terms of the Act and these Regulations (OHS Act No. 85 of 1993 and Regulations) on site • before appointing another contractor to perform construction work, be reasonably satisfied that the contractor to be appointed has the necessary competencies and resources to perform the construction work safely • cooperate with the principal contractor as necessary to enable them to comply with the provisions of the Act • as far as is reasonably practicable, provide the principal contractor with any information promptly that might affect the health and safety of any person at work carrying out construction work on the site, any person who might be affected by the work of such a person on site, or which might justify a review of the health and safety plan • where a contractor appoints another contractor to perform construction work, the duties determined in sub-regulation (1)(b) to (g) that apply to the principal contractor apply to the contractor, as if he or she were the principal contractor • a principal contractor must take reasonable steps to ensure cooperation between all contractors appointed by the principal contractor, to enable each of those contractors to comply with the required regulations

	• no contractor may allow any employee or person to enter any site, unless they have undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry • a contractor must ensure that all visitors to a construction site undergo health and safety induction pertaining to the hazards prevalent on the site, and must ensure that such visitors have the necessary personal protective equipment • a contractor must, at all times, keep records of the health and safety induction training contemplated in sub-regulation (6) on their construction site, and such records must be made available on request to an inspector, the client, their agent or the principal contractor • a contractor must ensure that all their employees have a valid medical certificate of fitness specific to the construction work to be performed (this must be issued by an occupational health practitioner)

2.3 Review of Previous Client-Related Studies

A review of literature was conducted using available frameworks, models and studies that have been developed to improve the health and safety performance of construction projects from the perspective of construction industry clients. The results are discussed in the following subsection.

2.3.1 Safety Responsibilities of Owners

Chunxianga (2012) considers how owners could assume safety responsibilities with a focus on safety management, and presents a model that suggests ways in which the owner can assume safety responsibilities by assisting contractors to concentrate on:

- safety management
- competitive bidding
- construction period
- construction budget
- clarification of safety requirements
- safety laws and regulations

- subcontracting
- safety production margin system

Emphasis is placed on the owner promoting the establishment and improvement of a safety production margin system. This system was adopted in areas where conditions permit. The owner is required to deposit the safety cost into the designated bank account (as the production safety margin); this is used for safety production work, solutions in relation to safety production accidents and reward and punishment for safety production.

Although the model recommends that higher legal standards should be set for public work to promote and develop construction industry safety and health, its application at a wider community level could have limitations due to the nature of contracts that dictate how costs incurred on construction projects must be paid.

2.3.2 Improving Contractor Health and Safety Performance

Spear (2005) argues that successful contracting management requires the involvement of various owners and contractor representatives. Key to improving Health, Safety and Environment (HSE) performance, according to them, is the integration of these into the contracting process; this includes establishing formal prequalification and contractor selection criteria and incorporating HSE requirements into the contract.

Spear (2005) maintains that since designing and planning with construction safety in mind provides the greatest opportunity to minimise incidents in the field, formal HSE reviews should be performed during the design and planning phases of the project. He further proposes that the performance of the contractor should be evaluated during, and on completion of the project – not only to provide feedback to the contractor so they can work to improve their performance as needed, but also to determine if the contractor should be considered for future projects. The main features of the study are:

- prequalification and selection of contractors
- planning of design
- assessing and verification of work in progress
- evaluation of performance post-construction period

The conclusion of the Spear (2005) study is consistent with the requirements of the Occupational Health and Safety Act 85 of 1993 and the Construction Regulations 2014.

2.3.3 Enhancing Health and Safety Communication

The theory behind the framework of Sperlling et al., (2008), is that it seeks to develop a guide to best practice for safer construction in the Australian construction industry, investigates the communication relationship between the client, designer and constructor, and identifies the conditions under which effective communication takes place (Sperlling et al., 2008). It is based on the idea that if there is effective communication between the client, designer and constructor, excellence in occupational health and safety can be easily achieved.

Sperlling et al., (2008) revealed that effective communication, consultation and information sharing between client, designer and constructor was an important contributing factor to best practice in construction safety. According to Sperlling et al., (2008), the following strategies can improve communication between the client, designer and constructor:

- collaborative engagement of all stakeholders
- face-to-face engagement
- ensuring effective communication
- an open-door policy
- ensuring an overlap between the design and construction aspects
- alliance contracting
- top-down management approach
- feedback to designers

Although the study by Sperlling et al., (2008) revealed that effective communication, consultation and information sharing between client, designer and constructor was an important contributing factor to best practice in construction safety, it was only limited to the use of an alliance contract. The study did not explore the possibilities of managing a design-and-construct contract through alliance-style methods.

2.3.4 Engineer Health and Safety Risks on Site

The American Council of Engineering Companies of Massachusetts (ACEC/MA) Risk Management Forum (2014) explains that project participants (owner, design professional and contractor), for the construction site have been well established in contracts and case law. ACEC/MA (2014) argues that as contractors assume control of the site, they become strictly liable for any injuries sustained by workers or other parties on the site. ACEC/MA (2014) contends that the project owner is considered strictly accountable for the site as they are the main beneficiary of the work, and is responsible to verify that the contractor has a safety programme in place (and is properly following it). If not, the owner faces potential fines for injuries that may arise from the contractor's unsafe practices.

According to ACEC/MA (2014), the engineer's duty regarding site safety is limited to knowing the contractor's safety programme and ensuring that the engineer's employees follow it – in addition to the engineer's safety plan. The study by ACEC/MA (2014) presents an approach that suggests that responsibilities of the engineers should be defined.

The argument in the ACEC/MA (2014) study is based on the Engineers Joint Contract Documents Committee (EJCDC) Owner/Engineer Agreement (2011), and it cannot be applicable to other contracts, and to legal and other requirements of various countries.

2.3.5 The Roles of Clients in Enhancing Health and Safety

Said, Shafiei and Omran (2009) investigated the role of the client in safety in the Malaysian construction industry. They examined the relationship between project safety performance and client influence, with particular emphasis on the selection of safety-minded contractors, contractual safety requirements and client proactive involvement in safety management. Said et al., (2009) suggested that all stakeholders should contribute to the planning and management of health and safety on the site.

The findings of the ACEC/MA (2014) study show that clients play a prominent role in institutionalising safety culture into construction project teams by various means:

- health and safety communication
- selection of contractors based on past performance and involvement in safety management
- zero harm objectives
- evaluating the health and safety of contractors using various means
- having a dynamic health and safety programme in place
- client involvement throughout the phases of the project
- change health and safety programme in line with site conditions
- getting involved in the contractor's health and safety programmes

The main feature of the ACEC/MA (2014) study is that all clients, regardless of the type and size of their projects, should recognise that they have a responsibility for construction safety; and safety should be integrated into the overall project objective of the client. The influence of clients on designers and contractors was not fully explored.

2.3.6 Influence of Clients on Contractor Health and Safety

Smallwood (2004) suggested that clients can influence contractor health and safety directly or indirectly. Direct influence includes the choice of structural frame, selection of materials, provision of finance and incentives. Indirect influence refers to appointment of all other stakeholders. According Smallwood (2004), the extent to which clients influence health and safety can be attributed to contractor status of H&S in their organisations. To support this argument, Smallwood (2004) investigated the influence of a Shell's health and safety requirements on contractor health and safety performance, while undertaking the construction of service stations. The selected findings emanating from a survey of contractors include: prioritising health and safety above other project parameters, and setting of H&S requirements as part of procurement; design and construction-related interventions can lead to an improvement in construction H&S.

The main features of Smallwood (2004) study are: prioritising health and safety as more important than the other project parameters, project-specific SHEQ plans, the integration of design and construction in terms of H&S, and the prequalification of contractors, making sure that the principal contractor has made adequate allowance for H&S. The Smallwood (2004) study found that Shell's health and safety requirements contributed to an improvement in H&S performance of contractors working in the company.

2.3.7 Client Contributions to Project Health and Safety Performance

Yin-Hung (2006) conducted a study in Hong Kong that aimed to compare how the public and private sectors organize and manage their projects in terms of safety – theoretically and practically. The study was motivated by the statement that most existing data at the time supported the suggestion that public clients had better safety performance than private clients (although this had not been supported by adequate examination (Yin-Hung, 2006).

Yin-Hung (2006) studied the role of clients from the public and private sectors in project safety performance, and further examined the relationship between project safety performance and the differences in safety measures between clients from the two sectors. Yin-Hung (2006) found that public clients had a higher commitment to safety than private clients had. He noted that the higher commitment of the public clients allowed them to take a more comprehensive approach on safety measures. The main features of the study were:

- client involvement
- having a higher degree of involvement in health and safety
- selecting contractors based on health and safety performance
- participating in the project health and safety management
- and establishing an appropriate health and safety contractual arrangement

Although the study proved that public clients had a higher commitment to safety than private clients in Hong Kong – it remains to be seen if the same conclusion can be reached in other countries.

2.3.8 Client Involvement in Construction Health and Safety

Kikwasi (2008) argued that although there have been various efforts to address safety and health issues in the industry, less has been attained as a result of client involvement having a low profile. According to Kikwasi (2008), the traditional roles of the client improving health and safety performance have been established – but several practitioners have accepted them with the rationale that the client is not directly involved in project safety undertakings.

While Kikwasi acknowledged that the provision of safety equipment has been improving significantly, the health and safety plan submitted during tendering and approved at the time of awarding the contract is no longer useful when the contractor goes on site. This approach has led the industry to perform poorly continually regarding health and safety. In view of the poor H&S performance by the industry, Kikwasi (2008) suggested that since the client has a final say on cost and time of the project – it is time for them to take up the health and safety obligation.

Kikwasi's (2008) view on the lack of client involvement led to the assessment of the role of the client in safety and health issues in the Tanzanian construction process. A survey of forty firms was conducted to establish the adequacy of the conventional and alternative roles played by clients to address safety and health issues. The findings indicate that the roles of clients are to:

- ensure incorporation of a health and safety component in project design and tender documentation
- a close follow-up on health and safety matters at site meetings
- preparation of a possible hazard occurrence checklist before and during construction
- provision of PPE

The main feature of the study was that each construction project should have a health and safety plan, that spans pre- to post-tender stages – with a clear delineation of the responsibility of each party to the contract. It has further emphasised the views shared by many authors that client involvement throughout the project can lead to improvement in health and safety performance.

2.3.9 Client Health and Safety Roles in Construction Projects in Australia

Votano and Sunindijo (2014) argue that although research has been done to investigate the importance of construction safety, most has focussed on construction organisations and workplace safety. They strongly believe that there was still a need to investigate this issue by considering stakeholders higher in the supply chain – particularly those who have the economic power to facilitate safety implementation. In their study, Votano and Sunindijo (2014) investigated the roles of construction clients in influencing safety performance using survey data collected from employees working on small and medium construction projects in Australia. The results have not only confirmed the importance of clients in implementing safety but have also determined specific client roles that influence the development of a safety climate in construction projects.

Votano and Sunindijo (2014) recommended that clients should focus on the following six safety roles to improve H&S performance:

- involvement in a site-based health and safety programme
- analysis of health and safety data
- appointment of health and safety team
- select safe contractors based on health and safety performance
- stating health and safety in tenders
- conduct regular plant/equipment inspections

The Votano and Sunindijo (2014) study highlighted the need for clients to realise that without their support contractors would face many constraints in implementing safety measures – especially given the competitive nature of the industry. It has also re-emphasised that clients must understand that the integration of safety into day-to-day business decisions can lead to economic benefit in the industry.

2.3.10 The Influence of Clients on Health and Safety

Lopes, Haupt and Fester (2011) highlighted that the South African construction industry is one of the most hazardous when compared to other industries and has an unacceptably high level of injuries and fatalities. Lopes et al., (2011) argue that while construction stakeholders – clients, designers, project managers and quantity surveyors – can influence project health and safety performance, their influence on health and safety decreases with project evolvement. By surveying a sample of 128 client entities and using a questionnaire, Lopes et al., (2011) investigated client entities in South Africa to examine the influential role that clients potentially play in health and safety outcomes, and how this is directly linked to project parameters. It was found that clients should be made aware of their ability to influence the health and safety of a project earlier (during the concept and design phases). The study also found that while health and safety was included as part of the project parameters, more effort is required to give it the same status as other project parameters.

The main features of the study: that increased client involvement in health and safety in all phases of projects results in reduced incidents and accidents, and that clients should be role models in affording health and safety the same status as other project parameters.

2.3.11 The Model Client Framework

Lingard, Blisman, Cooke and Cooper (2009) argued that as an important segment of the Project Management (PM) discipline, construction industry clients could make an important contribution to Occupational Health and Safety (OHS) performance of the construction projects that they procure. Lingard et al., (2009) contended that through its implementation, a model client framework developed by the Australian Office of the Federal Safety Commissioner, would help Australian government agencies ensure that the major stakeholders involved in the planning, design and execution of construction tasks, work collaboratively to allocate responsibility for OHS and to integrate OHS considerations into all project decision-making.

According to Lingard et al., (2009), the model client framework establishes principles for the management of and establishes processes for client involvement in OHS through the planning, design and procurement, construction, and completion stages of construction projects. Lingard et al., (2009) contend that this framework is the first comprehensive set of tools and resources to support construction clients in integrating OHS into their procurement and project management processes. The life cycle approach ensures that OHS information is transferred throughout the construction supply chain (from the client, through to the designer, constructor, and ultimately to the end-user) (Lingard et al., 2009).

Although the framework shows how the integration of OHS led by the client into all aspects of project decision-making can significantly improve the OHS performance of construction projects, this framework was developed for an already motivated client looking for tools to help them to perform required tasks. This, however, is not the case with most clients in much of South Africa. Clients (especially public clients), are not motivated to implement health and safety, and would most likely view this framework as an added responsibility.

2.3.12 Effectiveness of Economic Incentives on Health and Safety Performance

Musonda and Pretorius (2015) investigated the impact of economic incentives or disincentives on H&S performance of construction clients in the developing world using the Delphi technique. Musonda et al., (2015) wanted to know what would motivate clients to actively participate in health and safety programmes, since economic incentives have been reported to produce favourable results with other H&S stakeholders (such as employees in the construction industry). They concluded that economic incentives could:

- encourage the involvement of clients and for them to be accountable for health and safety implementation
- lead to clients assuming leadership in economic incentives and put health and safety programmes in place
- improve health and safety performance of clients, and that legislation could have a similar impact as economic incentives

Although Musonda et al., (2015) suggested that although economic incentives have a significant impact on client H&S performance, other critical influences such as legislation, political, social and technology factors may not be ignored. They, too, need to be considered and applied to motivate clients, so that they become effectively involved and accountable for H&S management in the construction industry.

2.3.13 Construction Health and Safety Performance Improvement Model

Musonda (2012) developed a client-centred health and safety performance improvement model, specifically identifying critical factors of client health and safety culture that have significant effects on project health and safety performance improvement in construction projects. The study findings were that the construction industry H&S performance remains unsatisfactory when compared to other industrial sectors, and that culture offered more prospects to improve this than any other approach. According to Musonda (2012), a) the client has a significant impact on contractor, designer, and project health and safety performance, b) client health and safety culture influenced the contractor, designer and project health and safety performance, and c) the external environment had a significant influence on client health and safety performance. The study added value to the body of knowledge in terms of the methodological approach and contribution to theory.

2.3.14 Client Health and Safety Rating Model

Liu, Jazayeri and Dadi (2017) conducted a study to explore and improve the involvement of the owner in safety issues. They developed the Owner's Role Rating Model that could be used to assess the degree of owner involvement in the safety process and presented a final score to evaluate overall owner performance in safety management. This was one of a few studies that has for the first time, attempted to provide construction clients with a practical tool that can be applied.

Liu et al., (2017) structured the ORRM into three levels: CTS, CTE, and Specification/Measurement (S/M) and used a questionnaire survey to investigate opinions of construction safety experts on the relative importance of CTS elements. The results are:

Table 2.2 Opinion of Construction Safety Experts on the Relative Importance of CTS Elements

Critical to Safety	Relative Weights
CTS 6: Monitoring contractor safety compliance	0.23
CTS 3: Selection of contractors	0.20
CTS 5: Owner’s involvement in safety before construction	0.19
CTS 1: Establishing attitudes towards safety	0.13
CTS 4: Contractual safety arrangement	0.13
CTS 2: Communicate attitude towards safety	0.12

Source: Liu et al., 2017

Liu et al., (2017 used the weighting as the rating model to assess the owner’s impact on construction safety for any individual project. In testing the model, Liu et al., (2017) conducted an empirical validation of twenty projects by using the ORRM to verify their effectiveness and efficiency in the construction environment. The findings were that owners with little involvement in construction projects could use the ORRM to identify the critical point for better performance.

Although Liu et al., (2017) provided a much needed tool to assist construction clients identify critical factors for enhanced performance, this may not be the case with most clients in many developing countries (such as a South Africa), where, compared to developed countries, the maturity of the health and safety culture is still in its infancy. In addition, the use of twenty construction projects only, as a sample size to validate the effectiveness and efficiency model may have compromised the justification of the model to represent the general situation in the construction industry; a larger sample size may have provided a better justification of the model. Furthermore, Liu et al., (2017) used Recordable Case Rate (RCR) as a single indicator to measure health and safety performance, without checking whether other H&S performance indicators could result in the same conclusion. To validate effectiveness and efficiency of the ORRM, the model could have been applied to many projects and tested in developing countries.

2.4 Comparative Analysis of Client-Related Health and Safety Studies

Table 2.3 lists the various health and safety features that were identified from the fourteen studies reviewed. A total of sixty-six key health and safety features were identified that describe the way in which construction clients could influence the improvement of health and safety on construction sites. From Table 2.3, health and safety features that were common to all studies were identified and a consolidated list of these features was drawn. The key health and safety features that seemed to describe the way in which the construction client could influence improvement of health and safety on construction sites, included:

- client involvement from the beginning to the end of the project
- selection of contractors based on their safety performance
- prequalification of contractors
- integration of design and construction in terms of health and safety
- evaluation of contractors using various measures
- establishment of an appropriate contractual health and safety arrangement
- use of a health and safety plan submitted during tendering during construction
- a more interactive form of health and safety communication
- post-construction performance evaluation
- client attitude towards health and safety

The identified features were found to be common to all studies and some of these can further be grouped together to describe a single feature (for example, the prequalification of contractors). Prequalification of contractors includes selection of contractors based on their safety performance. The grouping of some of these features resulted in the reduction of five key health and safety features (from eleven to six). The identified features are referred to as the six constructs for the CHSRM model and are discussed in detail in Chapter 4 of this study.

Table 2.4 lists the strengths and weaknesses of the fourteen studies that were reviewed. The strengths and weaknesses are measured by the extent to which the study provides a practical tool that can be used by a construction client to improve health and safety. While most of the studies have provided valuable knowledge on how the construction clients can influence health and safety improvements on construction sites, some have weaknesses that limit their wider application in the construction industry.

Table 2.3 List of Health and Safety Features Derived from Previous Client-Related Studies

Features	Safety Responsibilities for Owners (Chunxianga, 2012)	Improving Contractor Safety Performance (Spear, 2005)	Enhancing Communication between Clients, Constructors and Designers (Sperlling et al., 2008)	Engineer’ s Risk for Job Site Safety in Traditional Design/Bid/Build Projects (ACEC/MA, 2014)	Roles of Clients in Enhancing Construction Safety (Said et al., 2009)	Influence of Clients on Contractor Health and Safety (Smallwood, 2004)	Client's Contributions to Project Safety Performance a Comparison Between Public and Private Construction Projects (Hung, 2006)	Client Involvement in Construction (Kikwasi, 2008)	Client Safety Roles in Small and Medium Construction Projects in Australia (Sunindijo, 2016)	Influence of Clients on Construction Health and Safety Conditions in South Africa (Lopes et al., 2011)	The Model Client Framework (Lingard et al., 2009)	Effectiveness of Economic Incentives on Clients' Participation in Health and Safety Programmes (Musonda	Construction Health and Safety Performance Improvement - A Client Centred Model (Musonda, 2012)	Impact of Owner Practices and Procedures on Construction Project Safety Performance (Liu et al., 2017)
Competitive bidding	X													
Construction period	X													
Construction budget	X													
Clarification of safety requirements	X													

Safety laws and regulations	X													
Subcontracting	X				X		X		X					X
Safety production margin system	X													
Prequalification and contractor selection		X				X								
HSE reviews during designing and planning phases of the project		X							X					
Work-in-progress assessment and verification		X												
Post construction performance evaluation		X			X							X		
Collaborative engagement by all parties			X											
Face-to-face interaction			X											
More interactive form of communication			X		X									X
An open-door policy			X											
Overlap between design and construction			X	X		X								
Alliance contracting facilitates communication between team members			X		X									X
Top-down management commitment for fostering a safety culture			X											
The designer’s needs to receive feedback to ensure success of the current project			X	X		X								
Managing a design-and-construct contract via alliance-style methods			X	X		X								
Professional duty to immediately inform the contractor				X										
Zero exhaustive inspection or stopping the job				X										

Delegate joint responsibility to the engineer for site safety				X										
Use of health and safety plan submitted during tendering and during construction				X		X		X						
Incorporation of health and safety component in project design and tender documentation			X	X		X								
Communicating safety					X									
Selection of safe contractors	X				X		X		X					X
Participating in safety management					X		X		X					
Zero injuries objectives					X									
Evaluation of contractors using various measures	X				X		X		X					X
Promoting safety performance using a carefully designed dynamic safety programme		X			X							X		
Client involvement from the beginning to the end of the project					X			X						X
Participation in contractor safety programme					X		X		X					
Project and public health and safety are more important than other project parameters						X								
Project-specific plan for quality and health and safety				X		X		X						
Integration of design and construction in terms of health and safety			X	X		X								
Prequalification of contractors on quality and health and safety		X				X								
Adequate allowance for health and safety						X								
Client involvement					X		X	X						X
Selection of safe contractors	X				X		X		X					X

Participation in safety management					X		X		X					
Establishment of an appropriate contractual arrangement					X									X
Health and safety plan				X		X		X						
Clear delineation of responsibility					X			X						
Client involvement throughout the stages of the project								X						X
Participation in site-based safety programme					X		X		X					
Review and analyse safety data		X							X					
Appoint safety team									X					
Selection of safe contractors	X				X		X		X					X
Specifying how safety is to be addressed in tenders, and performing regular checks on plant/equipment									X					
Client support to contractors										X				
Clients can influence the health and safety of a project earlier during the concept and design phases										X				
Increasing client involvement in health and safety in all phases of projects					X			X		X				X
Principles of management of OHS in construction projects											X			
Allocating responsibility for OHS and integrating OHS considerations into all project decision-making											X			
Use of the life-cycle approach to ensure that OHS information is transferred throughout the construction supply chain											X			
Economic incentives for safety												X		

Health and safety performance		X			X							X		
External environment													X	
Client health and safety culture													X	
Client attitude towards safety													X	X
Selection of contractors	X				X		X		X					X
Client communicating attitude towards safety														X
Client involvement in health and safety before construction					X			X						X
Monitoring contractor safety compliance														X
Contractual health and safety arrangement					X									X

Table 2.4 List of Strengths and Weaknesses of Previous Client-Related Studies

Author	Title	Strength	Weakness
Spear (2005)	Improving contractor safety performance	• The study promoted the integration of health, safety and environment into the contracting process, which includes establishing formal prequalification and contractor selection criteria and incorporating HSE requirements into the contract.	• Although the conclusion of the study was consistent with the requirements of the Occupational Health and Safety Act 85 of 1993 and the Construction Regulations 2014, it did not provide the tools required to integrate H&S into the contracting process.
Yin-Hung (2006)	Client's contributions to project safety performance – a comparison between public and private construction projects	• Yin-Hung (2006) found that public clients had a higher commitment to safety than private clients. He noted that the higher commitment of public clients allowed them to take a more comprehensive approach in safety measures.	• Although the study had proven that public clients had a higher commitment to safety than private clients in Hong Kong, it remains to be seen if the same conclusion can be reached in other countries.
Kikwasi (2008)	Client involvement in construction in health and safety	• The main feature of the study was that each construction project should have a health and safety plan that spans pre- to post-tender stages, with clear delineation of the responsibility of each party to the contract.	• The content of H&S prescribed in the study was not provided. It is not clear if there were specific mandatory requirements in the H&S plan.
Sperlling et al., (2008)	Driving Safety: enhancing communication between clients, constructors and designers	• Sperlling et al., (2008) revealed that effective communication, consultation and information sharing between client, designer and constructor are important contributing factors to best practices in the construction safety.	• Although the study revealed that effective communication, consultation and information sharing between client, designer and constructor was an important contributing factor to best practices in construction safety, it was only limited to the use of an alliance contract. • The study did not explore the possibilities of managing a design-and-construct contract through alliance-style methods.

Lingard et al., (2009)	The model client framework: Resources to help Australian government agencies to promote safe construction	• The model client framework established principles for the management of OHS in construction projects, and established processes for client involvement in OHS through the planning, design and procurement, construction, and completion stages of construction projects. • The framework was the first comprehensive set of tools and resources to support construction clients to integrate OHS into their procurement and project management processes.	• Although the framework showed how the integration of OHS into all aspects of project decision-making led by the client could significantly improve the OHS performance of construction projects, this framework was developed for an already-motivated client looking for tools to help them perform the required tasks. This, however, is not the case with most clients in most parts of Southern Africa. Clients (especially public clients), are not motivated to implement H&S and would most likely view this framework as an added responsibility.
Said et al., (2009)	The roles of clients in enhancing construction safety	• The main feature of this study was that all clients, regardless of the type and size of their projects, should recognise that they have a responsibility for construction safety, and that it should be integrated into the overall project objective of the client.	• Although the study showed that clients played a prominent role in institutionalising a safety culture into construction project teams by various means, the influence of clients on designers and contractors was not thoroughly explored.
Lopes et al., (2011)	The influence of clients on construction health and safety conditions in South Africa	• The main features of the study were that increased client involvement in H&S in all phases of projects would result in reduction in incidents and accidents, and that clients should be role models in affording H&S the same status as other project parameters.	• Although the study has found that increased client involvement in H&S in all phases of projects would result in a reduction in incidents and accidents, it fell short in providing a much-needed tool to be used to realise the benefits of being actively involved.
Chunxianga (2012)	Safety responsibilities for owners	• The model suggested ways in which the owner could assume safety responsibilities by assisting contractors to focus on safety management. • It recommended that higher legal standards should be set for public work to promote	• Although the model recommended that higher legal standards should be set for public work to promote and develop construction industry safety and health, its application at a wider community level could have some limitations due to the nature of contracts that

		and develop construction industry safety and health.	dictate how costs incurred on construction projects must be paid.
Musonda (2012)	Construction health and safety performance improvement – a client-centred model	• The model specifically identified critical factors of client health and safety culture with a significant effect on project health and safety performance improvement in construction projects.	• While the study by Musonda (2012) contributed and added value to the body of knowledge in terms of the methodological approach and contribution to theory, it has not provided a much needed tool that can assist construction clients to identify the critical factors that are required for better performance.
ACEC/MA (2014)	Tip 8 – Engineer's risk for job site safety in traditional design/bid/build projects	• The main feature of this study was that the engineer's duty regarding site safety was limited to knowing the contractor's safety programme and ensuring that the engineer's employees follow it as well as following the engineer's safety plan.	• The argument presented in the ACEC/MA (2014) study, was based on the Engineers Joint Contract Documents Committee (EJCDC) Owner/Engineer Agreement (2011), and it cannot be applicable to other forms of contracts, legal and other requirements of various countries.
Smallwood (2004)	The influence of clients on contractor health and safety	• The main feature of the study was the finding that Shell's H&S requirements contributed to an improvement in H&S in Shell's projects and contractors' projects in general, and this led to the conclusion that Shell has influenced their contractors' H&S performance.	• The study was limited to one petrochemical client and the H&S requirements cited in the study have not been defined.
Musonda et al., (2015)	Effectiveness of economic incentives on clients' participation in health and safety programmes	• The study found that with economic incentives, clients were likely to implement all health and safety elements in a project, and were likely to assume leadership in health and safety and put health and safety programmes in place.	• Although Musonda et al., (2015) suggested that economic incentives have a significant impact on client H&S performance, other factors such as legislation, political, social and technology issues may not be ignored as critical factors that also need to be considered and applied to motivate clients – so that they may be effectively involved and be accountable for

			H&S management in the construction industry.
Sunindijo (2016)	Client safety roles in small and medium construction projects in Australia	• The results of the study not only confirmed the importance of clients in implementing safety, but also determined specific client roles that influence the development of a safety climate in construction projects.	• Although the study has highlighted the need for clients to realise that without their support, contractors would face many constraints in implementing safety measures (especially given the competitive nature of the industry), the success of its application in developing countries may be a challenge due to the lack of a safety culture.
Liu (2017)	Establishing the influence of owner practices in construction safety in an Operational Excellence Model	• The study provided an Owner's Role Rating Model (ORRM) that could be used to assess the degree of owner involvement in the safety process, and presented a final score to evaluate the owner's overall performance in safety management.	• Liu et al., (2017) provided a much-needed tool that can assist construction clients to identify the critical factors that can promote better performance. This, however, may not be the case with most clients in many of the developing countries such as a South Africa – where the maturity of the H&S culture is still in its infancy compared to developed countries. • The use of only twenty construction projects as a sample size to validate the effectiveness and efficiency model may have compromised the justification of the model to represent the general situation in the construction industry; a larger sample size may have provided a better justification of the model. • Furthermore, Liu et al., (2017) used recordable case rate (RCR) as a single indicator to measure H&S performance – without checking whether other H&S performance indicators could result in the same conclusion.

2.5 Research Gaps

Various client improvement models were evaluated with the following conclusions:

- Although the opinion amongst researchers that H&S improvement on construction sites is unlikely without the influence of construction clients, most models did not validate these claims using health and safety experts from the construction industry.
- While most models have provided valuable information about the key health and safety features that describe the way in which the client can influence the improvement of health and safety on construction sites, they have not provided practical tools on how to implement these features at a site level.
- It was noted that very few of the studies that were reviewed statistically tested the effectiveness of identified key health and safety features that were suggested at the construction project site.
- The models by Musonda (2012) and Liu et al., (2017) were some that have shed some light on how construction clients can practically influence the improvement of health and safety on construction sites.
- Most models were generated in developing countries, but very few were tested in developing countries where the health and safety culture maturity level is still in its infancy.

The CHSRM builds on the findings of previous studies from a South African perspective and provides a simplified representation that is easy to apply; it also considers other H&S attributes taken from the South African Construction Regulation (CR 2014). The CHSRM is verified using SEM and validated by health and safety experts using survey questionnaire.

2.6 Chapter Summary

The chapter has presented sufficient reasons why construction clients should be actively involved in the health and safety of construction projects that have been presented. It has been argued by various studies that health and safety improvement on construction sites is quite unlikely without the influence of construction clients. The key health and safety features that describe how the client can influence improvement of health and safety on construction sites were identified through the literature review. It was noted that very few of the studies that were reviewed offered indicators that could be used to measure the effectiveness of identified key health and safety features. The strengths and weaknesses of the various studies were identified and evaluated.

The literature review showed that there are multiple factors common in most studies, and if driven by the client, their influence can lead to improvement in the health and safety performance of construction projects. These observed that major factors are used in the development of the Client-Driven Health and Safety Rating Model that could assist clients in influencing contractors effectively, to improve the health and safety performance of construction projects. The chapter concluded by summarising the strengths and weaknesses of the various studies reviewed. The next chapter discusses the conceptual model of the research.

CHAPTER 3 : CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter presents the conceptual model of the research, based on a review of the literature. The conceptual model is described and the key concepts that constitute the building blocks of the conceptual model are explored. The building blocks identified during the review of literature include client attitude towards health and safety, communication attitude of clients towards health and safety, selection of contractors, client involvement before and during construction, contractual health and safety arrangement and monitoring of health and safety performance of contractors. These factors were found to be associated with involvement by clients of health and safety improvements in construction projects. The relevant literature that supports the constructs of the conceptual model is presented and hypothesised relationships among the constructs are discussed.

3.2 Conceptual Framework

A conceptual framework is a system of concepts, assumptions, expectations, beliefs and theories that supports and informs research (Maxwell, 2005). Hair et al., (2007) and Sekaran and Bougie, (2010), describe a conceptual model as the proposal of how the research concepts are hypothesised to be related to each other based on theory, logic and an explanation of why the concepts are believed to be related; it is also known as a theoretical framework. The conceptual model defines the concepts under study, develops a proposed model of how the concepts are related, and uses a theoretical basis to explain the possible relationships (Hair et al., 2007; Sekaran and Bougie, 2010). According to Hair et al., (2007) and Sekaran and Bougie, (2010), the proposed relationships between the concepts, assumptions, expectations, beliefs and theories must be tested hypothetically and statistically analysed to arrive at the conclusion. A conceptual or theoretical framework is the foundation of a hypothetic-deductive research approach, which is the favoured research approach for this research.

The influence of clients on construction project H&S performance is one of the wide research topics in the construction industry. Despite consensus amongst researchers that client involvement in all of the phases of the construction project can lead to improvements in the health and safety performance of construction projects, very few studies have developed models to hypothetically test and statistically analyse the relationship between the components responsible for H&S improvement. As a result, the construction industry experiences a high number of accidents that occur on construction sites every day, including medical treatment cases, lost time incidents, fatalities and damage to property. It was because of these unacceptable high number of accidents and the lack of a model that seeks to assist the construction industry with the improvement on health and safety on construction sites that the CHSRM model was proposed in this study.

According to Liu et al., (2017), successful construction projects require the involvement of the client, designers, contractors and subcontractors. However, very few studies have produced models that can be used as a tool to evaluate the overall performance by the client and that can help to identify gaps that construction clients can focus on to improve project health and safety performance. The objective of the current study is to identify critical health and safety elements that can be applied by construction clients to improve project health and safety performance. The current study investigates the relationship between involvement of clients in their own construction projects and improvement in the health and safety performance of their own, and construction projects in general, from a Southern African perspective.

3.3 Involvement of the Client in the Health and Safety of Construction Projects

Over the past few years, numerous studies dealing with client influence in construction project health and safety performance have reported various ways in which construction clients can improve health and safety on project sites. This section summarises the assessment of pertinent studies with an emphasis on the identified key critical factors arising from the literature review, namely, client attitude towards health and safety, client communication attitude towards health and safety, selection of contractors, client involvement before and during construction, contractual health and safety arrangement, monitoring of the health and safety performance of contractors and adopted approaches related to the current study.

Umeokafor (2018) conducted an investigation into the attitudes of public and private clients, commitment and impact on construction health and safety in Nigeria. In his study, Umeokafor (2018) found that while the attitudes of clients towards health and safety are not encouraging, commitment and attitudes of public clients are better than that of private clients. Furthermore, Umeokafor (2018) noted that when clients are involved in health and safety, it has resulted in a reduction in accidents, compensation claims and rework, and it improved the relationship between clients and contractors.

Musonda, Haupt, and Smallwood (2009) examined perceptions by contractors of clients attitudes relative to health and safety implementation in the construction industry of Botswana and Southern Africa. Musonda et al., (2009) found that clients do not perceive H&S to be very important on construction projects; the majority of clients do not address health and safety adequately in contract documentation and it is rarely a main item on the agenda of progress meetings. They also found that clients are not fully committed to health and safety implementation (Musonda et al., 2009). Musonda et al., (2009), argue that clients set the health and safety tone for construction projects and their attitude can exert a great influence on the performance of health and safety.

Said, Shafiei, and Omran (2009) examined the relationship between project safety performance and client influence, with particular emphasis on the selection of safety-minded contractors, contractual safety requirements and client proactive involvement in safety management. Said et al., (2009) found that clients play a prominent role in institutionalizing safety culture into construction project teams. Lopes, Haupt, and Fester (2011) investigated client entities in South Africa to examine the influential role that clients could potentially play in health and safety outcomes (and how this is directly linked to project parameters). This was done using a questionnaire and by surveying a sample of 128 client entities. Lopes et al., (2011) found that clients should be made aware of their ability to influence the health and safety of a project earlier – during the concept and design phases.

Sperlling, Charles, Ryan, and Brown (2008) developed a framework for enhancing communication between clients, constructors and designers. The theory behind the framework of Sperlling et al., (2008) was that it seeks to develop a guide to best practice for safer construction in the Australian construction industry, investigate the communication relationship between the client, designer and constructor and identifies the conditions under which effective communication takes place. It is based on the idea that if there is effective communication between the client, designer and constructor then excellence in occupational health and safety can easily be achieved. Sperlling et al., (2008) revealed that effective communication, consultation and information sharing between client, designer and constructor was an important contributing factor to best practice in construction safety.

Said et al., (2009) argue that clients play a prominent role in institutionalizing the safety culture into construction project teams by communicating safety, selecting safe contractors and participating in safety management. Smallwood (2004) found that the prequalification of contractors on quality and health and safety contributed to an improvement in construction health and safety in Shell projects. Sunindijo (2016) recommended that clients should focus on selecting safe contractors to improve health and safety performance. Spear (2005) argues that the key to improving health, safety and environment performance (according to them), is the integration of these elements into the contracting process – which includes establishing formal prequalification and contractor selection criteria and incorporating HSE requirements into the contract.

Yin-Hung (2006) conducted a study in Hong Kong that aimed to compare the ways the public and private sectors organize and manage their projects in terms of safety theoretically and practically. Yin-Hung (2006) states that clients can achieve better project safety performance by having a higher degree of involvement in safety, selecting safe contractors, participating in safety management in projects and establishing an appropriate contractual arrangement. Lingard, Blisman, Cooke, and Cooper (2009) argued that construction industry clients (as an important segment of the project management discipline), can make an important contribution to occupational health and safety performance of the construction projects they procure.

In South Africa, the Construction Regulation 2014 imposes a distinct responsibility on all parties to construction projects and owners of assets – clients, their agent, the designers, the principal contractors, contractors and owners of the structure. According to CR 2014, the client must take reasonable steps to ensure that each contractor's health and safety plan contemplated in regulation 7(1) is implemented and maintained, ensure that periodic health and safety audits and document verification are conducted at intervals mutually agreed on between the principal contractor and any contractor, but at least once in every thirty days. According to the Health and Safety Executive (2001), the primary purpose of measuring health and safety performance is to provide information on the progress and status of the strategies, processes and activities used by an organization to control risks for health and safety.

Kikwasi (2008) acknowledged that although the provision of safety equipment has been improving significantly, the health and safety plan submitted during tendering and which is approved at the time of awarding the contract is no longer useful when the contractor goes on site. He argued that this approach has led the industry to perform poorly continually regarding health and safety. Kikwasi (2008) surveyed forty organisations to establish the adequacy of the conventional and alternative roles played by clients in addressing safety and health issues. His study confirmed that the clients roles are to ensure incorporation of a health and safety component in project design and tender documentation, a close follow-up on health and safety matters at site meetings, preparation of a possible checklist of hazard occurrence before and during construction, and provision of personal protective equipment. Kikwasi

(2008) argues that the views shared by many authors are that client involvement throughout the project can lead to an improvement in health and safety performance.

Having reviewed the research conducted by various authors, similarities of the generic issues were evident in client influence in construction project health and safety performance. As far as client influence in construction project health and safety performance is concerned, the literature has highlighted eleven significant factors based on an empirical analysis, namely:

- client attitude towards health and safety
- client involvement from the beginning to the end of the project
- selection of contractors based on their safety performance
- prequalification of contractors
- integration of design and construction in terms of health and safety
- evaluation of contractors using various measures
- establishment of an appropriate contractual health and safety arrangement
- use of a health and safety plan submitted during tendering prior to construction
- a more interactive form of health and safety communication
- post-construction performance evaluation
- monitoring of contractors' health and safety performance

The identified features were found to be common to all studies and some can be further grouped together to describe one feature. The grouping of some health and safety features resulted in key health and safety features reducing from eleven to six significant factors as shown in Table 3.1. Liu et al., (2017) investigated the importance of these factors by asking construction industry experts to rate the degree of their importance. The study revealed that about ninety per cent of experts agreed with the significant effects of these factors on health and safety performance at construction sites. The six critical factors associated with client involvement in construction project health and safety improvements are summarised in Table 3.1 below:

Table 3.1 Summary of Critical Health and Safety Factors

Critical Health and Safety Factors		
No.	Description	Author(s)
1	Client's Attitude Towards H&S	Umeokafor (2018); Liu et al., (2017); Musonda et al.,
2	Client's Communication Attitude Towards	Sperlling et al., (2008); Said et al., (2009); Liu et al.,
3	Selection of Contractors	Smallwood (2004); Sunindijo (2016); Spear (2005);
4	Contractual H&S Arrangement	CR (2014); HSE (2001); Kikwasi (2008), Liu et al.,
5	Client Involvement Before and After	Yin-Hung (2006); Lingard et al., (2009); Liu et al.,
6	Monitoring H&S Performance	CR (2014); HSE (2001); Liu et al., (2017)

3.4 Hypothesis Development

The theoretical framework of this study is based on critical health and safety factors provided in Table 3.1. The six factors were developed from the analysis of previous client-related studies to determine the critical factors responsible for health and safety improvement. The relevant factors were found to be common to all studies and some were grouped together as the six significant factors, namely:

- client attitude towards health and safety
- client ability to communicate clearly their health and safety requirements
- selection of contractors based on health and safety performance
- contractual health and safety arrangement
- client involvement before and during construction
- and monitoring of contractor health and safety performance

Using the results of the literature review, a conceptual structural model was developed. Figure 3.1 shows the conceptual client-driven occupational health and safety, rating model. Key objectives of this study were to provide answers to the research questions and the hypothesis. One of the key objectives of the study was to identify critical health and safety elements that can be applied by construction clients to improve project health and safety performance. These are provided by Figure 3.1.

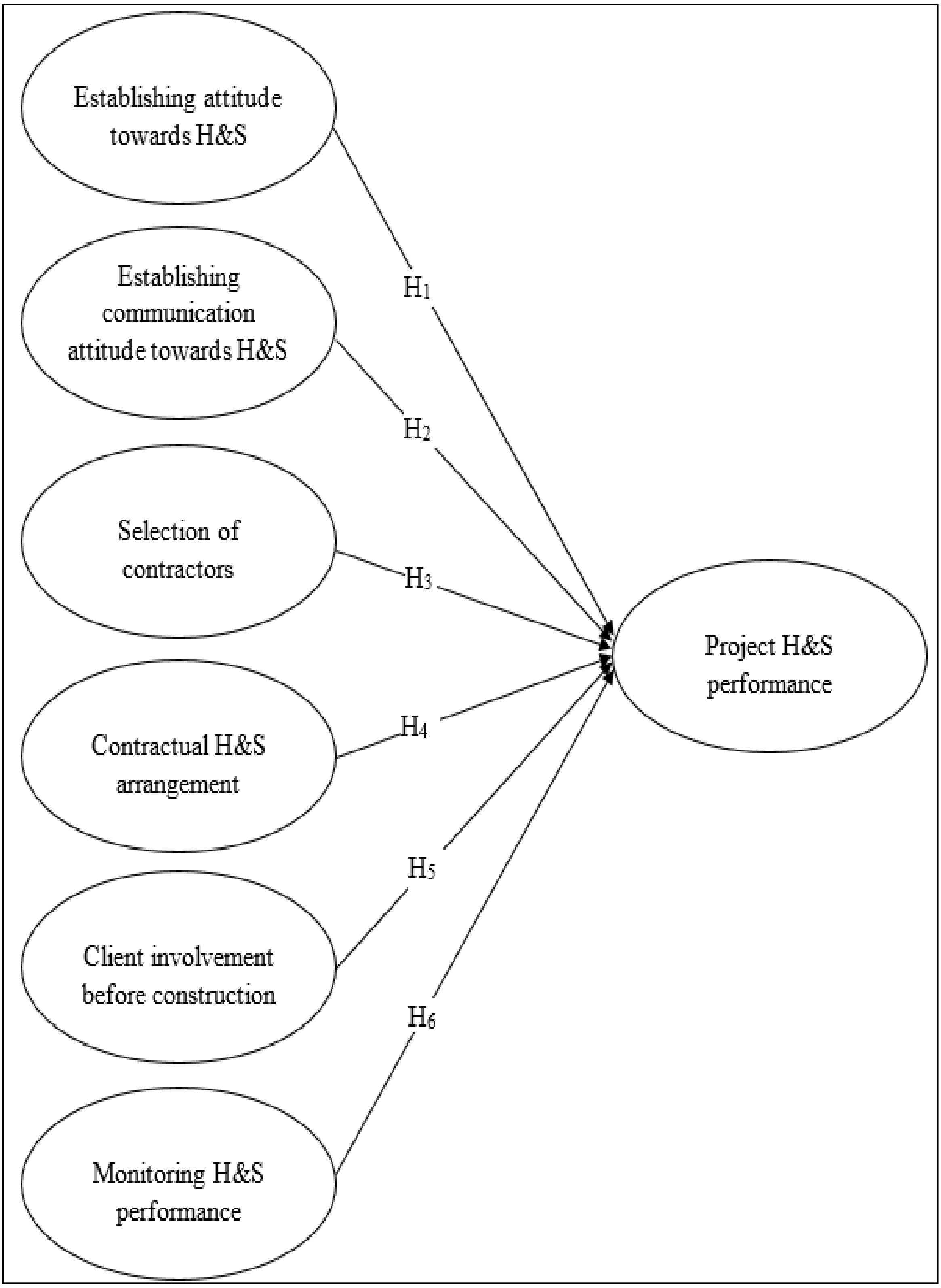


Figure 3.1 Theorised Client-Driven Occupational Health and Safety Model

Based on the conclusions made by previous studies that client involvement in all phases of the construction project can lead to improvements in the health and safety performance of construction projects, the following hypotheses were developed:

H_1: The construction client attitude towards health and safety has a direct influence on project health and safety performance

H_2: The client ability to communicate their health and safety requirements can directly improve project health and safety performance

H_3: The selection of contractors by construction clients based on proven health and safety track records can lead to improved project health and safety performance

H_4: The stipulation of health and safety duties for all participants in the construction project by construction clients in the contractual arrangement can improve project health and safety performance

H_5: The involvement of construction clients before and during construction directly improves project health and safety performance

H_6: The monitoring of contractor health and safety compliance by construction clients can directly improve the project health and safety

3.5 Chapter Summary

This chapter presented the conceptual model of the research, that is based on the review of previous studies. The conceptual model was described and the key concepts that constitute the building blocks of the conceptual model were explained. In this chapter, six critical health and safety factors (client attitude towards health and safety, client ability to communicate clearly their health and safety requirements, selection of contractors based on health and safety performance, contractual health and safety arrangement, client involvement before and during construction, and monitoring of contractor health and safety performance), were theorised to have a significant impact on project health and safety performance. The next chapter presents the research methodology followed to achieve the research objectives of the study and to respond to the research questions.

CHAPTER 4 : RESEARCH METHODOLOGY

4.1 Introduction

This chapter presents the research methodology followed to achieve the research objectives of the study and responds to the research questions. To guide the choice of research philosophy used in this study, key research terms are defined. The methodology adopted for this study is based on the research onion model suggested by Saunders, Lewis, and Thornhill (2012). The different layers of the research onion model that include research philosophies, approaches, designs, strategies, techniques and procedures, data collection methods and data analysis. In addition, the statistical techniques for addressing issues of validity and reliability of the instruments used for the collection of data are explained.

4.2 Research Definitions

To guide the choice of research philosophy used in this study key research terms are defined. Definitions to research, research process, research philosophy and paradigm are explained below (subsection 4.2.1 to 4.2.3).

4.2.1 Research

Rajasekar, Philominathan, and Chinnathambi (2013) define research as a logical and systematic search for new and useful information on a particular topic. Rajasekar et al., (2013) summarise the prime objectives of research as:

- to discover new facts
- verify and test important facts
- analyse an event, process or phenomenon to identify the cause and effect relationship
- develop new scientific tools, concepts and theories to solve and understand scientific and non-scientific problems
- to find solutions to scientific, non-scientific and social problems
- to overcome or solve the problems that occur in everyday life

Saunders et al., (2012) argue that research is a process by which individuals attempt to learn things in a systematic way to increase their knowledge. Scientific research is conducted by following systematic procedures that are controlled, empirical and critical investigations of hypothetical suggestions, on supposed associations among phenomenon (Saunders et al., 2012; Sekaran and Bougie, 2010; Thakur, 1993)

4.2.2 Research Process

Otago Polytechnic (2006) describes the research process as the systematic manner in which a researcher approaches their area of study to produce knowledge that the community considers worthwhile within the field. The research process consists of a series of actions or steps necessary to carry out research effectively and the desired sequencing of these steps (Vincze, 2013). The series of steps necessary to carry out research actively in this study are shown in Figure 4.1.

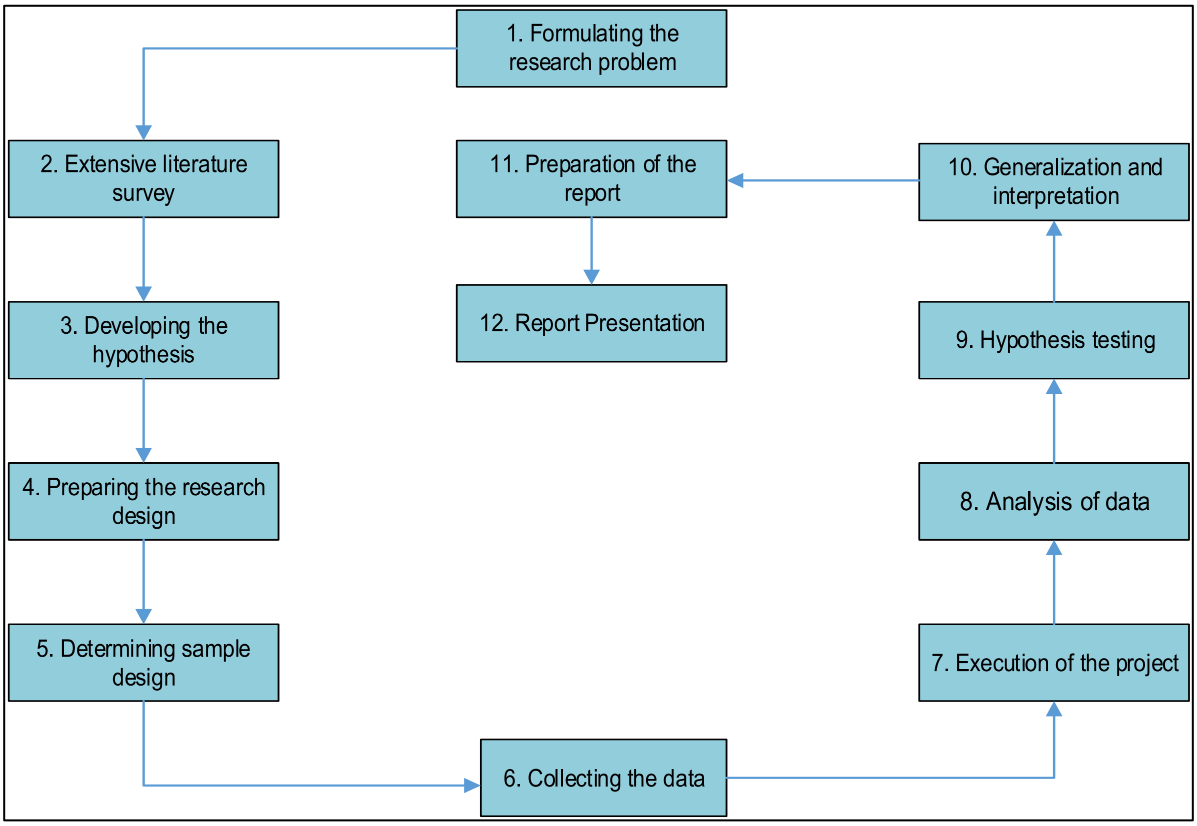


Figure 4.1 The Research Process Steps – Adapted from Vincze (2013)

According to Saunders et al., (2007), the research process can be represented as an onion. The numerous layers and approaches of the research process onion must be consistently employed when conducting research (Zefeiti and Mohamad, 2015). Figure 4.2 illustrates the contents of the research process onion layers. According to Zefeiti and Mohamad (2015), considerations on several issues must be taken into account before the central point (core of the onion), data collection and data analysis are addressed. The methodology adopted for this study is based on the research onion model suggested by Saunders et al., (2012). The following subsections explain the contents of the research process onion model and how they have been applied in the current study.

4.3 Research Methodology

The research methodology and design focus on achieving the aim and objectives of the study and responding to the research questions. Labaree (2009) describes research methodology as the action taken to investigate a research problem, and the rationale for the application of specific procedures or techniques used to identify, select, process and analyse information applied to understand the problem; thereby allowing the reader to critically evaluate the overall validity and reliability of the study. The research methodology provides answers as to how the data was collected and analysed. Kivunja and Kuyini (2017) describe methodology as the broad term used to refer to the research design, methods, approaches and procedures used in an investigation that is well planned to discover something.

The methodology includes assumptions made, limitations encountered – and how they were mitigated or minimized (Kivunja and Kuyini, 2017). According to Kivunja and Kuyini, 2017), the methodology focusses on how researchers come to know the world or gain knowledge about a part of it. In considering the methodology for the research proposal, a question must be asked as to how to go about obtaining the desired data, knowledge and understandings that enables research questions to be answered and how the contribution to knowledge is made (Kivunja and Kuyini, 2017).

4.4 Research Onion Model

The first attribute of any study is to link it to a particular philosophy. To give direction to this study, the author adopted the research process onion model (Figure 4.2) proposed by Saunders et al., (2012). This model provides a systematic and detailed presentation of the research process. The six layers of the model include philosophies, methodological choices, strategy, approaches, time horizons, techniques and procedures. As the layers of the research process onion model are related to each other, the study follows the same sequence of these layers to arrive at the desired output of the research. The different layers of the research onion model are analysed starting from the outermost and moving to the innermost layer. Each layer of the research onion model is discussed, and the justification of choices for the approaches chosen under each layer for this study is presented below.

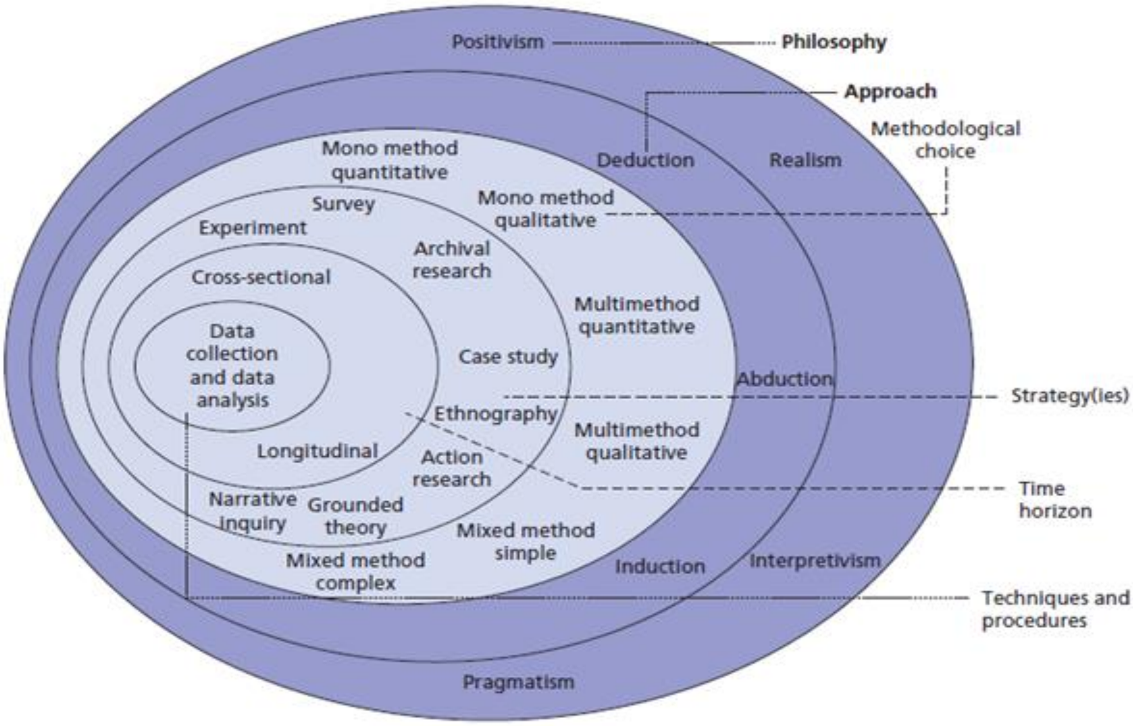


Figure 4.2 Research Process Onion (Saunders et al., 2012)

4.4.1 Layer 1: Research Philosophy

The first layer of the research process onion model is the research philosophy and is considered the most crucial layer (Zefeiti and Mohamad, 2015). A number of authors have provided definitions of research philosophies. Levin (1998) describes a research philosophy as a belief or an idea about the collection, interpretation and analysis of the collected data. Bandaranayake (2012) describes research philosophy as an over-arching term relating to the development of knowledge and the nature of that knowledge. Research philosophy can be described simply as a belief about the manner in which data about a phenomenon should be gathered, analysed and used (Moksha, 2013).

Researchers adopt this layer in specific studies to reflect important assumptions about their opinions and views, and the manner in which they understand the world (Simpson, 2009). According to Saunders et al., (2009), one of the most important considerations influencing the choice of a specific philosophy is the researcher’s specific view and opinion of the association between knowledge and the process with which it is developed. According to Kivunja and Kuyini (2017), there are various research philosophies, namely, epistemology, ontology, methodology and axiology. Research philosophies are of paramount importance, as they comprise the basic assumptions, beliefs, norms and values that each paradigm holds. Researchers are expected to locate their study in a particular research paradigm. The understanding is that the research is guided by, and upholds the assumptions, beliefs, norms and values of the chosen paradigm (Kivunja and Kuyini, 2017). In addition, each research philosophy has different philosophies attached to it. The following subsections explain the various philosophies, and how they have been applied in this study.

4.4.1.1 Epistemology

Thaxton (2015) defines epistemology as the study of knowledge acquisition. According to Kivunja and Kuyini, (2017), epistemology is used to describe how we come to know something, and how we know the truth or reality. Epistemology is concerned with addressing the facts by asking what the acceptable knowledge is. Epistemology is important as it helps researchers to establish the faith they put in their data and it affects how they go about uncovering knowledge in the social context that they investigate (Kivunja and Kuyini, 2017). Epistemological philosophies determine the approach to questioning and discovery in research (Saunders et al., 2012). According to Dudovskiy (2016), the main research epistemological philosophies are positivism, realism, interpretive and pragmatism philosophies.

a) Positivism

According to Williams (2011), a positivist philosophy is based on the highly structured methodology to enable generalization and quantifiable observations, and to evaluate the result with the support of statistical methods. According to Saunders (2003), in a positivist philosophy the researcher plays the role of an objective analyst to evaluate the collected data and to produce an appropriate result to achieve research aims and objectives. In a positivist philosophy, researchers can collect all the data that are associated with the research issue through general sources (Williams, 2011). Positivism advocates that knowledge should be generated by gathering facts either inductively or deductively (Saunders et al., 2012).

b) Realism

A realism philosophy is an important philosophy that is based on the interdependency of human values and beliefs. According to Dudovskiy (2016), a realism research philosophy relies on the idea of independence of reality from the human mind; it believes in the existence of an external and objective reality that influences people's social interpretations and behaviour. Furthermore, it believes that humans are not objects for the study in the style of natural science. Johnson and Christensen (2010) describe realism as the philosophy that defines how individuals react to a real-world situation.

Realism is divided into two groups, namely, direct and critical realism. Saunders et al., (2012) noted that direct realism portrays the world through personal human senses. Dudovskiy (2016) pointed out that critical realism argues that humans experience the sensations and images of the real world. Novikov and Novikov (2013) argue that in critical realism, sensations and images of the real world can be deceptive and they do not usually portray the real world.

c) Interpretivism (Interpretive)

According to Myers (2008), the important aspect of interpretivism is that it is based on a naturalistic approach of data collection – such as interviews and observations. Collins (2010) argues that interpretivism is associated with the philosophical position of idealism and is used to group together diverse approaches including social constructivism, phenomenology and hermeneutics; approaches that reject the objectivist view that meaning resides within the world independently of consciousness. Saunders et al., (2012) emphasize the fact that when using the interpretivism approach, it is important for the researcher as a social actor to appreciate differences between people. Dudovskiy (2016) states that interpretivism studies usually focus on meaning and may employ multiple methods to reflect different aspects of an issue.

d) Pragmatism

According to Saunders et al., (2012), pragmatics recognize that there are many different ways of interpreting the world and undertaking research, that no single point of view can give the entire picture and that there may be multiple realities. Dudovskiy (2016) revealed that pragmatics could combine both positivism and interpretivism positions within the scope of single research according to the nature of the research question. In studies with pragmatism, research philosophy can integrate the use of multiple research methods such as qualitative, quantitative and action research (Dudovskiy, 2016).

4.4.1.2 Ontology

Scotland (2012) describes ontology as a branch of philosophy concerned with the assumptions that something makes sense or is real, or the very nature or essence of the social phenomenon being investigated. Kivunja and Kuyini (2017) define it as the philosophical study of the nature of existence or reality, of being or becoming, as well as the basic categories of things that exist and their relations. According to Scott and Usher (2004), ontology is essential to a paradigm because it helps to provide an understanding of the things that constitute the world as it is known. Ontology enables researchers to examine their underlying belief system and philosophical assumptions as researchers, about the nature of being, existence and reality (Kivunja and Kuyini 2017). The main research philosophies on ontological positions are objectivism and subjectivism.

a) Objectivism

Saunders et al., (2012) describe objectivism (or positivism) as portraying the position that social entities exist in reality, external to social actors concerned with their existence. Bryman (2012) suggests that objectivism is an ontological position that asserts that social phenomena and their meanings have an existence that is independent of social actors.

b) Subjectivism

Dudovskiy (2016) suggests that subjectivism (as opposed to objectivism), perceives that social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence. Bryman (2012) states that subjectivism is an ontological position which asserts that social phenomena and their meanings are continually being accomplished by social actors.

4.4.1.3 Axiology

Saunders et al., (2012) define axiology as a branch of philosophy that studies judgments about value. According to Li (2016), axiology deals with the assessment of the role of the researcher’s own value on all stages of the research process. Dudovskiy (2016) describes axiology as the ethical issues that must be considered when planning a research proposal and take into consideration the philosophical approach to making decisions of value or the right decisions. For example, if the research involves human participants, it is necessary to follow strict ethical principles (Mabuda et al., 2008).

According to Dudovskiy (2016), ethical consideration is founded on the understanding that all humans have dignity that must be respected, and they have a fundamental human right to make choices that all researchers must respect. To ensure that ethical considerations are taken into account when dealing with participants and data during research, there are four principles that a researcher needs to uphold, namely, privacy, accuracy, property and accessibility (Dudovskiy, 2016).

a) Privacy

The privacy principle deals with the need for the researcher to consider what information from participants is required to reveal to the researchers or to others about themselves, their associations or organizations (Kaizer, 2009). It takes into consideration the conditions under which data is to be gathered, analysed and safeguarded (Wilms, 2019). Moreover, it considers which elements participants do not have to divulge, without being forced to reveal those to researchers (or any other people).

b) Accuracy

Under this principle, there is an expectation that researchers must take into consideration as to who is responsible for the authenticity, fidelity and accuracy of information. Similarly, it considers how researchers crosscheck information with participants so that they know that researchers have recorded the data accurately. This principle provides a clear indication of who is to be held accountable for any errors in the data. Furthermore, this principle provides clarity in terms of who is to be held responsible if any participants were to be injured – and how they would be compensated.

c) Property

According to Cooper and LaSalle (2018), the property principle requires that researchers take into consideration who owns the data. It requires clarity if their payment is required for data and what a just and fair price in exchange of the data would be. Cooper and LaSalle, (2018) argue that this principle further requires clarity in terms of who owns the channels (such as publications and media), through which information is to be disseminated.

d) Accessibility

Under this principle, researchers are required to take into consideration who has access to the data and how they ensure that the data is kept securely (Smith, 2003). Furthermore, the principle requires that researchers take into consideration under which conditions they and participants have access to the data, and how access to the data can be gained (Vanclay, 2013).

4.4.1.4 Research Philosophy for this Study

The assumptions created by a research philosophy provide the justification for the manner in which the research is undertaken (Flick, 2012). The lack of the effective involvement of clients in construction health and safety has left the industry with a high number of construction site accidents every day that result in medical treatment cases, lost time incidents, fatalities and damage to property. To address this disturbing situation, the researcher conducted the study using the epistemological position of a positivist research philosophy; this was so that the relationship between the involvement of clients and health and safety performance improvement of construction projects can be empirically tested. In conducting this study, the researcher applied a research process onion model (Figure 4.2) by formulating the research problem and conducting an extensive literature survey through which a number of theoretical propositions (each of which contained specific hypotheses) were developed, and factors that influence the client to improve health and safety on construction sites were identified.

The study followed an ontological objectivism quantitative approach because it is interested in the client as a social actor who has the ability to influence health and safety improvements on construction sites. The construction site is a social entity under the overall control of the client; furthermore, it is viewed as being as equally important as the client (as a social actor), because the environmental factors in which the site is located have the potential to influence the extent to which the client is involved with the project H&S improvement initiatives.

As the research involved human participants, it was necessary to follow strict ethical principles; prior to the study, ethical clearance from the contributing organizations and full consent from the participants was obtained. The anonymity of the individuals and organization participating in the study was maintained by not including their names in the study, and the participants were assured that the information provided would not be used to their detriment. Moreover, participants were informed that they had the right to withdraw from the study at any time.

Confidentiality was ensured by excluding the names of companies, project names, project-specific locations and project price. Where required, participants were sent a summary of the results of the study. While still working with the data from participants, confidentiality was assured by guarding against unauthorized access to the data and it was stored in a password-protected folder. Where there was a need to have printed copies, these copies were locked in a cupboard and were destroyed after working with them was completed; thereafter (on completion of the study), the data was stored on a compact disc. On the final submission of the dissertation, the compact disc was handed to the researcher's supervisor for safe storage in their office – for a minimum period of five years – and thereafter it will be cut up and disposed.

4.4.2 Layer 2: Research Approaches

The research approach is the second layer of the research process onion model (Figure 4.2). The research approach is defined as a plan and procedure that consists of steps (of broad assumptions) to the detailed method of data collection, analysis and interpretation (Chetty, 2016). According to Dudovskiy (2016), the research approach is another important element of research methodology that directly affects the choice of specific research methods. According to the research process onion by Saunders et al., (2009), the research approach can be divided into deductive, inductive and abductive categories. The subsections that follow explain these approaches.

4.4.2.1 Deductive

Wilson (2010) explains that the deductive approach deals with the development of hypothesis (or hypotheses) based on existing theory, and then by designing a research strategy to test the hypothesis. The thought process of deduction moves from theory, to the research question, to data collection, findings and to rejection or confirmation of the research hypothesis. The deductive approach can sometimes lead to the revision of the theory. Dudovskiy (2016) added that the deductive approach could be explained by means of hypotheses, that can be derived from the propositions of the theory. Babbie (2010) explained that the deductive approach can be distinguished from the inductive approach. This is because the deductive approach begins with an expected pattern that is tested against observations, whereas the inductive approach begins with observations and seeks to find a pattern within them.

Thakur (1993) pointed out that a weakness of the deductive approach is that there is the possibility for some researchers to collect evidence, that supports their ideas (or their hypotheses); this can lead to incorrect generalization and biased researchers. Gabriel (2013) explains that the main difference between the inductive and deductive approaches to research is that a deductive approach is aimed at testing theory, while an inductive approach is involved with the generation of new theory emerging from the data.

4.4.2.2 Inductive

Goddard and Melville (2004) describe the inductive approach as the research approach that starts with observations and proposes theories towards the end of the research process as a result of the observations. In the inductive approach, research is conducted to create theory. The inductive process moves in the opposite direction from the deductive approach. According to Bernard (2011), the inductive approach searches for patterns from observations, and then develops explanations for theories (for those patterns) through a series of hypotheses. The inductive approach begins with detailed observations of the world, that moves towards more abstract generalizations and ideas (Neumann, 2003). Although the inductive approach offers researchers some flexibility (as they are not required to follow pre-determined information), its weakness lies in that incorrect observations could result in incorrect conclusions (Dudovskiy, 2016). To avoid questionable accuracy of conclusions through inductive reasoning, collaboration using deductive approaches is recommended.

4.4.2.3 Abductive

Dudovskiy (2016) states that the abductive approach addresses weaknesses associated with deductive and inductive approaches. Saunders et al., (2012) argue that deductive reasoning is criticized for the lack of clarity – in terms of how to select the theory to be tested via formulating hypotheses; inductive reasoning, on the other hand, is criticized because no amount of empirical data necessarily enables theory building. According to Bryman & Bell (2015), in the abductive approach, the research process starts with surprising facts (or puzzles) and it is devoted to explaining them. Dudovskiy (2016) argues that a weakness of the abductive approach is the surprising facts (or puzzles) that emerge when researchers encounter an empirical phenomenon, that cannot be explained by the existing range of theories.

4.4.2.4 Research Approaches for this Study

The research approach followed in this study is a deductive approach; it develops hypotheses based on existing literature (or theory), and then designs a research strategy to test the hypotheses. Inductive research processes would not be suitable in the current study due to it starting with observations and proposing theories towards the end of the research process (as a result of observations); this means that if observations were incorrect, the researcher would end up with incorrect conclusions. Similarly, the abductive approach could not be used in this study due to possible is that the unexpected facts (or puzzles) that could emerge – as is the case when researchers encounter an empirical phenomenon that cannot be explained by the existing range of theories. The study does focus on theory testing; the theory was first adopted as the framework for developing and testing hypotheses in a specific research context. This emphasizes that the current study is of a deductive orientation.

4.4.3 Layer 3: Methodical Research Choices

De Vaus (2001) and Trochim (2006) define research design as the overall strategy that is chosen to integrate the different components of the study in a coherent and logical way, thereby, ensuring that the research problem is effectively addressed. Research design constitutes the blueprint for the collection, measurement and analysis of data (De Vaus, 2001; Trochim, 2006). According to Du Toit (2010), research design is the planning of the research and indicates the type of study undertaken, while the research methods indicate steps taken, instruments used and techniques implemented, to complete the research process. Saunders et al., (2012) expounds that the research design is a general plan used to answer the research questions and involves a methodological choice of either a quantitative or a qualitative design, or a mix of both designs; these designs are described in the following subsections.

4.4.3.1 Quantitative Research Design

Babbie and Muijs (2010) define quantitative research design as a method that emphasizes the objective measurements, and the statistical, mathematical or numerical analysis of data collected through polls, questionnaires and surveys – or by manipulating pre-existing statistical data using computational techniques. Saunders et al., (2012) state that quantitative research design is used to examine relationships among variables using statistical analyses and principles and uses either experimental or survey research strategies with questionnaires and structured interviews or structured observation. Gabriel (2013) explained that quantitative research is more commonly associated with deductive approaches.

4.4.3.2 Qualitative Research Design

According to Hancock, Ockleford, and Windridge (2009), the qualitative research design concerns developing explanations of social phenomena. Hancock et al., (2009) suggested that qualitative research design aims to help us to understand the social world in which we live – why things are the way they are – and it is concerned with the social aspects of the world. It seeks to answer questions of why people behave the way they do, how opinions and attitudes are formed, how people are affected by the events around them, and how and why cultures and practices have developed as they have.

Qualitative research design is primarily an exploratory research process. DeFranzo (2011) suggests that qualitative data collection methods vary, using unstructured or semi-structured techniques, focus groups, individual interviews and participation/observations. Saunders et al., (2012), argues that qualitative research design is associated with the inductive research approach, although it can also start with a deductive approach to test a theory using qualitative procedures. Saunders et al., (2012) pointed out that most qualitative research uses abduction and while it is associated with interpretivism philosophy, it may be used within the realist and pragmatist philosophies.

4.4.3.3 Mixed Method Research Design

Mafuwane (2011) defines mixed methods design as a technique that includes both qualitative and quantitative data collection and analysis in a parallel form. Johnson, Onwuegbuzie, and Turner (2007) define mixed methods research design as the type of research in which researchers combine elements of qualitative and quantitative research approaches, for the general purposes of breadth and depth of understanding and corroboration. Creswell, Fetters, and Ivankova (2004:7) note that mixed methods research design is not just about collecting qualitative and quantitative data; but it involves the integration of data relating and mixing at some stage of the research process. Saunders et al., (2012) claim that the mixed methods research design is often associated with the realist and pragmatist philosophies and is likely to combine both inductive and deductive reasoning.

4.4.3.4 Methodological Research Choices for the Current Study

In the opinion of Robison (2002), quantitative research is appropriate in particular when the relationship between variables is measured. Creswell (2002) argues that the appropriate design to examine the relationships between variables is predictive and correlational quantitative research. Goddard and Melville (2004) argue that quantitative research holds a number of accepted statistical standards for the validity of the approach (such as the number of respondents that are required to establish a statistically significant result). As maintained by May (2011), the quantitative approach can most effectively be used for situations where there are a large number of respondents available, where the data can be effectively measured using quantitative techniques and where statistical methods of analysis can be used.

In this study, the quantitative research design is used to examine relationships between client involvement in H&S and improvement in the project H&S performance. It is also used to examine the extent to which health and safety experts agree or disagree with the developed model (CHSRM) during the validation process. The quantitative method used in this study comprises survey research strategies with questionnaires to collect the required data. Based on the research questions and research objectives in the study, the researcher opted for the quantitative design in line with the use of a positivist philosophy, following a deductive research approach to examine relationships among the study variables; statistical software was used to analyse the data.

4.4.4 Layer 4: Research Strategies

Dennin (2014) describes a research strategy as a step-by-step plan of action that gives direction to thoughts and efforts, enabling research to be conducted systematically and on schedule to produce quality results and detailed reporting. The research strategy is the ‘nuts and bolts’ of a research process, describing the rationale for research, and the experiments that are done to accomplish desired goals (Dennin, 2014). As stated in the research process onion by Saunders et al., (2012), there are several strategies that can be employed, namely, experiment, survey, archival research, case study, ethnography, action research, grounded theory and narrative inquiry; in this study, a survey was employed during the research process. The next subsection discusses surveys as the research strategy.

4.4.4.1 Surveys

Jackson (2011) describes the survey method as a process of questioning participants on a topic or topics and then describing their responses. The two main purposes of the survey method are describing certain aspects or characteristics of the population and testing hypotheses about the nature of relationships within a population (Dudovskiy, 2016). The survey methods can be broadly divided into three categories, namely, mail survey, telephone survey and personal interview (Jackson, 2011).

Saunders et al., (2012), note that surveys are one of the most widely used methods and have the advantage of greater objectivity, lower cost and greater anonymity when compared to other methods. Survey methods could be used in quantitative and qualitative studies, and they could make use of questionnaires, interviews and documentation reviews (Dudovskiy, 2016). According to the Saunders et al., (2012) survey, data can be analysed using descriptive and inferential statistics, and the relationships between variables can be depicted in a model for the relationships of the variables. Although surveys are useful for revealing the status of a variable in an entity, they fail to highlight the unique way in which individual variables fit in the pattern within the collective averages (Jankowicz, 2005; Murray, 2003).

4.4.4.2 The Research Strategies for the Current Study

The current study used the survey strategy, as it is usually associated with the deductive approach (Zefeiti and Mohamad, 2015). In this study, survey data was analysed using descriptive and inferential statistics, and the relationships between variables depicted in a model for the relationships of the construction client involvement in H&S and improvement in the project H&S performance. The descriptive research approach was favoured, firstly, because it lends itself well to the research problem and secondly, the hypotheses needed to be tested. In addition, the survey strategy was favoured for the research as only a representative sample was required to test the research hypotheses and to establish the status of the client involvement in H&S of construction projects. Furthermore, the survey strategy was used to rate the opinion of the health and safety expert on the applicability, effectiveness and adaptability of the proposed CHSRM during the model validation process.

4.4.5 Layer 5: Time Horizons

The time horizon is the fifth layer of the research process onion and this refers to a particular period that has been taken to complete the research (Saunders et. al., 2007). There are two-time horizons available for conducting research, namely, cross-sectional and longitudinal (Babbie, 1990; Saunders et al., 2012; Sekaran and Bougie, 2010). The selection of time horizon is dependent on a specific research approach or methodology (Saunders et. al., 2007).

4.4.5.1 Cross-Sectional

For a shorter period, a cross-sectional study is used, and a longitudinal study is used for a longer period. The defining feature of a cross-sectional study is that it can compare different population groups at a single point in time (Institute for Work & Health, 2015). According to the Institute for Work & Health (2015), the benefit of cross-sectional study design is that it allows researchers to compare many different variables at the same time.

4.4.5.2 Longitudinal

According to the Institute for Work & Health (2015) in a longitudinal study, researchers conduct several observations of the same subjects over a period, sometimes lasting many years. A cross-sectional study is used when the research nature is qualitative or quantitative, and the researcher has intentions to study the behavioural aspects of various groups – or many individuals – at a single point in time. On the contrary, the longitudinal time horizon is applied when the researcher is studying the behaviour of total samples for a longer period; data can be gathered at two different points in time.

4.4.5.3 Time Horizon for the Current Study

In this study, a cross-sectional study was favoured because it has to take into account the intention of collecting a large amount of data from a sizeable population efficiently and economically. The time horizon for this study was limited to two years. In the study, many different variables were compared at the same time. While a longitudinal study has the ability to establish some causal relationships, such a study would be costly and time-consuming and did not fall within the objectives of this study.

4.4.6 Layer 6: Research Techniques and Procedures

The sixth layer of the research process onion model deals with techniques and procedures for data collection and data analysis tools. Saunders et al., (2012) describe research techniques and procedures as the details of data collection methods and procedures for choosing the research participants (Saunders et al., 2012). In this layer, the researcher takes the decisions regarding the selection of the most appropriate collection and analysis tools. The researcher focusses on various other decisions taken in the layers above of the research methodology. The following subsections describe data collection methods, instruments for data collection and sampling methods used in this research.

4.4.6.1 Data Collection Method

Dudovskiy (2016) describes data collection as a process of collecting information from all of the relevant sources to find answers to the research problem, to test the hypothesis and to evaluate the outcomes. The data collection could aid in gathering the most reliable and valid information. Furthermore, the data analysis techniques must be selected such so that the desired results could be generated. According to Dudovskiy (2016), data collection methods can be divided into two categories, namely, primary and secondary methods of data collection.

Ajayi (2017) describes primary data as that which is collected for the first time by the researcher while secondary data has already been collected or produced by others. According to Ajayi (2017), primary data sources include surveys, observations, experiments, questionnaires and personal interviews, etc., while secondary data collection sources are government publications, websites, books, journal articles and internal records, etc. Ajayi (2017) notes, the fundamental differences between primary and secondary data are that primary data refers to data originated by the researcher for the first time, while secondary data is the data that exists already, collected by the investigator agencies and organizations. He further maintains that primary data is real-time data whereas secondary data is one that relates to the past.

Ullar (2014) believes, that in statistics primary data is collected first-hand by a researcher (organization, person, authority, agency or party, etc.) through experiments, surveys, questionnaires, focus groups, conducting interviews and taking (required) measurements, while secondary data is readily available (collected by someone else) and is accessible to the public through publications, journals and newspapers. The three core approaches to data collection in qualitative research are interviews, focus groups and observation. Labaree (2009) maintains, quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires and surveys, or by manipulating pre-existing statistical data using computational techniques. The next subsection discusses the use of questionnaires as an instrument for collecting data.

4.4.6.2 Questionnaires

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from respondents (McLeod, 2018). To gather the required information related to the research problem, the questionnaire must be organized and prepared in an orderly manner (Sekaran, 2003; Thakur, 1993). According to McLeod (2018), questionnaires provide a relatively cheap, quick and efficient way of obtaining substantial volumes of information from a large sample of respondents. Judd et al., (1986) and Thakur (1993) argued that questionnaires have some disadvantages in that researchers are not normally available to supervise the dissemination and return of the questionnaires, or that respondents may not fill in the questionnaires. They, too may not have an opportunity to seek clarification on the questions when required, nor are they able to explain what has influenced their responses. McLeod (2018) suggested that as some questionnaires suffer from a response rate as low as five per cent, it is essential that they be well designed.

Questionnaires can be arranged based on the required responses, namely, closed response questions and open response questions (Saunders et al., 2012). Kabir (2018) suggested in research, a distinction must be made between open- and close-ended questions. According to McLeod (2018), closed questions structure the answer by only allowing responses that fit into pre-decided categories. Judd et al., (1986) and Thakur (1993) notes that in a closed response question type, the questions and answers are already given and can be further divided into dichotomous, multiple-choice type and rank order type that are based on the available alternative answers. McLeod (2018) argued that while large quantities of research data can be provided for closed response questions at a relatively low cost, they lack detail as the responses are fixed and there is less scope for respondents to supply answers, that reflect their true feelings on a topic.

In open-ended response type questions, respondents are allowed to express what they think and can answer with as much detail as they would like to, in their own words (McLeod, 2018). McLeod (2018) noted that while rich qualitative data can be obtained from open questions and allow respondents to elaborate on their answer (and researchers can easily find out why they hold a certain attitude), it is time-consuming to analyse the data. It takes longer for the researcher to analyse qualitative data, as they have to read the answers and put them into categories by coding, which is often subjective and difficult.

4.4.6.3 Sampling Methods

Cherry (2018) describes a sample as a subset of a population that is used to represent the entire group as a whole. Sampling is used when doing research where it is almost impossible to survey every member of a particular populated area because the population is too large. Sekaran (2003) expounds that a good sample should be a precise and correct representation of the population from which it is drawn. Cherry (2018) agrees that a sample is a fairly accurate reflection of the population from which the sample is drawn. Cherry (2008) added that if the sample is truly representative of the population in question, then researchers can take those results and apply them to the larger group. Page and Meyer (2006) state that the whole population used in a study is called a census. There are two general ways of choosing a sample (Page and Meyer, 2006), namely, non-probability and probability sampling methods.

a) Probability Sampling Method

Cherry (2018) explains that probability sampling means that every individual of the specific population chosen stands an equal chance of being selected. In probability sampling, a different subset of the population has an equal chance of being represented in the sample, as it involves random selection. Thus, the samples are more representative, and researchers are better able to apply their results to the group as a whole (Cherry, 2018). There are three types of probability sampling, namely, simple random sampling, stratified random sampling and cluster sampling.

Cherry (2018) describes simple random sampling as a sampling process where researchers take every individual in a population set and randomly select their sample – often using some type of computer program or random number generator. Stratified random sampling involves separating the population into subgroups and then taking a simple random sample from each of these subgroups (Cherry, 2018). Cherry (2018) explains that stratified random sampling often provides greater statistical accuracy than simple random sampling and helps to ensure that certain groups are accurately represented in the sample.

According to Cherry (2018), cluster sampling involves dividing a population into smaller clusters, often based on geographic location or boundaries.

b) Non-probability Sampling Method

In non-probability sampling method, participants are selected using methods that do not give every individual in a population group an equal chance of being chosen (Cherry, 2018). As stated by Showkat and Parveen (2017), one of the main shortcomings of non-probability sampling is that the findings established through this method lack generalizability. There are three types of non-probability sampling methods, namely, convenience sampling, purposive sampling and quota sampling. Dudovskiy (2016) describes convenience sampling as a specific type of non-probability sampling method that relies on data collection from population members who are conveniently available to participate in the study.

Cherry (2008) describes convenience sampling as involving participants in a study because they are convenient and available. Dudovskiy (2016) note that purposive sampling (also known as judgment, selective or subjective sampling) is a sampling technique in which the researcher relies on their own judgment when choosing members of the population to participate in the study; it involves seeking out individuals that meet certain criteria (Cherry, 2008). Cherry (2008) agrees that quota sampling involves intentionally sampling a specific proportion of a subgroup within a population. Cherry (2008) argues that while the resulting sample may not actually be representative of the actual proportions that exist in the population group, having a quota ensures that these smaller subgroups are represented.

4.4.6.4 Data Collection Methods for the Current Study

The current study applied both primary and secondary data collection methods. Secondary data was used to conduct extensive theoretical literature reviews to establish which theories already exist, the relationships between them, to what degree they have been investigated and to develop new hypotheses to be tested. The secondary data collection sources were construction industry bodies, previous studies, websites, books, journal articles and internal company records. Through the secondary data collection method, the researcher was able to identify gaps that exist in literature and factors that influence client involvement in health and safety of construction project sites.

In the study, the primary data collection method was applied to test the extent to which construction client involvement in H&S can lead to an improvement in project H&S performance. The primary data was collected first-hand by the researcher through survey questionnaires. The use of both primary and secondary data sources for data collection has enabled the researcher to do a comparative study through analysis of primary data and secondary information. The non-probability sampling method was preferred in this study, as the construction projects were selected using methods that did not give every project in the population set an equal chance of being chosen.

The study used convenience and purposive sampling methods. The convenience sampling method was applied due to the researcher using participants in the study who were conveniently available and had access to a database with the required data. The study applied purposive sampling methods since the participants for this study were deliberately chosen by the researcher due to their suitability in advancing the purpose of the research (Rule et al., 2011:64).

A survey questionnaire was adopted as an instrument for collecting data. This was for the reason that questionnaires have the ability to enable researchers to collect a large amount of data in a short period – and it is considered to be cost-effective (Murray, 2003). A structured multiple-choice questionnaire was used to study various aspects of construction client involvement through the phases of the project. The method was appropriate to use since the study is aimed at estimating the extent to which construction clients are involved in project H&S issues. The structured questionnaire promotes faster responses and increases the response rate (Landaeta, 2008). The questionnaire included close-ended questions and used the quantitative research approach as a preferred research design process. A small-scale, pre-test questionnaire study included five respondents (who were part of the targeted respondents) was conducted prior to the main study. This allowed the researcher to assess the study with a few participants so that adjustments could be made before the main study, thus saving time and money (McLeod, 2018). The list carrying the details of construction clients was collected using multiple sources. A letter from the researcher’s institution authorizing the data collection was produced, and the survey questionnaires were sent to construction clients and health and safety experts by email. The purpose of the study was explained to the respondents and the anonymity and confidentiality of the respondents were assured and they were requested to participate in the study (Kaur, 2019). For the purpose of meeting the research objectives, three sets of data were collected.

In the first data set, a survey questionnaire instrument designed from information gathered from the previous studies was used. A total of 150 construction clients who were managing projects with a value of more than R40 million were the target for this study. For the project to have been considered it had to have a value of R40 million or more and was not to be managed by the same health and safety agent. Furthermore, mining sector construction projects were excluded from the study.

The target population included construction clients of building, housing, civil construction, petrochemicals, roads and earthworks, and structural, mechanical, electrical, instrumentation, piping and plate work (SMEIPP). In the survey questionnaire, respondents were asked to rate the extent to which construction clients are involved in the project site health and safety issues using a five-point Likert scale, namely, never = 1, seldom = 2, sometimes = 3, often = 4 and always = 5. The scale was used to guide respondents to rate the extent to which construction clients are involved in project H&S. The rating scale was chosen as it fits with the type of questions that were being asked and was considered easy for the respondents to understand and to use (Achieng' Nyaura and Omwenga, 2016). Moreover, the scale made it easier for the researcher to construct, collect and analyse data.

The second data set used the same respondents as those used in the first data set. Here, the respondents were asked to provide different data in the form of the health and safety performance of the 150 projects, using the five health and safety lagging indicators. These indicators were:

- First Aid Incident Rate (FAIFR)
- Medical Incident Treatment Rate (MTIFR)
- Lost Time Incident Frequency Rate (LTIFR)
- Recordable Incident Frequency Rate/Recordable Case Rate (RIFR/RCR)
- All Incident Frequency Rate (AIFR)

The reason for using the same respondents in both the first and second data set was to verify the link between client involvement and improvement in the project health and safety performance. To analyse the project H&S performance, the frequency rate was converted into a five-point Likert scale, namely, 1 = poor, 2 = fair, 3 = good, 4 = very good and 5 = excellent. The choice of this Likert scale was favoured as it rates the extent to which project H&S performance is acceptable or not and this aligns well with the objectives of this study.

The third data set was collected from five-point Likert scale, experts during the validation process and twenty health and safety experts were asked to rate the extent to which they agree or disagree with the proposed model. The following criteria were used for the selection of health and safety experts:

- they should be registered with SACPCMP as Construction Health and Safety Agents (CHSA)

- have practical knowledge and experience in managing health and safety on behalf of clients for projects with a value of at least R40 million
- have worked in the construction industry for at least ten years
- be appropriately qualified in health and safety

Practical knowledge and experience in managing large construction projects on behalf of clients were important factors. A five-point Likert scale was adopted for this model validation process and anchored on, strongly disagree = (1), disagree = (2), neutral = (3), agree = (4) and strongly agree (5). The choice of the rating scale was informed by the respondents being asked to rate the statement based on their opinion of the proposed model. The cut-off criteria for the statement to be accepted was set at 3.5.

Low response rates have been considered one of the main problems for email surveys (to attain a high response rate in this study). Thus, reminders were sent by email to those that had not completed the survey after the pre-determined time (three weeks), placing increased emphasis on the importance of completing the survey questionnaire by the respondents (DeFranzo, 2014). On submission of the data by the respondents, the information was checked for accuracy before being entered into the computer for statistical analysis.

4.4.6.5 Data Analysis

Sharma (2018) defines data analysis as the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data. Shamoo and Resnik (2003) note that various analytic procedures are used to provide a way of drawing inductive inferences from data, and to distinguish the signal from the noise in the data. Data analysis can either be univariate, bivariate or multivariate. Univariate analysis deals with one variable at a time and usually takes the form of frequency tables, histograms, measures of central tendency and dispersion, while bivariate analysis establishes the relationship between two variables (Bryman and Bell, 2011).

Multivariate analysis is the scrutiny of three or more variables (Adams, 2017). Hazra and Gogtay (2017) describe multivariate analysis as the statistical techniques that simultaneously study three or more variables in relation to the subject under investigation with the aim of identifying or clarifying the relationships between them. The multivariable analysis is usually performed with software (i.e. SPSS or Statistical Analysis System (SAS)), as manually working with even the smallest of data sets can be overwhelming (Hazra and Gogtay, 2017).

Multivariable analysis methods include the additive tree, canonical correlation analysis, cluster analysis, correspondence analysis/multiple correspondence analysis, factor analysis, generalized procrustean analysis, Multivariate Analysis of Variance (MANOVA), multidimensional scaling, multiple regression analysis, partial least squares regression, principal component analysis/regression/Parallel Factor Analysis (PARAFAC) and redundancy analysis – among others. As stated by Srivastava (2018), in multivariate statistical data analysis, the structural equation model is the preferred technique used for analyses of the structural relationships – to establish causal relationships among variables.

4.4.6.6 Data Screening Process

Data screening is the process of ensuring that the collected data is clean and ready to be used before further statistical analyses can be conducted. Data screening is important as it assures that the data is useable, reliable and valid for testing the causal theory. Stephen (2015) states that before researchers conduct the actual statistical tests, they need to screen the data for any irregularities. When cleaning data, there are three specific issues that need to be addressed, namely, outliers, missing values and normality.

a) Outliers

Outliers can influence the research results by pulling the mean away from the median. As agreed by Stephan (2015), outliers are observations that differ greatly from the majority in a set of data and can affect the normality of the collected data. Hair et al., (2007) state that if it cannot be determined that an outlier constitutes a valid distinctly different response it should be removed.

b) Missing Values

Stephan (2015) explains that missing values are usually noted when participants either purposely or accidentally do not answer some questions, and he further notes that missing values may occur through data entry mistakes. According to Hair et al., (2007), if the proportion of missing data is greater than ten per cent of data points, it is recommended to omit the participant from the analysis; if it is less than ten per cent, the missing data points may be estimated by substituting with the mean scores for each of the data points.

c) Normality

Stephan (2015) describes normal distribution as a symmetric bell-shaped curve defined by two things – the mean (average) and variance (variability). Stephan (2015) states that if the data is not normal, the use of non-parametric tests that do not require normality can be applied. There are many ways to test the normality of data and can include Shapiro Wilk W/Kolmogorov-Smirnov test, skewness, and kurtosis.

4.4.6.7 Exploratory Factor Analysis

According to Panda (2017), Exploratory Factor Analysis (EFA) is a statistical technique that is used to identify the latent relational structure among a set of variables and to narrow those down to a smaller number of variables. Laher (2010) mentions that EFA is useful for determining the construct validity of an instrument. In this study, EFA was used for data reduction, and to examine the factor structure of the measurement instrument, using SPSS (Byrne, 2006; Laher, 2010; Matsunaga, 2010; Worthington and Whittaker, 2006). EFA prepares the variables to be used for cleaner structural equation modelling. EFA was performed using SPSS. Figure 4.3 shows the EFA process flow chart that was used in the study. EFA was used for the collected data to assess intercorrelations among the six constructs of the study. The data was screened using visual inspection of scatterplot matrices for problematic data patterns.

Factorability was assessed using Bartlett's Test of Sphericity, Kaiser-Myer-Olkin (KMO) statistic, initial estimates of communality and the anti-image correlation matrix. The factors were extracted using the Principal Component Analysis (PCA) as suggested by Pett et al., (2003). PCA was preferred, as the researcher found it to be simple, yet effective in determining the factors including the error variance (Laher, 2010). The objective of the data extraction was to reduce a large number of items into factors. William et al., (2010) suggested that the simultaneous use of multiple decision rules in data extraction is often desired and appropriate. The number of factors to be retained was determined by scree plot/Kaiser's rules (eigenvalue >1), scree test and the cumulative per cent of variance extracted. Oblique rotation was preferred over the orthogonal approach because it treats factors as correlated (Matsunaga, 2010).

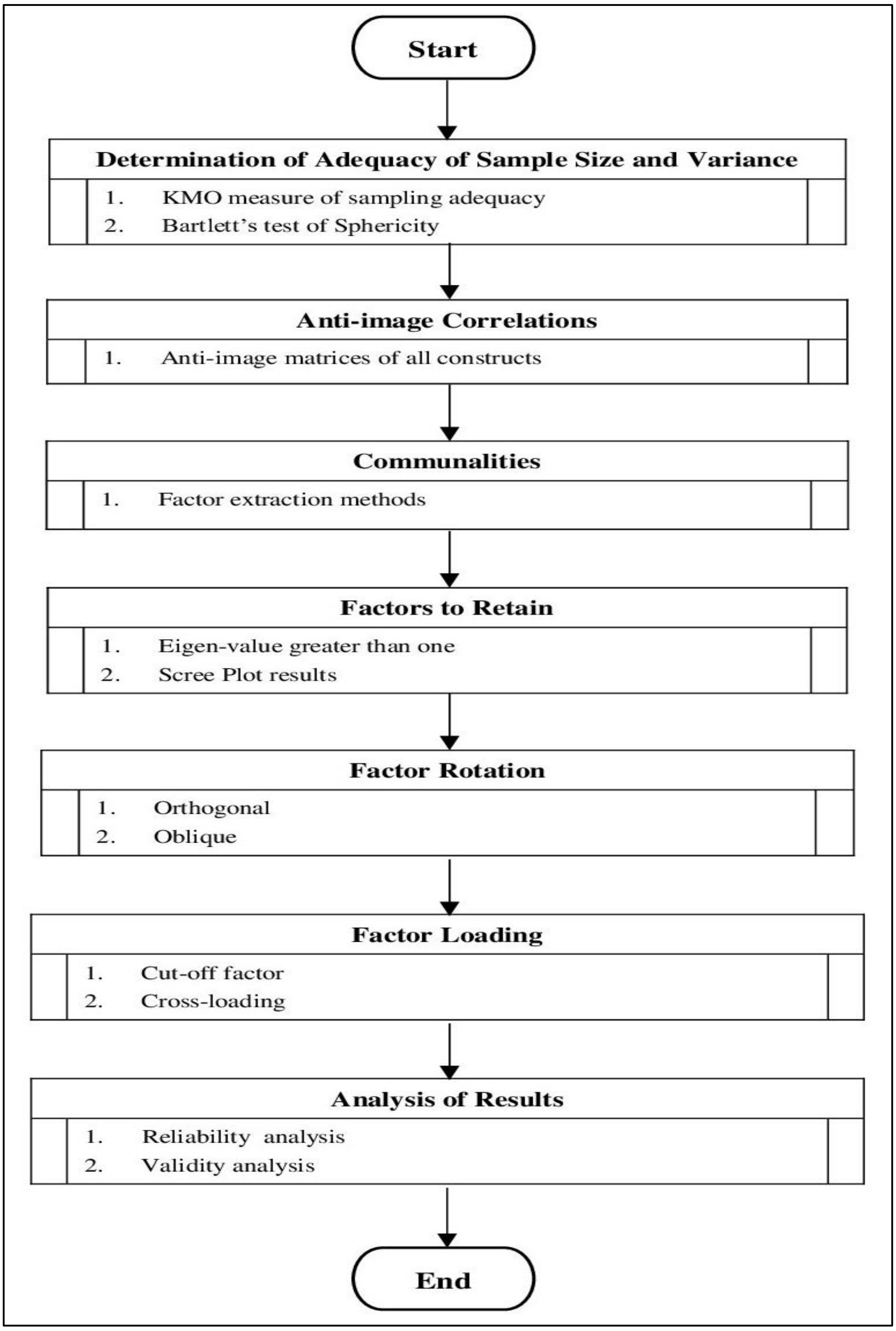


Figure 4.3 EFA Process Flow

For factor rotation, Promax with Kaiser Normalisation was preferred because it works well with both correlated and uncorrelated factors (Matsunaga, 2010). The strength of the solution was assessed by the per cent age of variance explained, a minimum number of factors loading per major factor, the magnitude of the commonalities, loadings and cross-loadings, and reproduced and residual correlations. A stringent cut-off criterion of 0.5 recommended by Gerbing (1998) was used. The items that did not load into any constructs were subsequently dropped and omitted from further analysis.

4.4.6.8 Reliability Analysis

Heale and Twycross (2015) define reliability as the consistency of a measure, or as the degree to which an instrument measures the same way each time it is used, under the same condition, with the same subjects. It relates to the degree of accuracy of the research-measuring instrument shown by the extent to which scores of a test remain the same (for the same unit of analysis over time). Thus, independent, but comparable measures of the same unit give similar results – unless the unit, the situation or conditions under which the study is done change (Hair et al., 2007; Nachmias and Nachmias, 1981; Sekaran, 2003; Thakur, 1993).

According to Heale and Twycross (2015), there are three attributes of reliability, namely, homogeneity (or internal consistency), stability and equivalence. Table 4.1 provides the definitions of the three attributes of reliability. According to Heale and Twycross (2015), Cronbach's α is the most commonly used test to determine the internal consistency of an instrument. In this study, an acceptable reliability score is one that is 0.7 or higher (Lobiondo-Wood and Haber, 2013; Shuttleworth, 2015).

Table 4.1 Definitions of the Three Attributes of Reliability

Term	**Definitions**	**Author(s)**
Homogeneity (or internal consistency)	Refers to the extent to which all the items on a scale measure one construct.	Tang, Ying, and Babenko (2014); Heale and Twycross (2015); Deviant (2016)
Stability	Refers to the consistency of results using an instrument with repeated testing.	Heale and Twycross (2015); Mohajan (2017)
Equivalence	Refers to the consistency among responses of multiple users of an instrument, or among alternate forms of an instrument.	Heale and Twycross (2015); Mohajan (2017)

4.4.6.9 Validity Analysis

According to Heale and Twycross (2015), validity is the extent to which a concept is accurately measured in a quantitative study. Bryman and Bell (2011), describe the validity of a measuring instrument as the assessment of how well the instrument measures (what it is supposed to measure) and that the instrument is not, in fact, evaluating something else. There are three main types of validity, namely, content validity, construct validity and criterion validity (Bryman and Bell, 2011; Hair et al., 2007; Sekaran, 2003; Heale and Twycross, 2015). Content validity refers to the extent to which a research instrument accurately measures all aspects of a construct (Heale and Twycross, 2015). Construct validity refers to the extent to which a research instrument (or tool) measures the intended construct (Bryman and Bell, 2011; Hair et al., 2007; Sekaran, 2003; Heale and Twycross, 2015). Construct validity has two facets, namely, convergent validity and discriminant validity. Convergent validity exists when two different scales designed to measure the same construct are highly correlated; discriminant validity exists when (based on theory), two scales that are predicted to be uncorrelated are empirically found to be so. Criterion validity refers to the extent to which a research instrument is related to other instruments that measure the same variables (Heale and Twycross, 2015). In assessing the reliability and validity of the measures for this study, the following threshold for testing the reliability and validity suggested by Hair et al., (2010) was applied:

- Composite reliability: CR > 0.7
- Convergent validity: verified through the use of Average Variance Extracted (AVE) > 0.5
- Discriminant validity: maximum shared variance < AVE, and the square root of AVE greater than an inter-construct correlation

4.4.6.10 Structural Equation Model

Srivastava (2018) defines Structural Equation Modelling as a multivariate statistical technique that analyses the structural relationships or establishes causal relationships between variables. According to Byrne (2006), SEM graphically models hypothesised relationships among constructs with structural equations. Srivastava (2018) explains that SEM can simultaneously test the measurement model and structural relationships specified in the model. SEM consists of confirmatory factor analysis, path analysis with observed variables and path analysis with latent variables.

According to Davcik (2014), there are two SEM streams, namely, Covariance-based SEM (CB-SEM), and Variance-based SEM or Partial Least Square SEM. CB-SEM is based on the covariance matrices and is used to explain the relationships between indicators and constructs, and to confirm the theoretical rationale that was specified by the model (Hair et al., 2014). CB-SEM utilizes software such as LISREL or AMOS (Hair et al., 2010; Henseler et al., 2009). According to Hair et al., (2014), VB-SEM is used when identifying key predictor constructs or when the structural model is complex or when the sample is small or non-normal. VB-SEM is considered vigorous when employed on highly non-normal data (Becker et al., 2012).

According to Hazen et al., (2015), CB-SEM has almost unanimously been used in literature, regardless of whether it might be the most appropriate method or not. Hazen et al., (2015), recommended that justification for choosing one method over the other method should be explicitly stated in the research report. Although the structural model for this research was complex and required identifying key predictor constructs (that are strong points of VB-SEM), CB-SEM was preferred as the researcher only had access to SPSS AMOS software to use for analysis. CB-SEM utilizes software such as LISREL or SPSS AMOS that do not require programming as compared to other software (Hair et al., 2010; Henseler et al., 2009). Further, the collected data in this study was considered normal and the sample size was large, thus suitable for CB-SEM.

4.4.6.11 Model Verification and Validation

Verification and Validation techniques have always been an essential part of the model development process because they offer the only way to judge the success of the model development process (Preece, 2001). Model verification is planned to ensure that the model does what it is intended to do (Preece, 2001, and Hillston, 2003). According to Adrion et al., (1982), the primary reason for early investment in verification activity is to catch potentially expensive errors early (before the cost of their correction escalates). Validation is the task of demonstrating that the proposed model is a reasonable representation of the final model (Hillston, 2003). Preece (2001) suggests that validation is the process of building the right system and that it checks whether the system being built meets the actual requirements of the intended users.

Uslu et al., (2013) mentions that there are two approaches to a verification framework, namely, tests with artificial data and tests with field data. In this study, field data from a sample of respondents with the required knowledge related to the proposed model was used. The respondents were randomly chosen from different construction clients and were requested to rate the extent to which they are involved in the project H&S issues. The respondents were requested to provide separate data consisting of project H&S performance statistics. Prior to the respondents completing the questionnaire, the model was explained to the respondents by the researcher. To ensure that the proposed model is correct and does what it is intended to do, the completed survey questionnaire was verified using SEM.

Hillston (2003) mentions that three separate aspects should be considered during model validation, namely, assumptions, input parameter values and distributions, and output values and conclusions. In the study, the assumption was made that more involvement by construction clients in project H&S issues should improve the project H&S performance. Hillston (2003) stated that there are three approaches to model validation, namely, expert intuition, real system measurements and theoretical results/analysis. According to Hillston (2003), any combination of the approaches to validation may be applied as appropriate to the different aspects of a particular model. In this study, the expert intuition approach was preferred in validating the proposed model.

Miles and Huberman (1994) noted that no matter the type of research method used for data collection and analysis, researchers are faced with difficulties in seeking to study everyone, in all places, doing all things. For this reason, the researcher chose a sample of health and safety experts to study and apply the results to the whole population. For this study, CHSA registered with SACPCMP were preferred because they are mandated by law to manage health and safety on behalf of construction clients. According to the SACPCMP website (SACPCMP, 2019: online), there were ninety-one CHSAs fully registered with the SACPCMP in South Africa. For this present study, all of the CHSA were chosen as the population. According to Zefeiti and Mohamad (2015), determining the sample size needed to be representative of a given population, is crucial for any research. In this study, statistical sampling that attempts to be representative of the population was not applied because the CHSA were experts who have a deep understanding of the client-related health and safety issues (Okoli et al., 2004:20). Saunders et al., (2007), suggest that to achieve the research objectives, researchers should conclude regarding the sample of the target population. In line with the previous model validation studies, a sample of twenty health and safety experts was considered adequate for the study. The sample participants for the survey were randomly selected from the SACPCMP website (SACPCMP, 2019: online).

The criteria used for selection of H&S experts were:

- they should be registered with SACPCMP as Construction Health and Safety Agents (CHSA)
- have practical knowledge and experience in managing health and safety on behalf of clients for projects with a value of at least R40 million

- have worked in the construction industry for at least ten years
- be appropriately qualified in health and safety

Practical knowledge and experience in managing large construction projects on behalf of clients were important factors. The H&S experts were given the model and statements that described the proposed model in terms of its applicability, effectiveness and adaptability. They were asked to review the model, provide comments where applicable, and to rate the extent to which they agree or disagree with the statements that described the proposed model in terms of its applicability, effectiveness, and adaptability in the construction industry. The results of the model verification and validation are discussed in detail in Chapter 7 of this study.

4.4.6.12 Data Analysis for the Current Study

As the current study looked at three or more variables in relation to the subject under investigation with the aim of identifying (or clarifying) the relationships between them, a multivariate analysis technique was preferred. The researcher used a questionnaire for the survey method. IBM Statistical Package for Social Sciences version 25 was utilized to analyse the collected data and to test the research questions, expectations and hypotheses. SPSS version 25 was chosen for its versatility and ability to handle many calculations expeditiously (Champoux and Ommanney, 1986); Obwoge et al., 2013).

Analysis of means, standard deviations and Pearson's correlations were used to describe and explore the relationships between all the variables used in the current study. Descriptive statistical analyses were used to provide an analysis of measures of central tendency and the measures of dispersion to get an overview of the sample and summarise the demographic details of the respondents (Nguyen, 2010). In ensuring that the data is useable, reliable and valid for testing causal theory, the data was screened for any irregularity using SPSS for outliers, extreme values, missing data and disengaged responses before subjecting them to exploratory factor analysis (EFA) to assess the factor structure and reliability and validity of the measures.

Exploratory Factor Analysis was used for data reduction and to examine the factor structure of the measurement instrument using SPSS. EFA prepares the variables to be used for cleaner structural equation modelling. After the EFA, Confirmatory Factor Analysis (CFA) as a pre-requisite for Structural Equation Modelling was conducted following a two-step approach SPSS Analysis of Moment Structures (AMOS) version 25. SPSS AMOS was preferred over other software programs for its user-friendly graphical interface (Huckleberry, 2011). Sharma and Singh (2012), explain that SPSS AMOS allows for the calculation of direct and indirect effects. According to Hansen and Lee (2013), and Kim et al., (2016), SPSS AMOS contributes to the field of literature by developing a new model and testing its fit in alignment with the objectives of the study, while other software programs only provide testing of existing theories and models. CB-SEM was preferred because the researcher only had access to SPSS AMOS version 25 software to use for analysis.

4.5 Research Justification

Research justification refers to the rationale for the research, or the reason why the research is being conducted, including an explanation for the design and methods employed (Given, 2008); in this study, the rationale for the research was provided in Chapter 1. The justification of the methods used is presented in Table 4.2. The summary of the research process followed is indicated by a process flowchart in Figure 4.4.

Table 4.2 Justification of the Methods Used in the Current Study

Summary of Methods Used and Justification		
Method	Justification	References
Research Onion Model	The research process onion model was preferred as it provides a systematic and detailed presentation of the research process.	Saunders et al., (2012)
Epistemological Research Philosophy	The current study was conducted using the epistemological and positivist research philosophy so that the relationship between involvement by clients and H&S performance improvement of construction projects can be empirically tested.	(Kivunja and Kuyini, (2017); Moon (2017)
Positivism	In the study, the researcher plays the role of an objective analyst to evaluate the collected data and produces an appropriate result to achieve research aims and objectives.	Saunders (2003); Williams (2011)

Deductive Research Approach	This study aims at the development of hypotheses based on existing literature or theory, and then designs a research strategy to test the hypotheses.	Babbie (2010); Wilson (2010); Dudovskiy (2016)
Quantitative Method	The quantitative method used in the current study comprises survey research strategies with questionnaires to collect the required data. Based on the research questions and the research objective of this study, the researcher opted for the quantitative design in line with the use of a positivist philosophy – following a deductive research approach to examine relationships among the study variables; statistical software was used to analyse the data.	Robison (2002); Creswell (2002); Melville (2004); May (2011)
Survey Research Strategy	The study used the survey strategy due to it usually being associated with the deductive approach. The survey data can be analysed using descriptive and inferential statistics and the relationships between variables can be depicted in a model of the relationships of the variables.	Jackson (2011); Saunders et al., (2012); Zefeiti and Mohamad, (2015); Dudovskiy (2016);
Cross-Sectional	Cross-sectional was favoured, as the study had to take into account the intention of collecting a large amount of data from a sizeable population efficiently and economically in a highly economical way. The benefit of cross-sectional study design is that it allows researchers to compare many different variables at the same time.	Institute for Work & Health (2015)
Primary Data Collection And Secondary Data Collection Methods	The current study applied primary data collection and secondary data collection methods. Secondary data was used to conduct extensive theoretical literature reviews to establish which theories already exist, the relationships between them, to what degree the existing theories have been investigated and to develop new hypotheses to be tested. In this study, the primary data collection method	Labaree (2009); Ullar (2014); Dudovskiy (2016);

	was applied to test the extent to which construction client's involvement in H&S could lead to an improvement in project H&S performance. The use of both primary and secondary data sources of data collection has enabled the researcher to do a comparative study by comparing the analysis of primary data and secondary information.	
Survey Questionnaire	A structured questionnaire with multiple choices was used to study various aspects of the construction client involvement through the phases of the project. The method was appropriate to use because the study is aimed at estimating the extent to which construction client is involved in project H&S issue. The structured questionnaire promotes faster responses and increases the response rate.	Landaeta (2008); McLeod (2018)
Convenience And Purposive Sampling Methods	The study used both convenience and purposive sampling methods. The convenience sampling method was applied because the researcher used participants in the study that were conveniently available and had access to the database with the required data. The study applied purposive sampling methods as the participants for this study were deliberately chosen by the researcher for their suitability in advancing the purpose of the research.	Cherry (2008); (Rule et al., 2011:64); Dudovskiy (2016),
	Data set #1: Used a survey questionnaire to collect data from construction clients. A five-point Likert scale, namely, never = 1, seldom = 2, sometimes = 3, often = 4, and always = 5, was adopted for guiding the respondents in rating the extent to which construction clients are involved in project H&S issues. The rating scale was chosen because it fits with the type of questions that were	Achieng' Nyaura and Omwenga, (2016)

Use Of Three Different Data Sets	being asked, and was considered easy for the respondents to understand and use.	
	Data set #2: Used the same respondents as those used in the first data sets, but here the construction clients were asked to provide different data in the form of H&S performance projects, which they were, managing using five H&S lagging indicators. The reason for using the same respondents in both the first and second data set was that the researcher wanted to verify the link between client involvement and improvement in the project H&S performance. To easily analyse the project H&S performance, the frequency rate was converted into a five-point Likert scale, name, 1 = poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent. The choice of this Likert was favoured as it rates the extent to which project H&S performance is acceptable or not. This aligns well with the objectives of this study.	
	Data set #3: Was collected from H&S experts during the validation process of the proposed model. A total of twenty H&S experts were asked to rate the extent to which they agree/disagree with the proposed model. A five-point Likert scale was adopted for this model validation process anchored on, strongly disagree = (1), disagree = (2), neutral = (3), agree = (4), and strongly agree (5). The choice of the rating scale was informed by the fact that respondents were asked to rate statement based on their opinion of the proposed model	

IBM SPSS	SPSS was chosen for its versatility and its ability to handle many calculations expeditiously.	Champoux and Ommanney, (1986); Obwoge et al., (2013).
Multivariate Analysis Technique	The study looked at three or more variables in relation to the subject under investigation with the aim of identifying or clarifying the relationships between them.	Adams (2017); Hazra and Gogtay (2017)
Descriptive Statistical Analysis	Descriptive statistical analyses were used to provide a study of measures of central tendency and the measures of dispersion to get an overview of the sample and summarises the demographic details of the respondent.	Nguyen (2010)
Exploratory Factor Analysis (EFA)	In the study, EFA was used for data reduction and to examine the factor structure of the measurement instrument. EFA prepares the variables to be used for cleaner structural equation modelling.	Byrne (2006); Laher (2010); Matsunaga (2010); Worthington and Whittaker, (2006)
Principle Component Analysis (PAC)	PAC was preferred as the researcher found it to be simple yet was effective in determining the factors including the error variance.	Pett et al., (2003); Laher (2010)
Oblique Rotation	Oblique rotation was preferred over the orthogonal approach because it treats factors as correlated.	Matsunaga (2010)
Promax	Promax with Kaiser Normalisation was preferred as it works well with both correlated and uncorrelated factors.	Matsunaga (2010)
Reliability Analysis	To test the degree of accuracy of the research measuring instrument.	Heale and Twycross (2015)
Validity Analysis	To test that the measuring instrument as the assessment of how well the instrument measures (what it is supposed to	Bryman and Bell (2011),

	measure) and that the instrument is not, in fact, evaluating something else.	
Correlation Analysis	The data in the study was collected using the Likert scale and the data was linearly related. In confirming the normality of data and the absence of outliers, visual inspection of histograms and boxplots were used. After the linearity and normality were confirmed, Pearson's correlation coefficient was conducted to measure the strength of the association between the variables.	Borah 2013; Kaur and Mehta 2016; Leech et al., 2005; Wintermark et al., 2014; Fros et al., (2016)
Regression Analysis	Linear regression analysis was used due to its robust technique for analysing the relationship between dependent and independent variables.	Willemsen and de Vries, (1996); Vanham et al., (2016)
Confirmatory Factor Analysis	CFA was used as it allows for the testing and refining of research constructs in relation to a theoretical framework. CFA assesses how well a theorized factor structure is consistent with empirical data.	Yale, Jensen, Carcioppolo, Sun and Liu, (20150
Structural Equation Modelling	SEM used to test the relationships among the hypothesised variables. SEM was chosen because of its superiority of the technique over other multivariate techniques. It graphically models hypothesised relationships among constructs with structural equations.	Einwiller (2003); Byrne (2006)
CB-SEM	CB-SEM was preferred as the researcher only had access to SPSS AMOS version 25 software to use for analysis. CB-SEM utilizes software such as LISREL or AMOS, which do not require programming as compared to other software. Further, the collected data was considered normal and the sample size was large.	Hair et al., (2010); Henseler et al., (2009)

Model Verification	Model verification was used to test whether the model does what it is intended to do.	Preece (2001); Hillston (2003)
Model Validation	Validation was used to check whether the model being built meets the actual requirements of the construction industry.	Preece (2001)

4.6 Research Process Summary

Otago Polytechnic (2006) describes the research process as the systematic manner in which a researcher approaches their area of study to produce knowledge, which the community will consider worthwhile within the field. The research process consists of a series of actions or steps necessary to carry out research effectively with the desired sequencing of these steps (Vincze, 2013). The series of steps necessary to carry out this study research actively is shown in Figure 4.1. The process flowchart in next figure below (Figure 4.4) summarises the research process followed in this study.

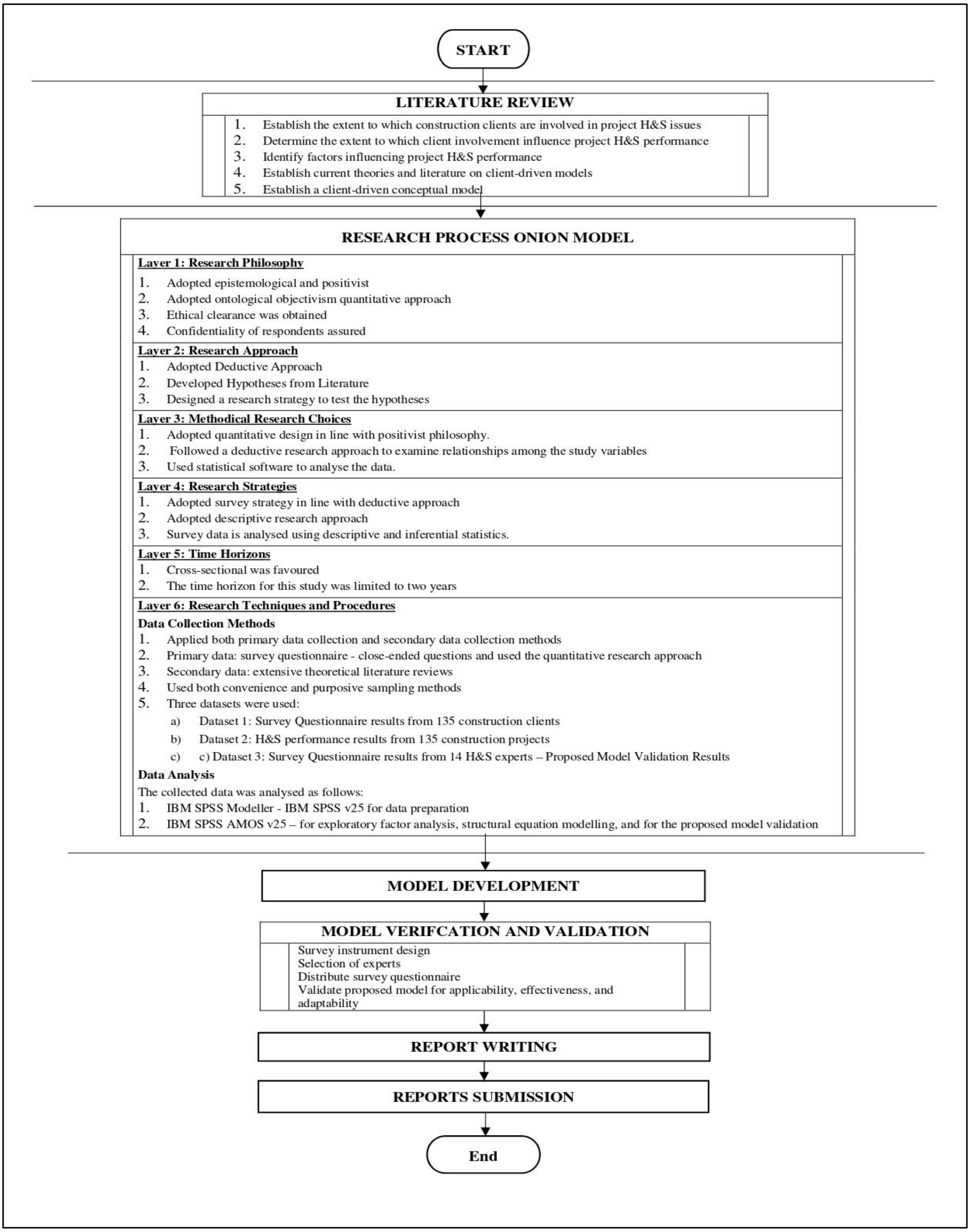


Figure 4.4 Research Process

4.7 Chapter Summary

This chapter outlined the research design and methodology that underpinned the study. It presented research philosophies, research approaches, research designs, research strategies, techniques and procedures, data collection methods and data analysis that has been applied during the research. The theoretical framework underpinning the research was described, and the methods selected, and the instruments designed for data collection were explained. The data analysis process was described, and an outline of the statistical techniques used to address issues of validity and reliability of the instruments used for the collection of data was explained. The justification of the methods used was explained. The next chapter discusses the steps followed in developing the proposed model.

CHAPTER 5 : CHSRM MODEL DEVELOPMENT

5.1 Introduction

This chapter presents a detailed description of the model development process. The summarised description of the constructs for the current study is provided and the process followed in developing the measurement instrument used to measure the constructs is presented in Figure 5.1. A description of the measurement instruments, measurement items, and the choice of the selected measurement scale is presented. The Critical to Health and Safety factors and their attributes/indicators are explained. The final CHSRM is presented.

5.2 Determining the Critical Elements of CHSRM

Based on an extensive literature review, legal and other requirements, a comprehensive list of attributes that represent the significant factors of the CHSRM was developed. These factors are considered key elements to improve and sustain client influence in the construction project health and safety performance. Liu, et al., (2017) maintains that in order for clients to influence improvement of health and safety performance on construction sites, their role has to be established and be deconstructed into specific, quantitative and measurable requirements.

In the CHSRM, there are three critical levels in which the construction client role can be established, namely, CTHS, CTE and measurements (Liu, et al., 2017). CTHS refers to the critical roles that the client is expected to play to ensure improvement in project health and safety. CTHS also refers to health and safety policies and systems construction clients are obligated by law to enforce on construction sites (CR 2014, CDM 2015). Table 5.1 indicates the major role that can be played by clients in the promotion of a systematic approach to the management of health and safety in construction (CDM 2015). Construction clients set the tone of the project and make decisions crucial to its development and to project health and safety performance (Tyler, 2018).

Table 5.1 Summary of Description of Various CHSRM Constructs

Construct	Description
CTHS1: Establishing Attitudes Towards Health and Safety	The client attitude towards H&S is critical to the performance of all stakeholders in construction projects. Once construction clients set the H&S tone for construction projects, their attitude can exert a great influence not only on the performance of H&S but also on other project key performance indicators (KPIs).
CTHS2: Communicating Attitudes Towards Health and Safety	The ability of the construction clients to communicate safety issues effectively with all stakeholders is vital to maintaining a safety culture at the construction site. When the construction clients regularly communicate with all stakeholders in an open, respectful manner, they are also more willing to give and receive feedback. Effective communication has the ability to support teamwork and coordination between contractors and subcontractors.
CTHS3: Selection of Contractors	As construction clients can be held responsible for their contractors' H&S performance, it is advisable that construction clients look at the H&S performance of the contractors before they awarded projects. Selection of contractors with a proven H&S record can be accomplished through looking for a combination of lagging and leading indicators. Selection of safety-minded contractors can lead to improvement in project H&S performance.
CTHS4: Contractual Health and Safety Arrangement	Construction clients are legally obligated to enter into H&S mandatory agreements with contractors that they are intending to employ. The mandatory agreement stipulates the health and safety requirements, roles and responsibilities of all stakeholders on site. Through the mandatory agreement, the construction clients can direct all stakeholders to focus on H&S on site.
CTHS5: Client Involvement in Health and Safety before Construction	Construction clients are legally required to: prepare a baseline risk assessment for an intended construction work project, to prepare a suitable, sufficiently documented and coherent site-specific health and safety specification for the intended construction work based

	on the baseline risk assessment contemplated in paragraph, to provide the designer with the health and safety specification contemplated, to ensure that the designer takes the prepared health and safety specification into consideration during the design stage and to ensure that the designer carries out all responsibilities contemplated in CR 6.
CTHS6: Monitoring Contractor Health and Safety Compliance	Construction clients are required to ensure the mechanisms put in place as part of planning for health, safety and wellbeing are monitored and reviewed throughout the construction period. The purpose of undertaking ongoing monitoring and review is to verify and adjust the mechanisms to ensure they achieve the intended outcome/s.
CTHS7: Overall Project Health and Safety Performance	This includes the determination of the criteria against which the construction project's OHS performance is evaluated, including appropriate indicators (lagging and leading). Criteria are used by the construction clients to compare performance (e.g. FAIFR, MTIFR, LTIFR, TRIR/RCR and AIFR etc.)

Adapted from Liu et al., (2017)

After a thorough review of the perceived impact of these significant factors and basic correlation analysis, attributes/indicators of the CTHS were derived. The attributes/indicators in this study are termed Critical to Expectation (CTE) and they form a framework for the CHSRM (Liu, et al., 2017). CTEs refers to processes, procedures and work instructions that construction clients are expected to establish, implement and monitor to ensure compliance with health and safety (CR 2014 and CDM 2015). The CTEs are signs of progress and are used to determine whether client intervention leads to improvement in project H&S performance. Table 5.2 provides a brief description of constructs (CTHS) and sixty-four attributes/indicators (CTE) associated with each construct for CHSRM. Measurements refer to the rating of CTE performance.

Table 5.2 Constructs and Attributes/Indicators

Factors	Attributes/Indicators	Source Reference
CTHS1: Establishing Attitude towards Health and Safety	CTE 1.1 Involvement in H&S CTE 1.2 Zero harm CTE 1.3 Going beyond regulatory compliance CTE 1.4 H&S specification CTE 1.5 Project H&S goals	Umeokafor (2018); Liu et al., (2017); Musonda et al., (2009)
CTHS2: Communicating Attitude towards Health and Safety	CTE 2.1 Communication with all project stakeholders CTE 2.2 Communicating project H&S goals and requirements CTE 2.3 Communicating commitment to H&S CTE 2.4 Demonstration of involvement in project H&S CTE 2.5 Prescribing of monitoring and reporting of performance CTE 2.6 Penalties and Rewards	Sperlling et al., (2008); Said et al., (2009); Liu et al., (2017)
CTHS3: Selection of Contractors	CTE3.1 Contractor prequalification CTE3.2 Contractor H&S in bidding process CTE3.3 Approval of subcontractors CTE3.4 Specific H&S requirements CTE3.5 Prioritising of H&S in contractor selection CTE3.6 Financial provision for H&S CTE3.7 Procedures for adjudication of H&S financial provision CTE3.8 Procedures for evaluating H&S plans CTE3.9 H&S file requirements CTE3.10 H&S file handover on final completion CTE3.11 H&S minutes CTE3.12 H&S structure	Smallwood (2004); Sunindijo (2016); Spear (2005); Liu et al., (2017)
CTHS4: Contractual Health and Safety Arrangement	CTE 4.1 Full time H&S specialist CTE 4.2 Client H&S guidelines CTE 4.3 H&S personnel CVs CTE 4.4 Specific minimum H&S training CTE 4.5 Site specific H&S plan CTE 4.6 H&S roles and responsibilities CTE 4.7 H&S policy CTE 4.8 Emergency plan CTE 4.9 Incident reporting procedure CTE 4.10 H&S mitigation plan CTE 4.11 H&S induction programme CTE 4.12 Inclusion of subcontractors H&S programme	CR (2014); HSE (2001); Kikwasi (2008), Liu et al., (2017)

	CTE 4.13 Contractor H&S responsibility CTE 4.14 H&S action plan CTE 4.15 H&S method statements CTE 4.16 Inspection and audits CTE 4.17 Enforcement of the approved H&S plan CTE 4.18 Penalties for noncompliance to H&S plans CTE 4.19 Approval of revised H&S plan	
CTHS5: Client Involvement in Health and Safety before Construction	CTE 5.1 H&S consideration during the design stage CTE 5.2 Duties of designers CTE 5.3 Design review CTE 5.4 Review design for H&S CTE 5.5 Promotion of H&S CTE 5.6 Preconstruction H&S meeting	Yin-Hung (2006); Lingard et al., (2009); Liu et al., (2017)
CTHS6: Monitoring Contractor Health and Safety Compliance	CTE 6.1 Full time H&S reps CTE 6.2 H&S responsibilities CTE 6.3 H&S department CTE 6.4 H&S meetings CTE 6.5 H&S statistics CTE 6.6 H&S communication CTE 6.7 H&S audits CTE 6.8 H&S recognition or rewards programme CTE 6.9 H&S audit reports CTE 6.10 Follow up audits CTE 6.11 Post contract H&S review	CR (2014); HSE (2001); Liu et al., (2017)
CTHS7: Overall Project Health and Safety Performance	CTE 7.1 First Aid Incident Frequency Rate (FAIFR) CTE 7.2 Medical Treatment Incident Frequency Rate (MTIFR) CTE 7.3 Lost Time Incident Frequency Rate (LTIFR) CTE 7.4 Recordable Incident Frequency Rate (RIFR/RCR) CTE 7.5 All Incident Frequency Rate (AIFR)	Middlesworth (2013); Young and Lunsford (2017)

Adapted from Liu et al., (2017) and Doloi et al., (2010)

The various constructs that constitute the CHSRM were described in Table 5.2. The number of attributes/indicators in Table 5.3 were derived from the review of literature, CR 2014, CDM 2015, legal and other requirements – and the number of attributes/indicators per each CTHS are summarised. These attributes formed the basis of developing the questionnaire for this study.

Table 5.3 The Number of Attributes/Indicators per CTHS

Critical to Health and Safety (CTHS)	Critical to Expectations (CTE)	Number of Indicators per CTHS
CTHS1	CTE 1.1 – CTE 1.5	5
CTHS2	CTE 2.1 – CTE 2.6	6
CTHS3	CTE 3.1 – CTE 3.12	12
CTHS4	CTE 4.1 – CTE 4.19	19
CTHS5	CTE 5.1 – CTE 5.6	6
CTHS6	CTE 6.1 – CTE 6.11	10
CTHS7	CTE7.1 – CTE 7.5	5

5.3 Questionnaire Development

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from respondents (McLeod, 2018). To gather the information related to the research problem, the questionnaire must be organized in an orderly manner (Sekaran, 2003; Thakur, 1993). In this study, a questionnaire was adopted as an instrument for collecting data; this form of survey has the ability to enable researchers to collect a large volume of data in a short time, cost-effectively (Murray, 2003). A questionnaire was designed using the attributes/indicators from subsection 5.2. The attributes/indicators adapted from a study by Liu et al., (2017) were transformed into questions. In adopting the attributes/indicators some were either added or deleted as necessary, as the current study was conducted from a South African perspective.

A structured questionnaire with multiply choices was used to study various aspects of construction client involvement through the phases of the project (Table 5.4). This method was appropriate to use because the study is aimed at estimating the extent to which construction clients are involved in project H&S issues. The structured questionnaire promotes faster responses and increased response rate (Landaeta, 2008). The questionnaire included close-ended questions and used a quantitative research approach as the preferred research design process.

Table 5.4 Survey Questionnaire

Critical to Health and Safety (CTHS)	**Critical to Expectations (CTE)**
CTHS1: Establishing Attitudes towards Health and Safety	CTE 1.1 Does the client understand that their involvement contributes to health and safety performance?
	CTE 1.2 Does the client set zero harm, injury or incidents as the objectives for the project?
	CTE 1.3 Does the client go beyond a regulatory compliance approach to prevent injuries or incidents?
	CTE 1.4 Does the client go beyond a regulatory compliance approach to prevent injuries or incidents?
	CTE 1.5 Does the client include all requisite information such as outcomes of baseline H&S hazard identification and risk assessment (HIRA) in the form of H&S specifications as part of tender documentation?
CTHS2: Communicating Attitudes towards Health and Safety	CTE 2.1 Does the client communicate with all project stakeholders clearly about their health and safety position and requirements?
	CTE 2.2 Does the client communicate specific H&S goals and requirements in appointments of all project stakeholders – consultants and contractors?
	CTE 2.3 Does the client communicate their commitment to health and safety to the contractors?
	CTE 2.4 Does the client demonstrate their involvement in health and safety to all project stakeholders?
	CTE 2.5 Does the client prescribe regular monitoring and reporting of performance of project stakeholders?
	CTE 2.6 Does the client impose penalties (punitive measures) and reward excellent health and safety performance?
CTHS3: Selection of Contractors	CTE 3.1 Does the client prequalify contractors?
	CTE 3.2 Does the client consider health and safety in prequalifying contractors for bidding on projects?
	CTE 3.3 Does the client require and approve procedures for the appointment of subcontractors with health and safety in mind?
	CTE 3.4 Does the client provide specific contractual health and safety goals and requirements to prospective contractors?
	CTE 3.5 Does health and safety have a high priority when selecting a contractor?
	CTE 3.6 Does the client include the explicit evaluation of the financial provisions and budget for implementing and monitoring health and safety measures when selecting a contractor?
	CTE 3.7 Does the client have specific procedures and/or requirements when adjudicating tenders to ensure adequate financial provision in tenders?

	CTE 3.8 Does the client have specific procedures and/or requirements when evaluating the adequacy of health and safety plans?
	CTE 3.9 Does the client understand what the health and safety file is and its purpose?
	CTE 3.10 Does the client have specific procedures and/or requirements to ensure that the health and safety file is adequate and handed over as part of completion requirements?
	CTE 3.11 Does the client require notices and copies of minutes of all meetings and forums where project health and safety will be discussed?
	CTE 3.12 Does the client ensure that the contractor has all the required health and safety structures in place before awarding tenders such as health and safety representative/s, health and safety committees, etc.?
CTHS4: Contractual Health and Safety Arrangement	CTE 4.1 Does the client assign at least one full-time construction health and safety specialist on the project?
	CTE 4.2 Does the client provide the contractor with health and safety guidelines that must be followed?
	CTE 4.3 Does the client require contractors to submit the resumes of key health and safety personnel for the client approval?
	CTE 4.4 Does the client require contractors to provide specific minimum health and safety training for workers?
	CTE 4.5 Does the client require contractors to submit a site-specific health and safety plan?
	CTE 4.6 Does the client require the contractor's employees at all levels to have specific health and safety responsibility integrated into work processes?
	CTE 4.7 Does the client require the contractor to submit a health and safety policy statement signed by its CEO?
	CTE 4.8 Does the client require the contractor to submit an emergency plan?
	CTE 4.9 Does the client require the contractor to submit and utilize an immediate reporting procedure for accidents and near-misses on this project?
	CTE 4.10 Does the client require the contractor to submit a mitigation plan for this project?
	CTE 4.11 Does the client require and approve an appropriate and adequate construction health and safety induction programme?
	CTE 4.12 Does the client require that subcontractors be included in the health and safety programme?
	CTE 4.13 Does the client make it clear that the contractor is ultimately responsible for the health and safety of their employees and other members of the project team and the general public?
	CTE 4.14 Does the client specify the actions that can be taken to contribute to health and safety performance in this project?

	CTE 4.15 Does the client require submission and approval of all requisite health and safety method statement?
	CTE 4.16 Does the client require regular inspections and audits to ensure implementation of the contractor's health and safety plan?
	CTE 4.17 Does the client enforce adherence to the approved health and safety plan?
	CTE 4.18 Does the client impose sanctions for non-approved deviations and failure to adhere to the health and safety plan?
	CTE 4.19 Does the client require approval of revised health and safety plans when changes or variations are made (including adjustment of the financial provision for health and safety) as required?
CTHS5: Client Involvement in Health and Safety before and during Construction	CTE 5.1 Does the client address health and safety issues in the feasibility study and conceptual design phases?
	CTE 5.2 Does the client require designers to consider construction health and safety during constructability/build ability reviews?
	CTE 5.3 Does the client require designers to conduct a review of the design for construction health and safety for this project?
	CTE 5.4 Does the client conduct a review of the design for health and safety?
	CTE 5.5 Does the client prefer to award the contract to a design-build contractor to promote health and safety performance?
	CTE 5.6 Does the client conduct the preconstruction meeting with the contractor for health and safety issues?
CTHS6: Monitoring Contractor Health and Safety Compliance	CTE 6.1 Does the client assign a full-time site health and safety representative to this project?
	CTE 6.2 Does the client specify the responsibilities of the site health and safety representative?
	CTE 6.3 Does the client establish a construction health and safety unit to monitor contractor health and safety?
	CTE 6.4 How frequently does the client conduct health and safety meetings with the contractor's managerial and supervisory personnel?
	CTE 6.5 Does the client maintain statistics of contractor accidents and near-misses?
	CTE 6.6 How frequently does the client communicate with the contractor's employees about health and safety on this project?
	CTE 6.7 How frequently does the client conduct health and safety audits on the contractor's processes?
	CTE 6.8 Does the client initiate or implement a health and safety recognition/reward programme in this project?
	CTE 6.9 How frequently does the client periodically discuss the health and safety audits of the contractor's operations with the contractor?

	CTE 6.10 Does the client follow up on ensuring that contractors remedy the deficiencies identified during the health and safety audit?
	CTE 6.11 Does the client conduct a post-construction review with all project stakeholders that includes health and safety performance?

Adapted from Liu et al., (2017)

5.4 Questionnaire Measurement Scale

There are various measurement scales that exist in literature. These scales differ in the manner in which they attempt to capture the position of an individual (with respect to the characteristic being measured); these are, the differential scale, the summated scale and the cumulative scale (Thakur, 1993). Likert, and Likert-type, responses are popular psychometric item-scoring techniques for endeavouring to quantify opinions on different issues (Bishop and Hebron, 2015). In this study, a five-point Likert scale approach was used to measure respondents' attitudes to a particular question or statement in the survey. Using the questionnaire, respondents were asked to rate the extent to which construction clients are involved in the project site H&S issues using a five-point Likert scale, (Table 5.5).

Table 5.5 First Data Set Rating Scale

Likert Scale	**Never**	**Seldom**	**Sometimes**	**Often**	**Always**
	1	2	3	4	5

The rating scale was chosen because it fits with the type of questions that were being asked and was considered easy for the respondents to understand and use (Achieng' Nyaura and Omwenga, 2016). The scale made it easier for the researcher to construct, collect and analyse data. In collecting the first data set for the current study, a total of 150 construction clients (who were managing projects with a value of more than R40 million) were targeted. The target population included construction clients of building, housing, civil construction, petrochemicals, roads and earthworks, and structural, mechanical, electrical, instrumentation, piping and platework (SMEIPP). Using the structured questionnaire indicated in the previous subsection of this study (Table 5.4) together with the with multiply choices based on the five-point Likert point scale (Table 5.5), as survey instrument shown in Table (5.7) was developed to study various aspects of construction client involvement through the phases of the project).

Table 5.6 Survey Instrument (Questionnaire) – First Data Set

SURVEY OF CRITICAL TO HEALTH AND SAFETY ELEMENTS (CTHS)						
Provide the type of project and rate the extent to which the client is involvement in project H&S issues by ticking (✔) in the appropriate box: Never (1), Seldom (2), Sometimes (3), Often (4), Always (5)						
TYPE OF PROJECT:						
CTHS1: Establishing attitudes towards health and safety						
CTE	QUESTIONS	NEVER (1)	SELDOM (2)	SOMETIMES (3)	OFTEN (4)	ALWAYS (5)
CTE 1.1	Does the client understand that their involvement contributes to health and safety performance?					
CTE 1.2	Does the client set zero harm, injury or incidents as the objectives for the project?					
CTE 1.3	Does the client go beyond a regulatory compliance approach to prevent injuries or incidents?					
CTE 1.4	Does the client through include all requisite information such as outcomes of baseline H&S hazard identification and risk assessment (HIRA) in the form of H&S specifications as part of tender documentation?					
CTE 1.5	Does the client have specific health and safety goals for each project?					
CTHS2: Communicating attitudes towards health and safety						
CTE	QUESTIONS	NEVER (1)	SELDOM (2)	SOMETIMES (3)	OFTEN (4)	ALWAYS (5)
CTE 2.1	Does the client communicate with all project stakeholders clearly about their health and safety position and requirements?					
CTE 2.2	Does the client communicate specific H&S goals and requirements in appointments of all project stakeholders – consultants and contractors?					
CTE 2.3	Does the client communicate their commitment to health and safety to the contractors?					
CTE 2.4	Does the client demonstrate their involvement in health and safety to all project stakeholders?					
CTE 2.5	Does the client prescribe regular monitoring and reporting of performance of project stakeholders?					

CTE 2.6	Does the client impose penalties (punitive measures) and reward excellent health and safety performance?					
CTHS3: Selection of contractor						
CTE	QUESTIONS	NEVER (1)	SELDOM (2)	SOMETIMES (3)	OFTEN (4)	ALWAYS (5)
CTE 3.1	Does the client prequalify contractors?					
CTE 3.2	Does the client consider health and safety in prequalifying contractors for bidding on projects?					
CTE 3.3	Does the client require and approve procedures for the appointment of subcontractors with health and safety in mind?					
CTE 3.4	Does the client provide specific contractual health and safety goals and requirements to prospective contractors?					
CTE 3.5	Does health and safety have a high priority when selecting a contractor?					
CTE 3.6	Does the client include the explicit evaluation of the financial provisions and budget for implementing and monitoring health and safety measures when selecting a contractor?					
CTE 3.7	Does the client have specific procedures and/or requirements when adjudicating tenders to ensure adequate financial provision in tenders?					
CTE 3.8	Does the client have specific procedures and/or requirements when evaluating the adequacy of health and safety plans?					
CTE 3.9	Does the client understand what the health and safety file is and its purpose?					
CTE 3.10	Does the client have specific procedures and/or requirements to ensure that the health and safety file is adequate and handed over as part of completion requirements?					
CTE 3.11	Does the client require notices and copies of minutes of all meetings and forums where project health and safety will be discussed?					
CTE 3.12	Does the client ensure that the contractor has all the required health and safety structures in place before awarding tenders such as health and safety representative/s, health and safety committees, etc.?					
CTHS4: Contractual health and safety arrangement						
CTE	QUESTIONS	NEVER (1)	SELDOM (2)	SOMETIMES (3)	OFTEN (4)	ALWAYS (5)
CTE 4.1	Does the client assign at least one full-time construction health and safety specialist on the project?					

CTE 4.2	Does the client provide the contractor with health and safety guidelines that must be followed?					
CTE 4.3	Does the client require contractors to submit the resumes of key health and safety personnel for the client approval?					
CTE 4.4	Does the client require contractors to provide specific minimum health and safety training for workers?					
CTE 4.5	Does the client require contractors to submit a site-specific health and safety plan?					
CTE 4.6	Does the client require the contractor's employees at all levels to have specific health and safety responsibility integrated into work processes?					
CTE 4.7	Does the client require the contractor to submit a health and safety policy statement signed by its CEO?					
CTE 4.8	Does the client require the contractor to submit an emergency plan?					
CTE 4.9	Does the client require the contractor to submit and utilize an immediate reporting procedure for accidents and near-misses on this project?					
CTE 4.10	Does the client require the contractor to submit a mitigation plan for this project?					
CTE 4.11	Does the client require and approve an appropriate and adequate construction health and safety induction programme?					
CTE 4.12	Does the client require that subcontractors be included in the health and safety programme?					
CTE 4.13	Does the client make it clear that the contractor is ultimately responsible for the health and safety of their employees and other members of the project team and the general public?					
CTE 4.14	Does the client specify the actions that can be taken to contribute to health and safety performance in this project?					
CTE 4.15	Does the client require submission and approval of all requisite health and safety method statement?					
CTE 4.16	Does the client require regular inspections and audits to ensure implementation of the contractor's health and safety plan?					
CTE 4.17	Does the client enforce adherence to the approved health and safety plan?					
CTE 4.18	Does the client impose sanctions for non-approved deviations and failure to adhere to the health and safety plan?					
CTE 4.19	Does the client require approval of revised health and safety plans when changes or variations are made including adjustment of the financial provision for health and safety as required?					
CTHS5: Client involvement in health and health and safety before construction						
CTE	QUESTIONS	NEVER (1)	SELDOM (2)	SOMETIMES (3)	OFTEN (4)	ALWAYS (5)

CTE 5.1	Does the client address health and safety issues in the feasibility study and conceptual design phases?					
CTE 5.2	Does the client require designers to consider construction health and safety during constructability/buildability reviews?					
CTE 5.3	Does the client require designers to conduct a review of the design for construction health and safety for this project?					
CTE 5.4	Does the client conduct a review of the design for health and safety?					
CTE 5.5	Does the client prefer to award the contract to a design-build contractor to promote health and safety performance?					
CTE 5.6	Does the client conduct the preconstruction meeting with contractor for health and safety issues?					
CTHS6: Monitoring contractor health and safety compliance						
CTE	QUESTIONS	NEVER (1)	SELDOM (2)	SOMETIMES (3)	OFTEN (4)	ALWAYS (5)
CTE 6.1	Does the client assign a full-time site health and safety representative to this project?					
CTE 6.2	Does the client specify the responsibilities of the site health and safety representative?					
CTE 6.3	Does the client establish a construction health and safety unit to monitor contractor health and safety?					
CTE 6.4	How frequently does the client conduct health and safety meetings with the contractor’s managerial and supervisory personnel?					
CTE 6.5	Does the client maintain statistics of contractor accidents and near-misses?					
CTE 6.6	How frequently does the client communicate with the contractor’s employees about health and safety on this project?					
CTE 6.7	How frequently does the client conduct health and safety audits on the contractor’s processes?					
CTE 6.8	Does the client initiate or implement a health and safety recognition/reward programme in this project?					
CTE 6.9	How frequently does the client periodically discuss the health and safety audits of the contractor’s operations with the contractor?					
CTE 6.10	Does the client follow up on ensuring that contractors remedy the deficiencies identified during the health and safety audit?					
CTE 6.11	Does the client conduct a post-construction review with all project stakeholders that includes health and safety performance?					
PLEASE PROVIDE ANY ADDITIONAL INFORMATION OR COMMENTS BELOW:						

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5.5 Project Performance Measurement

From a theoretical perspective, the overall project H&S performance improves as construction clients become more involved in construction projects (Musonda, 2012). In the construction industry, H&S performance is measured using leading and lagging indicators. Leading health and safety indicators are used to focus on future safety performance. Lagging health and safety indicators are often used to indicate progress towards compliance with health and safety rules (Middlesworth, 2013; Young and Lunsford, 2017). The five lagging indicators that are used in the construction to evaluate past health and safety performance are:

- First Aid Injury Frequency Rate (FAIFR)
- Medical Treatment Rate (MTIFR)
- Lost Time Injury Frequency Rate (LTIFR)
- Recordable Case Rate (RCR) Or Recordable Injury Frequency Rate (RIFR)
- All Injury Frequency Rate (AIFR)

Ling et al., 2018 argued that insufficient prediction of contractors' safety capacities using only lagging indicators may hinder the continuous improvement of safety performance in the construction industry. In this study, lagging indicators were preferred as the study wanted to test the link between client involvement and project health and safety performance.

5.5.1 First Aid Injury Frequency Rate (FAIFR)

A First Aid Injury (FAI) is any single treatment and any follow up visit for observation of minor scratches, cuts, burns and splinters that do not normally require medical care. First aid is normally treated on the project site without causing lost workdays (Middlesworth, 2013; Young and Lunsford, 2017). A First Aid Injury Frequency Rate (FAIFR) is the proportional representation of first aid injuries that are used as an indicator of health and safety performance. The FAIFR reflects a rough estimate of the percentage of the workforce that suffered a first aid injury. It is calculated as follows:

$$\text{FAIFR} = \frac{\text{Total Number of FAIs x 200 000}}{\text{Number of hours worked}}$$

The figure 200 000 refers to the average number of hours worked by 100 employees in one year.

5.5.2 Medical Treatment Rate (MTIFR)

A Medical Treatment Injury (MTI) is a work injury requiring treatment by a medical practitioner and which is beyond the scope of normal first aid and includes initial treatment given for more serious injuries (Middlesworth, 2013; Young and Lunsford, 2017). The procedure is to be of an invasive nature (e.g. stitches or removal of a foreign body). A Medical Treatment Injury Frequency Rate (MTIFR) is a proportional representation of medical treatment injuries that is used as an indicator of health and safety performance. The MTIFR reflects an estimate of the percentage of the workforce that suffered a first aid injury. It is calculated as follows:

$$\text{MTIFR} = \frac{\text{Total Number of MTIs x 200 000}}{\text{Number of hours worked}}$$

The figure 200 000 refers to the average number of hours worked by 100 employees in one year.

5.5.3 Lost Time Injury Frequency Rate (LTIFR)

Lost Time Injury (LTI) is a work-related injury that results in time lost from work of one day, a full shift or longer (Stanivuk, Bošnjak and Franić, 2018). Lost Time Injury Frequency Rate (LTIFR) is proportional representation of lost time injuries that is used as an indicator of health and safety performance. The LTIFR reflects an estimate of the percentage of the workforce that suffered a lost time injury. It is calculated as follows:

$$LTIFR = \frac{\text{Total Number of LTIs x 200 000}}{\text{Number of hours worked}}$$

The figure 200 000 refers to the average number of hours worked by 100 employees in one year.

5.5.4 Recordable Case Rate (RCR) or Recordable Injury Frequency Rate (RIFR)

Recordable injuries include all fatalities, lost time injuries, illnesses, restricted work cases and medical treatment injuries (Stanivuk et al., 2018). It is sometimes referred to as recordable cases. Recordable Injuries Frequency Rate (RIFR) is a proportional representation of the occurrence of recordable injuries. It is used as an indicator or measure of health and safety performance. The RIFR reflects an estimate of the percentage of the workforce that suffered a recordable injury. It is calculated as follows:

$$RIFR = \frac{\text{Total of Recordable Injuries x 200 000}}{\text{Number of hours worked}}$$

The figure 200 000 refers to the average number of hours worked by 100 employees in one year.

5.5.5 All Injury Frequency Rate (AIFR)

All Injuries Frequency Rate (AIFR) is a proportional representation of all injuries or illnesses that is used as an indicator of health and safety performance. The AIFR reflects a rough estimate of the percentage of the workforce that suffered an injury or illness. It is calculated as follows:

$$AIFR = \frac{\text{Total of AI x 200 000}}{\text{Number of hours worked}}$$

The figure 200 000 refers to the average number of hours worked by 100 employees in one year.

In collecting the second data set for the current study, the same respondents as the ones used in the first data sets but this time the respondent were asked to provide a different data set in the form of H&S performance of the 150 projects. A survey was designed for respondents to assess the performance of 150 projects they had participated in and evaluate their performance by providing data using five lagging indicators, namely:

- First Aid Injury Frequency Rate (FAIFR)
- Medical Treatment Rate (MTIFR)
- Lost Time Injury Frequency Rate (LTIFR)
- Recordable Case Rate (RCR) or Recordable Injury Frequency Rate (RIFR)
- All Injury Frequency Rate (AIFR)

Using the five lagging indicators, the project health and safety performance survey instrument as shown in Table 5.7 was developed. Table 5.7 was used to collect the second data set used in this study to measure progress made by clients in improving project health and safety. To assure the anonymity and confidentially of the respondent, the name of the client, project, project value and location were not captured (Kaur, 2019).

Table 5.7 Project Health and Safety Performance Survey Instrument – Second Data Set

<table>
<tr><th colspan="6">PROJECT HEALTH AND SAFETY PERFORMANCE SURVEY</th></tr>
<tr><td colspan="6">Please evaluate your project H&S performance using the following lagging indicators: First Aid Injury Frequency Rate (FAIFR), Medical Treatment Rate (MTIFR), Lost Time Injury Frequency Rate (LTIFR), Recordable Case Rate (RCR) or Recordable Injury Frequency Rate (RIFR), and All Injury Frequency Rate (AIFR).</td></tr>
<tr><td>Type of Project:</td><td colspan="5"></td></tr>
<tr><td>Project No.</td><td>FAIFR</td><td>MTIFR</td><td>LTIFR</td><td>RCR/RIFR</td><td>AIFR</td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5 - 150</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

PLEASE PROVIDE ANY H&S PERFORMANCE STATISTICAL TRENDS OF YOUR PROJECT
Thank you for your kind cooperation
Name: Joseph D. Khoza Cell: 0765113967 Email: jdkhoza@gmail.com Institution: University of KwaZulu-Natal (UKZN) Student No: 217075663 Course: Ph.D in Construction Management Supervisor: Prof. Theo C Haupt

As the data received from the respondents was in the form of rates, it was necessary that is converted into five-point Likert scale, so that it can be easily analysed. A five-point Likert scale (Table 5.8) was adopted. The choice of this Likert was favoured due to the objective of the survey – to capture the extent to which project H&S performance is acceptable or not. The adopted five-point Likert scale also aligned very well with the objectives of this study as it measures the quality and effectiveness of client involvement in construction project health and safety issues (Brown, 2010).

Table 5.8 Project Health and Safety Performance Likert Scale

Likert Scale	Poor	Fair	Good	Very Good	Excellent
	1	2	3	4	5

Using the lagging indicators and the five-point Likert scale, the second data set for the study dealing with project H&S performance from 150 construction projects was recorded in the instrument described in Table 5.10 below.

Table 5.9 Instrument for Recording Project Health and Safety Performance

PROJECT HEALTH AND SAFETY PERFORMANCE SURVEY					
PERFORMANCE MEASUREMENTS: FAIFR, MTIFR, LTIFR, RCR/RIFR, and AIFR					
RATING SCALE: poor = 1, fair = 2, good = 3, very good = 4, excellent = 5					
Type of Project:					
Project No.	FAIFR	MTIFR	LTIFR	RCR/RIFR	AIFR
1					
2					
2					
3					
4					
5 - 150					

5.6 Operationalising the Survey Instruments

In Chapter 3, the conceptual model was described and the way in which key concepts (that constitute the building blocks of the conceptual model), were explained. The conceptual model defined the concepts under study, a proposed model was developed of how the concepts were related, and possible relationships were explained theoretically (Hair et al., 2007; Sekaran and Bougie, 2010). The proposed relationships between the concepts, assumptions, expectations, beliefs and theories were hypothetically tested and statistically analysed to arrive at the conclusion (Hair et al., 2007 and Sekaran and Bougie, 2010). Liu, et al., (2017) expound that in order for the clients to influence improvement of H&S performance on construction sites, their role has to be established and be deconstructed into specific, quantitative and measurable requirements. To achieve the objectives of the study, two survey instruments were developed in this chapter (Chapter 4), namely, first survey questionnaire instruments dealt with the extent to which the client in is involved in project H&S issues (Table 5.6), and the second survey questionnaire dealt with project H&S performance (Table 5.7).

In the first data set, a survey questionnaire instrument designed from the information gathered from the literature was used. A total of 150 construction clients who were managing projects with a value of more than R40 million were the target for this study. For the project to have been considered it had to have a value of R40 million or more and was not to be managed by the same health and safety agent. Furthermore, mining sector construction projects were excluded from the study. The target population included construction clients of building, housing, civil construction, petrochemicals, roads and earthworks, and structural, mechanical, electrical, instrumentation, piping, and platework (SMEIPP).

The second data set used the same respondents as those used in the first data set but here the respondents were asked to provide different data in the form of health and safety performance of the 150 projects using the five H&S lagging indicators, namely, FAIFR, MTIFR, LTIFR, RIFR/RCR and AIFR. To analyse the collected data, IBM Statistical Package for Social Sciences version 25 was utilized (to test the research questions, expectations and hypotheses). SPSS version 25 was chosen for its versatility and ability to handle many calculations expeditiously (Champoux and Ommanney, 1986); Obwoge et al., 2013). The results of these analyses are discussed in Chapter 6.

5.7 Summary of the Model Development Process Steps

The process followed in developing the model is summarised in Figure 5.1.

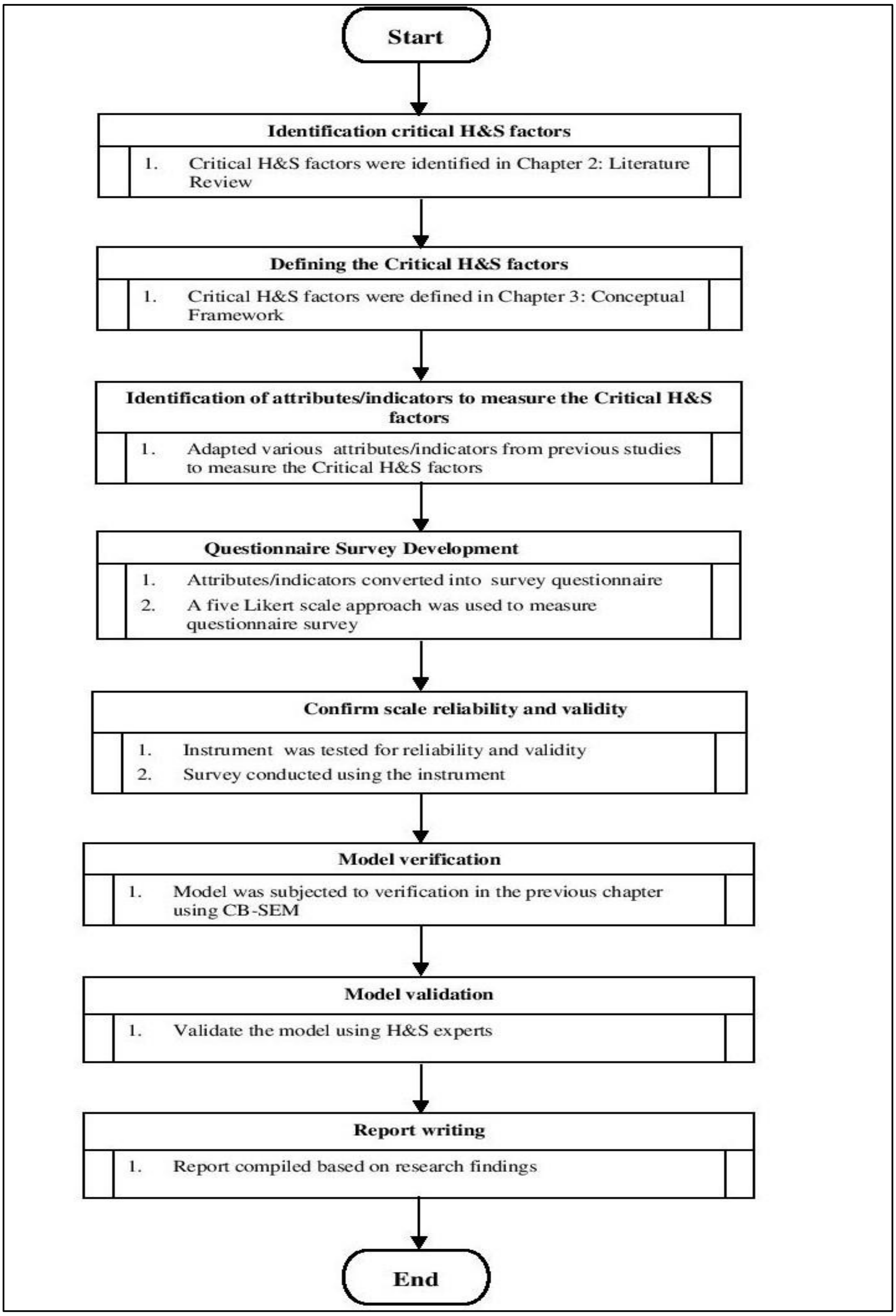

Figure 5.1 Model Development Process Steps

5.8 Chapter Summary

In this chapter the process of developing CTHS factors, CTEs and measurement development were explained. The processes to generate relative specifications or measurements (S/M), and survey instrument design were presented. The choice of Likert scales used in the first and second data set survey instruments was discussed, and the justification of their use was explained. The next chapter discusses the survey results from the first data set that dealt with the extent to which construction clients are involved in the project health and safety issues, and second data set that dealt with the project health and safety performance.

CHAPTER 6 : RESEARCH RESULTS ANALYSIS

6.1 Introduction

This chapter presents the research findings. An essential part of the chapter is demonstrated by the use of the IBM Statistical Package for Social Sciences version 25 and Structural Equation Modelling (SEM) software for analysis of the collected data. The chapter further presents research findings and analysis of the extent to which hypothesised multiple factors driven by a client act concurrently and by their combined influence lead to improvement in the health and safety performance of construction projects.

6.2 Survey Questionnaire Results Analysis

The first objective of this study was to identify the critical health and safety factors to improve project health and safety performance that construction clients could apply, from a South African perspective. An in-depth review of the relevant literature (as described in Chapter 2), was undertaken to identify those critical health and safety factors by construction client project health and safety performance that can be applied.

Twelve factors were identified that provided the basis for designing the questionnaire. To refine the factors, those that were found to be common to all studies were grouped together and described as one factor. The grouping of some of these health and safety factors resulted in the reduction of key factors from twelve to seven, namely:

- client attitude towards health and safety
- client ability to communicate clearly their health and safety requirements
- selection of contractors based on health and safety performance
- contractual health and safety arrangement
- client involvement before and during construction
- monitoring of contractor health and safety performance
- overall project performance

A study by Liu et al., (2017) revealed that about ninety per cent of experts agreed with the significant effects of these factors on construction site health and safety performance.

As there was consensus among industry experts that these factors have significant effects on H&S performance on construction sites (and combined with a robust literature backing that identified these factors as critical to improving project health and safety performance), they were included as the seven constructs in the final version of the questionnaire (discussed in Chapter 4). In this study, these requirements are called Critical to Health and Safety (CTHS) while their attributes/indicators are called Critical to Expectation (CTE) while forming a framework for the CHSRM. After a thorough review of the perceived impact of these important factors and basic correlation analysis, sixty-three attributes were developed as measurements to rate the CTE performance. A total fifty-eight attributes/indicators were designed to rate constructs CTHS1–CTHS6 while five attributes (H&S lagging indicators) were developed to rate the project performance constructs (CTHS7).

The questions outlined were simplified so that the respondents could easily understand the relationship of CTHS1–CTHS6 to the extent in which construction clients are involved in project health and safety and rate their relative influence without difficulty. Two five-Likert scales were adopted for study, namely:

The first five-point Likert scale for rating constructs (CTHS1–CTHS6) was adopted for guiding the respondents to rate the extent to which construction clients are involved in project health and safety.

- never = 1, seldom = 2, sometimes = 3, often = 4, and always = 5

The second first five-point Likert scale was used to rate project performance construct (CTHS7).

- 1 = poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent

The next sections present the findings, analysis and model validation.

6.3 Response Rate

Response rate is defined as the percentage of people who responded to a survey. Fincham (2008) explains that survey response rates help to ensure that the survey results are representative of the target population. Response rates are calculated by dividing the number of *usable* responses returned by the total number of eligible respondents in the sample chosen (Fincham, 2008). However, Mitchell (1989) suggested that the survey response rate should be calculated as the number of *returned* questionnaires divided by the total sample of those which were sent out. A review of literature suggest that acceptable response rates vary by how the survey is administered:

- mail: 50% adequate, 60% good, 70% very good
- phone: 80% good
- email: 40% average, 50% good, 60% very good
- online: 30% average
- classroom paper: > 50% = good
- face-to-face: 80–85% good

For the purpose of this study, the target population included construction clients of building, housing, civil construction, petrochemicals, roads and earthworks, and structural, mechanical, electrical, instrumentation, piping and platework (SMEIPP). A survey instrument adapted from the Owner's Role Rating Model (ORRM), developed by Liu et al., (2017), was used to measure the extent to which construction clients are involved in their own construction projects. Construction projects (150) with a value of more than R40 million were included in this study.

The survey was administered through a combination of emails and follow-up calls. The data was gathered directly from clients, professionals representing client health and safety agents, construction managers, construction health and safety managers and construction health and safety officers. By the cut-off date of the survey, 135 usable responses were received. This represented an approximate ninety per cent usable response rate, with most responses (thirty-four per cent) from building (commercial) projects being the highest. The various response rates are in shown in Table 6.1.

Table 6.1 Project Demographic and Percentage of Response

Research Population	Administered Questionnaire	Questionnaire Response/ Return Rate	Percentage of Response
Building (commercial)	49	46	34%
Civils	38	33	24%
Housing (residential)	25	22	16%
Roads and earthworks	10	9	7%
Structural steel, mechanical, electrical, instrumentation and piping (SMEIP)	19	16	12%
Oil and Gas (petrochemical)	9	9	7%
Total	150	135	90%

6.4 Data Preparation

The collected data was subjected to screening thus ensure it was clean and ready to be used before statistical analysis could be conducted. This was important because it provided the assurance that the data was useable, reliable and valid for the testing of causal theory. During the data cleaning process, three specific issues were addressed, namely, outliers, missing values and normality.

6.4.1 Missing Data

Stephan (2015) explains that missing values are usually present when participants either purposely or accidentally do not answer some questions, and it is possible that missing values may also occur through data entry errors. According to Hair et al., (2007), if the proportion of missing data is greater than ten per cent of data points, it is recommended to omit the participant from the analysis; if it is less than ten per cent, the missing data points may be estimated by substituting with the mean scores for each of the data points. A total of 20 data points was missing as shown in Table 6.2. There was a total of 8, 505 data points (135 respondents multiply by 63 questions in the questionnaire). Therefore, there was only 0.24% of missing data points (20 divides by 8, 505 multiply by 100). Table 6.2 shows the constructs with missing data. For the current study the missing data points were estimated by substituting with the mean scores for each of the data points during the computing of confirmatory factor analysis (CFA) and path models in structural equation modelling (SEM) in tandem with the recommendation by Hair et al., (2007).

Table 6.2 An Overview of Missing Values for the Current Study

Statistics								
		CTHS1	CTHS2	CTHS3	CTHS4	CTHS5	CTHS6	CTHS7
N	Valid	135	132	133	126	132	132	135
	Missing	0	3	2	9	3	3	0
Minimum		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maximum		5.00	5.00	5.00	5.00	5.00	4.73	4.20

6.4.2 Outliers, Extreme Values and Disengaged Responses

Outliers can influence the research results by pulling the mean away from the median. In this study, outliers were categorised as those values that were at least three standard deviations from the mean. Stephan (2015) notes that outliers are observations that differ greatly from most of a set of data and can affect the normality of the collected data. According to Hair et al., (2007), when it cannot be determined that an outlier constitutes a valid distinctly different response, it should be removed.

In this study outliers that were verified and found not to be disengaged responses, were retained. Extreme values were classified as those values that were at least five standard deviations from the mean. Boxplots (Figure 6.1 to Figure 6.7) were used to indicate outliers and extreme values. There were four outliers (Figure 6.3 and Figure 6.4) and zero extreme values. The completed questionnaires were visually scrutinised for disengaged responses and looked out for any visible predictable patterns of response. Based on this criterion, no questionnaires were flagged as being disengaged responses.

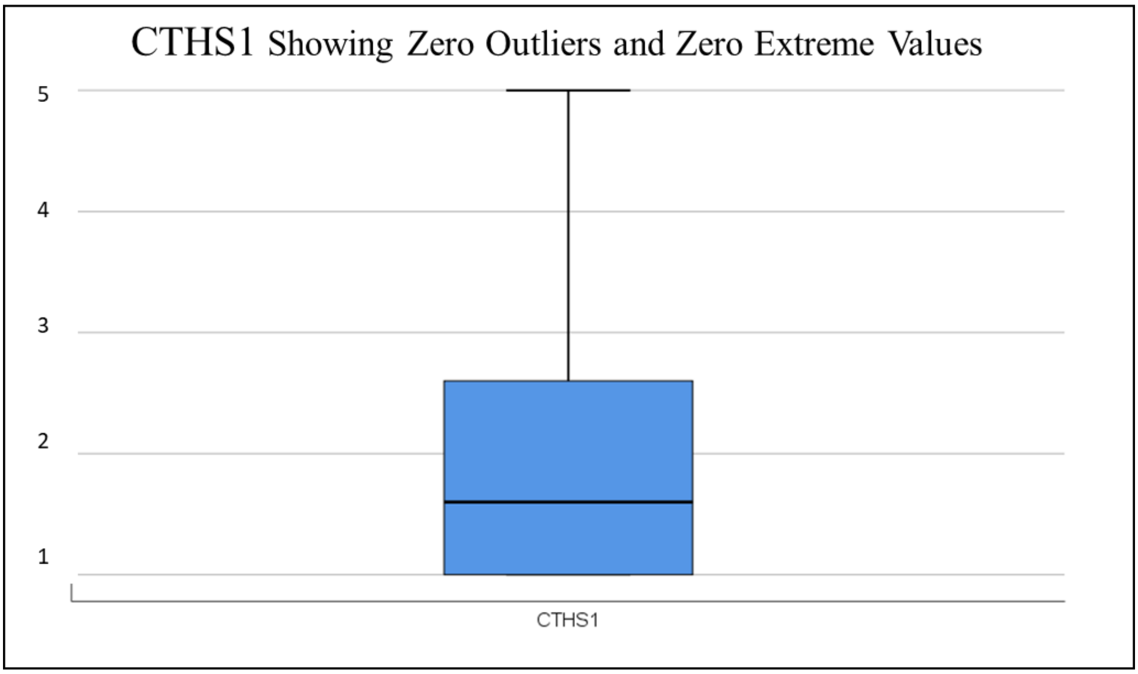

Figure 6.1 CTHS1 Showing Zero Outliers and Zero Extreme Values

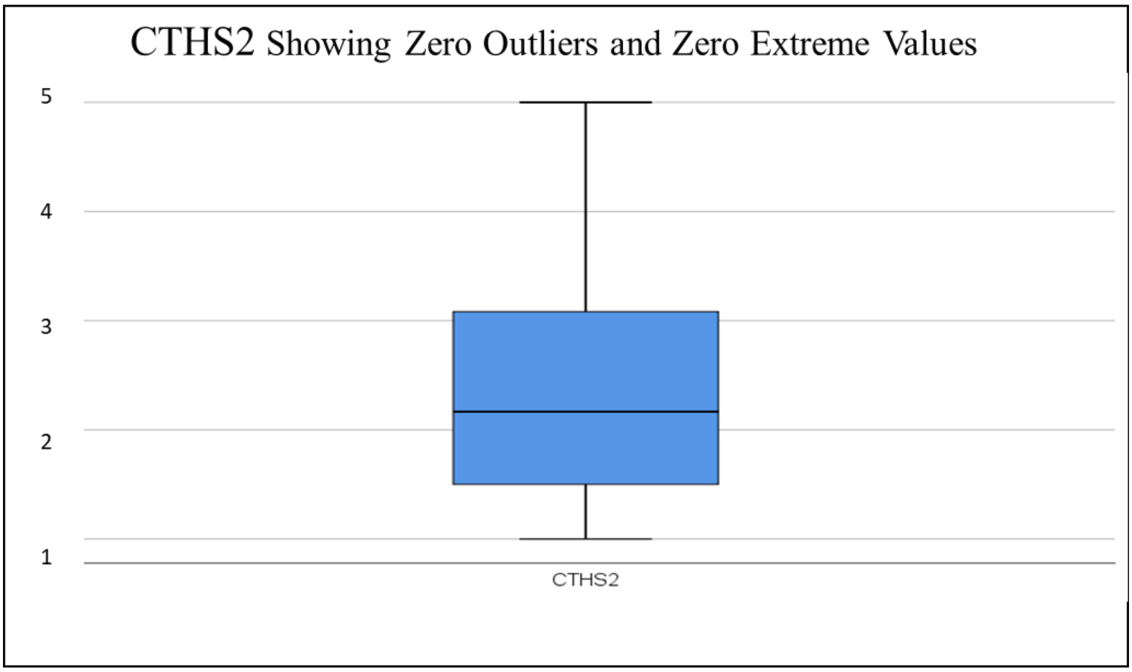

Figure 6.2 CTHS2 Showing Zero Outliers and Zero Extreme Values

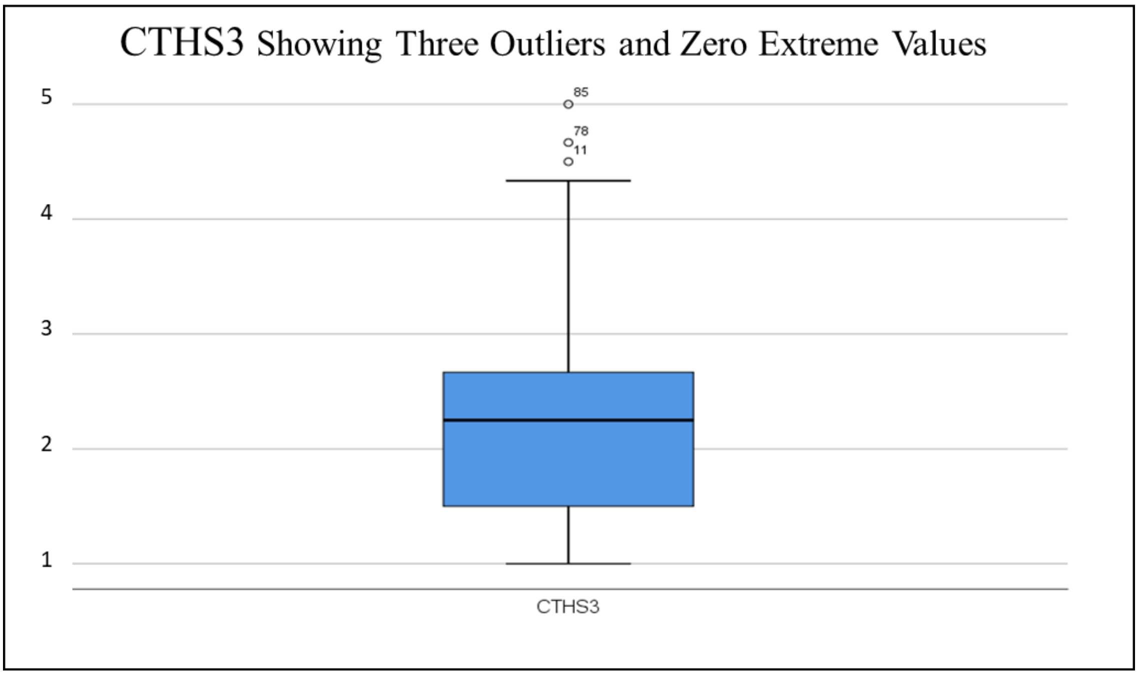

Figure 6.3 CTHS3 Showing Three Outliers and Zero Extreme Values

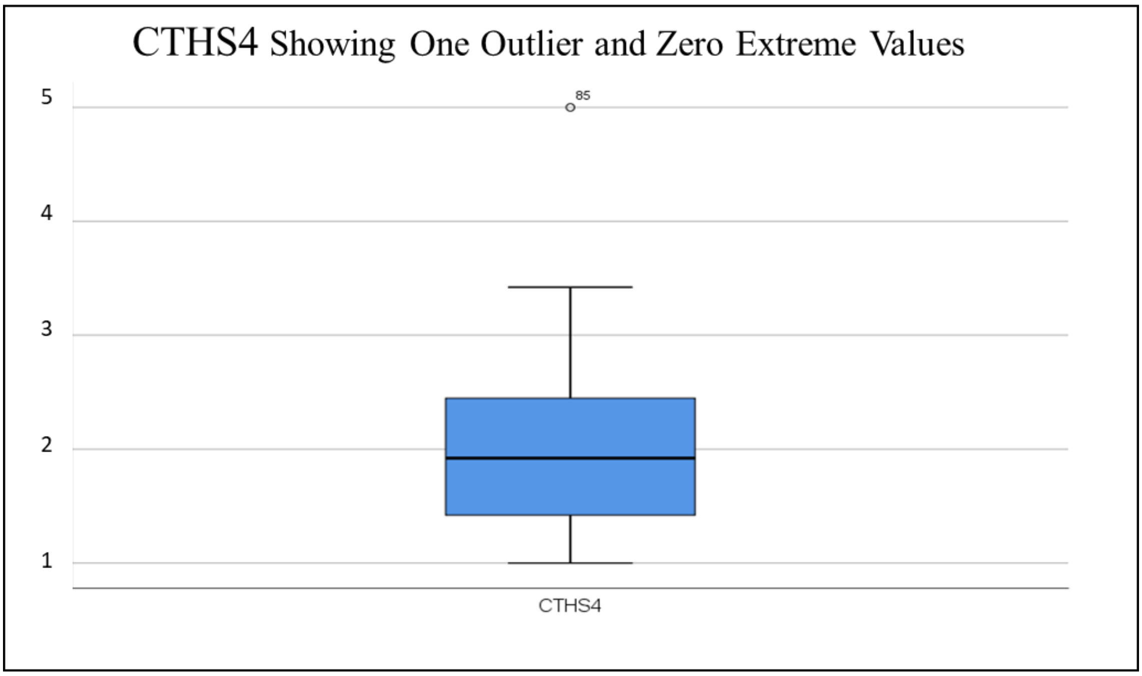

Figure 6.4 CTHS4 Showing One Outlier and Zero Extreme Values

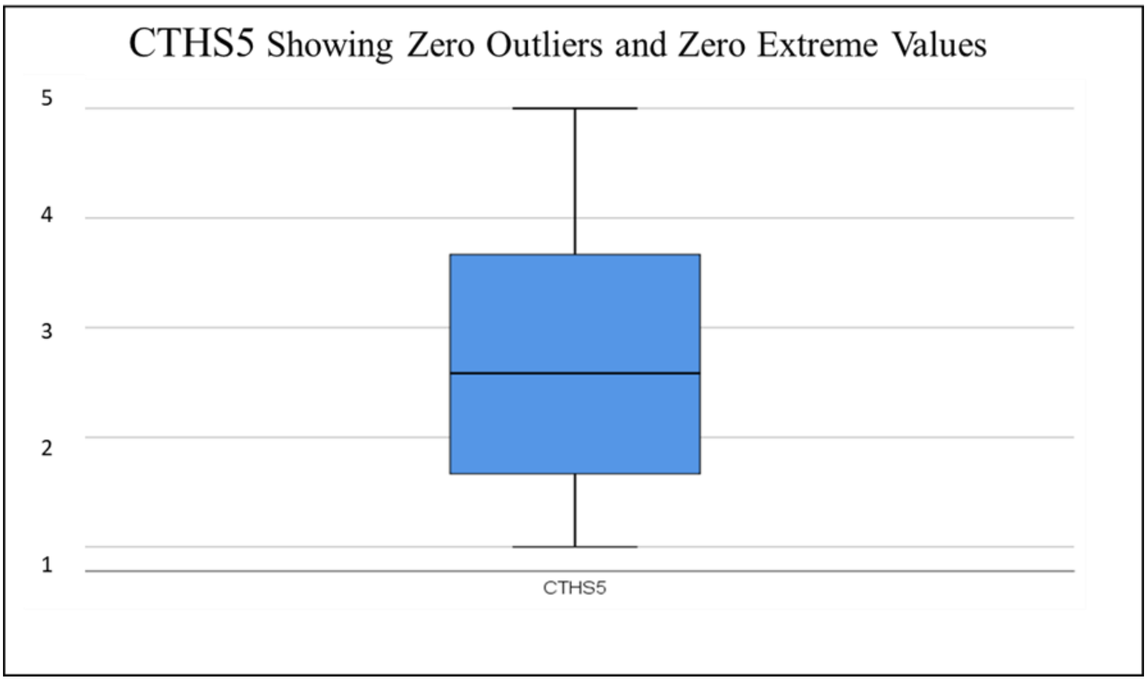

Figure 6.5 CTHS5 Showing Zero Outliers and Zero Extreme Values

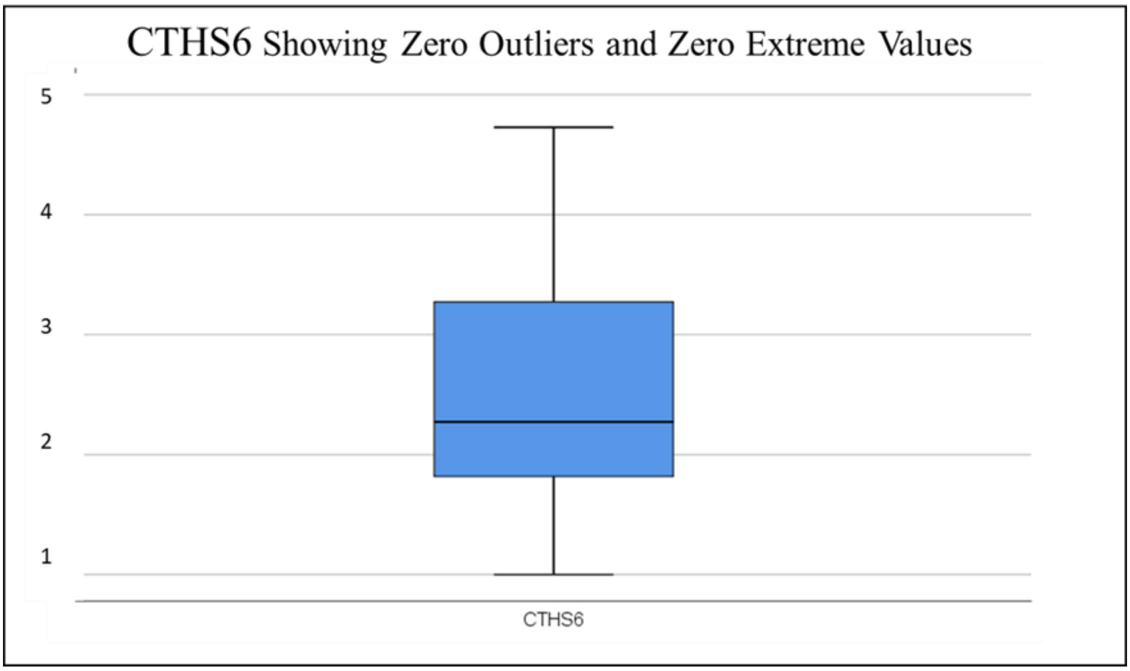

Figure 6.6 CTHS6 Showing Zero Outliers and Zero Extreme Values

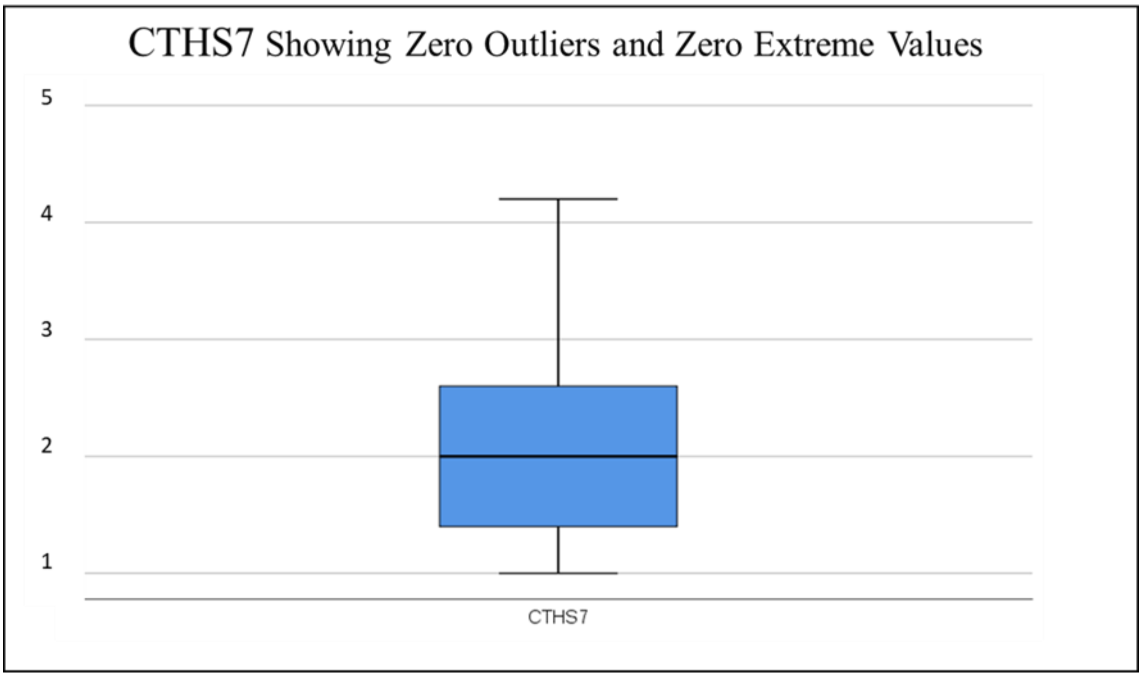

Figure 6.7 CTHS7 Showing Zero Outliers and Zero Extreme Values

6.4.3 Normality

Stephan (2015) describes normal distribution as a symmetric bell-shaped curve defined by two things – the mean (average) and variance (variability). Stephan (2015) states that if the data is not normal, the use of non-parametric tests that do not require normality can be applied. There are many ways to test normality of data, including the Shapiro Wilk W/Kolmogorov-Smirnov test, skewness and kurtosis. The following section present the results of normality tests conducted for the current study.

Table 6.3 below shows the descriptive statistics (including the measures of central tendency and measures of dispersion) for all the variables (constructs and performance measures). The distribution of mean scores of the constructs shows the means for all of the constructs are between 1.93 and 2.73 with the least mean being for CTHS1 (1.99) and the highest mean being for CTHS5 (2.73). The scores for all the constructs range from a minimum of one to a maximum of five (thus from never to always), for all of the six constructs.

Similarly, for performance the scores range from poor (one) to excellent (five). The standard deviation for the scores of all the variables ranges from 0.67 for CTHS4 to 1.25 for CTHS5, that implies that there is very little variability in the mean scores for CTHS4, while high variability is expected for the mean scores of CTHS5.

Table 6.3 Descriptive Statistics of the Constructs and Performance Variables

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness
CTHS1	135	1.00	5.00	1.9896	1.02603	1.070
CTHS2	132	1.00	5.00	2.3346	1.05580	.657
CTHS3	133	1.00	5.00	2.1992	.88077	.641
CTHS4	126	1.00	5.00	1.9365	.67343	.849
CTHS5	132	1.00	5.00	2.7298	1.24663	.305
CTHS6	132	1.00	4.73	2.5406	.97779	.652
CTHS7	135	1.00	4.20	2.0741	.82634	.739
CTHS7b	135	1.00	5.00	2.2025	1.14032	.708

From Table 6.3, the skewness values for all the variables are positive, indicating that the distribution is skewed to the right (that is, skewed towards larger values). The following graphs/histograms (Figures 6.1–6.14) show the distribution of each of the constructs and performance measures. The distribution displayed by the histogram for each variable (constructs and performance variables) is in agreement with the descriptive statistics shown in the Table 6.3.

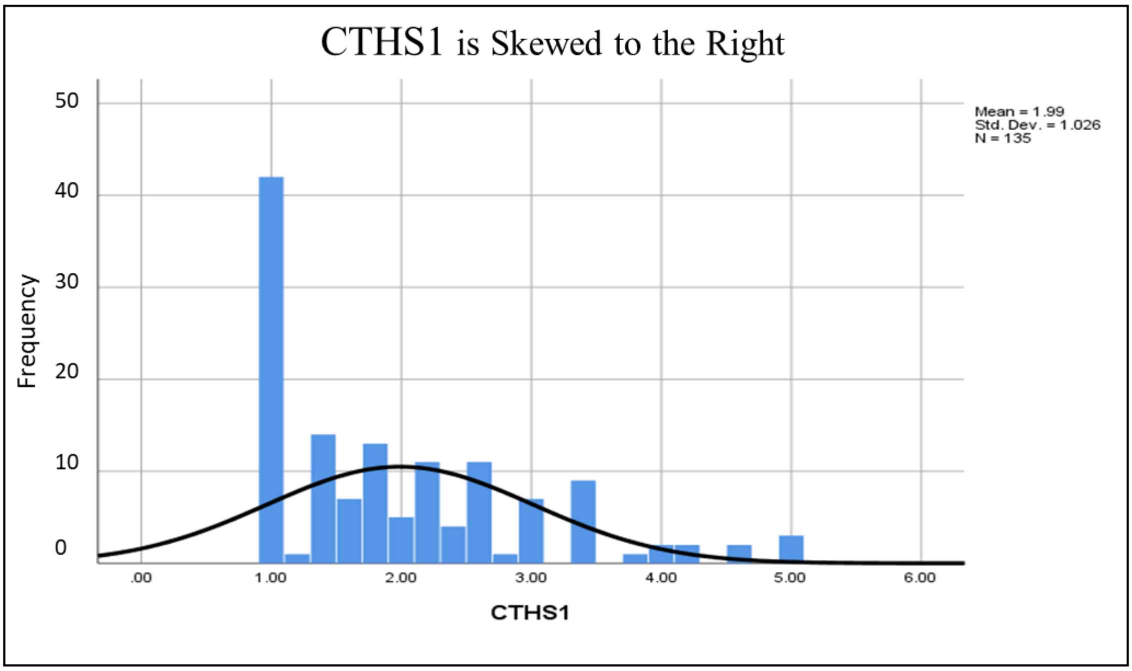

Figure 6.8 CTHS1 is Skewed to the Right

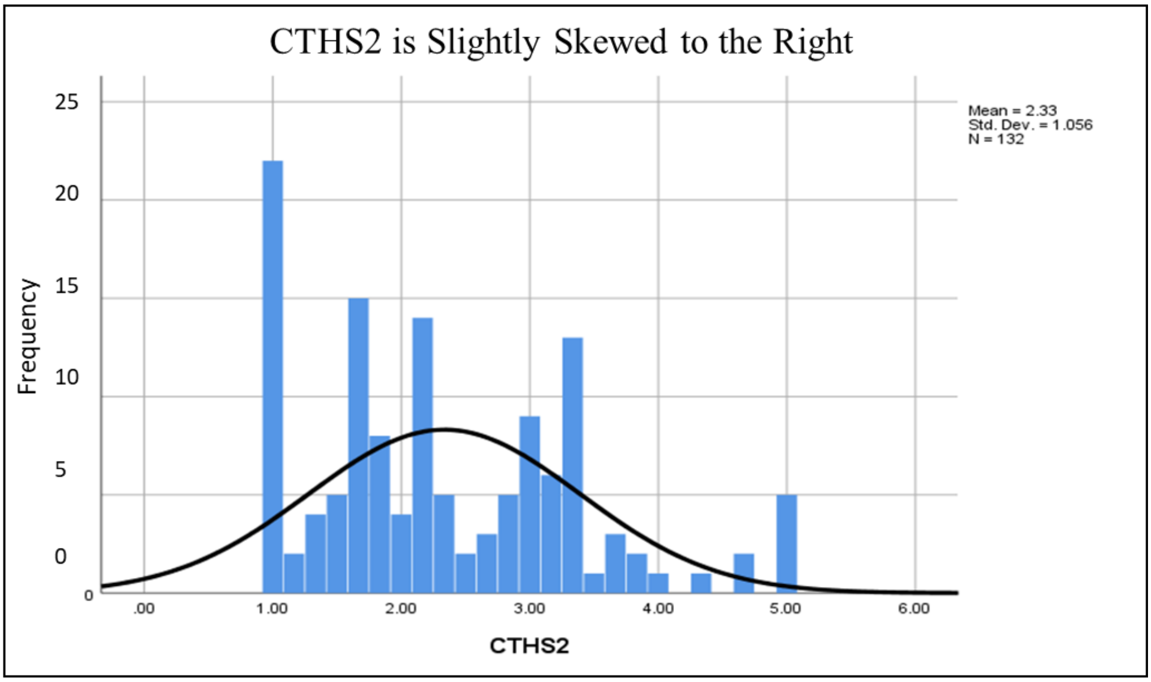

Figure 6.9 CTHS2 is Slightly Skewed to the Right

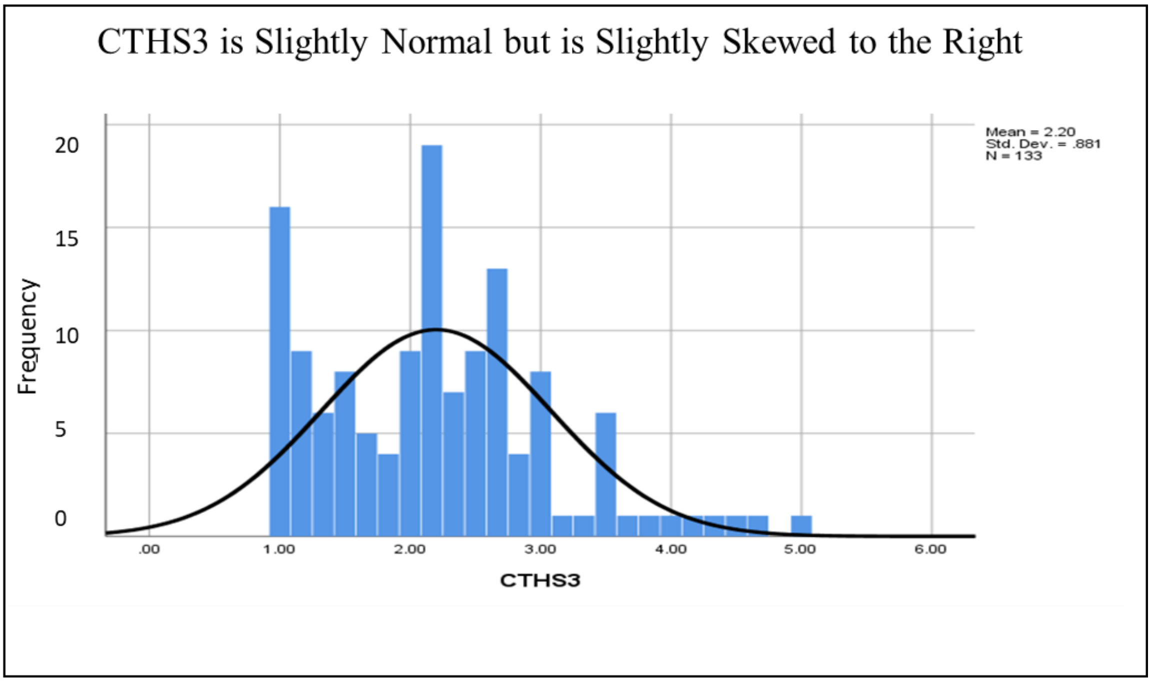

Figure 6.10 CTHS3 is Slightly Normal but is Slightly Skewed to the Right

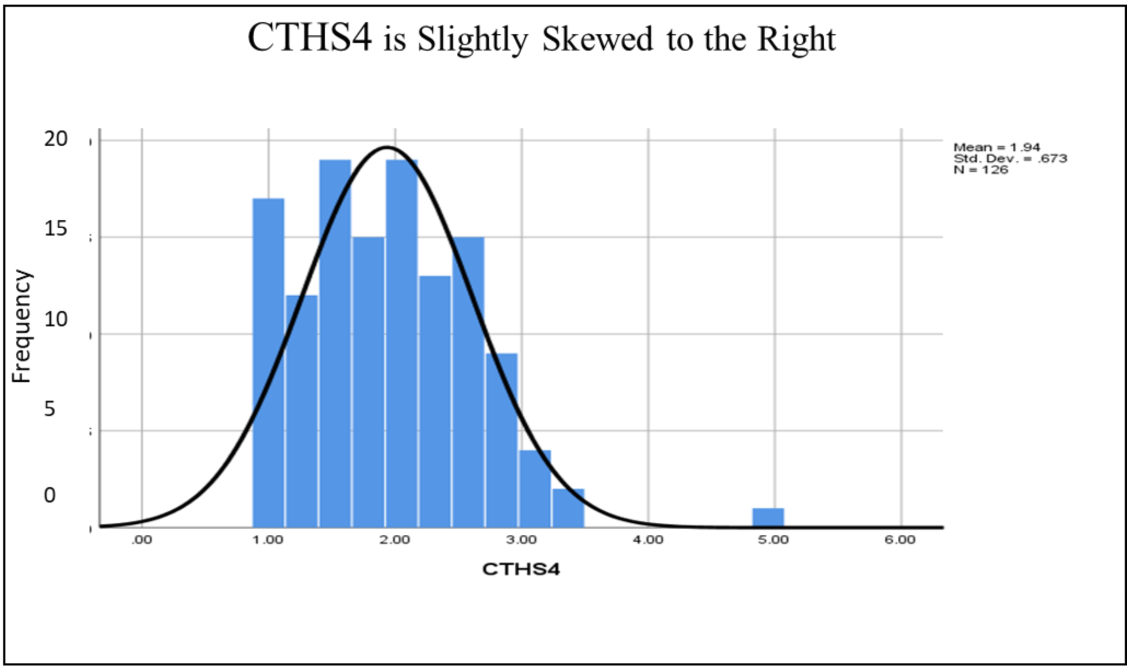

Figure 6.11 CTHS4 is Slightly Skewed to the Right

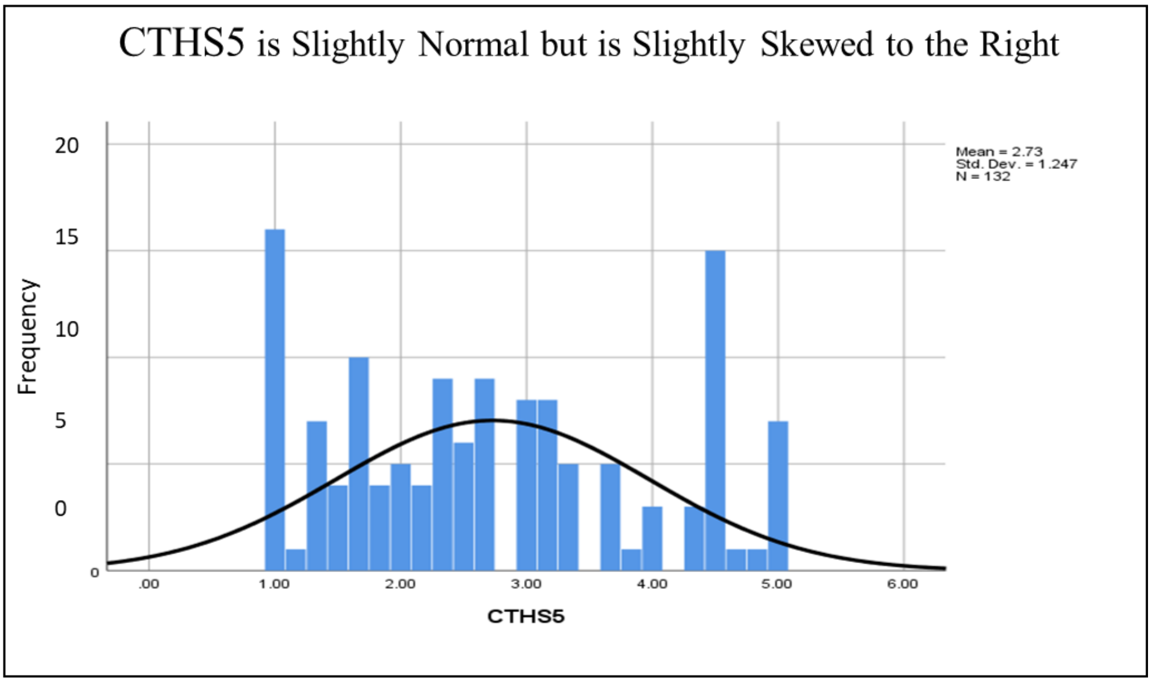

Figure 6.12 CTHS5 is Slightly Normal but is Slightly Skewed to the Right

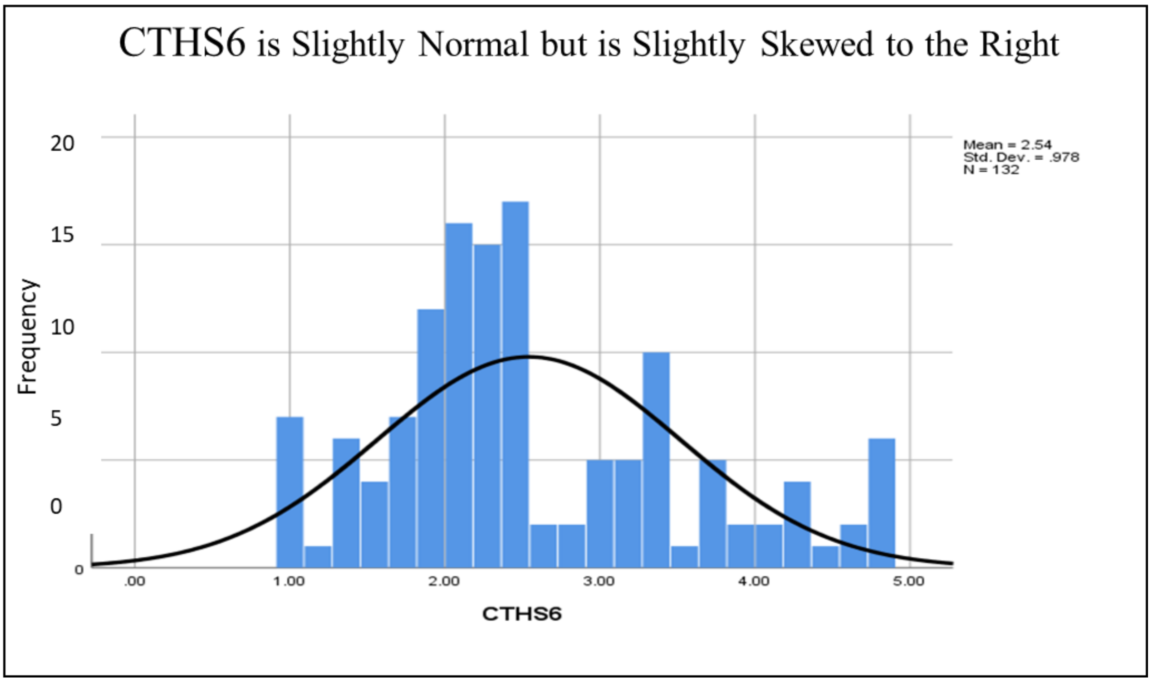

Figure 6.13 CTHS6 is Slightly Normal but is Slightly Skewed to the Right

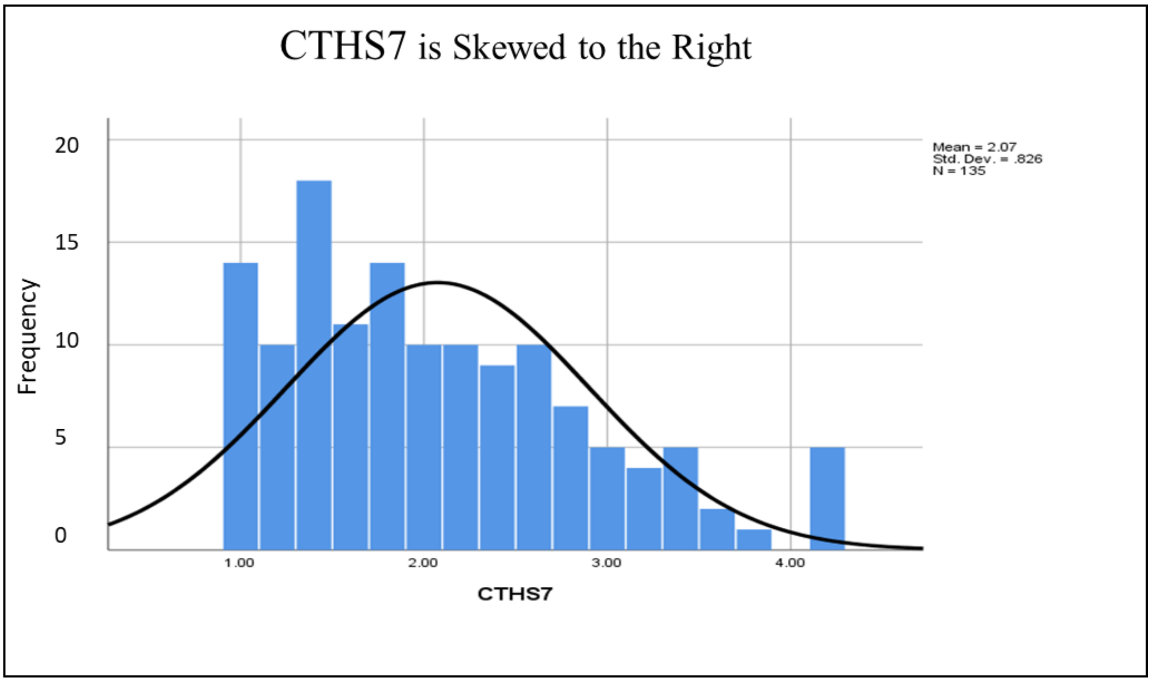

Figure 6.14 CTHS7 is Skewed to the Right

Assessing Table 6.4, it is evident that the skewness values for all of the variables are positive, suggesting that the data is skewed to the right compared to a normal distribution. The kurtosis of this data set is CTHS2, CTHS5, CTHS6 and CTHS7 (CTHS2 = -0.125, CTHS5 = -1.074, CTHS6 = -0.295 and CTHS7= -0.071) are negative. Since these values are less than zero, it is considered to be a 'light-tailed' data set. There is as much data in each tail as there is in the peak; since these kurtosis values are less than zero, the distribution is light tails and is called a platykurtic distribution. The kurtosis for CTHS1, CTHS3 and CTHS4 (CTHS1 = 0.579, CTHS3 =0.352 and CTHS4 = 2.106) are positive. Since these kurtosis values are greater than zero, the distribution has heavier tails and is called a leptokurtic distribution.

Table 6.4 SPSS Output for all Constructs Showing Skewness and Kurtosis

Statistics								
		CTHS1	CTHS2	CTHS3	CTHS4	CTHS5	CTHS6	CTHS7
N	Valid	135	132	133	126	132	132	135
	Missing	0	3	2	9	3	3	0
Mean		1.9896	2.3346	2.1992	1.9365	2.7298	2.5406	2.0741
Std. Deviation		1.02603	1.0558	0.88077	0.67343	1.24663	0.97779	0.82634
Skewness		1.07	0.657	0.641	0.849	0.305	0.652	0.739
Std. Error of Skewness		0.209	0.211	0.21	0.216	0.211	0.211	0.209
Kurtosis		0.579	-0.125	0.352	2.106	-1.074	-0.295	-0.071
Std. Error of Kurtosis		0.414	0.419	0.417	0.428	0.419	0.419	0.414
Minimum		1	1	1	1	1	1	1
Maximum		5	5	5	5	5	4.73	4.2

Table 6.5 shows SPSS output of the Kolmogorov-Smirnov and the Shapiro-Wilk tests. For both tests the p-value is less than 0.05 (rejecting the null hypothesis), that means rejecting the assumption of normality for the distribution. The alternate hypothesis is therefore that the data came from a population that is not normally distributed.

Table 6.5 Results of Testing of Normality with Kolmogorov-Smirnov and Shapiro-Wilk

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CTHS1	.182	116	.000	.842	116	.000
CTHS2	.119	116	.000	.922	116	.000
CTHS3	.092	116	.018	.943	116	.000
CTHS4	.081	116	.056	.935	116	.000
CTHS5	.099	116	.007	.935	116	.000
CTHS6	.154	116	.000	.933	116	.000
CTHS7	.128	116	.000	.933	116	.000
a. Lilliefors Significance Correction						

6.5 Descriptive Statistics

6.5.1 Descriptive Statistics of the Overall Constructs – Frequency Tables

6.5.1.1 CTHS1: Establishing Attitudes towards Health and Safety

The results from Table 6.6 show that the construct of establishing attitudes (for ‘often’, and ‘always’) towards health and safety is common in the construction industry with a combined percentage of almost seventy-two. Establishing attitudes (never) towards health and safety occurs in only 3.7% of projects in the survey.

Table 6.6 CTHS1 Survey Results

CTHS1: Establishing Attitudes towards Health and Safety					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Never	5	3.7	3.7	3.7
	Seldom	5	3.7	3.7	7.4

	Sometimes	28	20.7	20.7	28.1
	Often	40	29.6	29.6	57.8
	Always	57	42.2	42.2	100
	Total	135	100	100	

6.5.1.2 CTHS2: Communicating Attitudes towards Health and Safety

The results from Table 6.7 show that the construct of communicating attitudes towards health and safety is common in the construction industry with a combined percentage of about sixty per cent (for 'often' and 'always'). The communicating of attitudes towards health and safety (never) occurs in only 5.3% of the projects in the survey.

Table 6.7 CTHS2 Survey Results

CTHS2: Communicating Attitudes towards Health and Safety					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Never	7	5.2	5.3	5.3
	Seldom	8	5.9	6.1	11.4
	Sometimes	38	28.1	28.8	40.2
	Often	51	37.8	38.6	78.8
	Always	28	20.7	21.2	100
	Total	132	97.8	100	
Missing	System	3	2.2		
	Total	135	100		

6.5.1.3 CTHS3: Selection of Contractors

The results from Table 6.8 show that the construct of selection of contractor is common in the construction industry with a combined percentage of just over sixty-two (for 'often' and 'always'). The selection of contractor (never) occurs in only 2.3% of the projects in the survey.

Table 6.8 CTHS3 Survey Results

CTHS3: Selection of Contractors					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Never	3	2.2	2.3	2.3
	Seldom	11	8.1	8.3	10.5
	Sometimes	36	26.7	27.1	37.6
	Often	52	38.5	39.1	76.7
	Always	31	23	23.3	100
	Total	133	98.5	100	
Missing	System	2	1.5		
	Total	135	100		

6.5.1.4 CTHS4: Contractual Health and Safety Arrangement

The results from Table 6.9 show that the construct of contractual health and safety arrangement is very common in the construction industry with a combined percentage of about eighty-two (for 'often' and 'always'). Contractual health and safety (never) occurs in less than one per cent of the projects in the survey, further indicating that this construct is very common in the construction industry projects.

Table 6.9 CTHS4 Survey Results

CTHS4: Contractual Health and Safety Arrangement					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Never	1	0.7	0.8	0.8
	Sometimes	22	16.3	17.5	18.3

	Often	63	46.7	50	68.3
	Always	40	29.6	31.7	100
	Total	126	93.3	100	
Missing	System	9	6.7		
	Total	135	100		

6.5.1.5 CTHS5: Client Involvement in Health and Safety before Construction

The results from Table 6.10 show that the construct of client involvement in health and safety before construction is not common in the construction industry with a combined percentage of just less than forty-six per cent (for 'often' and 'always'). Client involvement in health and safety before construction (never) occurs in 18.2% of the projects in the survey. This is cause for concern that the client is rarely involved in the health and safety before construction in the industry.

Table 6.10 CTHS5 Survey Results

CTHS5: Client Involvement in Health and Safety before Construction					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Never	24	17.8	18.2	18.2
	Seldom	12	8.9	9.1	27.3
	Sometimes	36	26.7	27.3	54.5
	Often	36	26.7	27.3	81.8
	Always	24	17.8	18.2	100
	Total	132	97.8	100	
Missing	System	3	2.2		
	Total	135	100		

6.5.1.6 CTHS6: Monitoring Contractor Health and Safety Compliance

The results from Table 6.11 show that the construct of monitoring contractor health and safety compliance is common in the construction industry with a combined percentage of about fifty-nine per cent (for ‘often’ and ‘always’). Monitoring contractor health and safety compliance (never) occurs in only about 6.1% of the projects in the survey.

Table 6.11 CTHS6 Survey Results

CTHS6: Monitoring Contractor Health and Safety Compliance					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Never	8	5.9	6.1	6.1
	Seldom	15	11.1	11.4	17.4
	Sometimes	31	23	23.5	40.9
	Often	61	45.2	46.2	87.1
	Always	17	12.6	12.9	100
	Total	132	97.8	100	
Missing	System	3	2.2		
	Total	135	100		

6.5.1.7 CTHS7_RCR: Recordable Case Rate

The results from Table 6.12 show that the recordable case rate for health and safety performance of construction projects is very poor with sixty per cent of the projects rated as poor in the construction industry and with a combined percentage of about seventy-four (for poor and fair). This implies that the recordable case rate is poor with only three per cent of the projects rated as excellent and a combined twenty-three (for good and very good) in the survey.

Table 6.12 CTHS7_RCR: Recordable Case Rate

CTHS7: Recordable Case Rate					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Poor	81	60	60	60
	Fair	19	14.1	14.1	74.1
	Good	22	16.3	16.3	90.4
	Very Good	9	6.7	6.7	97
	Excellent	4	3	3	100
	Total	135	100	100	

6.6 Exploratory Factor Analysis (EFA)

Factor analysis is used to find factors amongst observed variables (Chetty and Datt, 2015). Latihan, Sondoh and Tanakinjal, (2017) expound that there are two main approaches to factor analysis that are described, namely, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Watson (2017) describes EFA as a data reduction technique used to condense information into smaller sets of summary variables, by identifying underlying factors that potentially account for patterns of collinearity among said variables. Confirmatory factor analysis is more complex and sophisticated set of techniques used later in the research process to test (confirm) specific hypotheses or theories regarding the structure, underlying a set of variables (Latihan et al., 2017)

During the EFA process, the internal structure of the model is determined by providing evidence of validity. Watson (2017) describes the five basic steps of EFA to include:

- evaluating the factorability of the inter correlation matrix
- determining how many factors to extract
- determining how many factors to retain
- determining the appropriate factor rotation method
- interpreting factor structure and naming factors

Latihan, Sondoh and Tanakinjal (2017) stated that the following assumptions must be met to ensure the appropriateness of factor analysis:

- Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy values must exceed 0.50. (0.70 Neuman, 2003). (0.60, Tabachnick & Fidell, 2008)
- the result of the Bartlett's test of sphericity should be at least significant at 0.05
- anti-image correlation matrix of items should be at least above 0.50
- communalities of the variables must be greater than 0.5
- factor loadings of 0.30 or above for each item are considered practical and statistically significant for sample sizes of 350 or greater
- factors with eigenvalues greater than one are considered significant.
- percentage of variance explained usually sixty per cent or higher
- no cross loaded

To distinguish the factors from those obtained from the EFA analysis using SPSS with those obtained from the Confirmatory Factor Analysis (CFA) in SPSS AMOS, the constructs were renamed as follows:

- CTHS1 = (F1) = client attitudes towards health and safety
- CTHS2 = (F2) = client ability to communicate their H&S requirements with all project stakeholders
- CTHS3 = (F3) = selection of contractor; CTHS4 = (F4) = contractual health and safety arrangement
- CTHS5 = (F5) = client involvement in project H&S before construction
- CTHS6 = (F6) = monitoring contractor health and safety

6.6.1 Missing Values

Kwik and Kim (2017) stated that the presence of missing values reduces the data available for analysis, compromising the statistical power of the study and eventually the reliability of results. Hair et al., (2007) mentions that if the proportion of missing data is greater than ten per cent of missing data points, it is recommended to omit the participant from the analysis; if it is less than yen per cent, the missing data points may be estimated by substituting with the mean scores for each of the data points. The missing data points for the current study were found to be only 0.24% and it was at random. The missing data was replaced with series means, and the data was rescreened and cleaned before proceeding with EFA and CFA. The screening process involved checking for errors, finding and correcting errors in the data file (Latihan et. al, 2017). Table 6.13 indicates that replacing missing data with series resulted in the data set having no missing data points.

Table 6.13 Constructs Processing Summary

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Per Cent	N	Per Cent	N	Per Cent
F1_1	135	100.0%	0	0.0%	135	100.0%
F2_2	135	100.0%	0	0.0%	135	100.0%
F3_3	135	100.0%	0	0.0%	135	100.0%
F4_4	135	100.0%	0	0.0%	135	100.0%
F5_5	135	100.0%	0	0.0%	135	100.0%
F6_6	135	100.0%	0	0.0%	135	100.0%
F7_7	135	100.0%	0	0.0%	135	100.0%

6.6.2 Outliers, Extreme Values and Disengaged Responses

In the opinion of Stephan (2015), outliers are observations that differ greatly from the majority of a set of data and can affect the normality of the collected data. Hair et al., (2007) states that when it cannot be determined that an outlier constitutes a valid distinctly different response, it should be removed. Aguinis and Gottfredson (2013) concluded that how outliers are dealt with can lead to false acceptance or rejection of hypotheses. Auginis et al., (2013) note that despite the importance of outliers, researchers do not have clear guidelines on how to deal with them accurately. Hitt et al., (1998) added that although in many cases outliers are seen as data problems that must be fixed, outliers can be of substantive interest and studied as unique phenomena that may lead to novel theoretical insights.

Auginis et al., (2013) suggested that there is a need for a better understanding and clear guidelines regarding how to define outliers, how to identify them and how to manage them. In this study, the researcher used boxplots and Stem-and-Leaf plot techniques in SPSS to identify outliers. Auginis et al., (2013) noted that a boxplot depicts a summary of the smallest value of a construct (excluding outliers), lower quartile (Q1), median (Q2), upper quartile (Q3) and largest value (excluding outliers). Stem-and-Leaf pairs that are substantially far away from the rest of the pairs signal the presence of outliers.

Auginis et al., (2013) added that outliers can be identified as those points that lie beyond the plot whiskers, namely, the smallest and largest values, excluding outliers. Parke (2012) stated that SPSS identifies outliers as cases that fall more than 1.5 box lengths from the lower or upper hinge of the box and distinguishes extreme outliers by identifying values more than three box lengths from either hinge. Beasley, Kuh, and Welsh (1980) and Edwards and Cable (2009), stated that identifying potential error outliers involves using a variety of visual and quantitative techniques, that compensates for the relative weakness of each.

The current study used Stem-and Leaf (Tables 6.8–6.14) and boxplot (Figures 6.1–6.7) as the two techniques to identify outliers and extreme values. Outliers were classified as cases that fell more than 1.5 box lengths from the lower or upper hinge of the box, and extreme were classified as those values that were more than three box lengths from either hinge. In the study, the first step in identifying outliers and extreme values was through the SPSS explore procedure. This has the ability to produce descriptive statistics such as skewness, kurtosis and a Stem-and-Leaf plot, which gave a visual display of the data. Table 7 indicates descriptive statistics for skewness and kurtosis while the Stem-and-Leaf results are shown in Tables 8–14.

Table 6.14 displays the summary descriptive statistics. The output clearly shows that the mean, median and trimmed mean for all the individual constructs (F1_1 to F7_7), are nearly identical. This indicates that the distributions are not skewed in one direction or another. To examine skewness and kurtosis, the author used the standard errors provided for each value of the individual constructs to obtain standardized values for each statistic.

Dividing skewness by the standard error of each construct yields standardized values of F1_1 = -5.301, F2_2 = -3.856, F3_3 = -3.144, F4_4 = -8.574, F5_5 = -1.364, F6_6 = -2.388 and F7_7 = 4.713. This indicates that the distribution of constructs (F1_1 to F6_6) is negatively skewed, while the distribution construct F7_7 is positively skewed.

In a similar fashion, each individual construct kurtosis was divided by its standard error to obtain a standardized value (F1_1 = 0.783, F2_2 = -1.531, F3_3 = -1.901, F4_4 = 8.703, F5_5 = -2.722, F6_6 = -2.488, and F7_7 = -0.147). This indicates that the distributions have heavier tails than the normal distribution (F1_1 = 0.783 & F4_4 = 8.703) and while other constructs (F2_2 = -1.531, F3_3 = -1.901, F5_5 = -2.722, F6_6 = -2.488 and F7_7 = -0.147) have lighter tails than the normal distribution.

Table 6.14 First Output of SPSS Explore: Statistics for Constructs

Descriptive				
			Statistic	Std. Error
F1_1	Mean		4.0716	0.09652
	95% Confidence Interval for Mean	Lower Bound	3.8807	
		Upper Bound	4.2625	
	5% Trimmed Mean		4.1811	
	Median		4.3333	
	Variance		1.258	
	Std. Deviation		1.12147	
	Minimum		1.00	
	Maximum		5.00	
	Range		4.00	
	Interquartile Range		1.67	
	Skewness		-1.108	0.209
	Kurtosis		0.324	0.414
F2_2	Mean		3.6509	0.11918
	95% Confidence Interval for Mean	Lower Bound	3.4152	
		Upper Bound	3.8867	
	5% Trimmed Mean		3.7233	
	Median		4.0000	
	Variance		1.918	
	Std. Deviation		1.38476	
	Minimum		1.00	
	Maximum		5.00	
	Range		4.00	
	Interquartile Range		2.33	
	Skewness		-0.806	0.209
	Kurtosis		-0.634	0.414

F3_3	Mean		3.6211	0.12162
	95% Confidence Interval for Mean	Lower Bound	3.3806	
		Upper Bound	3.8617	
	5% Trimmed Mean		3.6901	
	Median		4.0000	
	Variance		1.997	
	Std. Deviation		1.41313	
	Minimum		1.00	
	Maximum		5.00	
	Range		4.00	
	Interquartile Range		2.00	
	Skewness		-0.657	0.209
	Kurtosis		-0.787	0.414
F4_4	Mean		4.4244	0.06873
	95% Confidence Interval for Mean	Lower Bound	4.2884	
		Upper Bound	4.5603	
	5% Trimmed Mean		4.5226	
	Median		4.8000	
	Variance		0.638	
	Std. Deviation		0.79858	
	Minimum		1.00	
	Maximum		5.00	
	Range		4.00	
	Interquartile Range		0.80	
	Skewness		-1.792	0.209
	Kurtosis		3.603	0.414
F5_5	Mean		3.3105	0.11205
	95% Confidence Interval for Mean	Lower Bound	3.0889	
		Upper Bound	3.5321	
	5% Trimmed Mean		3.3450	
	Median		3.5000	

	Variance		1.695	
	Std. Deviation		1.30195	
	Minimum		1.00	
	Maximum		5.00	
	Range		4.00	
	Interquartile Range		2.50	
	Skewness		-0.285	0.209
	Kurtosis		-1.127	0.414
F6_6	Mean		3.6642	0.10912
	95% Confidence Interval for Mean	Lower Bound	3.4484	
		Upper Bound	3.8800	
	5% Trimmed Mean		3.7184	
	Median		3.6642	
	Variance		1.607	
	Std. Deviation		1.26782	
	Minimum		1.00	
	Maximum		5.00	
	Range		4.00	
	Interquartile Range		2.00	
	Skewness		-0.499	0.209
	Kurtosis		-1.030	0.414
F7_7	Mean		1.9667	0.09796
	95% Confidence Interval for Mean	Lower Bound	1.7729	
		Upper Bound	2.1604	
	5% Trimmed Mean		1.8704	
	Median		1.5000	
	Variance		1.296	
	Std. Deviation		1.13821	
	Minimum		1.00	
	Maximum		5.00	
	Range		4.00	

	Interquartile Range	2.00	
	Skewness	0.985	0.209
	Kurtosis	-0.061	0.414

The following section discusses the Stem-and-Leaf plots (Tables 6.15–6.21) and boxplots outputs (Figures 6.15–6.21) from the SPSS explore procedure. Tables 6.14–6.15 display the Stem-and-Leaf plot for all the constructs (F1_1 to F7_7) in the study and indicate whether outliers are present in the data. The stems represent the digit data values for the constructs and each leaf represents a case with that particular data value. The frequency column represents the total number of cases for each data value shown in the stem and leaf. Table 6.15, F1_1 Stem-and-Leaf output (construct F1_1: Client attitude towards H&S) shows that there are no outliers and extreme values construct F1_1. This is also confirmed by the F1_1 boxplot output in Figure 6.18.

Table 6.15 F1_1 Stem-and-Leaf Output Client Attitude towards Health and Safety

F1_1 Stem-and-Leaf Plot

```
Frequency    Stem & Leaf
 6.00        1 .  000033
 2.00        1 .  66
 8.00        2 .  33333333
 5.00        2 .  66666
14.00        3 .  00000000003333
12.00        3 .  666666666666
21.00        4 .  000000000333333333333
 8.00        4 .  66666666
59.00        5 .  00000000000000000000000000000000000000000000000000000000000

Stem width:     1.00
Each leaf:      1 case(s)
```

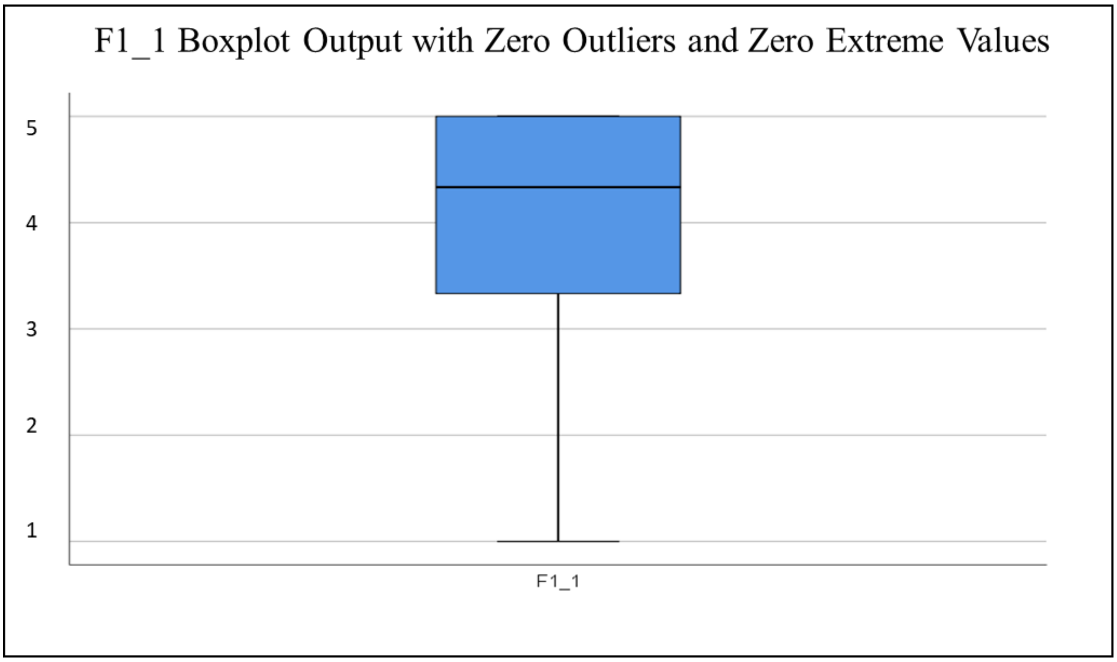

Figure 6.15 F1_1 Boxplot Output with Zero Outliers and Zero Extreme Values

In Table 6.16, F2_2 Stem-and-Leaf output (construct F2_2: client ability to communicate their H&S requirements to all stakeholders) shows that there are no outliers and extreme values construct F1_1. This is also confirmed by the F2_2 boxplot output in Figure 6.19.

Table 6.16   F2_2 Stem-and Leaf Plot SPSS Output

F2_2 Stem-and-Leaf Plot

```
Frequency    Stem &  Leaf
   20.00        1.  00000000000000000333
    2.00        1.  66
    8.00        2.  00333333
    5.00        2.  66666
    8.00        3.  00023333
   21.00        3.  666666666666666666666
   22.00        4.  0000000000033333333333
    6.00        4.  666666
   43.00        5.  0000000000000000000000000000000000000000000

Stem width:      1.00
Each leaf:       1 case(s)
```

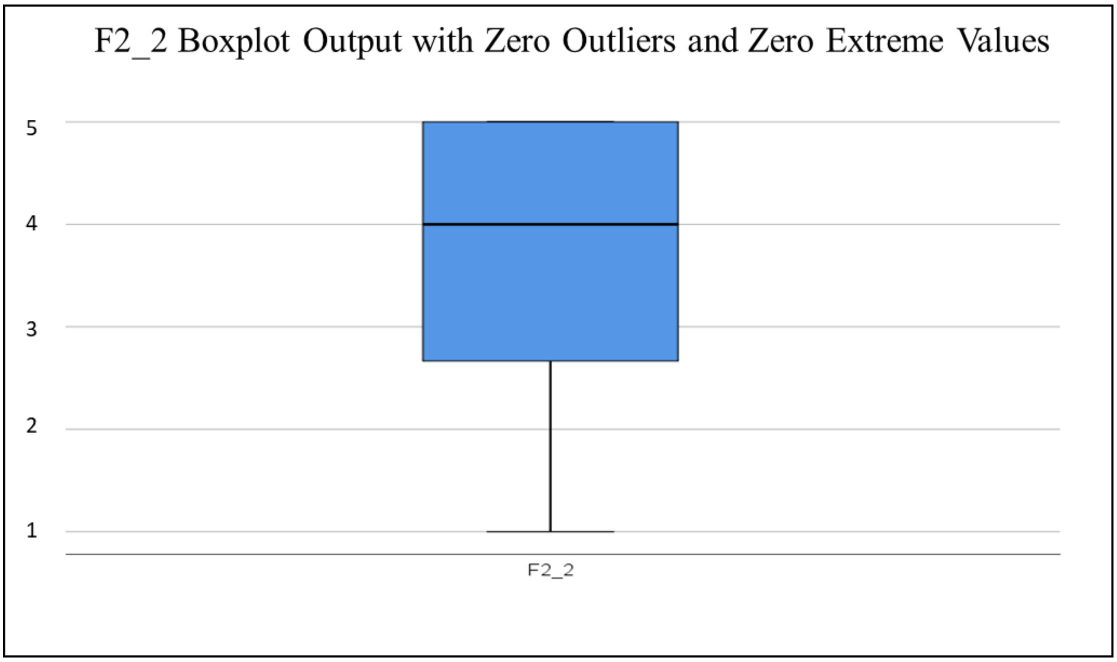

Figure 6.16   F2_2 Boxplot Output with Zero Outliers and Zero Extreme Values

In Table 6.17, F3_3 Stem-and-Leaf output (construct F3_3: Selection of Contractors based on H&S performance records) shows that there are no outliers and extreme values construct F3_3. This is also confirmed by the F3_3 boxplot output in Figure 6.17.

Table 6.17 F3_3 Stem-and-Leaf Plot SPSS Output

F3_3 Stem-and-Leaf Plot

Frequency	Stem &	Leaf
20.00	1.	00000000000000000000
.00	1.	
3.00	2.	003
6.00	2.	555555
27.00	3.	000000000000000000000000000
9.00	3.	555555555
12.00	4.	000000000000
6.00	4.	555555
52.00	5.	0000000000000000000000000000000000000000000000000000

Stem width: 1.00

Each leaf: 1 case(s)

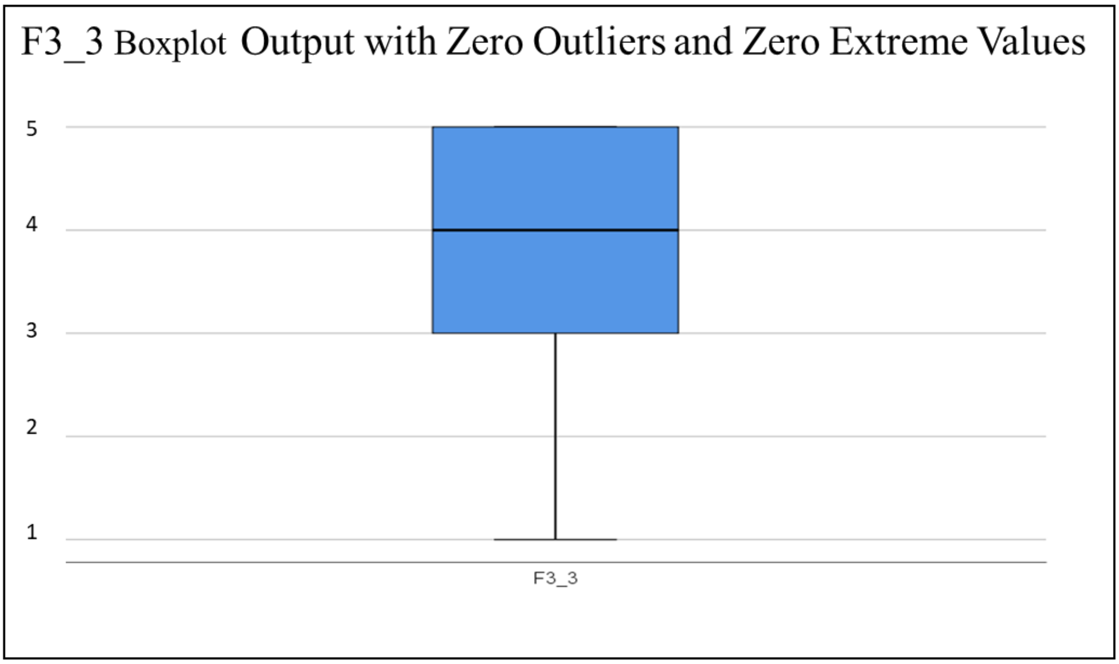

Figure 6.17 F3_3 Boxplot Output with Zero Outliers and Zero Extreme Values

In Table 6.18, F4_4 Stem-and-Leaf output (construct F4_4: Contractual H&S Arrangement) shows that there are no outliers but there are nine 'extreme' values at the lower end of the distribution that are less than or equal to three, and four outliers as confirmed by the F4_4 boxplot output in Figure 6.18.

Table 6.18 F4_4 Stem-and-Leaf Plot SPSS Output Showing Outliers and Extreme Values

F4_4 Stem-and-Leaf Plot

```
Frequency    Stem &  Leaf
    9.00 Extremes    (=<3.00)
    3.00       32.  000
     .00       33.
    6.00       34.  000000
     .00       35.
    6.00       36.  000000
     .00       37.
    4.00       38.  0000
     .00       39.
    4.00       40.  0009
     .00       41.
   15.00       42.  000000000000000
     .00       43.
    8.00       44.  00000000
     .00       45.
    7.00       46.  0000000
     .00       47.
    9.00       48.  000000000
     .00       49.
   64.00       50.
0000000000000000000000000000000000000000000000000000000000000000

Stem width:      .10

Each leaf:       1 case(s)
```

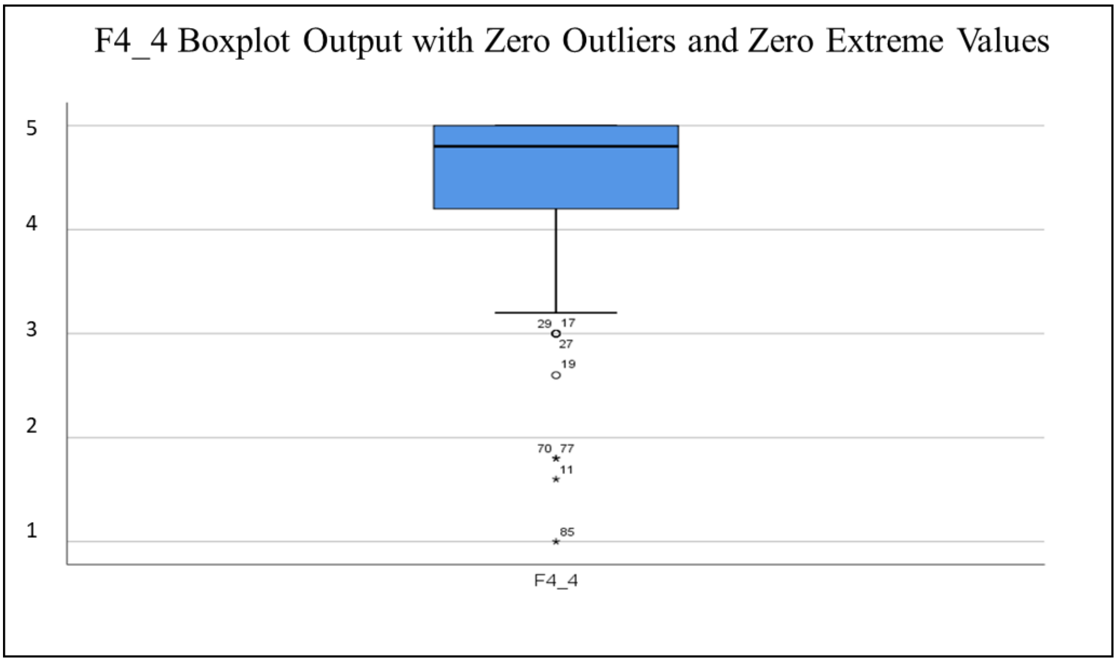

Figure 6.18 F4_4 Boxplot Output with Zero Outliers and Zero Extreme Values

In Table 6.19, F5_5 Stem-and-Leaf output (construct F5_5: Client involvement before construction) shows that there are no shows that there are no outliers and extreme values construct F5_5. This is also confirmed by the F5_5 boxplot output in Figure 6.19.

Table 6.19   F5_5 Stem-and-Leaf Plot SPSS Output

F5_5 Stem-and-Leaf Plot

```
Frequency    Stem &  Leaf
   12.00       1.  000000000000
   16.00       1.  5577777777777777
   10.00       2.  0000000222
    9.00       2.  555577777
   16.00       3.  0000000000002233
   17.00       3.  55555555557777777
   18.00       4.  000000000000000022
   11.00       4.  55555555557
   26.00       5.  00000000000000000000000000

Stem width:     1.00
Each leaf:      1 case(s)
```

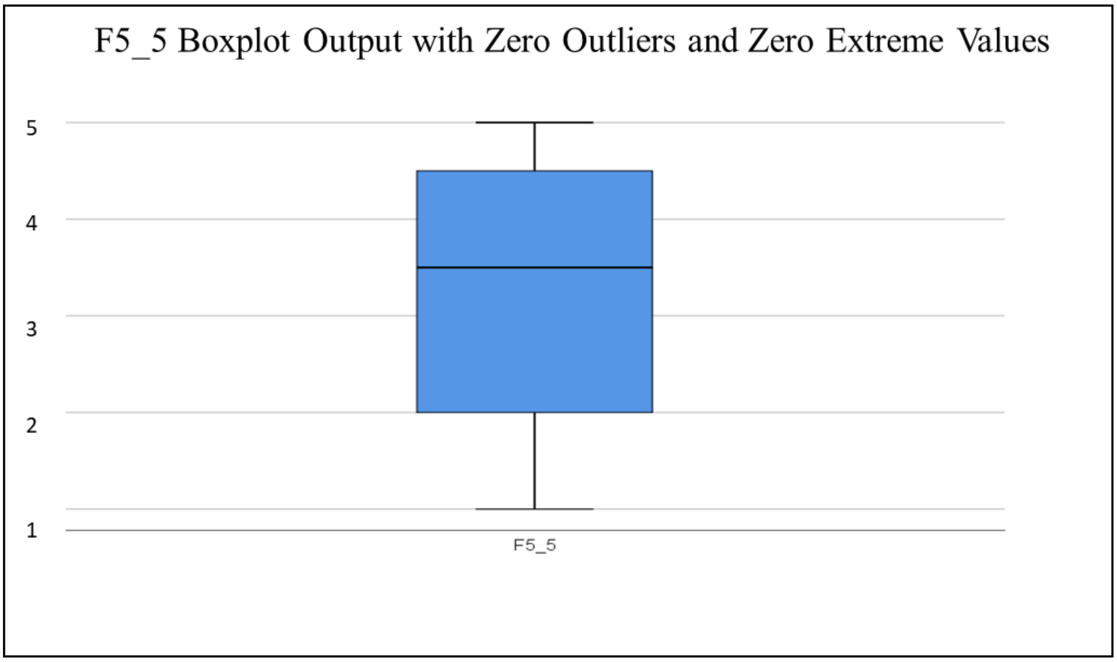

Figure 6.19   F5_5 Boxplot Output with Zero Outliers and Zero Extreme Values

In Table 6.20, F6_6 Stem-and-Leaf output (construct F6_6: Monitoring of Contractor's H&S Performance) shows that there are no outliers and extreme values. This is also confirmed by the F6_6 boxplot output in Figure 6.20.

Table 6.20 F6_6 Stem-and-Leaf Plot SPSS Output

F6_6 Stem-and-Leaf Plot

Frequency	Stem &	Leaf
2.00	1.	00
17.00	1.	55555555555555555
4.00	2.	0000
10.00	2.	5555555555
15.00	3.	000000000000000
20.00	3.	55555555555555555556
10.00	4.	0000000000
12.00	4.	555555555555
45.00	5.	000000000000000000000000000000000000000000000

Stem width: 1.00

Each leaf: 1 case(s)

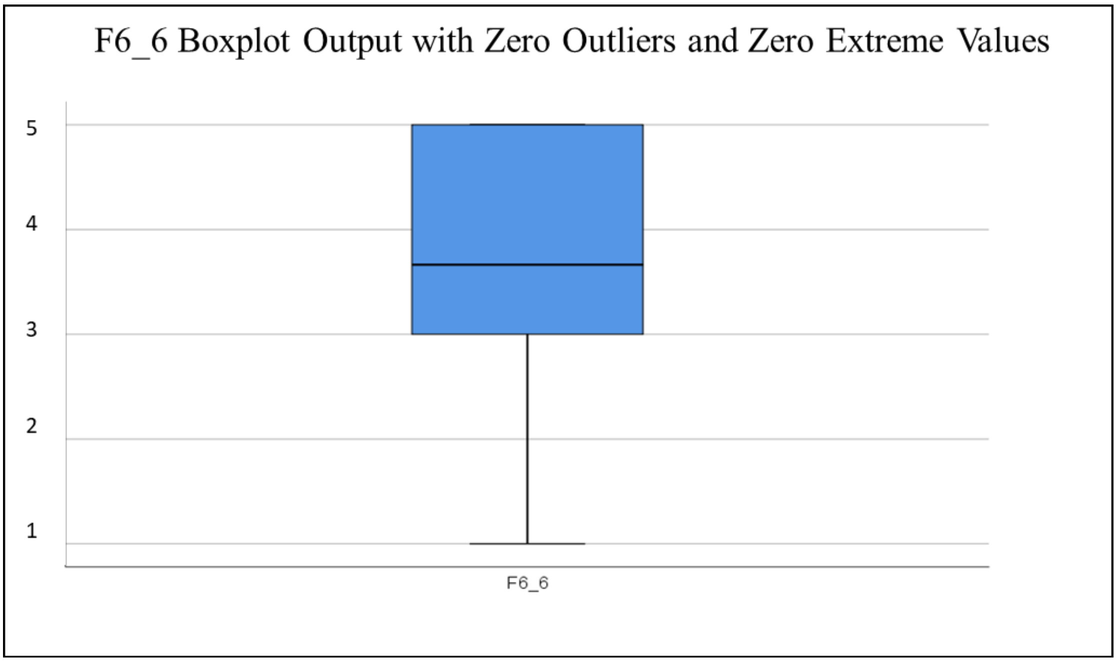

Figure 6.20 F6_6 Boxplot Output with Zero Outliers and Zero Extreme Values

In Table 6.21, F7_7 Stem-and-Leaf output (construct F7_7: Overall Project H&S Performance) shows that there are no outliers and extreme values in the construct. This is also confirmed by the F7_7 boxplot output in Figure 6.21.

Table 6.21 F7_7 Stem-and-Leaf Plot SPSS Output

F7_7 Stem-and-Leaf Plot

```
Frequency    Stem &  Leaf
   60.00        1. 000000000000000000000000000000000000000000000000000000000000
   12.00        1.  555555555555
   20.00        2.  00000000000000000000
    6.00        2.  555555
   18.00        3.  000000000000000000
    4.00        3.  5555
   10.00        4.  0000000000
    1.00        4.  5
    4.00        5.  0000

Stem width:      1.00
Each leaf:       1 case(s)
```

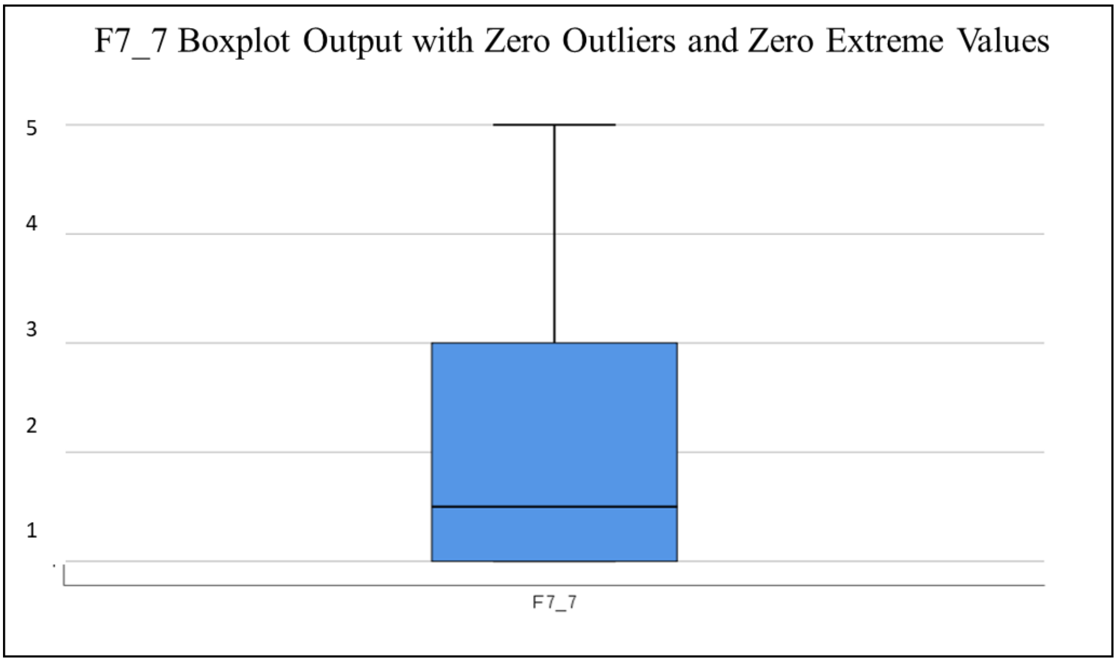

Figure 6.21 F7_7 Boxplot Output with Zero Outliers and Zero Extreme Values

Outliers and extreme values were identified in Table 6.18: F4_4 Stem-and Leaf plot and Figure 6.18: F4_4 boxplot SPSS. The data collection instrumentation was revisited to determine whether these outliers and extreme values were due to a data entry error or an instrumentation error. The outliers found not to be disengaged responses and were retained. The extreme values found to be caused by coding errors were eliminated. The completed questionnaires were visually scrutinised for disengaged responses and looked out for any visible predictable patterns of response. Based on this criterion, no questionnaires were flagged as being disengaged responses.

6.6.3 Testing for Normality

When the missing values were replaced with series means, the means of all the constructs changed from those that were obtained using the data set with missing values (Table 5.22) to the new means as indicated in Table 6.22. Table 6.22 shows the descriptive statistics (including the measures of central tendency and measures of dispersion) for all the variables (constructs and performance measures). The distribution of mean scores of the constructs (F1_1 to F6_6) show the means for all of the constructs range between 3.31 and 4.42 – with the least mean for F5_5 (3.31) and the highest mean for F4_4 (4.42). The scores for all the constructs range from a minimum of one to a maximum of five, which is ranges from ‘never’ (one) to ‘always’ (five) for all of the six constructs. Similarly, for performance, the scores range from ‘poor’ (1) to ‘excellent’ (five) for the performance construct (F7_7).

The standard deviations for the scores of all the variables range from 0.79 for F4_4 to 1.41 for F3_3, this implies that there is very little variability in the mean scores for F4_4 while high variability is expected for the mean scores of F3_3. From Table 6.22, skewness and kurtosis values for most of the variables are negative – suggesting that most of the data is left-skewed and peaked (leptokurtic) compared to a normal distribution. The F7_7 result for skewness is positive suggesting that its data is skewed to the right while kurtosis results for F1_1 and F4_4 are positive, suggesting that its data is skewed to the right.

Table 6.22 Descriptive Statistics for Data Set without Missing Values

Descriptive Statistics									
	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
F1_1	135	1.00	5.00	4.0716	1.12147	-1.108	0.209	0.324	0.414
F2_2	135	1.00	5.00	3.6509	1.38476	-0.806	0.209	-0.634	0.414
F3_3	135	1.00	5.00	3.6211	1.41313	-0.657	0.209	-0.787	0.414
F4_4	135	1.00	5.00	4.4244	0.79858	-1.792	0.209	3.603	0.414
F5_5	135	1.00	5.00	3.3105	1.30195	-0.285	0.209	-1.127	0.414
F6_6	135	1.00	5.00	3.6642	1.26782	-0.499	0.209	-1.030	0.414
F7_7	135	1.00	5.00	1.9667	1.13821	0.985	0.209	-0.061	0.414
Valid N (Listwise)	135								

Rose et al., (2015) suggested that if either score of skewness and kurtosis are divided by their standard error and the result is greater than ±1.96, then data is not normal with respect to that statistic. Table 6.23 below indicates an output for skewness and kurtosis tests when the test scores were divided by standard error. Skewness and kurtosis data are mostly negative, indicating that the data is slightly negative-skewed and peaked (leptokurtic) compared to a normal distribution. Applying the rule of thumb as per Rose et al., (2015) of dividing each value by its standard error, the skewness and kurtosis for most constructs are well within ±1.96 limits, suggesting departure from normality.

Table 6.23 Descriptive Statistics for Data Set without Missing Values

Constructs	Skewness			Kurtosis		
	Statistic	Std. Error	Statistic/ SE = Std. Value	Statistic	Std. Error	Statistic/ SE = Std. Value
F1_1	-1.108	0.209	-5.30	0.324	0.414	0.78
F2_2	-0.806	0.209	-3.85	-0.634	0.414	-1.53
F3_3	-0.657	0.209	-3.14	-0.787	0.414	-1.90
F4_4	-1.792	0.209	-8.57	3.603	0.414	8.70
F5_5	-0.285	0.209	-1.36	-1.127	0.414	-2.72
F6_6	-0.499	0.209	-2.39	-1.03	0.414	-2.49
F7_7	0.985	0.209	4.71	-0.061	0.414	-0.15

A perfectly normal distribution should return a score of zero (Rose, Spinks & Canhoto, 2015). According to Stephan (2015) if the data is not normal, the use of non-parametric tests that do not require normality can be applied. Table 6.24 shows SPSS output of the Kolmogorov-Smirnov and the Shapiro-Wilk tests. For both tests, the p-value is less than 0.05, rejecting the null hypothesis – meaning rejecting the assumption of normality for the distribution. Therefore, the alternate hypothesis is that the data come from a population that is not normally distributed.

Table 6.24 Results of Kolmogorov-Smirnov and the Shapiro-Wilk Tests

Tests of Normality						
Construct	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
F1_1	0.233	135	0.000	0.809	135	0.000
F2_2	0.186	135	0.000	0.837	135	0.000
F3_3	0.221	135	0.000	0.830	135	0.000
F4_4	0.239	135	0.000	0.750	135	0.000

F5_5	0.109	135	0.000	0.920	135	0.000
F6_6	0.187	135	0.000	0.869	135	0.000
F7_7	0.247	135	0.000	0.812	135	0.000
a. Lilliefors Significance Correction						

6.6.4 Adequacy of Sample Size and Variance

To assess the suitability of the respondent data for factor analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA) and Bartlett's test of sphericity were used. According to Latihan et al., (2017) the KMO MSA is a test of the extent of variance within the data that could be explained by factors. Latihan et al., (2017) stated that as a measure of factorability, a KMO value of 0.5 is poor, 0.6 is acceptable while a value closer to one is better. Neuman (2003) and Tabachnick & Fidell, (2008) suggested that KMO measure of sampling adequacy must be 0.7 and 0.60 respectively. For this present study, the KMO MSA was 0.771 as indicated in Table 5.25 suggesting that the sample size is adequate for EFA. The Bartlett's test of sphericity needs to be significant for the sample to be deemed to have sufficient variance for EFA. Peri (2012) stated that for factor analysis to be recommended suitable, the Bartlett's test of sphericity must be less than 0.05. Taking a ninety-five per cent level of significance, $\alpha = 0.05$ and from Table 6.25 the p-value (Sig.) of $.000 < 0.05$, shows that the factor analysis is therefore valid.

Table 6.25 KMO and Bartlett's Test for the Current Study

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.771
Bartlett's Test of Sphericity	Approx. chi-square	5891.295
	df	2016
	Sig.	0.000

Latihan et al., (2017) suggested that a measure to quantify the degree of intercorrelations among the variables and the appropriateness of factor analysis be conducted, using the anti-image correlation technique. In using the anti-image correlation technique, the MSA index ranges from zero to one, reaching one when each variable is perfectly predicted without an error by other variables (Latihan et al., 2017). As described by Hair et al., (2010), the measure can be interpreted as follows:

- 0.8 or above, meritorious
- 0.70 or above, middling
- 0.60 or above, mediocre
- 0.50 or above, miserable
- below 0.50, unacceptable

Table 6.26 below indicates the MSA for the study. From Table 6.26 it can be seen that all of the constructs have an anti-image correlation of above 0.5. Hair et al., (2006; 2010) notes that the anti-image correlation matrix of items should be at least above 0.50.

Table 6.26 Anti-image Matrices for all Constructs

Anti-Image Matrices								
		F1_1	F2_2	F3_3	F4_4	F5_5	F6_6	F7_7
Anti-image Covariance	F1_1	0.770	-0.189	-0.103	-0.107	-0.012	-0.081	0.082
	F2_2	-0.189	0.623	-0.033	-0.070	-0.157	-0.173	-0.035
	F3_3	-0.103	-0.033	0.843	-0.150	-0.105	0.137	-0.129
	F4_4	-0.107	-0.070	-0.150	0.790	-0.060	-0.035	-0.196
	F5_5	-0.012	-0.157	-0.105	-0.060	0.656	-0.232	-0.024
	F6_6	-0.081	-0.173	0.137	-0.035	-0.232	0.642	0.074
	F7_7	0.082	-0.035	-0.129	-0.196	-0.024	0.074	0.884
Anti-image Correlation	F1_1	.769[a]	-0.273	-0.127	-0.137	-0.017	-0.115	0.099
	F2_2	-0.273	.764[a]	-0.045	-0.099	-0.246	-0.274	-0.047
	F3_3	-0.127	-0.045	.627[a]	-0.184	-0.141	0.187	-0.149
	F4_4	-0.137	-0.099	-0.184	.755[a]	-0.084	-0.050	-0.234
	F5_5	-0.017	-0.246	-0.141	-0.084	.747[a]	-0.357	-0.031
	F6_6	-0.115	-0.274	0.187	-0.050	-0.357	.692[a]	0.098
	F7_7	0.099	-0.047	-0.149	-0.234	-0.031	0.098	.576[a]
a. Measures of Sampling Adequacy								

6.6.5 Factor Extraction and Factor Rotation

Williams, Onsman and Brown, (2010) agree that there are numerous ways to extract factors:

- Principal Components Analysis (PCA)
- Principal Axis Factoring (PAF)
- image factoring
- maximum likelihood
- alpha factoring
- canonical

Pett et al., (2003) suggested using PCA in establishing preliminary solutions in EFA. PCA was the preferred factor extraction method in this study as it was found to be simple, yet effective in determining factors, including the error variance (Laher, 2010). The objective of the data extraction is to reduce a large number of items into factors (Williams et al., 2010). Thompson and Daniel (1996) stated that the simultaneous use of multiple decision rules is appropriate and often desirable. For this study, Kaiser's criteria (eigenvalue > 1 rule), the scree test and the cumulative per cent of variance extracted were used.

6.6.6 Factor Rotation

After a decision is made of how many factors are to be retained, the factors have to be rotated. Williams et al., (2010) noted that rotation maximises high item loadings and minimises low item loadings, therefore producing a more interpretable and simplified solution. Rotational methods include the orthogonal method that consists of varimax, equamax and quartimax, while the oblique rotational method consists of direct olbimin and promax. Tabachnick and Fidell (2007) found that orthogonal rotation results in solutions are easier to interpret and to report. However, they do require the researcher to assume (usually incorrectly) that the underlying constructs are independent (not correlated), while oblique approaches allow for the factors to be correlated, but they are more difficult to interpret, describe and report. Matsunaga (2010) shared the same view with Tabachnick and Fidell (2007) that orthogonal rotation treats the factors as uncorrelated while oblique rotation treats them as correlated. Latihan et al., 2017 concluded that most researchers conduct both orthogonal and oblique rotations and then report the clearest and easiest to interpret.

William et al., (2010) stated that regardless of which rotation method is used, the main objective is to provide easier interpretation of results and produce a solution that is more parsimonious. According to Latihan et al., (2017), the most commonly used orthogonal approach is the varimax method, which attempts to minimise the number of variables that have high loadings on each factor; the most commonly used oblique technique is the direct olbimin rotation. Matsunaga (2010) recommended the use of promax rotation because it works well with both correlated and not correlated factors.

For this study, promax with Kaiser Normalization was the preferred factor rotation method with a kappa value of four. Table 6.27 indicates communalities of the variables; these indicate how much variance in each variable is explained by the analysis. The extraction communalities are calculated using the extracted factors, which are useful values. From Table 6.27, it can be seen that eighty-seven per cent of the variance is explained by the sixty-four extracted factors. The communalities for all of the items (questions) used in the questionnaire to gather information were significantly high (>.0.65) indicating that the questionnaire instruments used to gather information were all significant.

Table 6.27 Communalities of All Variables

Communalities		
	Initial	Extraction
CTE1.1_1	1.000	0.628
CTE1.2_1	1.000	0.740
CTE1.3_1	1.000	0.692
CTE1.4_1	1.000	0.688
CTE1.5_1	1.000	0.671
CTE2.1_1	1.000	0.673
CTE2.2_1	1.000	0.767
CTE2.3_1	1.000	0.749
CTE2.4_1	1.000	0.781
CTE2.5_1	1.000	0.820
CTE2.6_1	1.000	0.653
CTE3.1_1	1.000	0.790
CTE3.2_1	1.000	0.800
CTE3.3_1	1.000	0.688
CTE3.4_1	1.000	0.748
CTE3.5_1	1.000	0.737

CTE3.6_1	1.000	0.719
CTE3.7_1	1.000	0.708
CTE3.8_1	1.000	0.688
CTE3.9_1	1.000	0.704
CTE3.10_1	1.000	0.662
CTE3.11_1	1.000	0.730
CTE3.12_1	1.000	0.798
CTE4.1_1	1.000	0.789
CTE4.2_1	1.000	0.763
CTE4.3_1	1.000	0.701
CTE4.4_1	1.000	0.632
CTE4.5_1	1.000	0.721
CTE4.6_1	1.000	0.615
CTE4.7_1	1.000	0.778
CTE4.8_1	1.000	0.804
CTE4.9_1	1.000	0.738
CTE4.10_1	1.000	0.563
CTE4.11_1	1.000	0.727
CTE4.12_1	1.000	0.741
CTE4.13_1	1.000	0.639
CTE4.14_1	1.000	0.687
CTE4.15_1	1.000	0.687
CTE4.16_1	1.000	0.764
CTE4.17_1	1.000	0.777
CTE4.18_1	1.000	0.727
CTE4.19_1	1.000	0.675
CTE5.1_1	1.000	0.742
CTE5.2_1	1.000	0.748
CTE5.3_1	1.000	0.807
CTE5.4_1	1.000	0.838

CTE5.5_1	1.000	0.737
CTE5.6_1	1.000	0.756
CTE6.1_1	1.000	0.708
CTE6.2_1	1.000	0.745
CTE6.3_1	1.000	0.602
CTE6.4_1	1.000	0.640
CTE6.5_1	1.000	0.738
CTE6.6_1	1.000	0.753
CTE6.7_1	1.000	0.635
CTE6.8_1	1.000	0.602
CTE6.9_1	1.000	0.749
CTE6.10_1	1.000	0.777
CTE6.11_1	1.000	0.695
CTE7.1_1	1.000	0.874
CTE7.2_1	1.000	0.845
CTE7.3_1	1.000	0.617
CTE7.4_1	1.000	0.907
CTE7.5_1	1.000	0.871
Extraction Method: Principal Component Analysis		

When factor analysis was performed on all of the questionnaires, sixteen factors were extracted (with a total variance of 72.7%), as indicated by Table 6.28. This implies that all of the sixteen latent factors extracted contribute about 72.7% of the total variation – which is a reasonably good contribution. This means that when all the questionnaire instruments are put together, they can be reduced by grouping them into sixteen latent factors (variables). This is supported by the scree plot in Figure 6.22, that shows that after component sixteen there is little contribution from the remaining latent components. The pattern matrix table in Table 6.29 shows the grouping of the questionnaire instruments and it shows the specific questionnaire items that fall into a particular latent factor.

Table 6.28 Total Variable Explained

Total Variance Explained							
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	14.731	23.017	23.017	14.731	23.017	23.017	7.821
2	6.286	9.822	32.839	6.286	9.822	32.839	6.614
3	3.533	5.521	38.360	3.533	5.521	38.360	7.247
4	2.665	4.165	42.525	2.665	4.165	42.525	6.481
5	2.458	3.840	46.365	2.458	3.840	46.365	5.134
6	2.105	3.289	49.654	2.105	3.289	49.654	6.366
7	1.936	3.026	52.680	1.936	3.026	52.680	5.666
8	1.800	2.812	55.492	1.800	2.812	55.492	8.155
9	1.708	2.669	58.161	1.708	2.669	58.161	5.208
10	1.572	2.456	60.618	1.572	2.456	60.618	3.439
11	1.496	2.338	62.956	1.496	2.338	62.956	5.414
12	1.447	2.261	65.217	1.447	2.261	65.217	3.624
13	1.347	2.104	67.321	1.347	2.104	67.321	6.285
14	1.288	2.012	69.333	1.288	2.012	69.333	2.237
15	1.099	1.717	71.051	1.099	1.717	71.051	2.008
16	1.075	1.680	72.731	1.075	1.680	72.731	2.655
Extraction Method: Principal Component Analysis							
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance							

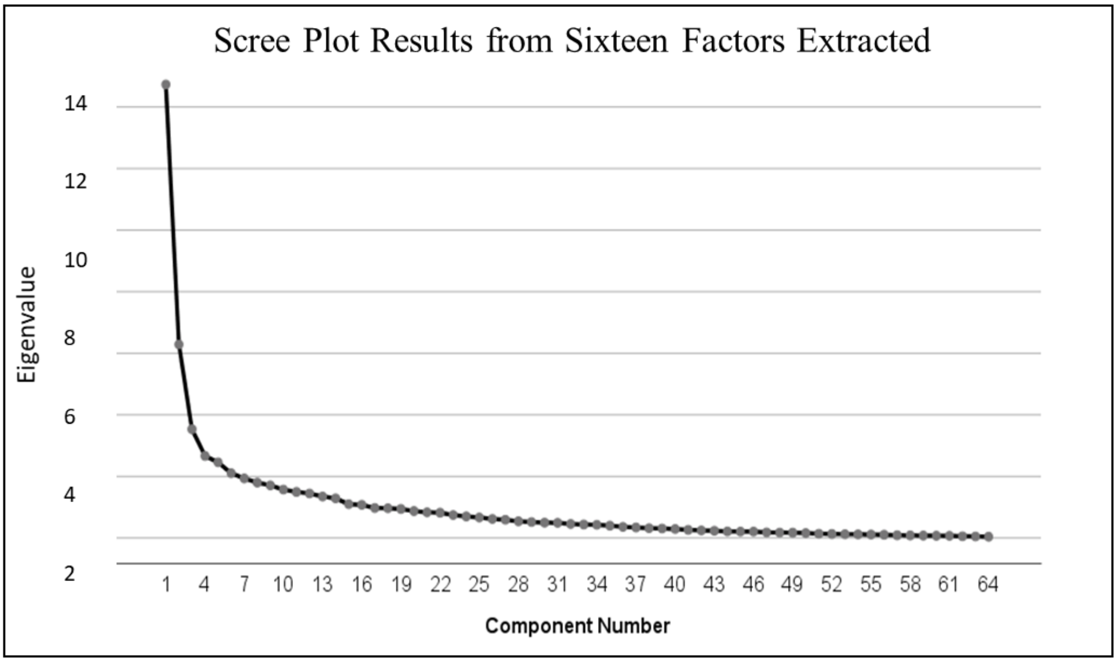

Figure 6.22 Scree Plot Results from Sixteen Factors Extracted

Table 6.29 Pattern Matrix Showing Zero Cross-Loading

Pattern Matrix[a]																
	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CTE1.1_1		0.78														
CTE1.2_1		0.84														
CTE1.3_1		0.62														
CTE1.5_1		0.75														
CTE2.1_1													0.5			
CTE2.2_1																
CTE2.3_1	0.52															
CTE2.4_1																

CTE2.5_1													0.54			
CTE2.6_1													0.77			
CTE3.1_1										0.88						
CTE3.2_1										0.84						
CTE3.3_1								0.53								
CTE3.4_1																
CTE3.5_1																
CTE3.6_1																
CTE3.7_1					0.6											
CTE3.8_1					0.57											
CTE3.9_1																
CTE3.10_1					0.75											
CTE3.11_1					0.63											
CTE4.1_1						0.95										
CTE4.2_1						0.83										
CTE4.3_1									0.7							
CTE4.4_1									0.68							
CTE4.5_1				0.68												
CTE4.6_1									0.67							
CTE4.7_1				0.91												
CTE4.8_1				0.95												
CTE4.9_1				0.59												
CTE4.11_1							0.54									
CTE4.12_1							0.57									
CTE4.13_1				0.53												
CTE4.14_1																
CTE4.15_1											0.77					
CTE4.16_1											0.83					
CTE4.17_1							0.76									
CTE4.18_1							0.75									

CTE4.19_1																0.79
CTE5.1_1																
CTE5.2_1			0.57													
CTE5.3_1			0.94													
CTE5.4_1			1													
CTE5.5_1			0.59													
CTE5.6_1																
CTE6.1_1						0.53										
CTE6.2_1	0.59															
CTE6.3_1	0.73															
CTE6.4_1	0.77															
CTE6.5_1	0.56															
CTE6.6_1																
CTE6.7_1																
CTE6.8_1															0.66	
CTE6.9_1					-0.53											
CTE6.10_1								0.65								
CTE6.11_1								0.92								
CTE7.1_1														0.94		
CTE7.2_1												0.96				
CTE7.3_1															-0.69	
CTE7.4_1												0.96				
CTE7.5_1														0.88		

Extraction Method: Principal Component Analysis

Rotation Method: Promax with Kaiser Normalization

a. Rotation converged in 17 iterations

6.6.6.1 Factor Loadings

A stringent cut-off factor of 0.5 for factor loading as recommended by Anderson and Gerbing (1998) was used. There was no cross loading among the extracted factors and a total of fourteen items did not load (blanks where low loadings exist) into any constructs (see Table 6.29). These items were subsequently omitted from further analysis. In summary, one item was omitted from construct F1_1, 2 from F2_2, 5 from F3_3, 2 from F4_4, 2 from F5_5 and 2 from F6_6. The reliability and validity of the remaining items was assessed. A total of two were negatively loaded (CTE6.9_1 from F6_6 (CTE6.9_1) and F7_7 (CTE7.3_1), simply meaning that a certain characteristic is lacking in a latent variable associated with the given principal component (Burstyn, 2004). According to Burstyn (2004), negative correlations among variables and negative loadings do not cause any specific concerns in principal component analysis.

6.6.7 Reliability and Validity

Field (2005) describe reliability as an analysis for testing whether a group of items measuring a construct generated from factor analysis consistently reflects the construct it is measuring. Reliability analysis measures the reliability of the measuring instrument. For this study, the instrument used to obtain information was in the form of a questionnaire. Respondents were asked to rate each statement of the constructs (F1_1 to F6_6) on a frequency of a five-point Likert scale of 1–5 (1= never, 2 =rarely/seldom, 3 = sometimes, 4 = often and 5 = always) developed by Vagias, Wade M. (2006). A separate five-point Likert-type scale of 1- 5 (1 = poor, 2 = fair 3, = good 4, = very good, and 5 = excellent) for the Project H&S Performance (F7_7) was used.

Hair et al., (2006) stated that Cronbach's alpha most common measure of reliability is internal consistency of the scale. Kline (1999) found that the acceptable value of alpha in reliability analysis is 0.8 in the case of intelligence tests, and the acceptable value of alpha in reliability analysis is 0.7 in the case of ability tests. Latihan et al., (2017) pointed out that Cronbach's alpha coefficient could range from 0.0 to 1.0. Sekaran (2003) noted that Cronbach's alpha close to 1.0 indicates that the item is considered to have a high internal consistency reliability (above 0.8 is considered good, 0.7 is considered acceptable and less than 0.6 is considered to be poor).

Reliability analysis was conducted to check the validity of the questions used in the questionnaire for all of the Likert scale variables (i.e. questions). The Cronbach's alpha of at least 0.70 for a questionnaire instrument was used to obtain information for the study to produce reliable results or findings. The reliability analysis of the retained factors during the EFA was performed and the results are shown in Table 6.30. The Cronbach's alpha for the constructs (F1_1 to F6_6) were F1_1 = 0.785, F2_2 = 0.716, F3_3 = 0.775, F4_4 = 0.831, 0.836, F5_5 = 0.841 and F6_6 = 0.841. The Cronbach's alpha for all of the construct is greater than 0.70 indicating that the questionnaire instrument regarding the construct is reliable and therefore, the results obtained in this study regarding constructs (F1_1 to F6_6) can be taken to be reliable. The Cronbach's alpha for F7_7 is 0.667, which is just less than 0.70, indicating that the questionnaire instrument regarding the construct was in need of adjustment to meet reliability requirements. The usual adjustment procedure to delete the item (or question) that lowers the Cronbach's alpha, was followed.

Table 6.30 Results of Reliability Analysis of Factors that were Retained during EFA

Item Total Statistics			
Factors	Item Correlation	Factor Loading	Cronbach's Alpha
F1_1: Client Attitude towards Health and Safety			
CTE1.1_1	0.620	0.778	0.785
CTE1.2_1	0.660	0.835	
CTE1.3_1	0.587	0.622	
CTE1.5_1	0.524	0.751	
F2_2: Client Ability to Communicate Health and Safety Requirements to All Stakeholders			
CTE2.1_1	0.414	0.501	0.716
CTE2.3_1	0.557	0.521	
CTE2.5_1	0.638	0.542	
CTE2.6_1	0.423	0.765	
F3_3: Selection of Contractors Based on Health and Safety Performance Record			
CTE3.1_1	0.453	0.449	0.775
CTE3.2_1	0.613	0.640	
CTE3.3_1	0.341	0.357	
CTE3.7_1	0.562	0.556	
CTE3.8_1	0.621	0.574	
CTE3.10_1	0.499	0.462	
CTE3.11_1	0.531	0.495	
F4_4: Contractual Health and Safety Arrangement			
CTE4.1_1	0.266	0.952	0.831
CTE4.2_1	0.251	0.827	
CTE4.3_1	0.356	0.696	
CTE4.4_1	0.507	0.682	
CTE4.5_1	0.535	0.680	
CTE4.6_1	0.497	0.673	

CTE4.7_1	0.516	0.905	
CTE4.8_1	0.528	0.947	
CTE4.9_1	0.533	0.592	
CTE4.11_1	0.638	0.539	
CTE4.12_1	0.527	0.565	
CTE4.13_1	0.494	0.526	
CTE4.15_1	0.345	0.772	
CTE4.16_1	0.401	0.827	
CTE4.17_1	0.598	0.757	
CTE4.18_1	0.428	0.748	
CTE4.19_1	0.301	0.790	
F5_5: Client Involvement Before and During Construction			
CTE5.2_1	0.608	0.593	0.836
CTE5.3_1	0.724	0.732	
CTE5.4_1	0.756	0.774	
CTE5.5_1	0.591	0.556	
F6_6: Monitoring of Contractor Health and Safety Performance			
CTE6.1_1	0.590	0.530	0.841
CTE6.2_1	0.684	0.593	
CTE6.3_1	0.509	0.732	
CTE6.4_1	0.586	0.774	
CTE6.5_1	0.639	0.556	
CTE6.8_1	0.341	0.662	
CTE6.9_1	0.594	-0.530	
CTE6.10_1	0.643	0.653	
CTE6.11_1	0.428	0.920	
F7_7: Project Health and Safety Performance			
CTE7.1_1	0.238	0.944	0.667
CTE7.2_1	0.511	0.958	
CTE7.3_1	0.319	-0.692	
CTE7.4_1	0.728	0.960	
CTE7.5_1	0.531	0.881	

Table 6.31 showed an improved Cronbach's alpha value which was achieved by dropping the item (lost time incidence frequency rate) from the construct F7_7. The improved Cronbach's alpha for CTHS7 is 0.721, which is greater than 0.70 indicating that the questionnaire instrument regarding the construct is now reliable. It is clear, therefore, that the results obtained in this study regarding the construct can be taken to be reliable.

Table 6.31 F7_7 Cronbach's Alpha when Item CTE7.3.1 is Dropped

Item Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item Total Correlation	Cronbach's Alpha if Item Deleted
CTE7.1_1	8.1630	14.063	0.238	0.685
CTE7.2_1	8.2222	11.144	0.511	0.573
CTE7.3_1	7.6963	9.974	0.319	0.721
CTE7.4_1	8.5852	10.513	0.728	0.483
CTE7.5_1	8.8148	13.480	0.531	0.604

A reliability analysis was carried out on the instrument comprising seven constructs. Cronbach's alpha showed the constructs to reach acceptable reliability of greater than 0.7($\alpha = 0.7$). Constructs (F1_1 – F7_7) appeared to be worthy of retention, resulting in a decrease in the alpha if deleted. The one exception to this was construct F7_7, which produced a Cronbach's alpha of 0.667 (less than 0.70), indicating that the questionnaire instrument regarding the construct needed adjustment to meet the reliability requirements. The adjustment procedure was performed by deleting the item (or question) that lowers the Cronbach's alpha. The reliability statistics construct F7_7 showed an improved Cronbach's alpha value 0.72.1, which was achieved by dropping the item (lost time incidence frequency rate) from the construct. Therefore, the results obtained in this study regarding all constructs were considered to be reliable. Although reliability statistics for construct F7_7 showed an improved Cronbach's alpha value 0.721 – achieved by dropping the item (lost time incidence frequency rate) from the construct, the author decided to retain the construct F7_7 with the original of 0.667 for the further assessment.

6.6.8 Correlations Constructs

For this section the variables were obtained by averaging out the items for each construct, that resulted in the variables being continuous, allowing for the application of correlation analysis and/or multiple linear regression analysis. All of the six constructs (F1_1 to F6_6) reveal a highly significant positive correlation ($p<0.01$) at a one per cent level of significance amongst each other (Table 6.32). Two of the constructs, F3_3 (Selection of Contractors based on H&S Performance Records) and F4_4 (Contractual H&S Arrangement), showed a significant positive correlation with F7_7 ($p<0.001$) at a one per cent level of significance. However, all of the remaining four constructs (F1_1, F2_2, F5_5 and F6_6) showed no significant correlation with construct F7_7 (Project H&S Performance).

Table 6.32 Inter-Constructs Correlation

Inter-Constructs Correlations								
		F1_1	F2_2	F3_3	F4_4	F5_5	F6_6	F7_7
Pearson Correlation	F1_1	1						
	F2_2	.422**	1					
	F3_3	.181*	0.146	1				
	F4_4	.257**	.280**	.283**	1			
	F5_5	.273**	.471**	.175*	.255**	1		
	F6_6	.302**	.472**	-0.047	.171*	.491**	1	
	F7_7	-0.017	0.065	.224**	.269**	0.067	-0.068	1
** Correlation is significant at the 0.01 level (2-tailed)								
* Correlation is significant at the 0.05 level (2-tailed)								

6.7 Structural Equation Modelling (SEM)

Srivastava (2018) defines structural equation modelling as a multivariate statistical technique that analyses the structural relationships or establishes causal relationships between variables. As shared by Byrne (2006), SEM graphically models hypothesised relationships among constructs with structural equations. Srivastava (2018) explains that SEM can simultaneously test both the measurement model and the structural relationship specified in the model. SEM consists of confirmatory factor analysis path, analysis with observed variables and path analysis with latent variables. Schreiber et al., (2006) found that CFA is related to EFA but is a theory-driven technique that tests the extent that the proposed factor structure is replicated in another sample. Kelloway (1995) stated that EFA is often considered to be more appropriate than CFA in the early stages of scale development because CFA does not show how well items load on the non-hypothesised factors. The purpose of CFA is to confirm to what extent a model fits the data. Figure 6.23 shows the hypothetical model indicating the relation between client involvement and the overall project health and safety performance.

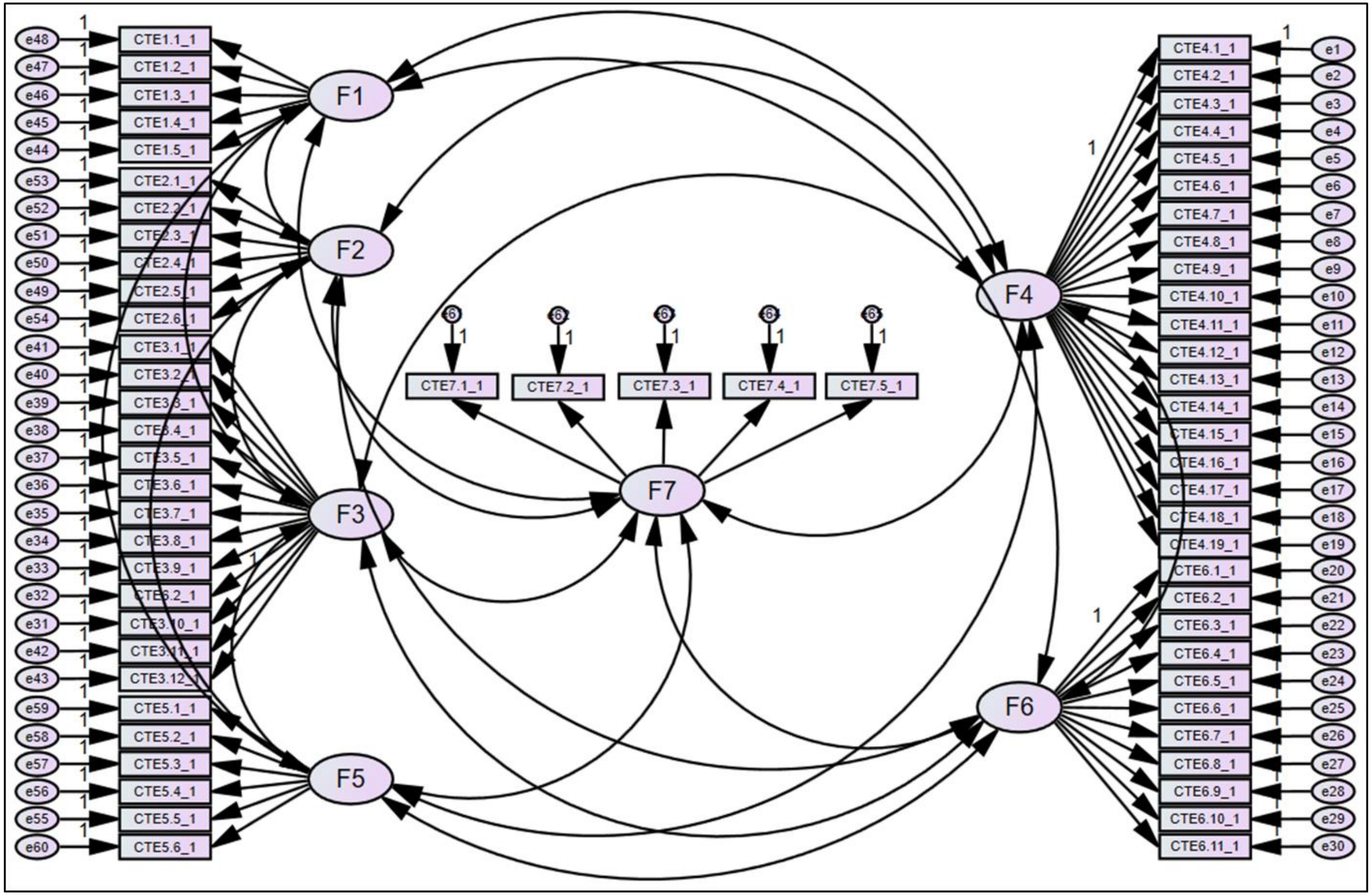

Figure 6.23 Hypothetical Model Showing Relationship Between Client Involvement and Project Health and Safety Performance

The hypothetical model in Figure 6.23 was developed using the framework of client influence related factors and dimension of project H&S success from previous studies. The arrows in Figure 6.23 represent the direction of the hypothesised client influences on the project H&S performance. The corresponding hypotheses are as follows:

H_1: Construction client attitude towards H&S has direct influence on project H&S performance.

H_2: Client ability to communicate their H&S requirements can directly improve project H&S performance.

H_3: The selection of contractors by construction clients based on proven H&S track records can lead to improved project H&S performance.

H_4: The stipulation of H&S duties for all participants in the construction project by construction clients in the contractual arrangement can improve project H&S performance.

H_5: The involvement of construction clients before and during construction directly improve project H&S performance.

H_6: The monitoring of contractor H&S compliance by construction clients can directly improve the project H&S.

6.7.1 Confirmatory Factor Analysis (CFA)

According to Statistics Solutions (2013), CFA is a multivariate statistical procedure that is used to test how well the measured variables represent the number of constructs. Yale, Jensen, Carcioppolo, Sun and Liu (2015) described CFA as a necessary and important step that must be followed after the EFA has been conducted. Statistics Solutions (2013) pointed out that in EFA all measured variables are related to every latent variable while in CFA researchers can specify the number of factors required in the data – and which measured variable is related to which latent variable. During the CFA process the measurement theory can either be confirmed or rejected (Statistics Solutions, 2013).

After the EFA analysis was conducted using SPSS, the resulting constructs from the EFA were validated using Confirmatory Factor Analysis (CFA) in SPSS AMOS. The CFA was performed using the initially hypothetical model (Figure 22) to test the covariance structure of latent variables. Ahmad, Zulkurnain and Khairushalimi (2016) point out that CFA is a special form of factor analysis, employed to test whether the measure of a construct is consistent with the researcher's understanding of the nature of that construct. As the hypothetical model was based on theoretical expectations and past empirical findings, it was necessary to be subjected to the CFA process so that it shows the extent to which it meets the standard indices of model fit. Figure 6.24 shows the measurement model combining all constructs after running the CFA process. The items that have factor loading of below 0.60 were deleted. The measurement model was refined to check for reliability and validity, and if the values of fitness indices achieve the required level.

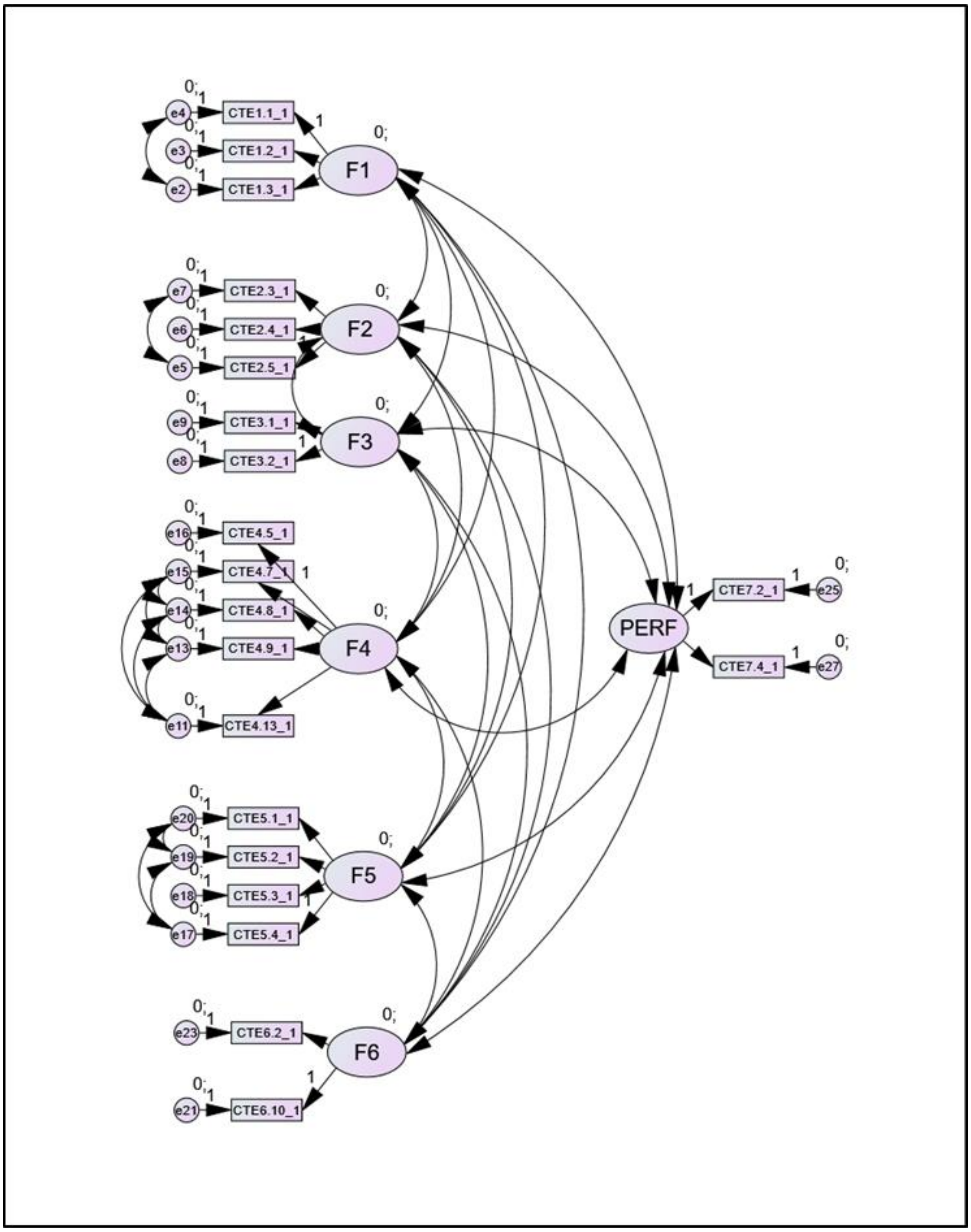

Figure 6.24 CFA Measurement Model

6.7.2 CFA Measurement Model – Reliability and Validity

After EFA, the constructs were again assessed for reliability and validity. This is done to check further, how well the measurement factors fit the theory. Ahmad, Zulkurnain and Khairushalimi, (2016), described reliability as the extent of how reliable the said measurement model is, in measuring the intended latent constructs. According to Ahmad et al., (2016) the reliability of measurement model is assessed based on the three criteria as described in Table 6.33.

Table 6.33 Criteria for Assessing the Measurement Model

Reliability	Criteria
Internal Reliability	Internal reliability is achieved when the Cronbach's alpha value is 0.6 or higher.
Construct Reliability	The measure of reliability and internal consistency of the measured variables representing a latent construct. To achieve the construct reliability, a value of CR ≥ 0.6 is required.
Average Variance Extracted	Average Variance Extracted is the average percentage of variation explained by the items in a construct. An AVE ≥ 0.5 is required.

Adapted from Ahmad et al., (2016)

Table 6.34 shows the results from the CFA process, and indicates that the factor loadings range from 0.580 to 0.947. All of the factors met the adopted threshold of 0.5 as recommended by Anderson and Gerbing (1988). Taber (2017) stated that Cronbach's alpha is a statistic commonly quoted by authors to demonstrate that tests and scales that have been constructed or adopted for research projects are fit for purpose. Goforth (2015) defines Cronbach's alpha as a measure used to assess the reliability, or internal consistency, of a set of scale or test items.

As mentioned by McLeod (2013), internal reliability is the extent to which a measure is consistent with itself, while an external reliability is the extent to which a measure varies from one use to another. Ahmad et al., (2015) stated that internal reliability is achieved when the Cronbach's alpha value is 0.6 or higher. The Cronbach's alpha of all the constructs from Table 34 ranges from 0.792 to 0.951 which is above the 0.7 threshold and indicate that the all the constructs have a high internal consistency.

Ahmad et al., (2016) explain that construct reliability is the measure of reliability and internal consistency of the measured variables representing a latent construct. To achieve the construct reliability, a value of CR ≥ 0.6 is required (Ahmad et al., 2016). For this study, CR the construct range is from 0.791 to 0.920 (Table 34). This indicates that the construct reliability of all constructs was achieved.

Ahmad et al., (2016) describe the Average Variance Extracted (AVE) as the average percentage of variation explained by the items in a construct; they, too, state that an AVE ≥ 0.5 is required. Table 6.34 indicates the AVE ranges from 0.570 to 0.819 and that the requirements of AVE ≥ 0.5 were achieved.

Table 6.34 Reliability of All Constructs from the CFA Process

Summary of All Constructs				
Factors	Factor Loading	Cronbach's Alpha	CR	**AVE**
F1_1: Client Attitude towards Health and Safety				
CTE1.1_1	0.845	0.829	0.821	0.606
CTE1.2_1	0.749			
CTE1.3_1	0.754			
F2_2: Client Ability to Communicate Health and Safety Requirements to All Stakeholders				
CTE2.3_1	0.823	0.878	0.873	0.696
CTE2.4_1	0.855			
CTE2.5_1	0.843			
F3_3: Selection of Contractors Based on Health and Safety Performance Record				
CTE3.1_1	0.820	0.792	0.791	0.654
CTE3.2_1	0.797			
F4_4: Contractual Health and Safety Arrangement				
CTE4.5_1	0.580	0.951	0.920	0.703
CTE4.7_1	0.840			
CTE4.8_1	0.901			
CTE4.9_1	0.947			
CTE4.13_1	0.812			
F5_5: Client Involvement Before and During Construction				
CTE5.1_1	0.604	0.890	0.849	0.590
CTE5.2_1	0.686			

CTE5.3_1	0.846			
CTE5.4_1	0.892			
F6_6: Monitoring of Contractor Health and Safety Performance				
CTE6.2_1	0.640	0.821	0.797	0.570
CTE6.10_1	0.694			
F7_7: Project Health and Safety Performance				
CTE7.2_1	0.865	0.920	0.900	0.819
CTE7.4_1	0.943			

Zainudin (2015) defined validity as the ability of the instrument to measure what was supposed to be measured for a construct. According to Ahmad et al., (2016) the validity of a measurement model is assessed based on the three types of validity requirements as shown in Table 6.35.

Table 6.35 Requirements for Validity

Validity	Requirements
Convergent Validity	The convergent validity is achieved when all items in a measurement model are statistically significant. This validity could also be verified through Average Variance Extracted (AVE). The value of AVE should be greater or equal to 0.5 to achieve this validity.
Construct Validity	The construct validity is achieved when the Fitness Indices achieve the level of acceptance. (Refer to Table 37).
Discriminant Validity	The discriminant validity is achieved when the measurement model is free from redundant items. Another requirement for discriminant validity is the correlation between each pair of latent exogenous construct should be less than 0.85. Other than that, the square root of AVE for the construct should be higher than the correlation between the respective constructs (Hair et al., 2010)

In Table 6.36, the convergent validity was conducted using AVE. The composite reliability of each latent variable was estimated, as it is a more suitable indicator of reliability than Cronbach's coefficient alpha (Qazi, and Umer, 2016). Moreover, MaxR (H) that refers to McDonald Construct Reliability and Maximum Shared Variance (MSV) were estimated. Table 6.36 further shows that the CR results of all of the seven latent constructs are greater than 0.70 and AVE exceeded 0.50, showing a very good construct reliability and convergent validity respectively (Byrne, 2010). Farrell (2009) stated that if the square root of the AVE (which is shown on diagonals in bold faces) is greater than the rest of the inter-construct correlations, the discriminant validity between the seven latent constructs is established. Hair et al., (2010) suggested the following thresholds for testing reliability and validity:

- CFA: Reliability: CR > 0.7
- Convergent Validity: AVE > 0.5
- Discriminant Validity: MSV < AVE
- Square root of AVE greater than inter-construct correlations

Table 6.36 Model Validity Measures

Constructs	CR	AVE	MSV	MaxR (H)	F1	F2	F3	F4	F5	F6	PERF
F1	0,821	0,606	0,230	0,829	**0,778**						
F2	0,873	0,696	0,260	0,878	0,480***	**0,834**					
F3	0,791	0,654	0,075	0,792	0,215*	0,158	**0,809**				
F4	0,920	0,703	0,085	0,951	0,290*	0,276*	0,275*	**0,839**			
F5	0,849	0,590	0,259	0,890	0,278**	0,489***	0,213*	0,292*	**0,768**		
F6	0,797	0,570	0,260	0,821	0,299**	0,510***	-0,163	0,137	0,509***	**0,755**	
PERF	0,900	0,819	0,066	0,920	0,007	0,066	0,256*	0,256*	0,093	-0,094	**0,905**

6.7.3 CFA Model Fit Indices

According to Byrne (2006) and Hu & Bentler (1999), the primary objective of SEM is the assessment of model fitness against empirical data and the estimation of the regression parameters. There are several model fit indices that are used in the assessment of model fitness namely, absolute, incremental and parsimonious fit indices. Hazen (2015) suggests the use of Comparative Fit Index (CFI) with values ranging from 0.0 to 1.0;

- values closet to 1.0 being ideal
- Root Mean Square Error of Approximation (RMSEA) where a value zero indicates best fit
- mode chi-square ($\chi 2m$) a significant ($p<.05$)
- Standard Root Mean Square Residual (SRMR) with values ranging from zero
- values closest to 0.0 being ideal
- Goodness-of-Fit Index (GFI) with values ranging from 0.0 to 1.0

- and values closet to 1.0 being ideal and a confidence interval for RMSEA

Table 6.37 shows model fit indices and their acceptable thresholds used to test acceptance level of a model.

Table 6.37 Model Fit Indices with their Acceptable Thresholds

Model Fit Index	Abbreviation	Acceptable Threshold	Source
Absolute Fit Indices			
Chi-Square Significance	$\chi 2$	$P<0.05$	Hazen (2015)
Relative Normed Chi-Square value	CMIN/DF	<2	Marsh and However (1985)
Random Measures of Sample Error Approximation	RMSEA	<0.080 <0.06	Browne and Cudeck (1993); Hu & Bentler (1999)
Standard Root Mean Square Residual	SRMR	≤ 0.080	Kaiser (1960); Tucker and Lewis (1973); Hu & Bentler (1999); Kline (2015); Hazen (2015)
Goodness-of-Fit Index	GFI	>0.900	Joreskog and Sorbom (1984); Hooper et al., (2008); Hazen (2015)
Adjusted Goodness-of-Fit Index	AGFI	>0.900 >0.85	Tanaka and Huba (1985); Schermelleh-engel et al., (2003)
Hoelter's CN (p=0.01)	CN (p=0.01)	>200	Hoelter (1983)
Incremental Fit Indices			
Incremental Fit Index	IFI	>0.900	McDonald and Ho (2002); Miles and Shevlin (2007)
Normed Fit Index	NFI	>0.900	Bollen (1989); (Arbuckle, 1995)
Comparative Fit Index	CFI	>0.900 >0.95	Bentler (1990); Hu & Bentler (1999); Hazen (2015)
Tucker Lewis Index	TLI	>0.900 >0.95	Bentler and Bonett (1980) Hu & Bentler (1999)
Relative Fit Index	RFI	>0.900	Jöreskog and Sörbom (1993)
Parsimonious Fit Indices			
Parsimony Adjusted Normed Fit Index	PNFI	>0.900	Mulaik et al., (1989)
Parsimony Adjusted Comparative Fit Index	PCFI	>0.900	Mulaik et al., (1989)

Hooper, Coughlan and Mullen (2008) mentioned that absolute fit indices determine how well and a priori model fits the sample data and demonstrates which proposed model has the most superior fit. Hooper, et al., (2008) added that absolute indices provide the most fundamental indication of how well the proposed theory fits the data; they argued that unlike incremental fit indices, absolute indices calculation does not rely on comparison with a baseline model but is instead a measure of how well the model fits (in comparison to no model at all). Absolute fit indices include:

- model chi-square (X^2)
- Root Mean Square Error of Approximation (RMSEA)
- Goodness-Of-Fit (GFI) statistic and the Adjusted Goodness-Of-Fit (AGFI) statistic
- Root Mean Square Residual (RMR)
- Standardized Root Mean Square Residual (SRMR)

Hooper et al., (2008) describe incremental fit indices as a group of indices that do not use the chi-square in its raw form but compare the chi-square value to a baseline model. McDonald and Ho (2002) pointed out that in incremental fit indices, null hypothesis for all variables are uncorrelated. The incremental fit indices include Normed-Fit Index (NFI) and Comparative Fit Index (CFI). Hooper et al., (2008) note that NFI assesses the model by comparing the $\chi 2$ value of the model to the $\chi 2$ of the null model. Hooper et al., 2008) adds that CFI is one of the most popularly reported fit indices, due to being one of the measures least affected by sample size and is included in all SEM programs.

Hooper et al., (2008) suggest that parsimonious fit indices were developed to penalise for model complexity – because complex, nearly saturated models are dependent on the sample during the estimation process. Parsimonious fit indices are Parsimony Goodness-of-Fit Index (PGFI) and the Parsimonious Normed Fit Index (PNFI). Hooper et al., (2008) strongly recommend the use of parsimony fit indices in tandem with other measures of goodness-of-fit however, because no threshold levels for these statistics have been recommended and it has made them more difficult to interpret. There are many different fit statistics, that researchers use to assess their confirmatory factor analyses and structural equation models. A list of the most popular fit statistics and recommended cut-offs that indicate a good fit based on literature were used. Table 6.38 shows the model fit indices and their cut-off criteria that were adopted for the study.

Table 6.38 Adopted Model Fit Indices Cut-off Criteria

Measure	Terrible	Acceptable	Excellent
CMIN/DF	> 5	> 3	<2
CFI	<0.90	<0.95	>0.95
SRMR	>0.10	>0.08	<0.08
RMSEA	>0.08	>0.06	<0.06
CLOSE	<0.01	<0.05	>0.05

The summary of the measurement model fit indices is depicted in Table 6.39. All value of fitness indices for the model have achieved the level of acceptance – except for the chi-square which achieved P=0.000 compared to the required threshold of P>0.05 (Wheaton, 1987). The Relative Normed Chi-Square (CMIN/DF) value met the required threshold of being <2 (Marsh and However, 1985). The Comparative Fit Index value of 0,921 was acceptable when compared to the required threshold of >0.900 (Bentler 1990). The Standard Root Mean Square Residual (SRMR) of 0,067 was achieved when compared to <0.080 (Kaiser, 1960; Tucker and Lewis, 1973); Hu & Bentler, 1999 and Kline (2015). The Random Measures of Sample Error Approximation (RMSEA) of 0,070 was acceptable when compared to <0.080 (Browne and Cudeck, 1993). A PClose of 0.016 achieved the acceptable level when compared to the excellent level of >0.05 (Browne and Cudeck, 1993). Therefore, the measurement model exhibits an acceptable model fit.

Table 6.39 Summary of Measurement Model Fit Indices

Measure	Estimate	Threshold	Interpretation
CMIN	261,519	--	--
DF	157,000	--	--
CHI-SQUARE	P=0.000	P>0.05	Terrible
CMIN/DF	1,666	Between 1 and 3	Excellent
CFI	0,921	>0.95	Acceptable
SRMR	0,067	<0.08	Excellent
RMSEA	0,070	<0.06	Acceptable
PCLOSE	0,016	>0.05	Acceptable

6.7.4 CFA Results Summary

The main purpose of the CFA was to assess how well the measured variables represent the number of constructs and to test the validity and reliability of a measurement model using SEM. The measurement model has achieved its reliability (refer to Table 6.34) and validity (Table 6.36). The convergent validity was achieved through the value of AVE which was higher than 0.50 (Fornell and Larcker, 1981). According to Ahmad et al., (2016) if fitness indices for the measurement model achieved the level of acceptance, then the construct validity achieved the required level (Table 6.37). The correlation between all constructs was less than 0.85 (Table 6.36) and the square root of AVE for all of the constructs was higher than the correlation between the respective constructs (Hair et al., 2010).

Since values of Cronbach's alpha for all constructs in the measurement model were greater than 0.6 therefore, the internal reliability for the measurement achieved the required level (Nunnally and Bernstein, 1994). The composite reliability was achieved through the value of CR which was greater than 0.6 (Fornell and Larcker, 1981). The value of AVE for the measurement model was higher than 0.5 showing a very good construct reliability and convergent validity, respectively (Byrne, 2010). Here, the measurement model was found to be acceptable for structural modelling of further analysis.

6.7.5 Path Analysis

Wuensch (2016) defines path analysis as a method that is employed to determine whether a multivariate set of nonexperimental data fits well with a particular causal model. Schreiber et al., (2006) argue that although the strength of the path analysis lies in the ability to decompose the relationships among variables and to test the credibility of the model, its use is predicated on a set of assumptions that are highly restrictive in nature, namely,

(a) the assumption that variables used in the testing of a causal mode through path analysis, should be measured without error

(b) the assumption that error terms are not intercorrelated

(c) the supposition that the variables in the model flow are unidirectional

Schreiber et al., (2006) further add that although these assumptions are highly desirable, they rare exist. Statistics Solutions (2013) suggest that during the CFA process the measurement theory model can either be confirmed or rejected. When comparing to the CFA measurement model and the structural model (Figure 6.25), two errors (e23 and e21) from construct F6 were unlinked. These two errors were linking the two attributes (CTE6.2_1 and CTE6.10_1) from construct F6. SEM allows for the estimation of the structural or regression relationships among the constructs. As the model was found to be a good fit, the measurement model (Figure 6.25) was developed.

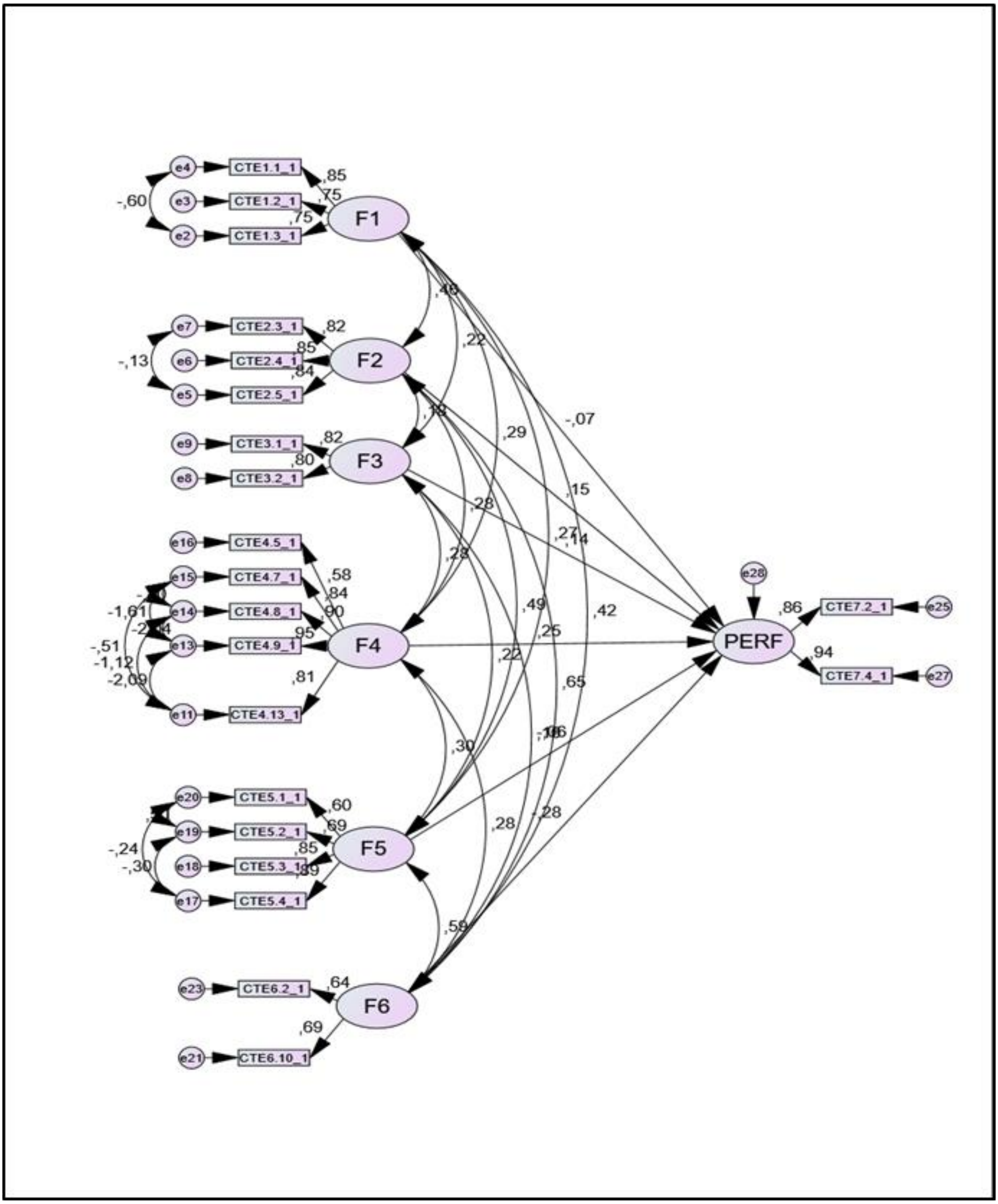

Figure 6.25 Structural Model

6.7.5.1 Structural Model Fit Indices

Table 6.40 shows the model fit indices and their cut-off criteria that were adopted.

Table 6.40 Model Fit Indices Cut-off Criteria for the Structural Model

Measure	Terrible	Acceptable	Excellent
CMIN/DF	> 5	> 3	<2
CFI	<0.90	<0.95	>0.95
SRMR	>0.10	>0.08	<0.08
RMSEA	>0.08	>0.06	<0.06
PClose	<0.01	<0.05	>0.05

The summary of the structural model fit indices is shown in Table 6.41. All the value of fitness indices for the model have achieved the level of acceptance – except for the chi-square which achieved P=0.000 compared to the required threshold of P>0.05. The CMIN/DF value met the required threshold at <2. The CFI value of 0.921 was acceptable when compared to the required threshold of >0.900) and the SRMR of 0.067 was achieved when compared to <0.080. The RMSEA of 0.070 was acceptable when compared to <0.080. A PClose of 0.016 achieved the acceptable level when compared to the excellent level of >0.05; thus, the measurement model exhibits an acceptable model fit.

Table 6.41 Model Fit Measures for the Structural Equation Model

Measure	Estimate	Threshold	Interpretation
CMIN	261,519	--	--
DF	157,000	--	--
CHI-SQUARE	P=0.000	P>0.05	Terrible
CMIN/DF	1,666	Between 1 and 3	Excellent
CFI	0,921	>0.95	Acceptable
SRMR	0,067	<0.08	Excellent
RMSEA	0,070	<0.08	Excellent
PCLOSE	0,016	>0.05	Acceptable

6.7.5.2 Model Structural Relationships

Table 6.42 provides the AMOS text output estimates of structural paths. The critical ratio, which represents the parameter estimate divided by its standard error is a significance test is. The parameter estimate is significant at $p \leq 0.05$ and value of CR is > 1.96. Among the six constructs (F1 to F6), one significant structural path among the exogenous and endogenous latent variables has been found to be significant. The relationships among the constructs were estimated from the structural and were hypothesised as follows:

- F1 (H_1) has a non-significant relationship with PERF (F7)
- F2 (H_2) has a non-significant relationship with PERF (F7)
- F3 (H_3) has a non-significant relationship with PERF (F7)
- F4 (H_4) has a positive significant relationship with PERF (F7)
- F5 (H_5) has non-significant relationship with PERF (F7)
- F6 (H_6) has non-significant relationship with PERF (F7)

Table 6.42 Structural Model Regression Weights

Constructs			Estimate	S.E.	C.R.	P	Comments
PERF	←	F1	-,075	,128	-,588	,556	Not Supported
PERF	←	F2	,124	,132	,940	,347	Not Supported
PERF	←	F3	,125	,116	1,078	,281	Not Supported
PERF	←	F4	,554	,211	2,623	,009	Supported
PERF	←	F5	,077	,105	,729	,466	Not Supported
PERF	←	F6	-,353	,292	-1,213	,225	Not Supported

Supported = Has Impact; Not Supported = No Impact

As depicted in Table 6.42, the results generally support the relationship between a contractual health and safety arrangement (F4) and project health and safety performance construct (F7). F4 is the only factor, that leads to positive effect on project health and safety performance. This indicates that as F4 increases, performance improves which validated both hypotheses H_4 and H_7. The relationship between these two factors suggests that if construction clients stipulate their health and safety requirements and also the health and safety duties (for all participants in the construction project) in the contractual arrangement (as per H_4), this can lead to improved project H&S performance. In addition, the results confirmed that H_7 hypothesised that there is a relationship between client involvement in their own construction projects and the improvement in the H&S performance of construction projects.

Contrary to the findings of previous studies, the structural model did not support the other five constructs (F1, F2, F3, F5 and F6) and as a result, hypotheses (H_1, H_2, H_3, H_5 and H_6**)** were rendered invalid by this structural model as evidenced in Figure 6.25. These results were in line with the inter-construct correlations as shown in Table 6.34 and Table 6.36, which showed that both F3 and F4 have significant positive correlation with F7 ($p<0.001$) at one per cent level of significance; the remaining four constructs (F1, F2, F5 and F6) showed no significant correlation with construct F7_7 (Project H&S Performance).

The only difference in this result is that F3 fell short of having a significant positive relationship with performance due to its CR of 1.078 not meeting the required threshold value of CR > 1.96. Although the structural model has a good fit and was found to be acceptable, it failed to take into account the relationships between the other constructs in the model. To ensure that all the possible relationships among all the constructs in the model were taken into consideration, two alternative structural models shown in Figure 6.26 and Figure 6.27 were developed, and their model fitness was evaluated using the same criteria as those adapted for the structural model in Figure 6.25.

6.7.6 Alternative Structural Model One (ASM1)

Based on the evaluation of relationships among the various factors from the initial structural model in Figure 6.25, a refined ASM1 was produced in Figure 6.26.

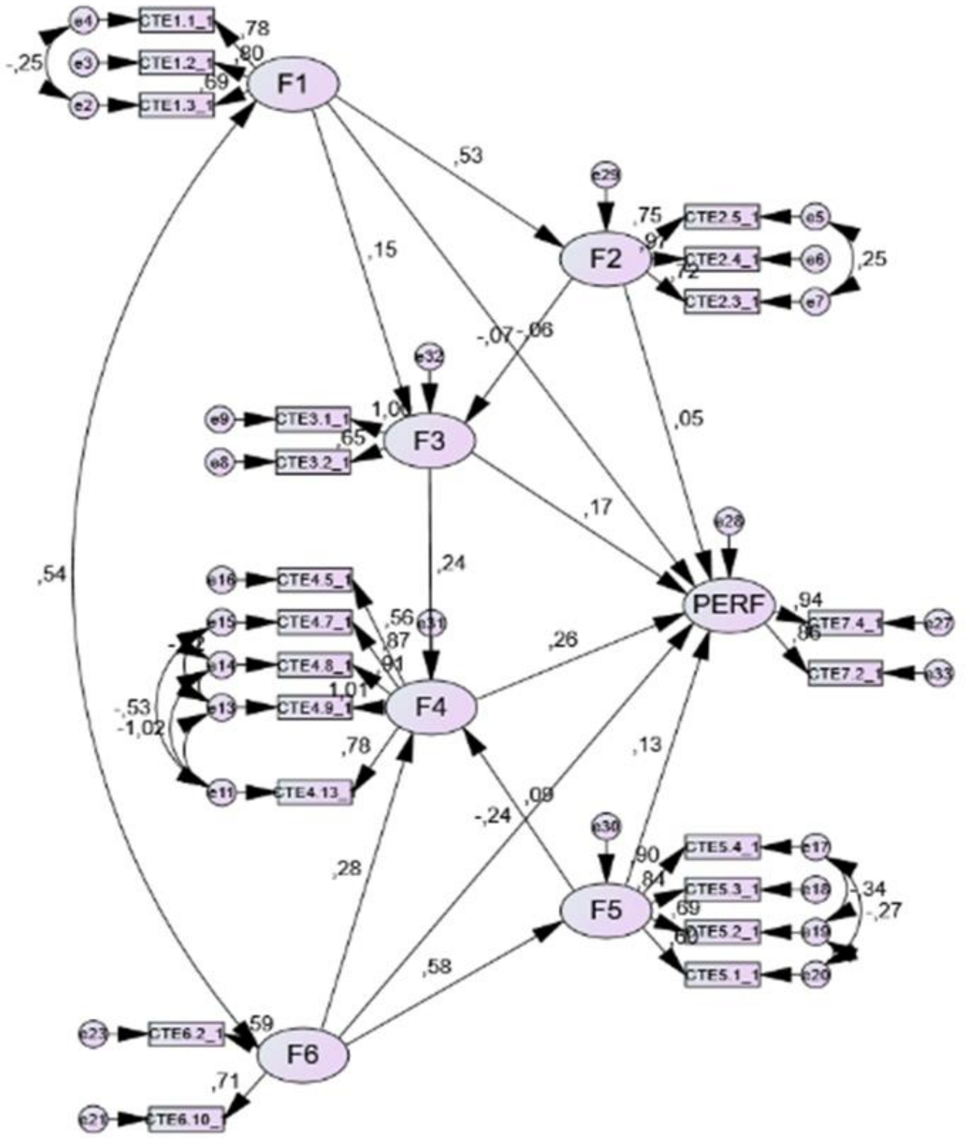

Figure 6.26 Alternative Structural Model 1

The summary of the structural model fit indices for ASM1 is shown in Table 6.43. Three out of six model fitness indices adopted for the current did not achieve the level of acceptance in the ASM1. The chi-square was P=0.000 compared to the required threshold of P>0.05. The CMIN/DF value 1.814 was achieved compared to the required threshold at <2. The CFI value 0,899 was not acceptable as it fell short of meeting the required threshold of >0.900. The SRMR value of 0.108 was acceptable when compared to required threshold of <0.080. The RMSEA value of 0.078 was acceptable when compared to the required threshold of <0.080. A PClose value of 0.001 was not acceptable when compared to the required threshold level of >0.05, thus ASM1 exhibits a poor model fit when compared to the initial structural model in Figure 6.25 and requires some refinement.

Table 6.43 Alternative Structural Model 1 Fit Indices

Measure	Estimate	Threshold	Interpretation
CMIN	297,556	--	--
DF	164,000	--	--
CHI-SQUARE	P=0.000	P>0.05	Terrible
CMIN/DF	1,814	Between 1 and 3	Excellent
CFI	0,899	>0.95	Terrible
SRMR	0,108	<0.08	Acceptable
RMSEA	0,078	<0.08	Excellent
PCLOSE	0,001	>0.05	Terrible

Table 6.44 shows the AMOS text output estimates of structural paths for ASM1. The critical ratio which represents the parameter estimate divided by its standard error, is a significance test. The parameter estimate is significant at p≤0.05 and value of the critical ratio is > 1.96. Among the six constructs (F1 to F6), four significant relationships among the exogenous and endogenous latent variables were found to be significant. The relationships among the constructs were estimated from the structural model (ASM1) and were hypothesised as follows:

- F1 has a positive significant relationship with F2
- F6 has a positive significant relationship with F5
- F1 has a non-significant relationship with F3
- F2 has a no-significant relationship with F3

- F6 has non-significant relationship with F4
- F3 has a positive significant relationship with F4
- F5 has a non-significant relationship with F4
- F1 (H_1) has a non-significant relationship with PERF (F7)
- F2 (H_2) has a non-significant relationship with PERF (F7)
- F3 (H_3) has a non-significant relationship with PERF (F7)
- F4 (H_4) has a positive significant relationship with PERF (F7)
- F5 (H_5) has non-significant relationship with PERF (F7)
- F6 (H_6) has non-significant relationship with PERF (F7)

Table 6.44 Alternative Structural Model 1 Regression Weights

Constructs			Estimate	S.E.	C.R.	P	Comments
F2	←	F1	,670	,153	4,373	***	Supported
F5	←	F6	,975	,217	4,488	***	Supported
F3	←	F1	,164	,134	1,220	,223	Not Supported
F3	←	F2	-,059	,095	-,622	,534	Not Supported
F4	←	F6	,147	,077	1,894	,058	Not Supported
F4	←	F3	,116	,049	2,384	,017	Supported
F4	←	F5	,028	,033	,875	,381	Not Supported
PERF	←	F1	-,066	,174	-,382	,702	Not Supported
PERF	←	F2	,048	,102	,469	,639	Not Supported
PERF	←	F3	,187	,104	1,798	,072	Not Supported
PERF	←	F4	,600	,219	2,742	,006	Supported
PERF	←	F5	,092	,094	,979	,328	Not Supported
PERF	←	F6	-,293	,237	-1,234	,217	Not Supported

Supported = Has Impact; Not Supported = No Impact

As depicted in Table 6.44, the results generally support the relationship between Contractual H&S Arrangement (F4) and Project H&S Performance Construct (F7). F4 is the only factor, which leads to a positive effect on project H&S performance – as it was the case in the initial structural model shown in Figure 24. This once again indicates that as F4 increases, performance improves which validates both hypotheses H_4 and H_7. The relationship between these two factors suggests that if construction clients stipulate their H&S requirements and also the H&S duties for all participants in the construction project in the contractual arrangement (as per H_4), this can lead to an improved project H&S performance. The results also confirmed that H_7 hypothesised that there is a relationship between client involvement in their own construction projects and the improvement in the H&S performance of construction projects.

Contrary to the initial structural model in Figure 6.24, the ASM1 shows some positive significant relationships between a few of the constructs as indicated in Table 6.42. F1 has a positive significant relationship with F2. This means that the attitude of clients towards H&S (F1) has an effect in the way the construction clients communicate their H&S requirements to all stakeholders (F2) and can indirectly improve project H&S performance. F6 has a positive significant relationship with F5. This means that the monitoring of contractor H&S compliance (F6) can lead to improvement in client involvement during the construction phases (F5) and creating an environment where all H&S issues are resolved timeously.

F3 has a positive significant relationship with F4. This means that the selection of contractors are based on their past performance records (F3); construction clients will not have problems with contractual H&S issues (F4) on their sites, and assures the client that there will be no project delays due to contractual H&S issues. Although ASM1 was not a good fit model when compared to the initial structural model shown in Figure 6.24, it has provided some positive significant relationships between some of the constructs. Due to the weakness of ASM1 model fit indices, the model was further refined as per Figure 6.27 (ASM2).

6.7.7 Alternative Structural Model Two (ASM2)

ASM2 builds on the results of ASM1 by looking for factors that exhibit relationships that result in an improved model fit. Figure 6.27 shows the refined structural model.

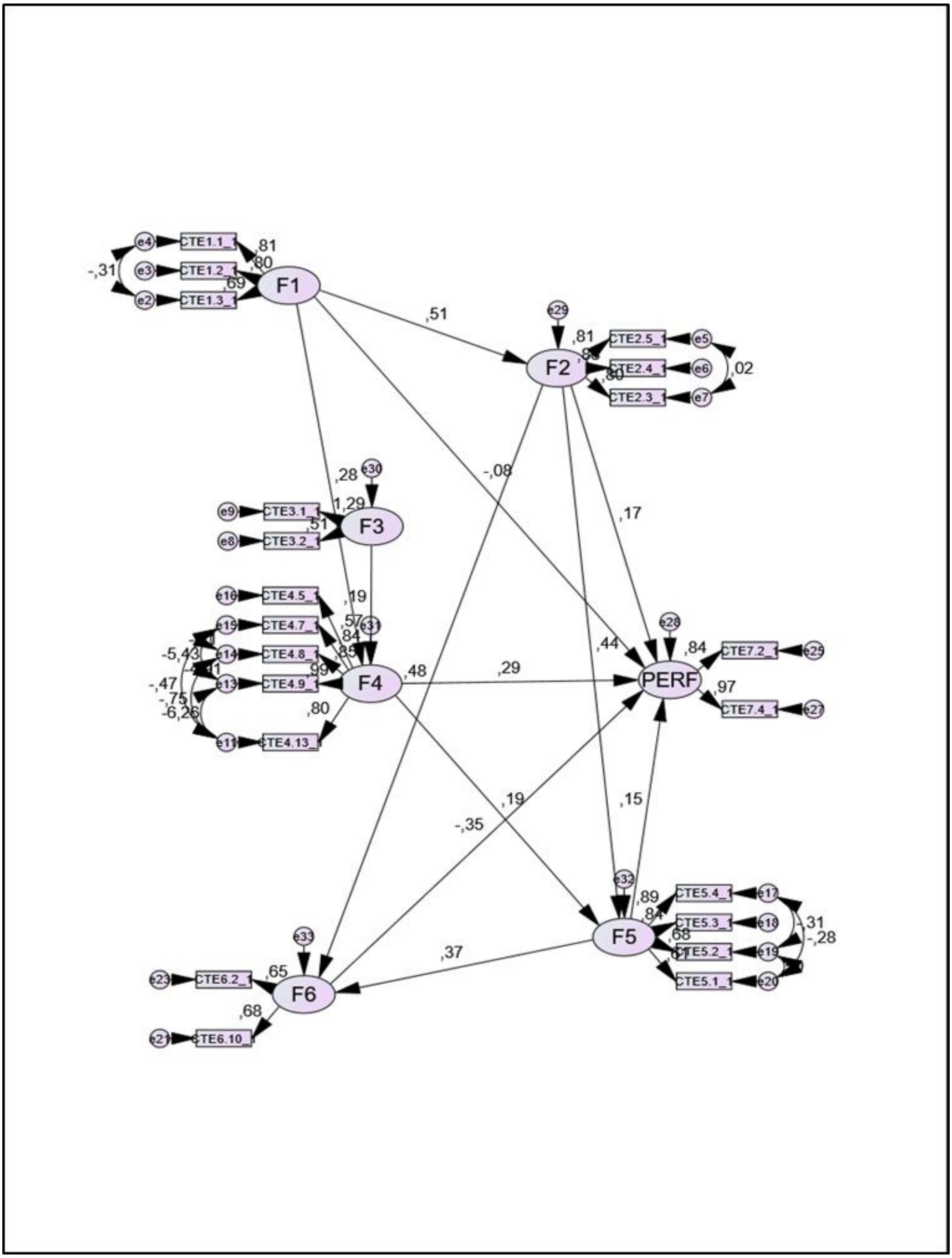

Figure 6.27 Alternative Structural Model 2

The summary of the structural model fit indices for ASM2 are shown in Table 6.45. One out of six model fitness indices adopted for the current model did not achieved the level of acceptance in the ASM2. The chi-square was P=0.000 compared to the required threshold of P>0.05. The CMIN/DF value 1,661 was achieved compared to the required threshold of being <2 and was excellent. The CFI value 0,917 was in terms of the established cut-off criteria for this present study acceptable. The SRMR value of 0,086 was within the acceptable threshold of <0.080. The RMSEA value of 0,070 was acceptable when compared to the required threshold of <0.080. A PClose value of 0.001 was not acceptable when compared to the required threshold level of >0.05; thus, ASM2 had a good model fit when compared to ASM1 in Figure 6.25 and did not require any further refinement.

Table 6.45 Alternative Structural Model 2 – Model Fit Measures

Measure	Estimate	Threshold	Interpretation
CMIN	275,679	--	--
DF	166,000	--	--
CHI-SQUARE	P=0.000	P>0.05	Terrible
CMIN/DF	1,661	Between 1 and 3	Excellent
CFI	0,917	>0.95	Acceptable
SRMR	0,086	<0.08	Excellent
RMSEA	0,070	<0.08	Excellent
PCLOSE	0,015	>0.05	Acceptable

The resulting structural relationships from the alternative ASM2 model are shown in the Table 6.46. The significant relationships are highlighted green. In terms of the relationships with performance consistent with the initial structural model and the alternative structural model one, only F4 has an effect on performance. All of the six constructs (F1 to F6), show significant relationships among the exogenous and endogenous latent variables. The relationships among the constructs were estimated from the structural model (ASM2) and were hypothesised as follows:

- F3 has a positive significant relationship with F4
- F1 has a positive significant relationship with F2
- F1 has a non-significant relationship with F4
- F2 has a no-significant relationship with F5

- F4 has non-significant relationship with F5
- F2 has a positive significant relationship with F6
- F5 has a non-significant relationship with F6
- F1 (H_1) has a non-significant relationship with PERF (F7)
- F2 (H_2) has a non-significant relationship with PERF (F7)
- F3 (H_3) has a non-significant relationship with PERF (F7)
- F4 (H_4) has a positive significant relationship with PERF (F7)
- F5 (H_5) has non-significant relationship with PERF (F7)
- F6 (H_6) has non-significant relationship with PERF (F7)

All six constructs (F1 to F6) show significant relationships among the exogenous and endogenous latent variables. ASM2 has proven to be the best model of all three that were tested. It has a good model fit and has shown positive significant relationships among all constructs, even although only one construct has a direct effect on the project health and safety performance.

Table 6.46 Alternative Structural Model 2 Regression Weights

Constructs			Estimate	S.E.	C.R.	P	Comment
F4	←	F3	,119	,049	2,424	,015	Supported
F2	←	F1	,676	,146	4,624	***	Supported
F4	←	F1	,144	,056	2,558	,011	Supported
F5	←	F2	,518	,112	4,626	***	Supported
F5	←	F4	,591	,230	2,567	,010	Supported
F6	←	F2	,326	,087	3,737	***	Supported
F6	←	F5	,211	,071	2,982	,003	Supported
PERF	←	F2	,145	,140	1,037	,300	Not Supported
PERF	←	F4	,640	,210	3,043	,002	Supported
PERF	←	F5	,110	,098	1,132	,258	Not Supported
PERF	←	F6	-,437	,269	-1,627	,104	Not Supported
PERF	←	F1	-,096	,133	-,721	,471	Not Supported

***$p < 0.001$
Supported = Has Impact; Not Supported = No Impact

6.7.8 Correlation Analysis of Factors and Each Individual Indicator of Performance

Table 6.47 shows the correlation of all the variables. Pearson's coefficient was used because the Shapiro-Wilk test showed that the data is not normally distributed. The correlations were used to understand the relationships between the various factors and each individual indicator of performance. The correlations show that the first (CTE7.1_1 = FAIFR) and last (CTE7.5_1 = AIFR) indicators of performance are not influenced by any of the research variables. The second (CTE7.2_1 = MTIFR), third (CTE7.3_1 = LTIFR) and fourth (CTE7.4_1 = RIFR/RCR) indicators of project performance are all influenced by F3 (F3 = Selection of Contractors) and F4 (F4 = Contractual H&S Arrangement). The correlation is positive and according to how data was coded, when performance variable F3 and F4 increases, performance improves.

Table 6.47 Correlation Analysis of Constructs and Performance Indicators

Correlations

		CTE7.1_1	CTE7.2_1	CTE7.3_1	CTE7.4_1	CTE7.5_1	F1_1	F2_2	F3_3	F4_4	F5_5	F6_6	F7_7
Correlation Coefficient	CTE7.1_1	1.000	.100	.029	.148	.752**	-.009	.024	.027	-.040	.018	.106	.120
	CTE7.2_1	.100	1.000	.235**	.799**	.276**	.019	.065	.286**	.223**	.053	-.049	.982**
	CTE7.3_1	.029	.235**	1.000	.488**	.173*	.243**	.139	.173*	.291**	.089	.034	.334**
	CTE7.4_1	.148	.799**	.488**	1.000	.326**	.094	.091	.283**	.296**	.076	-.046	.894**
	CTE7.5_1	.752**	.276**	.173*	.326**	1.000	.035	.093	-.005	.004	.052	.000	.302**
	F1_1	-.009	.019	.243**	.094	.035	1.000	.458**	.240**	.348**	.245**	.292**	.046
	F2_2	.024	.065	.139	.091	.093	.458**	1.000	.213*	.352**	.447**	.444**	.077
	F3_3	.027	.286**	.173*	.283**	-.005	.240**	.213*	1.000	.297**	.161	-.051	.308**
	F4_4	-.040	.223**	.291**	.296**	.004	.348**	.352**	.297**	1.000	.284**	.185*	.263**
	F5_5	.018	.053	.089	.076	.052	.245**	.447**	.161	.284**	1.000	.457**	.063
	F6_6	.106	-.049	.034	-.046	.000	.292**	.444**	-.051	.185*	.457**	1.000	-.047
	F7_7	.120	.982**	.334**	.894**	.302**	.046	.077	.308**	.263**	.063	-.047	1.000

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

6.8 Summary of Key Findings

The final SEM results suggested that the contractual health and safety arrangement (F4) is the only factor that has a direct effect on project health and safety performance. This indicates that as F4 increases, performance improves which validated both hypotheses H4 and H7. The relationship between these two factors suggests that if construction clients stipulate their H&S requirements and the H&S duties for all participants in the construction project in the contractual arrangement (as per H4), this can lead to an improved project H&S performance. The study has also revealed that all of the six constructs have positive significant relationships amongst each other. This is an indication of an indirect influence on the project health and safety performance.

The correlations show that the first (CTE7.1_1 = FAIFR) and last (CTE7.5_1 = AIFR) indicators of performance are not influenced by any of the research variables. The second (CTE7.2_1 = MTIFR), third (CTE7.3_1 = LTIFR) and fourth (CTE7.4_1 = RIFR/RCR) indicators of project performance are all influenced by F3 (F3 = Selection of Contractors) and F4 (F4 = Contractual H&S Arrangement). The correlation was positive and according to how data was coded, when variables F3 and F4 increase, performance improves. The significant findings from the study with significant relationships retained are shown in Table 6.48. The final structural model is shown in Figure 6.28.

Table 6.48 Final Structural Model Constructs Relationships

Constructs			Estimate	S.E.	C.R.	P	Comment
F4	←	F3	,119	,049	2,424	,015	Significant
F2	←	F1	,676	,146	4,624	***	Significant
F4	←	F1	,144	,056	2,558	,011	Significant
F5	←	F2	,518	,112	4,626	***	Significant
F5	←	F4	,591	,230	2,567	,010	Significant
F6	←	F2	,326	,087	3,737	***	Significant
F6	←	F5	,211	,071	2,982	,003	Significant
PERF	←	F2	,145	,140	1,037	,300	Non-Significant
PERF	←	F4	,640	,210	3,043	,002	Significant
PERF	←	F5	,110	,098	1,132	,258	Non-Significant
PERF	←	F6	-,437	,269	-1,627	,104	Non-Significant
PERF	←	F1	-,096	,133	-,721	,471	Non-Significant

*** $p < 0.001$

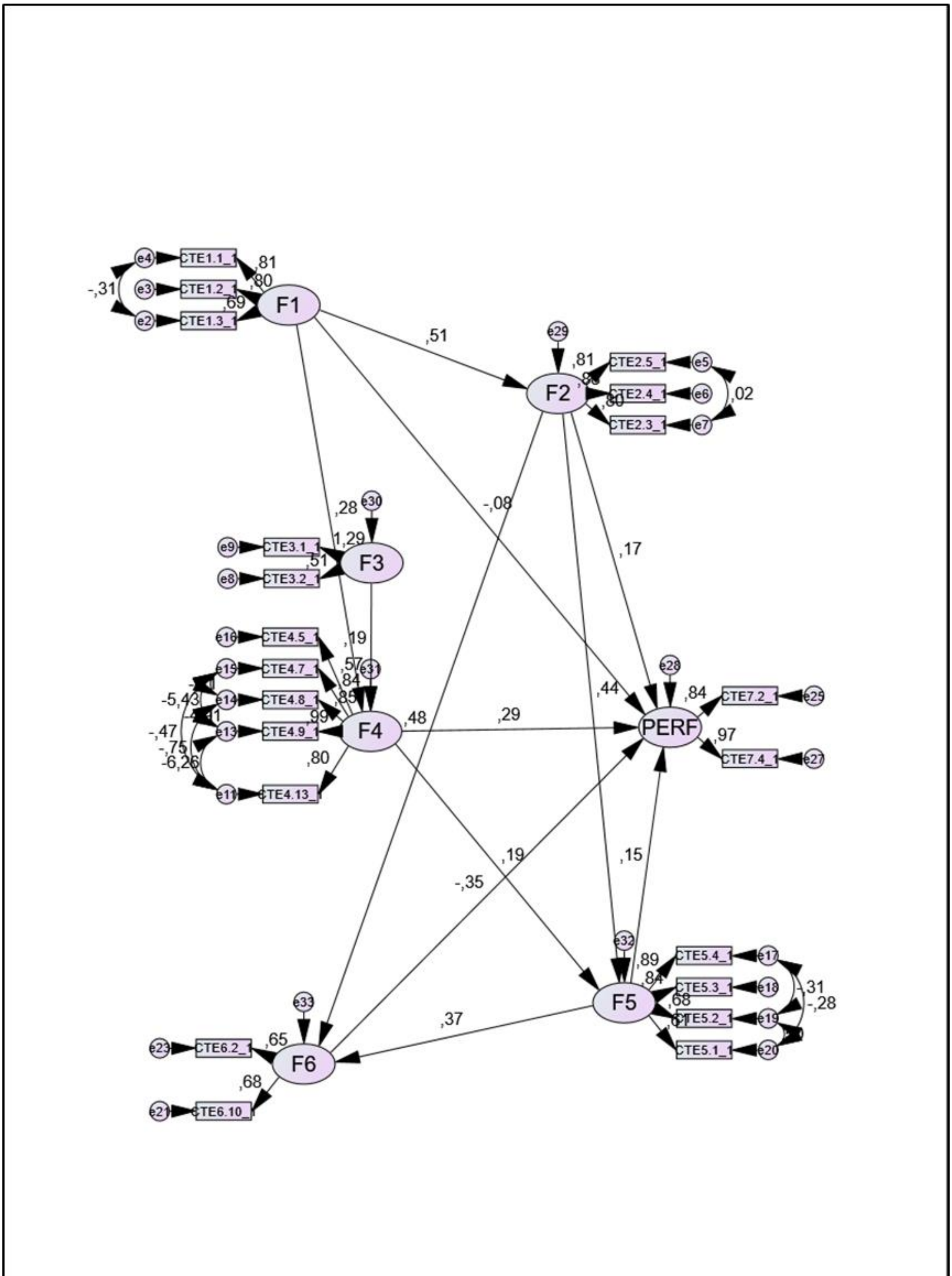

Figure 6.28 Final Structural Model for the Study

6.9 Direct and Indirect Effect

Hazen et al., (2015) found after examination of adequacy for the measurement and structural model, it can be used as the basis for hypothesis testing. The structural model (Figure 6.29) displays the interrelations among the latent constructs and observable variables in the final model, as per results from SEM.

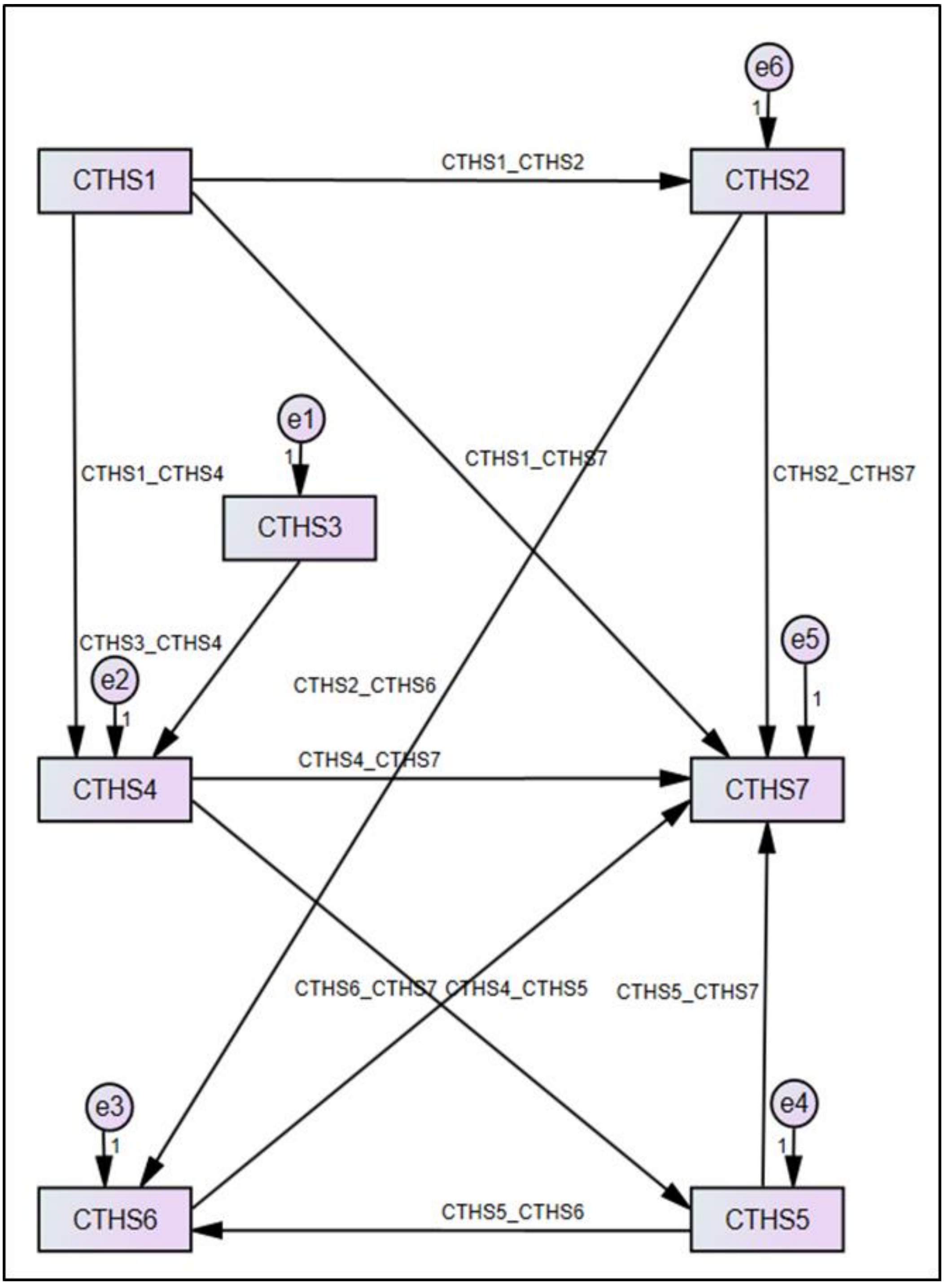

Figure 6.29 Final Structural Model Interrelationships

Schreiber et al., (2006) suggested the reporting of direct, indirect and total effect among the latent constructs as dictated by theory or empirically based suppositions. In figure 6.29, a direct effect represents the effect of an independent variable on a dependent variable. Hazen et al., (2015) suggested that to ensure simplicity and consistency, the hypothesis test results for direct effects should include the standardized beta, p-value and (if an endogenous variable), the extent of variance explained by the predictor variables (squared multiple correlation or R2).

Based on the final model (Figure 6.29), it was hypothesised that CTHS1 (F1), CTHS2 (F2), CTHS3 (F3), CTHS4 (F4), CTHS5 (F5) and CTHS6 (F6) have a direct effect on performance (PERF or CTHS7). The results of these hypotheses are shown in Table 6.48. All hypotheses except the one with CTHS4 were rejected. It was also hypothesised that CTHS3 would have a direct effect on CTHS4, CTHS1 on CTHS2, CTHS1 on CTHS4, CTHS2 on CTHS6, CTHS5 on CTHS6, CTHS2 on CTHS5 and CTHS4 on CTHS5. The hypotheses were found to be significant and acceptable (Table 6.49).

Table 6.49 Total Effect Hypotheses Results

Total Direct Effect				
Parameter	Estimate	Lower	Upper	P
CTHS4 ← CTHS3	0,119	0,012	0,25	0,019
CTHS2 ← CTHS1	0,676	0,395	1,231	0,001
CTHS4 ← CTHS1	0,144	0,036	0,396	0,01
CTHS5 ← CTHS2	0,518	0,225	0,753	0,004
CTHS5 ← CTHS4	0,591	0,001	1,978	0,05
CTHS6 ← CTHS2	0,326	0,091	0,623	0,004
CTHS6 ← CTHS5	0,211	0,009	0,372	0,039
CTHS7 ← CTHS2	0,145	-0,116	0,983	0,286
CTHS7 ← CTHS4	0,64	0,157	1,562	0,003
CTHS7 ← CTHS5	0,11	-0,097	0,603	0,275
CTHS7 ← CTHS6	-0,437	-2,278	-0,002	0,05
CTHS7 ← CTHS1	-0,096	-0,468	0,227	0,628

Hazen et al., (2015) recommended the examination of moderating and mediating variables when employing SEM in supply chain research. Hazen et al., (2015) argued that moderator analyses are important in testing complex relations, because if these relationships are not tested in most structural equation models, the relevance of study results may be seriously affected.

Based on the final model (Figure 6.29), it was also hypothesised that there is mediation and therefore indirect effect on performance (PERF) by CTHS1 through CTHS2, CTHS1 through CTHS4, CTHS2 through CTHS6, CTHS3 through CTHS4, CTHS4 through CTHS5 and CTHS5 through CTHS6.

Following the procedure suggested by Zhao et al., (2010) to identify mediation effects, a bootstrapping procedure of the specific, indirect effects was run to identify unique indirect effects for every possible mediation (Gaskin and Lim 2018). The results (Table 6.49) show that only the following have an indirect effect on performance and are statically significant:

- CTHS1 through CTHS4 has an indirect effect on CTHS7 and is statistically significant
- CTHS3 through CTHS4 has an indirect effect on CTHS7 and is statically significant

Table 6.50 Indirect Effect Hypotheses Results

Indirect Effect					
Indirect Path	Un standardized Estimate	Lower	Upper	P-Value	Standardized Estimate
CTHS1 → CTHS4 → CTHS5	0,087	0,014	0,179	0,045	0,073*
CTHS1 → CTHS4 → CTHS7	-0,026	-0,074	-0,005	0,033	-0,033*
CTHS1 → CTHS2 → CTHS6	0,113	0,042	0,197	0,009	0,126**
CTHS1 → CTHS2 → CTHS7	-0,073	-0,193	0,008	0,141	-0,091
CTHS3 → CTHS4 → CTHS5	0,354	0,217	0,493	0,002	0,255**
CTHS3 → CTHS4 → CTHS7	-0,107	-0,213	-0,029	0,028	-0,114*
CTHS4 → CTHS5 → CTHS6	0,385	0,264	0,542	0,001	0,290***
CTHS4 → CTHS5 → CTHS7	-0,017	-0,124	0,101	0,793	-0,014

CTHS5 → CTHS6 → CTHS7	0,066	-0,014	0,161	0,194	0,098
CTHS2 → CTHS6 → CTHS7	0,027	-0,001	0,084	0,119	0,034

Significance of Estimates:
*** $p < 0.001$
** $p < 0.010$
* $p < 0.050$

6.10 Client-Driven Health and Safety Measurement Rating Model

The objective of this study was to establish a model that can be used as a tool to evaluate client overall performance and which can help to identify gaps that construction clients can focus on, to improve project health and safety performance. To develop the model, it was necessary that the critical H&S factors that could be used as building blocks of the model be identified. An in-depth review of the relevant literature was undertaken to identify critical H&S elements of the proposed model. A survey questionnaire was conducted to develop the model. The proposed model was verified using SEM. The study showed that contrary to previous studies, contractual H&S arrangement was the only factor that has a direct effect on project H&S performance (Table 6.45). The study has also revealed that all of the six constructs have positive significant relationships amongst each other. This is an indication of an indirect influence on the project H&S performance. The final model is indicated by the figure 6.29 below.

6.10.1 Using the CHSRM in Practise

Based on the final structural model (Figure 6.28) for the study, the CHSRM was converted into a tool to evaluate client overall performance. The rating tool could help identify gaps that construction clients could focus on, to improve project H&S performance (Table 6.49). The CHSRM as a rating tool consists of the critical to H&S elements (CTHS1–CTHS6), the attributes/indicators known as Critical To Expectation and the rating scale. The number of attributes/indicators for each CTHS summarised in Table 6.48 are based the results of SEM. The rating scale of YES/NO, Not Applicable (N/A) or Not Verified (N/V) was preferred because the CHSRM used close-ended questions to arrive at the conclusions quickly and efficiently (Stilles, 2015). The CHSRM can be applied in practice as follows:

- **Step 1**: Rate CTHS elements using a scale of YES/NO, Not Applicable (N/A) or Not Verified (N/V). N/A indicates that either the CTHS or the CTE is not applicable to the project being assessed. Not Verified shows that the CTHS element as was not assessed (e.g. the client may choose only to assess CTHS4 based on the project specific risk that the client is interested in verifying)

- **Step 2**: The assessment score for each element/construct is calculated based on the number of compliant findings (Yes) divided by a combination of the number of compliant and non-compliant findings (Yes + No) and multiply by the weight of each CTHS, namely: CTHS1 = 0.13, CTHS2 = 0.12, CTHS3 = 0.20, CTHS4 = 0.13, CTHS5 = 0.19 and CTHS6 = 0.23). The scores are calculated as follows:
  a) CTHS1 = [(No. of Yes)/(No of Yes + No)]*CTHS1 Weight = 0.13
  b) CTHS2 = [(No. of Yes)/(No. of Yes + No)]*CTHS2 Weight = 0.12
  c) CTHS3 = [(No. of Yes)/(No. of Yes + No)]*CTHS3 Weight = 0.20
  d) CTHS4 = [(No. of Yes)/(No. of Yes + No)]*CTHS4 Weight = 0.13
  e) CTHS5 = [(No. of Yes)/(No. of Yes + No)]*CTHS5 Weight = 0.19
  f) CTHS6 = [(No. of Yes)/(No. of Yes + No)]*CTHS6 Weight = 0.23
- **Step 3**: The overall score is calculated by adding the scores of CTHS:

  Overall Rating Score = CTHS1 + CTHS2 + CTHS3 + CTHS4 + CTHS5 + CTHS6

- **Step 4:** The overall CHSRM rating score uses the traffic risk rating system as follows:

0–49% = Noncompliance (High Risk)	**50–89% = Partial Compliance (Medium Risk)**	**90% Upward Compliance (Low Risk)**

  The CHSRM risk rating score (red = high; yellow = medium and green = low) indicates the level of effort that the client is required to make to improve compliance to legal requirements and to improve project health and safety performance.

- **Step 5:** The overall CHSRM rating is compared with the benchmark score of ninety per cent. The benchmark score is set by the client at the beginning of the project.

  The CHSRM is in Microsoft Excel format and the formulae mentioned above are automated. The CTHS weights (Table 2.2) were adopted from a study by Liu et al., (2017).

- **Step 6:** The information regarding the CHSRM is captured in the section ‘Information On The Rating System’. This section explains how the scores are calculated. The client can choose to configure the CHSRM based on their perceived risk of the project.
- **Step 7:** The details of the assessor completing the CHSRM are captured in the last section.

Table 6.51 CHSRM as a Rating Tool

CTE	QUESTIONS	Y	N	N/A	N/V
CLIENT-DRIVEN OCCUPATIONAL HEALTH AND SAFETY RATING MODEL (COHSRM)					
Please rate the extent to which client is involved in the construction project by placing (1) in the appropriate box: Y = Yes = Comply, N = No = Noncompliance, N/A = Not Applicable, N/V = Not Verified.					
CTHS1: Establishing Attitudes towards Health and Safety					
CTE	QUESTIONS	Y	N	N/A	N/V
CTE 1.1	Does the client understand that their involvement contributes to health and safety performance?				
CTE 1.2	Does the client set zero harm, injury or incidents as the objectives for the project?				
CTE 1.3	Does the client go beyond a regulatory compliance approach to prevent injuries or incidents?				
Scores for CTHS1 Element					
Element Percentage					
CTHS2: Communicating Attitudes towards Health and Safety					
CTE	QUESTIONS	Y	N	N/A	N/V
CTE 2.3	Does the client communicate their commitment to health and safety to the contractors?				
CTE 2.4	Does the client demonstrate their involvement in health and safety to all project stakeholders?				
CTE 2.5	Does the client prescribe regular monitoring and reporting of performance of project stakeholders?				
Scores for CTHS2 Element					
Element Percentage		%			
CTHS3: Selection of Contractors					
CTE	QUESTIONS	Y	N	N/A	N/V
CTE 3.1	Does the client prequalify contractors?				

CTE 3.2	Does the client consider health and safety in prequalifying contractors for bidding on projects?				
Scores for CTHS3 Element					
Element Percentage		0%			
CTHS4: Contractual Health and Safety Arrangement					
CTE	QUESTIONS	Y	N	N/A	N/V
CTE 4.5	Does the client require contractors to submit a site-specific health and safety plan?				
CTE 4.7	Does the client require the contractor to submit a health and safety policy statement signed by its CEO?				
CTE 4.8	Does the client require the contractor to submit an emergency plan?				
CTE 4.9	Does the client require the contractor to submit and utilize an immediate reporting procedure for accidents and near-misses on this project?				
CTE 4.13	Does the client make it clear that the contractor is ultimately responsible for the health and safety of their employees and other members of the project team and the general public?				
Scores for CTHS4 Element		11	8	0	0
Element Percentage		7.53%			
CTHS5: Client Involvement in Health and Safety before Construction					
CTE	QUESTIONS	Y	N	N/A	N/V
CTE 5.1	Does the client address health and safety issues in the feasibility study and conceptual design phases?				
CTE 5.2	Does the client require designers to consider construction health and safety during constructability/build ability reviews?				
CTE 5.3	Does the client require designers to conduct a review of the design for				

	construction health and safety for this project?				
CTE 5.4	Does the client conduct a review of the design for health and safety?				
Scores for CTHS5 Element					
Element Percentage		%			
CTHS6: Monitoring Contractor Health And Safety Compliance					
CTE	QUESTIONS	Y	N	N/A	N/V
CTE 6.2	Does the client specify the responsibilities of the site health and safety representative?				
CTE 6.10	Does the client follow up on ensuring that contractors remedy the deficiencies identified during the health and safety audit?				
Scores for CTHS6 Element					
Element Percentage		%			
COHSRM OVERALL RATING SCORES					
OVERALL CHSRM RATING SCORES = (CTS1 + CTS2 + CTS3 + CTS4 + CTS5 + CTS6)					
BENCH MARK SCORE		90%			
RISK RATING SCORE		PROJ NO.: 01	0–49% = Noncompliance	50–89% = Partial Compliance	90% Upwards = Compliance
INFORMATION ON THE RATING SYSTEM:					

This composition is reflective of the assessment approach which focussed on assessments with distinct occupational health and safety scopes. A checklist-type approach has been used in all parts and sections, whereby the legal provision reference and requirements are listed. The following indicators have been used to indicate the assessment findings:

1) Y = Yes = Comply, N = No = Noncompliance, N/A = Not Applicable, N/V = Not Verified.
2) The assessment scoring for each element/construct is based on the number of compliant findings (Yes) divided by a combination of the number of compliant and non-compliant findings (Yes + No) and multiply by the weight of each CTHS, namely, CTHS1 = 0.13,

CTHS2 = 0.12, CTHS3 = 0.20, CTHS4 = 0.13, CTSH5 = 0.19 and CTSH 6 = 0.23). The scores of N/A & N/V do not count.	
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6.11 Chapter Summary

This chapter presented the findings of the study. The results of the survey questionnaire, descriptive statistics, exploratory factor analysis, confirmatory factor analysis and the development of the measurement and of the final structural model were presented. The process of arriving at the final structural model was outlined. The CHSRM as a rating was developed using the final structural model and details of how to use the CHSRM as a rating tool were explained. The next chapter discusses the results, analysis and empirical validation of the proposed model by health and safety experts.

CHAPTER 7 : RESULTS FROM THE MODEL VALIDATION SURVEY

7.1 Introduction

This chapter presents the results, analysis and empirical validation of the proposed model by health and safety experts. The proposed model was developed in Chapter 5 of this study. The proposed rating model (Table 6.49) was developed using the results from the structural equation model of this study. Prior to the validation process, the model was subjected to verification in the previous chapter using CB-SEM. The verification process was to ensure that the model does what it is intended to do (Preece, 2001, and Hillston, 2003). In demonstrating that the proposed model is a reasonable representation of the final model, it was subjected to a validation process (Hillston, 2003) by health and safety experts. The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it met the requirements of the construction industry (Preece, 2001).

According to Hillston (2003) there are three approaches to model validation, namely, expert intuition, real system measurements and theoretical results/analysis. In this study, both expert intuition and theoretical results approaches were preferred to validate the proposed model due to the researcher wanting experts to examine and critique the proposed model from different perspectives and to check the consistency with legal and other requirements (ibidem). This approach ensured that problems with the proposed model were discovered prior to implementation. In this validation process, the quantitative research method was used to gather expert's opinion of the proposed model in line with the deductive approach of this study (Chen, 2010; Devault, 2019).

7.2 Selection of Health and Safety Experts

Construction Health and Safety Agents (CHSA) registered with SACPCMP were preferred as they are mandated by law to manage the H&S on behalf of construction clients. The criteria used for selection of H&S was that they should be registered with SACPCMP as Construction Health and Safety Agents (CHSA), have practical knowledge and experience of managing H&S on behalf of clients on projects with a value of at least R40 million, have worked in the construction industry for at least ten years and be appropriately qualified in health and safety. Practical knowledge and experience in managing large construction projects on behalf of clients were important factors. The minimum years of experience was set at ten years as this is in line with the recognition of prior learning as per the SACPCMP Act at registration.

7.3 Target Population and Sample Size

Initially, twenty health and safety experts from a population of ninety-one CHSAs who are fully registered with the SACPCMP in South Africa (SACPCMP, 2019: online) were targeted for the validation of the proposed model. They experts were sourced from the SACPCMP website using emails and follow-up phone calls. A survey questionnaire was used to ask health and safety experts to comment on the content of the proposed model. These experts were also asked to highlight any unclear questions that describe the constructs. This feedback would allow the researcher to redesign the proposed model according to their comments and criticisms (Zefeiti et al., 2015). The survey questionnaire was preferred to the Delphi approach as it provided an expeditious, economical and reliable means of gathering data about the population (Nguyen, 2010). While a Delphi approach was more suited to this study, it was not feasible due to the time required to assemble the experts and to optimally execute the process.

7.4 Model Validation Process

The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it met the requirements of the construction industry (Preece, 2001). In this validation process, a quantitative research method was used to gather expert's opinions of the proposed model in line with the deductive approach of the study (Chen, 2010; Devault, 2019). A survey questionnaire was conducted to confirm if the proposed model could be applied in the construction industry. The survey questionnaire was preferred as it provides a relatively inexpensive, quick and efficient way of obtaining information from respondents (McLeod, 2018).

The health and safety experts were given the proposed model (as indicated in Table 6.51 of this study) and statements that described the proposed model in terms of its applicability, effectiveness and adaptability as indicated in Table 7.1. The experts were asked to review the model and to rate the extent to which they agree/disagree with the statements that described its applicability, effectiveness and adaptability in the construction industry. They were also requested to provide comments, where applicable, on the shortcomings of the proposed model and how it could be improved – space was provided in the last section of the survey instrument (Table 7.1).

The survey questionnaire was administered through a combination of email and follow-up phone calls over a period of three weeks. A five-point Likert scale was adopted for this model validation process anchored on:

- Strongly Disagree = (1)
- Disagree = (2)
- Neutral = (3)
- Agree = (4)
- Strongly Agree (5)

The choice of the rating scale was informed by the respondent's opinion of the proposed model (Williamson, 2018). The five-point Likert scale offers ease of item preparation, speed of administration and reduced administration costs (Revilla et al., 2013). This scale ranges from 'Strongly Disagree' on one end to 'Strongly Agree' on the other with 'Neither Agree or Disagree' in the middle. The cut-off criteria for the statement to be accepted were therefore set at 3.5.

7.5 Questionnaire Development Process

The survey questionnaire (Table 7.1) comprises of three sections:

7.5.1 Section A

Includes five items requiring the CHSA to indicate their years' experience in managing construction project health and safety.

7.5.2 Section B

Consists of several Likert scale questions that aim at collecting information about the opinion of the CHSA with regard to the extent that they agree/disagree with the statements that described the proposed model in terms of its applicability, effectiveness and adaptability in the construction industry.

7.5.3 Section C

Requires the CHSA to provide comments where applicable on the shortcomings of the proposed model and how it could be improved using the space provided in the last section of the survey instrument. The variables of the survey instruments were defined by the following statements.

7.5.3.1 Applicability (AP):

- **AP1**: the model applies to the construction industry
- **AP2**: the model has captured the critical duties of construction clients

- **AP3**: the model is consistent with the Construction Regulation CR 2014 and other legal requirements

7.5.3.2 Effectiveness (EF)

- **EF1**: the model can be beneficial to the construction industry stakeholders
- **EF2**: the model can contribute to H&S performance improvement in the construction industry
- **EF3**: the model is a risk-based evaluation tool that can help construction clients identify potential hazards and risks to H&S

7.5.3.3 Adaptability (AD)

- **AD1**: the model can easily be adapted to include other aspects of H&S to be used during audits/assessments
- **AD2**: the rating scale of the model can be easily adapted to suit any H&S rating system
- **AD3**: the model can easily be adapted and be used by other authorities to assess the extent to which construction clients fulfil their legal obligation

Table 7.1 Health and Safety Expert Survey Questionnaire

HEALTH AND SAFETY EXPERT PROFILE						
	Years of experience in construction project H&S	**10 - 12**	**13 - 15**	**16 - 18**	**19 - 21**	**Over 25**
	Please indicate your years of experience in managing H&S in construction projects by placing (√) in the appropriate box:	☐	☐	☐	☐	☐
YOUR OVERALL RATING OF THE CLIENT-DRIVEN OCCUPATIONAL HEALTH AND SAFETY RATING MODEL (COHSRM)						
The below statements describe the proposed model in terms of Applicability, Effectiveness and Adaptability. Please indicate to what extent do you agree/disagree with the statements below by placing (√) in the appropriate box: Strongly Disagree = (1), Disagree = (2), Neutral = (3), Agree = (4), and Strongly Agree (5)						
COHSRM APPLICABILITY RATING						
NO.	**QUESTIONS**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
AP1.1	The model is applicable to the construction industry	☐	☐	☐	☐	☐
AP1.2	The model has captured the critical duties of construction clients	☐	☐	☐	☐	☐
AP1.3	The model is consistent with the Construction Regulation CR 2014 and other legal requirements	☐	☐	☐	☐	☐
COHSRM EFFECTIVENESS RATING						
NO.	**QUESTIONS**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
EF2.1	The model can be beneficial to the construction industry stakeholders	☐	☐	☐	☐	☐
EF2.2	The model can contribute to health and safety performance improvement in the construction industry.	☐	☐	☐	☐	☐
EF2.3	The model is a risk-based evaluation tool that can help construction clients identify potential hazards and risks to health and safety.	☐	☐	☐	☐	☐
COHSRM ADAPTABILTY RATING						
NO.	**QUESTIONS**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
AD3.1	The model can easily be adapted to include other aspects of H&S to be used during audits/assessments	☐	☐	☐	☐	☐
AD3.2	The rating scale of the model can be easily adapted to suit any health and safety rating system	☐	☐	☐	☐	☐
AD3.3	The model can easily be adapted and be used by other authorities assess the extent to which construction clients fulfil their legal obligation.	☐	☐	☐	☐	☐
Please add your comment on how the model can be improved						

7.6 Response Rate

By the cut-off date of the survey, fourteen out of twenty targeted responses were received. This represents a 70% usable response rate as indicated in Table 7.2. The response rate was calculated by dividing the number of usable responses returned by the total number eligible in the sample (Fincham, 2008). Table 7.1 indicates that 57.1% of health and safety experts who responded had sixteen to eighteen years' experience, 21.4% had thirteen to fifteen years' experience, 14.3% had ten to twelve years' experience and 7.1% had nineteen to twenty-one years' experience.

Table 7.2 Health and Safety Experts Composition by Years of Experience

Years of practical experience	Number of Experts	Per Cent (%)
10 - 12	2	14.29
13 - 15	3	21.43
16 - 18	8	57.14
19 - 21	1	7.14
Over 25	0	0
Total	14	100

7.7 Reliability and Validity

The model validation results were first assessed to establish whether conclusions arrived at from the results are reliable and valid. Several aspects were assessed. Discriminant validity was assessed using Average Variance Extracted (AVE) and the comparison of the square root of the highest shared variance (Fornell and Larcker, 1981). Discriminant validity is considered to exist when the square root of the AVE is higher than the intercorrelation between constructs (Fornel and Larcker, 1981) and also when the intercorrelation between constructs is less than 0.60 (Hulland, 1999). There is convergent validity when the AVE values exceed 0.50 (Fornell and Larcker, 1981; Worthington and Whittaker, 2006). The research instrument was assessed for reliability using Cronbach's alpha (Alpha) and composite reliability, both of which measure the internal consistency of an instrument.

All the statistics for the assessment of construct validity can be seen in Table 7.3. AVE and CR were computed from the confirmatory factor analysis (CFA) using the Master Validity tool by James Gaskin in SPSS AMOS. CFA was preferred over Exploratory Factor Analysis (EFA) because of the small sample size, which yielded a non-positive definite matrix; a problem associated with small sample sizes. Initially, CFA could also not run, as the covariance matrix was non-positive definite. To overcome this problem, the CFA was run by allowing AMOS to compute statistics with a non-positive definite sample covariance matrix. The CFA model is shown in Figure 7.1.

The resulting scores for AVE ranged between 0.634 and 0.720. Based on the widely accepted minimum threshold of 0.50 by Fornell and Larcker (1981), all constructs exceeded the thresholds. The scores for Cronbach's alpha ranged between 0.637 and 0.843. Several studies recommend a cut-off of 0.70 for an acceptable Cronbach's alpha (Byrne, 2006; Cronbach's and Meehl, 1955; Nunnally, 1978). Nunnally (1978) further qualified the threshold of 0.70 as being appropriate for basic research. It was recommended that for applied research, a Cronbach's alpha of 0.80 may not be high enough. Generally, it was recommended that when important decisions affecting the fate of individuals were going to be made, a Cronbach's alpha of at least 0.90 – or better still 0.95 – was preferable. Therefore, the appropriate cut-off for an acceptable Cronbach's alpha is related to the use and decisions that will be made with the resulting scales.

Considering the recommendation to base the cut-off value on the use of the resulting scales and the potential impact of results, several studies have adopted cut-offs lower than the commonly accepted 0.70 (for example, Chinomona and Omoruyi, 2015). Based on this, the scale that fell below the 0.70 Cronbach's alpha threshold was retained for further scrutiny. The square root of the AVE is shown in bold in the diagonal of the table. All the square roots of the AVE are greater than the inter-construct correlations. Further, for discriminant validity, the means shared variance (MSV) should be less than the AVE. Therefore, the constructs exhibited good general discriminant validity.

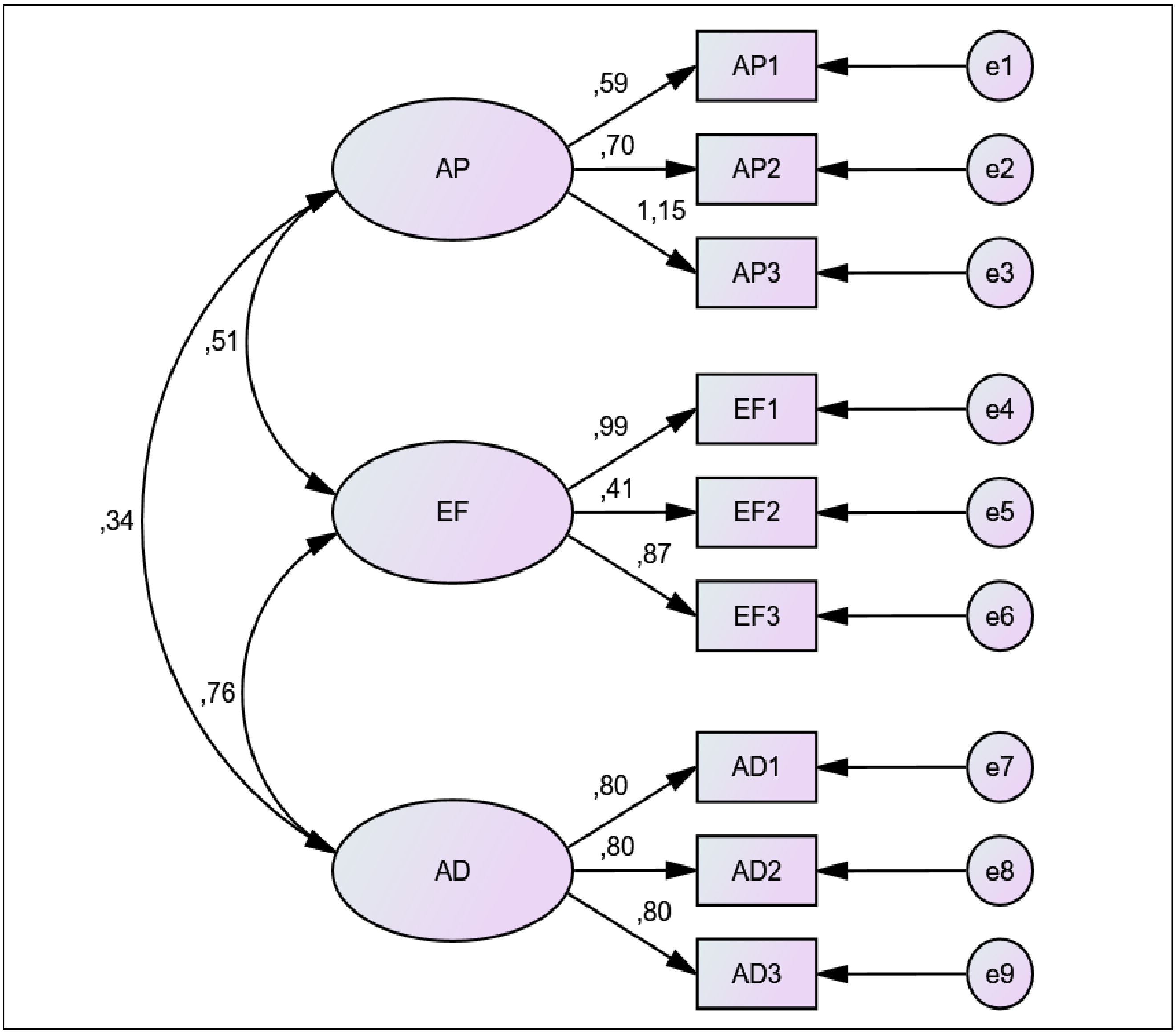

Figure 7.1 Confirmatory Factor Analysis Model

Table 7.3 Reliability and Validity Statistics

	CR	AVE	MSV	Alpha	Correlations		
					AP	EF	AD
AP	0,876	0,720	0,260	0,717	**0,848**		
EF	0,824	0,634	0,582	0,637	0,510	**0,796**	
AD	0,846	0,647	0,582	0,843	0,338	0,763†	**0,804**

(† significant at $p<0.100$)

7.8 Analysis of the Overall Rating of CHSRM

7.8.1 Descriptive Statistics Analysis

Table 7.4 below shows the descriptive statistics (including the measures of central tendency and measures of dispersion) for all the variables relating to model applicability, effectiveness and adaptability. The distribution of mean scores of the validation rating from the health and safety experts shows that the means for all the variables range between 4.50 and 4.71, with the least mean being 4.50 for AP1 and AD3, and the highest mean being 4.71 for AD2. This implies that, based on the mean which is a measure of central tendency, we can conclude that the health and safety experts strongly agree that CHSRM meets the requirements of the construction industry in terms of applicability, effectiveness and adaptability.

The scores for the majority of the variables range from a minimum of four to a maximum of five, that is, ranging from 'agree' to 'strongly agree', except EF2 where the scores range from one to five, that is, ranging from 'strongly disagree' to 'strongly agree'. The standard deviation for the scores of all the variables range from 0.469 for AD2 to 1.089 for EF2. Since both the range (maximum value – minimum value) and the standard deviation are measures of absolute deviation and are both relatively small in this model validation study, this suggests that there is little variability in terms of the extent of agreement of the health and safety experts. Overall, based on mean results which are measures of central tendency and the absolute deviation (range and standard deviation) findings, we conclude that the health and safety experts are happy with the proposed model. These findings confirm that the CHSRM meets the requirements of the construction industry in all three core areas of applicability, effectiveness and adaptability.

Table 7.4 Descriptive Statistics of the Overall Rating of CHSRM by Health and Safety Experts

	N	Minimum	Maximum	Mean	Std. Deviation
AP1-CHSRM Applicability Rating	14	2.00	5.00	4.50	0.855
AP2-CHSRM Applicability Rating	14	3.00	5.00	4.64	0.633
AP3-CHSRM Applicability Rating	14	4.00	5.00	4.64	0.497
EF1-CHSRM Effectiveness Rating	14	4.00	5.00	4.64	0.497
EF2-CHSRM Effectiveness Rating	14	1.00	5.00	4.57	1.089
EF3-CHSRM Effectiveness Rating	14	4.00	5.00	4.57	0.514
AD1-CHSRM Adaptability Rating	14	4.00	5.00	4.57	0.514
AD2-CHSRM Adaptability Rating	14	4.00	5.00	4.71	0.469
AD3-CHSRM Adaptability Rating	14	4.00	5.00	4.50	0.519

7.9 Frequency Analysis of CHSRM Rating Results

7.9.1 Objective 1 – Model Applicability Rating

7.9.1.1 AP1 – The model applies to the construction industry

This section presents the frequency analysis of the data using frequency tables. The frequency table (Table 7.5) for AP1-CHSRM Applicability Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that about sixty-four per cent of the health and safety experts strongly agreed that the model applied to the construction industry. Overall, about ninety-three per cent (combining ‘agreed’ and ‘strongly agreed’) of the H&S experts agreed that the model applied to the construction industry.

Table 7.5 AP1-CHSRM Applicability Rating Results

AP1-CHSRM Applicability Rating: The model applies to the construction industry					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Disagree	1	7.1	7.1	7.1
	Agree	4	28.6	28.6	35.7
	Strongly Agree	9	64.3	64.3	100.0
	Total	14	100.0	100.0	

7.9.1.2 AP2 – The model has captured the critical duties of construction clients

The frequency table (Table 7.6) for AP2-CHSRM Applicability Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that about seventy-one per cent of the health and safety experts strongly agreed that the model captured the critical duties of construction clients. Overall, about ninety-three per cent (combining 'agreed' and 'strongly agreed') of the H&S experts agreed that the model captured the critical duties of construction clients.

Table 7.6 AP2-CHSRM Applicability Rating Results

AP2-CHSRM Applicability Rating: The model has captured the critical duties of construction clients					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Neutral	1	7.1	7.1	7.1
	Agree	3	21.4	21.4	28.6
	Strongly Agree	10	71.4	71.4	100.0
	Total	14	100.0	100.0	

7.9.1.3 AP3 – The model is consistent with the construction regulation CR 2014 and other legal requirements

The frequency table (Table 7.7) for AP3-CHSRM Applicability Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that sixty-four per cent of health and safety experts strongly agreed that the model was consistent with the Construction Regulation CR 2014 and other legal requirements. Overall, one hundred per cent (combining ‘agree’ and ‘strongly agree’) of the H&S experts agreed that the model was consistent with the Construction Regulation CR 2014 and other legal requirements.

Table 7.7 AP3-CHSRM Applicability Rating Results

AP3-CHSRM Applicability Rating: The model is consistent with the Construction Regulation CR 2014 and other legal requirements					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Agree	5	35.7	35.7	35.7
	Strongly Agree	9	64.3	64.3	100.0
	Total	14	100.0	100.0	

7.9.2 Objective 2 – Model Effectiveness Rating

7.9.2.1 EF1 – The model can be beneficial to the construction industry stakeholders

The frequency table (Table 7.8) EF1-CHSRM Effectiveness Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that about sixty-four per cent of the health and safety experts strongly agreed that the model could be beneficial to the construction industry stakeholders. Overall, one hundred per cent (combining ‘agree’ and ‘strongly agree’) of the health and safety experts agreed that the model could be beneficial to the construction industry stakeholders.

Table 7.8 EF1-CHSRM Effectiveness Rating Results

EF1-CHSRM Effectiveness Rating: The model can be beneficial to the construction industry stakeholders					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Agree	5	35.7	35.7	35.7
	Strongly Agree	9	64.3	64.3	100.0
	Total	14	100.0	100.0	

7.9.2.2 EF2 – The model can contribute to health and safety performance improvement in the construction industry

The frequency table (Table 7.9) for EF2-CHSRM Effectiveness Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that about seventy-nine per cent of the health and safety experts strongly agreed that the model could contribute to health and safety performance improvement in the construction industry. Overall, about ninety-three per cent (combining 'agree' and 'strongly agree') of the H&S experts agreed that the model could contribute to health and safety performance improvement in the construction industry.

Table 7.9 EF2-CHSRM Effectiveness Rating Results

EF2-CHSRM Effectiveness Rating: The model can contribute to health and safety performance improvement in the construction industry					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Strongly disagree	1	7.1	7.1	7.1
	Agree	2	14.3	14.3	21.4
	Strongly Agree	11	78.6	78.6	100.0
	Total	14	100.0	100.0	

7.9.2.3 EF3 – CHSRM The model is a risk-based evaluation tool that can help construction clients identify potential hazards and risks to health and safety

The frequency table (Table 7.10) for EF3-CHSRM Effectiveness Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that about fifty-seven per cent of the health and safety experts strongly agreed that the model was a risk-based evaluation tool that could help construction clients identify potential hazards and risks to health and safety. Overall, one hundred per cent (combining 'agree' and 'strongly agree') of the H&S experts agreed that the model was a risk-based evaluation tool that could help construction clients identify potential hazards and risks to health and safety.

Table 7.10 EF3-CHSRM Effectiveness Rating Results

EF3-CHSRM Effectiveness Rating: The model is a risk-based evaluation tool that can help construction clients identify potential hazards and risks to health and safety					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Agree	6	42.9	42.9	42.9
	Strongly Agree	8	57.1	57.1	100.0
	Total	14	100.0	100.0	

7.9.3 Objective 3 – Adaptability Rating

7.9.3.1 AD1 – The model can easily be adapted to include other aspects of health and safety to be used during audits/assessments

The frequency table (Table 7.11) for AD1-CHSRM Adaptability Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that about fifty-seven per cent of the health and safety experts strongly agreed that the model could easily be adapted to include other aspects of H&S to be used during audits/assessments. Overall, one hundred per cent (combining 'agree' and 'strongly agree') of the H&S experts agreed that the model could easily be adapted to include other aspects of health and safety to be used during audits/assessments.

Table 7.11 AD1-CHSRM Adaptability Rating Results

AD1-CHSRM Adaptability Rating: The model can easily be adapted to include other aspects of health and safety to be used during audits/assessments					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Agree	6	42.9	42.9	42.9
	Strongly Agree	8	57.1	57.1	100.0
	Total	14	100.0	100.0	

7.9.3.2 AD2 – CHSRM Adaptability rating

The frequency table (Table 7.12) for AD2-CHSRM Adaptability Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that about seventy-one per cent of the health and safety experts strongly agreed that the rating scale of the model could be easily adapted to suit any health and safety rating system. Overall, one hundred per cent (combining 'agree' and 'strongly agree') of the H&S experts agreed that the rating scale of the model could be easily adapted to suit any health and safety rating system.

Table 7.12 AD2-CHSRM Adaptability Rating Results

AD2-CHSRM Adaptability Rating: The rating scale of the model can be easily adapted to suit any health and safety rating system					
		Frequency	Per Cent	Valid Per Cent	Cumulative Per Cent
Valid	Agree	4	28.6	28.6	28.6
	Strongly Agree	10	71.4	71.4	100.0
	Total	14	100.0	100.0	

7.9.3.2 AD3 CHSRM – The model can easily be adapted and be used by other authorities to assess the extent to which construction clients fulfil their legal obligations

The frequency table (Table 7.13) for AD3-CHSRM Adaptability Rating presents the distribution of the percentage of ratings by the H&S experts. The results show that fifty per cent of the health and safety experts strongly agree that the model could easily be adapted and be used by other authorities to assess the extent to which construction clients fulfilled their legal obligation. Overall, one hundred per cent (combining 'agree' and 'strongly agree') of the H&S experts agreed that the model could easily be adapted and be used by other authorities to assess the extent to which construction clients fulfilled their legal obligation.

Table 7.13 AD3-CHSRM Adaptability Rating Results

AD3-CHSRM Adaptability Rating: The model can easily be adapted and be used by other authorities to assess the extent to which construction clients fulfil their legal obligation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	7	50.0	50.0	50.0
	Strongly Agree	7	50.0	50.0	100.0
	Total	14	100.0	100.0	

7.9.4 Objective 4 – Comments from Health and Safety Experts on how the Model can be Improved

For Objective 4, respondents were asked to provide comments on how the model could be improved. The H&S experts were also requested to provide comments, where applicable, on the shortcomings of the proposed model and how it could be improved using the space provided in the last section of the survey instrument (Table 7.1). There were five comments received from the CHSAs. The comments are summarised in Table 7.14. The comments were incorporated into the final model in Table 6.51 of this study.

Table 7.14 Summary of Comments from CHSA

Health and Safety Expert	Comments on the Proposed Model
CHSA10	Consider proving a risk rating score for each CTHS
CHSA7	Add column at the end of each question to substantiate score allocation
CHSA3	Graphs can be added for easy understanding of the degree of compliance
CHSA2	Headings can be added that describe audit information, example, client, date, time, auditor's name and qualification
CHSA13	As CTE 6.4, CTE 6.6, CTE 6.7, CTE 6.9 are frequency questions, consider phrasing the questions in line with the CR 2014

7.9.5 Objective 5 – Addressing Comments from Health and Safety Experts

The comments from CHSAs were addressed and described in Table 7.15. The final model is Table 6.51 of this study.

Table 7.15 Actions from CHSA Comments

Health and Safety	Comments on the Proposed Model	How Comments were Addressed
CHSA10	Consider proving a risk rating score for each CTHS	Each CTHS was allocated the score taking into consideration its weight
CHSA7	Add column at the end of each question to substantiate score allocation	A column for comments was added in the final model
CHSA3	Graphs can be added for easy understanding of the degree of compliance	A worksheet tab was added in the final model
CHSA2	Headings can be added that describe audit information, example, client, date, time, auditor's name and qualification	Rows were added in the final model to accommodate the suggested information
CHSA13	As CTE 6.4, CTE 6.6, CTE 6.7, CTE 6.9 are frequency questions, consider phrasing the questions in line with the CR 2014	The frequency questions in the final model were aligned to the CR 2014 requirements

7.10 Chapter Summary

Findings from the model validation process were discussed in this chapter. The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it met the requirements of the construction industry. The questionnaire was administered among twenty H&S experts who were registered with SACPCMP. By the cut-off date of the survey, fourteen out of twenty targeted responses were received. The justification of the research instrument used in gathering data from H&S experts was discussed. The key findings were that the CHSRM meets the requirements of the construction industry in all three core areas of applicability, effectiveness and adaptability. The next chapter discusses the overall conclusion of this study.

CHAPTER 8 : DISCUSSION OF RESULTS

8.1 Introduction

This chapter discusses the research results and the extent to which research objectives and hypotheses have been met. The validity of the developed client-driven occupational health and safety measurement model is presented. The significant relationships among the critical factors that act as building blocks of the developed client-driven occupational health and safety rating model are discussed. The conclusion of the findings of the study is presented.

8.2 Literature Review Results

An in-depth review of the relevant literature was undertaken and found that there is consensus among researchers that there are critical factors influencing the client to improve project health and safety performance (Table 3.1), namely:

- client attitude towards H&S
- client ability to communicate their H&S requirements to all stakeholders
- selection of contractors based on the H&S performance records
- contractual H&S arrangement
- client involvement before and during construction
- monitoring of contractor H&S performance

8.2.1 Survey Question Results

A survey questionnaire was conducted to measure the extent to which construction clients are involved in their own projects. The extent to which construction clients are involved in their own construction projects was measured by six factors, namely:

- client attitude towards H&S
- client ability to communicate their H&S requirements to all stakeholders
- selection of contractors based on the H&S performance records
- contractual H&S arrangement
- client involvement before and during construction
- monitoring of contractor H&S performance

A five-point Likert scale for rating the factors was adopted to guide the respondents in rating the extent to which construction clients are involved in project health and safety. The findings are discussed in the next subsections.

8.2.1.1 Client attitude towards Health and Safety

The client attitude towards health and safety starts with their understanding that their involvement could contribute to project health and safety performance. According to Musonda et al., (2009), client attitude can be explained by the extent of the client involvement in the management of H&S. This could be achieved by the clients setting zero harm, injury or incidents as the objectives for the project. Liu (2017) stated that the client attitude towards H&S determines the effort the client is willing to make towards ensuring that H&S is not compromised on project sites. One of the efforts the client could make is to go beyond a regulatory compliance approach to prevent injuries or incidents on site.

The results from the questionnaire show that the client attitude towards H&S was perceived to be positive in the construction industry with a combination of almost 72% for ‘often’ and ‘always’. Respondents indicated that the client attitude towards H&S was not consistent in the construction industry with a combination of 24.3% for ‘seldom’ and ‘sometimes’. About 3.7% of the respondents rated the client attitude towards H&S as ‘never’. This means that these clients never show commitment to H&S.

8.2.1.2 Client Ability to Communicate Health and Safety Requirements to all Stakeholders

In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation to construction clients to prepare a suitable, sufficiently documented and coherent site-specific health and safety specification based on the baseline risk assessment. Sperlling et al., 2008 stated that if there is effective communication between the client, the designer and the constructor, excellence in occupational health and safety could be easily achieved. Huang (2003) pointed out that all owners have a legal and moral responsibility to insist on the safe performance of their construction contractors and to use reasonable care to prevent contractors from injuring others on the site. According to Liu (2017), the client should communicate their concerns on health and safety issues to all stakeholders on the construction project, through various channels. The client could demonstrate their commitment to H&S by communicating specific H&S goals and requirements in appointments of all project stakeholders.

The results from this study show that the client ability to communicate H&S requirements to all stakeholders is common in the construction industry with a combination of about 60% for 'often' and 'always'. The results are rather disappointing as the clients have a legal and moral responsibility to communicate H&S requirements through the provision of H&S plan. Respondents indicated that the client ability to communicate their H&S requirements to all stakeholders was not consistent in the construction industry with a combination of 24.3% for 'seldom' and 'sometimes'. A total of 5.3% of respondent rated client ability to communicate their H&S requirements to all stakeholders as 'never'. This indicates that construction clients do not communicate their H&S requirement to the project stakeholders.

8.2.1.3 Selection of Contractors Based on the Health and Safety Performance Records

According to Huang (2003), selection of safe contractors has always been recognised by many owners as the most effective way to guarantee safety performance on their projects. Spear (2005) pointed out that the key to improving health, safety and environment (HSE) performance requires the integration of health, safety and environment into the contracting process that includes establishing formal prequalification and contractor selection criteria and incorporating HSE requirements into the contract. Liu (2017) pointed out that if the client selects a contractor with a proven track record of safety, the safety performance should be improved.

The results from this study show that selection of a contractor with a combination of just over 62% for 'often' and 'always' is common in the construction industry. This indicates that clients do consider H&S in prequalifying contractors for bidding on projects and they ensure that contractors have all the required health and safety structures in place before awarding tenders. Respondents indicated that clients are not consistent in taking H&S into consideration when prequalifying contractors for bidding on projects – these clients have a combination of 35.7% for 'seldom' and 'sometimes'. The selection of contractor never occurring in projects is only 2.3% in the survey. This indicates that clients who do not place a high priority on health and safety when selecting a contractor are on the minority.

8.2.1.4 Contractual Health and Safety Arrangement

Levitt and Samelson (1993) stated that owners must ensure that contractors recognise their contractual responsibility to perform safely. Huang (2003) pointed out that contractually, most owners have the contractor indemnify the owner from any losses or liabilities resulting from injuries, but it is also essential to include specific and thorough safety requirements in the construction contract. Liu (2017) stated that contracts stipulate the health and safety duties for all participants in the construction project.

In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation on all parties to construction projects and owners of assets – clients, the client agent, the designers, the principal contractors, contractors and owners of the structure. According to Smallwood, Haupt and Shakantu (2009), CR 2014 has redistributed responsibility for construction H&S away from the contractor (who was previously solely responsible) to include all participants in the construction process – from the client to the end user.

The results from the frequency table show that the construct of contractual health and safety arrangement is very common in the construction industry with a combination of about 82% for ‘often’ and ‘always’. This indicates that the majority of construction clients in South Africa do comply with the legal obligation of stipulating a health and safety requirement through a contractual arrangement. Respondents indicated that clients are not consistent with the legal obligation of contractual H&S arrangement with 17% rating for ‘seldom’ and ‘sometimes’. Contractual H&S arrangement never occurs in less than 1% of the projects in the survey. This indicates that construction clients who do not provide contractors with H&S guidelines are in the minority in the South African construction industry.

8.2.1.5 Client Involvement Before and During Construction

Liu (2017) pointed out that there are many activities before construction commences that could affect the health and safety performance. Huang (2003) stated that owners could impact designers and contractors through their proactive participation in construction safety issues. In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation to clients to provide the designers with the health and safety specification and ensure that designers consider safety specification during the design stage.

The results from the questionnaire survey show that client involvement in H&S before construction is not common in the South African construction industry with a combination of just less than 46% for ‘often’ and ‘always’. Respondents indicated that clients are not consistent with the legal obligation of being involved before construction with a combination of 35.8 % rating for ‘seldom’ and ‘sometimes’. Client involvement in H&S before construction never occurs in 18.2% of the projects in the survey. The fact that the client is rarely involved in health and safety before and during construction in the industry is a cause for concern.

8.2.1.6 Monitoring of Contractor Health and Safety Performance

Liu (2017) stated that excellent results in health and safety could be achieved if clients monitor the contractor's compliance with health and safety. Gambatese (2000b) suggested that owners should request contractors to provide H&S reports that detail information on the results of jobsite inspections, a listing of all injuries, safety meeting minutes and investigations of major accidents. In South Africa, the Construction Regulation (CR) 2014 imposes a clear obligation to clients to inspect the site at least once every 30 days and issue a copy of H&S audit report to the principal contractor within 7 days of the audit.

The results from the questionnaire survey show that the monitoring contractor's H&S compliance is common in the construction industry with a combination of about 59% for 'often' and 'always'. Respondents indicated that clients are not consistent with the legal obligation of monitoring contractors' H&S performance with 34.9 % rating for 'seldom' and 'sometimes'. Monitoring contractor health and safety compliance never occurs in only 6.1% of the projects in the survey.

8.2.1.7 Project Health and Safety Performance

From a theoretical perspective, the overall project health and safety performance becomes better as construction clients become more involved in construction projects. In the construction industry, H&S performance is measured using leading and lagging indicators. Leading health and safety indicators are used to focus on future safety performance. Lagging health and safety indicators are used to indicate progress towards compliance with H&S rules.

Previous studies have recommended that a mix of leading and lagging indicators be used as part of the health and safety programme to achieve excellent H&S performance. For this study, lagging indicators were preferred as the objective of the study was to measure the extent to which client involvement could lead to improvement in project H&S performance. A survey was designed for respondents to assess the performance of projects they had participated in and evaluate their performance by providing data using lagging indicators. The results from the survey questionnaire are discussed in the next subsections.

a) First Aid Injury Frequency Rate (FAIFR)

The results from the questionnaire survey show that the FAIFR for H&S performance of construction projects is poor with 32.6% of the projects rated as poor in the construction industry and with a combination of about 60% for 'poor' and 'fair'. This implies that the FAIFR is poor with only 1.5% of the projects rated as excellent and a combined 38.5% for ‘good’ and ‘very good’ in the survey.

b) Medical Treatment Incident Frequency Rate (MTIFR)

A Medical Treatment Injury (MTI) is a work injury requiring treatment by a Medical Practitioner and which that is beyond the scope of normal first aid including initial treatment given for more serious injuries.

The results from the questionnaire survey show that the MTIFR for H&S performance of construction projects is poor with 44.4% of the projects rated as poor in the construction industry and with a combination of about 63.7% for ‘poor’ and ‘fair’. This implies that the MTIFR is poor with only 5.9% of the projects rated as excellent and a combined 30.4% for ‘good’ and ‘very good’ in the survey.

c) Lost Time Injury Frequency Rate (LTIFR)

The results from the questionnaire survey show that the LTIFR for H&S performance of construction projects is poor with 45.2% of the projects rated as poor in the construction industry and with a combination of about 62.2% for ‘poor’ and ‘fair’. This implies that the LTIFR is poor with 37% of the projects rated as excellent and a combined 0.8% for ‘good’ and ‘very good’ in the survey.

d) Recordable Case Rate (RCR) or Recordable Injury Frequency Rate (RIFR)

The results from the questionnaire survey show that the RCR/RIFR for H&S performance of construction projects is very poor with 60% of the projects rated as poor in the construction industry and with a combination of about 74% for ‘poor’ and ‘fair’. This implies that the recordable case rate is poor with only 3% of the projects rated as excellent and a combined 23% for ‘good’ and ‘very good’ in the survey.

e) All Injury Frequency Rate (AIFR)

The results from the questionnaire survey show’ that the AIFR for health and safety performance of construction projects is very poor with 59% of the projects rated as poor in the construction industry and a combination of 87.4% for ‘poor’ and ‘fair’. This implies that the all incident frequency rate is poor in general with no project rated as excellent and a combination of just less than 13% for ‘good’ and ‘very good’ in the whole survey.

8.2.1.8 Ranking of Constructs by Means Score (MS)

According to Latihan, Sondoh and Tanakinjal (2017), when a scale of one to five is used, the mean scores could be explained as follows:

- a mean score of less than 2 is rated as low
- a mean score between 2 to 4 is rated as average
- a mean score of greater than 4 is rated as high

The results presented in Table 8.1 show that from a ranking perspective, project H&S performance (F7_7) has the lowest mean score of 1.97. Contractual H&S arrangement (F4_4) has the highest number of indicators. This is because most of the indicators are prescribed by the health and safety act. Based on Latihan et al., (2017) cut-off points, it could be concluded that six out seven constructs have acceptable mean scores, and are considered critical for health and safety. Project H&S performance (F7_7) low means score could be attributed to the different Likert scale used when compared to the rest of the constructs, and that the results of the questionnaire survey has revealed that overall project H&S performance was rated poor (RCR = 60%).

Table 8.1 Constructs Ranked by Means

Ranking by Means						
Constructs	N	Minimum	Maximum	Mean	Std. Deviation	Number of indicators per construct
	Statistic	Statistic	Statistic	Statistic	Statistic	
F4_4	135	1.00	5.00	4.4244	0.79858	19
F1_1	135	1.00	5.00	4.0716	1.12147	5
F6_6	135	1.00	5.00	3.6642	1.26782	11
F3_3	135	1.00	5.00	3.6211	1.41313	12
F2_2	135	1.00	5.00	3.6509	1.38476	6
F5_5	135	1.00	5.00	3.3105	1.30195	6
F7_7	135	1.00	5.00	1.9667	1.13821	5
Valid N (Listwise)	135					

8.3 Results from Correlation Analysis

The relationship between client involvement in their own construction projects and the improvement in the H&S performance was investigated using correlation analysis. For this section the variables were obtained by averaging the items for each construct that resulted in the variables being continuous, allowing for the application of correlation analysis and/or multiple linear regression analysis.

The finding was that all six constructs (F1_1 to F6_6) reveal a highly significant positive correlation ($p<0.01$) at 1% level of significance among each other. Only two out of six constructs – selection of contractors based on H&S performance records (F3_3) and contractual H&S arrangement (F4_4) – show a significant positive correlation with the project H&S performance constructs (F7_7) at 1% ($p<0.001$) level of significance. The remaining four constructs (F1_1; F2_2; F5_5 and F6_6) show no significant correlation with construct F7_7 (Project H&S Performance). The findings show that if clients increase the efforts of selection of contractors based on H&S performance records (F3_3) and make appropriate contractual H&S arrangement (F4_4), project H&S performance (F7_7) will also increase.

The finding that selection of contractors based on H&S performance records (F3_3) show a significant positive correlation with the project H&S performance constructs (F7_7) at 1% ($p<0.001$) level of significance is consistent with Liu (2017) who pointed out that if the client selects a contractor with a proven track record of safety, the safety performance should be improved. A study by Huang (2003) found that projects had better safety performances when the owners placed a higher priority on safety when evaluating contractors. The finding highlighted that the clients could influence project H&S performance through increasing the efforts of selection of contractors based on their H&S performance records.

The finding that contractual H&S arrangements (F4_4) show a significant positive correlation with the project H&S performance constructs (F7_7) at 1% ($p<0.001$) level of significance is consistent with Section 37(2) of the Occupational Health and Safety Act 85 of 1993 and regulations that in terms of this agreement the mandatory warrants that contractors agree to the arrangements and procedures, as prescribed by the client for the purposes of compliance with the Occupational Health and Safety Act 85 of 1993 and to improve H&S in the workplace. Levitt and Samelson (1993) suggested that owners must ensure that contractors recognise their contractual responsibility to perform safely. The findings highlighted that the clients could influence project H&S performance through increasing efforts of ensuring that contractual H&S arrangements are in place for every project.

8.4 Results from Hypotheses Testing

The objective of this study was to identify critical factors of the model that could have significant influence on the overall project health and safety performance. Results of the hypotheses testing revealed that one of the general hypotheses has a direct effect on project H&S performance and five have an indirect effect on project H&S performance.

8.4.1 Construction Client Attitude towards Health and Safety

The general hypothesis was that the construction client attitude towards H&S has a direct influence on project H&S performance (**H_1**). The finding was that client attitude towards H&S has an indirect influence on project H&S performance and has a high significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs. The three critical indicator variables for the construct requires the client to:

- be actively involved in project H&S
- set zero harm objectives for the project
- go beyond the regulatory compliance

Therefore, the hypothesis that the construction client attitude towards health and safety has a direct influence on project H&S performance is rejected.

8.4.2 Construction Client Ability to Communicate Health and Safety Requirements

The general hypothesis was that the construction client attitude towards H&S has a direct influence on project H&S performance (**H_1**). The finding was that the client attitude towards H&S has an indirect influence on project H&S performance and has a high significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs. The three critical indicator variables for the construct requires the client to:

- be actively involved in project H&S
- set zero harm objectives for the project
- go beyond the regulatory compliance

Therefore, the hypothesis that the construction client attitude towards health and safety has a direct influence on project H&S performance is rejected.

8.4.2.1 Selection of Contractors

The general hypothesis was that the selection of contractors by construction clients based on proven H&S track records could lead to improved project H&S performance (**H_3**). The finding was that the selection of contractors by construction clients based on proven H&S track records has an indirect influence on the overall project H&S performance and has also revealed a high significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs. The two critical indicator variables for the construct requires the client to:

- prequalify contractors
- consider H&S in prequalifying contractors bidding for projects

Therefore, the hypothesis that the selection of contractors could directly improve project health and safety performance is rejected.

8.4.2.2 Contractual Health and Safety Arrangement

The general hypothesis was that the stipulation of H&S duties for all participants in the construction project by construction clients in the contractual arrangement could improve project H&S performance (**H_4**). The finding was that the contractual H&S arrangement does have a direct influence on the overall project H&S performance and has also revealed a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs. The five critical indicator variables for the construct necessitates the client to:

- require contractors to submit a site-specific H&S plan
- require contractors to submit a H&S policy statement signed by their CEO
- require contractors to submit an emergency plan
- require contractors to submit and utilise an immediate reporting procedure for accidents and near-misses
- make it clear to contractors that they are ultimately responsible for the H&S of their employees, project team members and the general public

Therefore, the hypothesis that contractual health and safety arrangement could directly improve project H&S performance is rejected.

8.4.2.3 Client Involvement Before and During Construction

The general hypothesis was that the involvement of construction clients before and during construction has a direct influence on project H&S performance (**H_5**). Contrary to the previous studies, the finding was that client involvement before and during construction does not have a direct influence on project H&S performance but has reveal a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs. The four critical indicator variables for the construct necessitates the client to:

- address H&S issues in the feasibility study and conceptual design
- require designers to consider construction H&S during constructability/buildability reviews
- require designers to conduct a design review for H&S
- conduct a design review in the interest of H&S

Therefore, the hypothesis that the involvement of construction clients before and during construction could directly impact project health and safety performance is rejected.

8.4.2.4 Monitoring Contractor Health and Safety Compliance

The general hypothesis was that the monitoring of contractor H&S compliance by construction clients could directly improve the project H&S performance (**H_6**). Contrary to the previous studies, the finding was that the monitoring of contractor H&S compliance does not have a direct influence on project H&S performance but has reveal a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs. The two critical indicator variables for the construct requires the client to:

- specify the responsibilities of the site H&S representatives
- follow-up on ensuring that contractors remedy deficiencies identified during H&S audits

Therefore, the hypothesis that the monitoring of contractor health and safety compliance could directly improve project H&S performance is rejected.

8.5 Results from Structural Equation Model

The overall objective of the study was to develop a client-driven H&S model for measurement of health and safety performance of construction projects in South Africa based on previous studies and SEM. To achieve this objective, a review of literature was conducted. The conceptual model theorised that construction clients could directly influence project H&S performance through their:

- attitude towards H&S
- ability to clearly communicate H&S requirements to all stakeholders
- selection of contractors based on their past H&S performance
- contractual H&S arrangement
- involvement before and during construction
- monitoring of the contractor's H&S compliance

These hypotheses were verified statically using SEM.

Contrary to the findings of the previous studies, the final SEM results suggested that the contractual H&S arrangement (F4) is the only factor that has a direct effect on project H&S performance. This indicates that as F4 increases, performance improves that validated both hypotheses H4 and H7. The relationship between these two factors suggests that if construction clients stipulate their H&S requirements and also the H&S duties for all participants in the construction project in the contractual arrangement (as per H4), this could directly lead to an improve project H&S performance. The study has also revealed that all six constructs have positive significant relationships among each other. This is an indication of an indirect influence on the project H&S performance.

8.5.1 Project Health and Safety Performance

The relationship between the six constructs with the project H&S performance indicators was tested with correlation analysis. The correlations show that the FAIFR and AIFR indicators of project H&S performance are not influenced by any of the research variables. The MTIFR, LTIFR and RIFR/RCR indicators of project performance are all influenced by the selection of contractors and contractual H&S arrangements. The correlation was positive and according to how data was coded, when variable F3 and F4 increase, performance improves. These findings validated the conceptual client-driven occupational H&S model for measurement of H&S performance of construction projects.

8.6 CHSRM Validation Results

The final SEM results suggest that the contractual H&S arrangement (F4) was the only factor that has a direct effect on project H&S performance. This indicates that as F4 increases, performance improves that validated both hypotheses H4 and project H&S performance. The relationship between these two factors suggests that if construction clients stipulate their H&S requirements and also the H&S duties for all participants in the construction project in the contractual arrangement (as per H4), this could lead to an improvement of project H&S performance. The study has also revealed that all six constructs have positive significant relationships among each other. This is an indication of an indirect influence on the project H&S performance.

Based on the final structural model (Figure 6.28) for the study, the CHSRM was converted into a rating tool to evaluate client overall performance (Table 6.49). The rating tool assisted in identifying gaps that construction clients could focus on to improve project H&S performance. The model was subjected to verification by using CB-SEM. The verification process aimed to ensure that the model does what it is intended to do. In demonstrating that the proposed model was a reasonable representation of the final model, it was subjected to a validation process by H&S experts.

The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it met the actual requirements of the construction industry. The questionnaire was administered among twenty H&S experts that were registered with SACPCMP. By the cut-off date of the survey, fourteen out of twenty targeted responses were received. The key findings were that the CHSRM meets the requirements of the construction industry in all three core areas of applicability, effectiveness and adaptability.

8.7 Chapter Summary

A client-driven H&S model for measuring the H&S performance of construction projects in South Africa was developed using statistical software. The findings of the study were that only the contractual H&S arrangement had a direct effect on project H&S performance. All the other five remaining constructs had an indirect effect on project H&S performance. The selection of contractors based on their past safety performance and contractual H&S arrangement were found to have direct influence on the MTIFR, LTIFR and RIFR/RCR indicators of project performance while FAIFR and AIFR were not influence by any of the constructs. This study builds on the previous studies that have found that there is a relation between client involvement and project H&S performance. This study deviated from approaches used by other studies by using SEM to verify the CHSRM and also used the Construction Health and Safety experts to validate the model. The final structural model from SEM was used to convert CHSRM as a rating tool to evaluate the client overall performance. The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it met the actual requirements of the construction industry. The key findings were that the CHSRM meets the requirements of the construction industry in all three core areas of applicability, effectiveness and adaptability.

CHAPTER 9 : CONCLUSION AND RECOMMENDATION

9.1 Introduction

The overall objective of the study was to develop a client-driven health and safety rating model measuring the H&S performance of construction project in South Africa. To achieve this objective, significant factors that are considered as key elements to improve and sustain client influence in the construction project H&S performance were to be identified, statistically tested and analysed. To achieve the overall objective of the study, a survey questionnaire was adopted as an instrument for collecting data. A structured questionnaire with multiple choices was used to study various aspects of construction client involvement throughout the phases of the project.

The survey data was analysed using descriptive and inferential statistics to test the relationship between client involvement in project H&S issues and improvement in H&S performance. In ensuring that the proposed model does what it is intended to do, it was verified using the structural equation modelling. In demonstrating that the proposed model is a reasonable representation of the final model, it was validated by H&S experts. The overall conclusion of the study is discussed below using the research questions and objectives of the study as described in Chapter 1.

9.2 Research Questions

Over the past years, various studies dealing with client influence in construction project H&S performance have reported various ways in which construction clients can improve H&S on project sites. Although there is consensus among researchers that client involvement throughout all the project phases can lead to improvements in the health and safety performance of construction projects, there are still key questions that were not effectively answered by the previous studies. To address the questions that remained unsatisfactory answered, a survey questionnaire was conducted on construction projects to seek specific answers to these questions. The survey was conducted with construction clients on selected projects performed in South Africa. Conclusions regarding the study are presented relative to the research questions.

9.2.1 Research Question 1

To what extent do construction clients exhibit a positive attitude towards health and safety?

Findings from the survey were that construction client attitude towards H&S is critical to the performance of all stakeholders in the projects (Table 6.6). The literature also revealed that once the construction client sets the H&S tone then their attitude can exert a great influence not only on the performance of H&S but also on other project Key Performance Indicators (KPIs).

9.2.2 Research Question 2

To what extent do construction clients communicate health and safety issues with all stakeholders?

Findings from the survey were that construction clients communicate effectively on H&S issues with all stakeholders, they see it as vital to maintaining a safety culture at the construction site (Table 6.7).The literature also confirmed that when the construction clients regularly communicate with all stakeholders in an open and respectful manner, they are also more willing to give and receive feedback. Previous studies also found that effective communication has the ability to support teamwork and coordination between contractors and subcontractors.

9.2.3 Research Question 3

To what extent do construction clients select contractors based on their historical health and safety performance?

Findings from the survey were that construction clients do look at the H&S performance of the contractors before they awarded projects (Table 6.8). The literature found that as construction clients can be held responsible for their contractors' H&S performance, it is advisable that they look at the H&S performance of the contractors before they awarded projects. Literature also advises that the selection of contractors with a proven H&S record through the use of a combination of lagging and leading indicators. The selection of safety-minded contractors can lead to improvement in project H&S performance.

9.2.4 Research Question 4

To what extent do construction clients enter into contractual health and safety arrangement with contractors?

Findings from the survey were that construction clients enter into H&S mandatory agreements with contractors at overwhelming rate (Table 6.9). The literature found that where construction projects have a mandatory agreement, the construction clients can direct all stakeholders to focus on H&S on site.

9.2.5 Research Question 5

To what extent construction clients are involved in health and safety issues before construction?

Findings were that most construction clients are not involved with H&S before construction (Table 6.10). This finding is a cause for concern especially since the construction client is:

- legally required to prepare a baseline risk assessment for an intended construction work project
- required to prepare a suitable, sufficiently documented and coherent site-specific health and safety specification for the intended construction work based on the baseline risk assessment contemplated
- required to provide the designer with the health and safety specification contemplated
- required to ensure that the designer takes the prepared health and safety specification into consideration during the design stage
- required to ensure that the designer carries out all responsibilities contemplated in Construction Regulation 6

Literature has revealed that some construction clients still leave the H&S issue to the contractors.

9.2.6 Research Question 6

The sixth research question was to establish the extent construction clients monitor contractor health and safety compliance?

Findings were that construction clients monitor contractor H&S compliance (Table 6.11). Literature suggested that construction clients must ensure that mechanisms are put in place as part of planning for health, safety and wellbeing and are monitored and reviewed throughout the construction period to realise improvement in project H&S performance. Previous studies also explained that the purpose of undertaking ongoing monitoring and review is to verify and adjust the mechanisms to ensure they achieve the intended outcome/s.

9.3 Research Objectives

The overall objective of the study was to develop a client-driven H&S for measuring H&S performance of construction project in South Africa. To develop the model, it was necessary that the critical H&S factors that can be used as building blocks of the model be identified. An in-depth review of the relevant literature was undertaken to provide answers to the research questions and the hypotheses. The overall conclusion of the study is discussed below using the research objectives and hypotheses of the study as described in Chapter 1 and Chapter 3 respectively. To achieve the research objectives stated in subsection 1.4 of this study, the direct, indirect and total effect among the latent constructs as suggested by Schreiber et al., (2006) were investigated. Following a procedure suggested by Zhao et al., (2010) to identify mediation effects of the specific indirect effects was run to identify unique indirect effects for every possible mediation (Gaskin and Lim 2018). The extent to which the research objectives of this study have been met are discussed in the next subsections.

9.3.1 Research Objective 1

The first objective of the study was to investigate the impact of client attitude towards H&S and project H&S performance. The general hypothesis was that the construction client attitude towards H&S has a direct influence on project H&S performance (**H_1**). Contrary to the outcomes of previous studies, the finding of this study was that the client attitude towards H&S does not have direct influence on project H&S performance but has found a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs (Table 6.49).

Mediation analysis was used to investigate the hypothesis that CTHS2 mediates the effect of CTHS1 on CTHS7. Results indicated that CTHS2 was a non-significant predictor on CTHS7 (Figure 6.29 and Table 6.50). The conclusion is that the hypothesis that CTHS2 mediates the effect of CTHS1 on CTHS7 is rejected. It was also hypothesised that CTHS4 mediates the effect of CTHS1 on CTHS7. Results indicated that CTHS4 was a significant predictor on CTHS7 (Figure 6.29 and Table 6.50). The conclusion of the hypothesis that CTHS4 mediates the effect of CTHS1 on CTHS7 is accepted.

9.3.2 Research Objective 2

The second objective of the study was to establish whether client ability to communicate H&S requirements lead to better project H&S performance. The general hypothesis was that client ability to communicate their H&S requirements could directly improve project H&S performance (**H_2**). Contrary to the finding from previous studies, this study revealed that client ability to communicate their H&S requirements does not have a direct influence on project H&S performance but has revealed a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs.

Mediation analysis was used to investigate the hypothesis that CTHS6 mediates the effect of CTHS2 on CTHS7. Results indicated that CTHS6 was a non-significant predictor on CTHS7 (Figure 6.29 and Table 6.50). The conclusion that the hypothesis of communicating and stipulating H&S requirements on contracts when selecting contractors has an indirect influence on project H&S performance is rejected.

9.3.3 Research Objective 3

The third objective of the study was to establish whether stipulating H&S requirements in the contract enhance compliance to H&S by contractors. The general hypothesis was that the selection of contractors by construction clients based on proven H&S track records can lead to improved project H&S performance (**H_3**). The finding was that the selection of contractors by construction clients based on proven H&S track records has an indirect influence on the overall project H&S performance and has also revealed a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs (Figure 6.29 and Table 6.49).

Mediation analysis was used to investigate the hypothesis that CTHS4 mediates the effect of CTHS3 on CTHS7 (Figure 6.29 and Table 6.50). The conclusion is that the selection of contractors based on their historical performance and contractual H&S has an indirect influence on project H&S performance.

9.3.4 Research Objective 4

The fourth objective of the study was to establish whether stipulating H&S requirements in the contract enhance compliance to H&S by contractors. The general hypothesis was that the stipulation of H&S duties for all participants in the construction project by construction clients in the contractual arrangement can improve project H&S performance (**H_4**). The finding was that the contractual H&S arrangement has a direct influence on the overall project H&S performance and has also revealed a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs (Figure 6.29 and Table 6.48).

9.3.5 Research Objective 5

The fifth objective of the study was to establish whether client involvement before and during construction leads to better project H&S performance. The general hypothesis was that the involvement of construction clients before and during construction will directly lead to improved project H&S performance (**H_5**). The finding was that client involvement before and during construction has an indirect influence on project H&S performance but has revealed a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs (Figure 6.29 and Table 6.49).

Mediation analysis was used to investigate the hypothesis that CTHS5 mediates the effect of CTHS4 on PERF. Results indicated that CTHS5 was a non-significant predictor on CTHS7 (Figure 6.29 and Table 6.50). The conclusion is that the hypothesis that involvement of the client before construction contractual H&S arrangement has an indirect influence on project H&S performance is rejected.

9.3.6 Research Objective 6

The sixth objective of the study was to establish the extent to which clients monitoring H&S compliance of contractors leads to improvement on project H&S. The general hypothesis was that the monitoring of contractor H&S compliance by construction clients can directly improve the project H&S (**H_6**). Contrary to the previous studies, findings from this study was that the monitoring of contractor H&S compliance does not have a direct influence on project H&S performance but has revealed a highly significant positive correlation ($p<0.001$) at 1% level of significance with the other constructs (Figure 6.29 and Table 6.49).

Mediation analysis was used to investigate the hypothesis that CTHS6 mediates the effect of CTHS2 on CTHS7. Results indicate that CTHS6 was a significant predictor on CTHS7 (Figure 6.29 and Table 6.50). The conclusion was that monitoring of contractor H&S together with communication has an indirect effect on project H&S performance. The conclusion that the hypothesis of monitoring contractor H&S compliance and client involvement has an indirect influence on project H&S performance is accepted.

9.3.7 Research Objective 7

The seventh objective was to develop, verify and validate CHSRM for measuring H&S performance of construction projects in South Africa. To achieve this objective, a review of literature was conducted. The conceptual model theorised that construction clients can directly influence project H&S performance through their:

- attitude towards H&S
- ability to clearly communicate H&S requirements to all stakeholders
- selection of contractors based on their past H&S performance
- contractual H&S arrangement
- involvement before and during construction
- monitoring contractor's H&S compliance

The proposed model was verified using SEM.

The final SEM results indicated that the contractual H&S arrangement (CTHS4) is the only factor that has a direct effect on project H&S performance. This indicates that as CTHS4 increases, performance improves that validated hypotheses $\mathbf{H_4}$. The relationship between these two factors suggests that if construction clients stipulate their H&S requirements and duties for all participants in the contractual arrangement (as per $\mathbf{H_4}$), this can directly lead to an improve project H&S performance. Mediation hypotheses have revealed that CTHS1, CTHS3 and CTHS2 have an indirect effect of CTHS7. The final model was validated by CHS expert. The CHS experts were asked to review the proposed model and to rate the extent to which they agree/disagree with the statements that described the proposed model in terms of its applicability, effectiveness and adaptability in the construction industry. The key findings were that the CHSRM meets the requirements of the construction industry in all three core areas of applicability, effectiveness and adaptability.

9.4 Research Contributions

This section focusses on the contributions of this dissertation. There are multiple ways in which research achieves impact and create value (Salter and Martin, 2001). This section is divided into three subsections addressing contribution to theory, methodology and practice.

9.4.1 Theoretical Contributions

Both theorical and empirical findings contributed to a better understanding of the influence of construction clients in the improvement of project H&S performance. This study also contributed to the understanding of the question of how South African construction clients are involved in project H&S issues. Based on an extensive literature review (see Chapter 2) and legal and other requirements, a comprehensive list of attributes that represent the significant factors of the CHSRM was identified. The H&S factors were:

- client attitude towards health and safety
- client ability to communicate clearly their health and safety requirements
- selection of contractors based on health and safety performance
- contractual health and safety arrangement
- client involvement before and during construction
- monitoring of contractor health and safety performance

A survey was conducted to test the extent to which construction clients comply with these factors. The results were analysed using SPSS. The findings of the survey questionnaire suggest that client attitude towards H&S, client ability to communicate H&S requirements, selection of contractors based on H&S performance, contractual H&S arrangement and monitoring of contractor H&S performance are common in the construction industry. However, the study revealed that most of the construction clients are not involved with H&S before construction. The finding that construction clients are rarely involved in the H&S issues before construction is a cause for concern because construction clients are legally required to be involved with H&S issues before construction.

CHSRM was developed using the SEM. Findings from the SEM results indicated that only the contractual H&S arrangement had a direct effect on project H&S performance. The rest of the construct have indirect influence on the project H&S performance. This study also revealed that all six constructs have a highly significant positive correlation ($p<0.001$) at 1% level of significance with each other. The selection of contractors based on their past safety performance and contractual H&S arrangement were found to have direct influence on the MTIFR, LTIFR and RIFR/RCR indicators of project performance while FAIFR and AIFR were not influence by any of the constructs.

While previous studies provided various ways on how construction clients can improve the H&S performance of construction projects, very few studies have used field data to verify and validate the proposed model to reach conclusion. In this study, a validation process was undertaken to ensure that the proposed model was built correctly and to check whether it meets the actual requirements of the construction industry (Chapter 7). The questionnaire was administered among H&S experts that were registered with SACPCMP. The key findings are that the CHSRM meets the requirements of the construction industry in all the three core areas of applicability, effectiveness and adaptability.

9.4.2 Methodological Contributions

The main methodological contribution of the research has been based on the research onion model suggested by Saunders et al., (2012). The research process onion model provided a systematic and detailed presentation of the research process (see Chapter 4). The six layers of the research process onion model included philosophies, methodological choices, strategy, approaches, time horizons and techniques and procedures. As the layers of the research process onion model are related to each other, this study followed the same sequence of these layers to arrive at the desired output of the research. The different layers of the research onion model were analysed starting from the outermost layer and moving to the innermost layer. Each layer of the research onion model was discussed, and the justification of which approach chosen under each layer for this study was presented. With the research onion model suggested by Saunders et al., (2012), it was possible to achieve the research objectives of the study and respond to the research questions. Its usefulness lies in its adaptability for almost any type of research methodology and can be used in a variety of contexts (Bryman, 2012).

Another methodological contribution lies in the experience gained through the application of CB-SEM (Chapters 5 and 6), verification and validation approach and techniques to develop the CHSRM. With the CB-SEM analysis, it was possible to identify significant factors that are considered as key elements to improve and sustain client influence in the construction project H&S performance. Verification and validation techniques were essential parts of the CHSRM development process as they offer the only way to judge the success of the model development process (see Chapter 7). This experience may be useful for other studies to adopt the same approach used in this study. Findings from the conceptual model developed from literature and the survey questionnaire were used to develop CHSRM. The CHSRM was verified using SEM and validated by H&S experts that it can be used by construction clients to identify areas that they must focussed on.

Finally, a methodological contribution relates to the appropriateness of applying theories developed by previous studies. The applicability of some research theories and models established in developed countries to studies in the context of a developing country has been questioned owing to the differences that exist in social and cultural settings. The successful use of these theories in this study contributes towards providing examples that research theories and models can be used in developing countries like South Africa although the results may differ.

9.4.3 Practical Contributions

One of the practical contributions of this research is the detailed insight provided by the study. This study contributes to our understanding of the question of the extent to which construction clients are involved in project H&S issues. Based on extensive literature review, and legal and other requirements, a comprehensive list of attributes that represent the significant factors of the CHSRM was identified. (Table 5.1). The study has revealed that: attitude towards H&S, communicating H&S requirements, selection of contractors based on their historical H&S performance, client involvement before construction, contractual H&S and arrangement and monitoring of contractor H&S compliance should be linked to client project H&S activities. This implies that construction clients must effectively implement these significant H&S factors, as they are key elements of improving and sustaining project H&S performance.

The revelation revealed by the study that most construction clients are rarely involved in the H&S issues before construction must be a cause of concern to the CIDB and labour unions, as policymakers. As a result of this finding, an appropriate intervention in terms of policies, procedures and active monitoring could be formulated that seek to enforce construction client compliance to H&S legal requirements. Another finding from the final SEM results indicated that the contractual H&S arrangement (F4) is the only factor that has a direct effect on project H&S performance (see Chapter 6). This indicates that as F4 increases, performance improves that validated hypothesis $\mathbf{H_4}$. The relationship between these two factors suggests that if construction clients stipulate their project H&S requirements and duties for all participants in the contractual arrangement (as per $\mathbf{H_4}$) this can directly lead to an improve project H&S performance. This finding has an implication to policymakers, CIDB, labour unions and researchers as it provides an opportunity for strengthening current legislations.

Another practical contribution is the use of the CHSRM for analysing the extent to which construction clients are involved in the project H&S activities and the ability to identified areas that require their intervention in a specific project. The contribution of this research is to understand, based on theoretical assumptions, how the CHSRM if effectively implemented can contribute to the improvement in project H&S performance. To this end, the proposed CHSRM can be used as a practical tool.

9.5 Assessing the Contribution of the Study

Whetten (1989) identified four important components to be taken into account as part of a theoretical contribution. They are as follows:

- **What?** What factors and concepts should be included as part of the explanation of the contribution? For this purpose, two criteria are considered – comprehensiveness (the inclusion of all the relevant factors) and parsimony (excluding those who have little role to play in improving the understanding of the contribution).
- **How?** Subsequent to the identification of the factors and concepts that are part of the contributions, the researcher should reflect on how these factors are interrelated.
- **Why?** Why select certain factors? What are the underlying assumptions of the theory or model? The logic of the proposed conceptualisation should be of interest to other researchers.
- **Who, Where and When**? These enquiries define the boundaries for generalisation.

Based on Whetten's (1989) framework for the evaluation of the theoretical contribution, a set of questions are now asked to assess the theoretical contribution of this study.

What is new? Does this study make a significant contribution to current thinking?

The contributions of this study are three-fold:

- Firstly, they lie in the review of the relevant literature on the client-related models, identifying critical H&S factors, attributes/indicators and developing a model in the context of a developing country like South Africa.
- Secondly, the contribution lies in the empirically rich insights provided by the study and in the refined framework for analysis of the adoption and use of client-driven H&S rating model. This framework can be used to guide the construction clients on areas that require their efforts so that H&S can be improved.
- Thirdly, the contribution lies in the combination and application of different client related models developed for construction industries in western countries to study the process of adoption and use of these models in a developing country. The fieldwork description and

the data techniques applied in this study process can also help other researchers in conducting similar studies in other developing country contexts.

So what? Is it likely that the CHSRM will change the way in which construction clients implement H&S in the South African context?

Based on the assumption that the implementation of new the CHSRM has both a direct and indirect effect to project H&S performance, this study seeks to contribute to the way in which construction clients implement critical H&S elements to increase the likelihood of improved H&S on project sites. In this regard the CHSRM presented in Chapter 6 (Table 6.51) is a contribution that can be used as a practical tool to guide the implementation process. This study also revealed new key attributes in terms of new key attributes/indicators for measuring project H&S performance in the construction industry.

How so? Are the underlying logic and supporting evidence compelling?

In Chapter 1, the research problem was conceived from the fact the construction industry plays an important role and contributes to economic growth of countries, but it remains a risky sector where the most vulnerable unskilled and semi-skilled workers are continually involved in serious construction accidents. The lack of effective client participation in construction H&S has left the construction industry with a very high number of accidents that occur on construction sites on a daily basis. While previous studies provided various ways on how construction clients can improve the H&S performance of construction projects, very few studies have produced models that can be used as a framework to assess client overall performance and that can help identify gaps that construction clients can focus on to improve performance in H&S. This study builds on models from previous studies and uses an alternative method to develop a CHSRM; this was aimed at assisting clients to influence contractors effectively to improve the H&S performance of construction projects.

In Chapter 2, the literature review suggested that the construction client could influence H&S improvements on project sites. It also shows that there are multiple factors that are common in most studies and if driven by a client their influence can lead to improvement in the H&S performance of construction projects. These observed major factors were used in the development of the CHSRM.

In Chapter 3, the conceptual model of the research was presented. The conceptual model was based on a review of the literature. The conceptual model was described and the key concepts that constitute the building blocks of the conceptual model were explored. The building blocks of the conceptual model identified during the review of literature included; client attitude towards H&S, client communication attitude towards H&S, selection of contractors, client involvement before and during construction, contractual H&S arrangement and monitoring of contractors' H&S performance. These factors were found to be associated with client involvement in construction project H&S improvements. The relevant literature that supports the constructs of the conceptual model was presented and hypothesised relationships among the constructs were discussed.

In Chapter 4, the research methodology followed to achieve the research objectives of the study and responses to the research questions were presented. The methodology adopted for this study was based on the research onion model suggested by Saunders, Lewis and Thornhill (2012). The different layers of the research onion model that include research philosophies, research approaches, research designs, research strategies, techniques and procedures, data collection methods, data analysis and also the statistical techniques used to address issues of validity and reliability of the instruments used for the collection of data, were explained.

In Chapter 5, a detailed description of the model development process was presented. The process in developing the measurement instrument used to measure the constructs was presented. A description of the measurement instruments, measurement items and the choice of the selected measurement scale were explained. The Critical to Health and Safety factors and their attributes/indicators CHSRM were presented.

In Chapter 6, the research findings were presented. The essential part of this chapter was exhibited in accordance with the use of SPSS and SEM software for analysing the collected data. The chapter further presented research findings and analysis of the extent to which hypothesised multiple factors driven by a client act concurrently and by their combined influence lead to improvement in the health and safety performance of construction projects.

In Chapter 7, the results, analysis and empirical validation of the proposed model by health and safety experts were presented. Prior to the validation process, the model was subjected to verification in the previous chapter using CB-SEM. The verification process was to ensure that the model does what it is intended to do (Preece, 2001 and Hillston, 2003). In demonstrating that the proposed model was a reasonable representation of the final model, it was subjected to a validation process (Hillston, 2003) by

H&S experts. The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it met the actual requirements of the construction industry (Preece, 2001).

Findings from the model validation process were discussed in this chapter. The validation process was undertaken to ensure that the proposed model was built correctly and to check whether it meets the actual requirements of the construction industry. The questionnaire was administered among twenty H&S experts that were registered with SACPCMP. By the cut-off date of the survey, fourteen out of twenty targeted responses were received. The justification of the research instrument used in gathering data from H&S experts was discussed. The results are that the CHSRM meets the requirements of the construction industry in all three core areas, namely, applicability, effectiveness and adaptability.

In Chapter 8, the research results and the extent to which research objectives and hypotheses have been met were discussed. The validity of the developed measurement model was presented. The significant relationships among the critical factors that act as building blocks of the developed CHSRM were discussed. The research conclusions presented in Chapter 9 were therefore drawn from a solid base of evidence.

Why now? Is the topic of current interest to scholars and practitioners in this area?

Despite the programmes implemented by government authorities and other relevant stakeholders to improve the standard of health and safety at construction project sites, the construction industry in South Africa still has an unacceptably high level of incident rates. This results in extensive human suffering and despite measures introduced by the contractors themselves, construction workers are still fatally injured and are continually exposed to occupational health hazards (Lopes, Haupt and Fester, 2011). A study by Saïdani (2012) has found that developing countries have a very high number of construction-related fatalities and the construction industry in these countries continues to lag behind most other industries in this regard.

Recently, Liu et al., (2017) developed a model called Owner's Role Rating Model (ORRM) to test the extent to which construction clients are participating in H&S and presented a questionnaire survey to assess the owner's level of participation in site-safety management. Contrary to Liu et al., (2017), this study was conducted in a developing country where the maturity of the health and safety culture still lags behind when compared to the developed country where Liu et al., (2017) conducted their study. It was also important to conduct empirical studies in the context of South Africa to contribute to a better understanding of the process of adoption and use of this model. Moreover, the need to understand the key critical H&S factors and attributes/indicators in the context of developing countries has been of interest to different scholars in the construction industry. This study emphasises the consideration of a developing country in the process of the adoption and use of a CHSRM and, in this way, contributes to the discourse on a new approach to implementing a CHSRM in South Africa.

Who cares? What percentage of academic readers are interested in this topic?

Besides the author, this topic is of interest to the academics, policymakers, construction industry and labour unions in South Africa who are continuously seeking ways to improve the standard of health and safety at construction project sites. The CHSRM might be of particular interest to CHSA, safety managers, safety officers and construction managers in terms of the implementation of H&S initiatives that contribute to improvement of project H&S.

9.6 Recommendation for Future Research

The current study offers an opportunity for future research to improve the model in the following ways:

- Include all types of construction projects irrespective of their value and location
- The survey indicator variables may be refined to suit specific project environments.
- Contrary to the lagging indicators used in this study as a measure of project H&S performance, the use of leading and lagging indicators could be considered.
- Future studies should be conducted using a larger sample size to improve the application of the model in the construction industry.
- The structural model for this study was complex, future studies should consider using VB-SEM in identifying key predictor constructs.
- The research should be conducted using other model fit indices that were not used in this study.
- The selection of contractors based on their past performance and contractual H&S arrangement could be defined by more indicator variables that can be obtained from industry experts using a Delphi study.

9.7 Limitations

The following are the limitations of the study:

- This study was only limited to construction projects that had project value of more R40 million.
- Construction projects with a value of less than R40 million and those conducted in the mining environment, were excluded.
- The assumption that all construction professionals are knowledgeable and capable of answering the survey questionnaire without any difficulties, was proven to be wrong as some of the questionnaires were found to have been answered more than once – they were not used in this study.
- The sample size was limited to 135 large construction projects, a larger sample size could have benefited considering the importance of this study.
- The structural model for this study was complex and required identifying key predictor constructs using VB-SEM. CB-SEM was used due the limitation of the statistical software package available to the author.

9.8 Chapter Summary

Previous studies identified that client attitude towards health and safety, the ability to clearly communicate H&S requirements to all stakeholders, selection of contractors based on the past H&S performance, contractual H&S arrangement, client involvement before and during construction and monitoring contractors' H&S compliance have a direct effect on project H&S performance. However, contrary to the previous studies, the findings of this study indicated that only the contractual H&S arrangement has a direct effect on project H&S performance. All the other five remaining constructs have an indirect effect on project H&S performance. Mediation hypotheses was performed and revealed that the attitude, communication and selection of contractors based on their historical H&S have an indirect effect of project H&S performance.

The study also revealed that all six constructs have a highly significant positive correlation ($p<0.001$) at 1% level of significance with each other. The selection of contractors based on their past safety performance and contractual H&S arrangement were found to have a direct influence on the MTIFR, LTIFR and RIFR/RCR indicators of project performance. The study also revealed that the FAIFR and AIFR indicators of project H&S performance are not influenced by any of the research variables. The conceptual Client-Driven Occupational Health and Safety Rating Model for measurement of H&S performance of construction projects was verified via a questionnaire survey. The final proposed model was validated by H&S experts. The finding is that the CHSRM can be adopted for use by construction clients.

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APPENDIX A: ETHICAL CLEARANCE LETTER

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

15 November 2018

Mr Joseph Dumizulu Khoza (217075663)
School of Engineering
Howard College Campus

Dear Mr Khoza,

Protocol reference number: HSS/1929/018D
Project title: Development of a Client-driven Occupational Health and Safety Model (COHSRM) for measurement of Health and Safety performance of construction projects in South Africa

Full Approval – No Risk / Exempt Application

In response to your application received on 18 October 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....
Dr Shamila Naidoo (Deputy Chair)

/ms

Cc Supervisor: Professor Theo C Haupt
Cc Academic Leader Research: Professor Akshay Kumar Saha
cc School Administrator: Ms Nombuso Dlamini

Humanities & Social Sciences Research Ethics Committee
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APPENDIX B: QUESTIONNAIRE SURVEY INSTRUMENT

The following is the cover letter and an example of questionnaire survey instrument used during the study

Part 1: Cover Letter

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

20 February 2017

<u>To Whom It May Concern:</u>

I, **Joseph Dumizulu Khoza** (**SN217075663**), am currently registered for studies leading to a PhD in Construction Management. A requirement to be met in the awarding of a PhD in Construction Management is that an approved research project should be undertaken leading to a submission of a dissertation.

The study involves establishing the influence of client (owner) practices in construction health and safety (H&S) on overall H&S performance on their projects. The study is significant in that the findings will contribute to the existing body of knowledge by providing an understanding of the factors which impact contractor H&S. The findings of the study will enable industry stakeholders to understand and know the factors that need to be addressed from the client perspective to improve H&S performance on projects resulting in fewer incidents, accidents, injuries, delays and fatalities.

You are invited to participate in this research study by completing the attached questionnaire which only requires you to check an appropriate box after reading the accompanying statement. The exercise takes only between 20 to 30 minutes to complete. Your participation is vital to the success of this study and we cordially request that you treat the exercise with the importance it deserves. In so doing, you will be helping in the noble effort to improve the overall construction H&S performance on construction projects in South Africa.

Responding to the questionnaire is completely voluntary and you are guaranteed complete confidentiality in the treatment of your responses; you have the right not to respond to any questions which you may deem inappropriate and you are assured that the information collected will be used for academic purposes only. Should you wish to know the findings of the research, we will be glad to send you a summary of the results at the end of study.

Please note that this investigation is being conducted in my personal capacity. Should you need to contact me regarding any aspect of this research, you can do so either by email on: jdkhoza@gmail.com or 217075663@stu.ukzn.ac.za or telephonically on: 0765113967

My academic supervisor is Prof. Theo Haupt, based in the School of Engineering on the Howard College campus of the University of KwaZulu Natal. His contact details are:

Prof. Theo C. Haupt
Professor and Program Co-ordinator: Construction Studies,
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I appreciate the time and effort it will take you to participate in this study. I would highly appreciate your participation, as it would help me to complete this research project. I thank you in advance.

Yours faithfully

Joseph Khoza (Ph D Candidate)

Part 2: Questionnaire Survey Instrument

PROJECT TYPE:						
SURVEY OF CRITICAL TO HEALTH AND SAFETY ELEMENTS (CTHS)						
Please tick (x) appropriate box : Never (1), Seldom (2), Sometimes (3), Often (4), Always (5)						
CTHS 1: Establishing attitudes toward health and safety						
CTE	**QUESTIONS**	**ALWAYS**	**OFTEN**	**SOMETIMES**	**SELDOM**	**NEVER**
CTE 1.1	Does the client understand that his or her involvement contributes to health and safety performance?					
CTE 1.2	Does the client set zero harm, injury or incidents as the objectives for the project?					
CTE 1.3	Does the client go beyond a regulatory compliance approach to prevent injuries or incidents?					
CTE 1.4	Does the client through include all requisite information such as outcomes of baseline H&S hazard identification and risk assessment (HIRA) in the form of H&S specifications as part of tender documentation?					
CTE 1.5	Does the client have specific health and safety goals for each project?					
CTHS 2: Communicating attitudes toward health and safety						
CTE	**QUESTIONS**	**ALWAYS**	**OFTEN**	**SOMETIMES**	**SELDOM**	**NEVER**
CTE 2.1	Does the client communicate with all project stakeholders clearly about his or her health and safety position and requirements?					
CTE 2.2	Does the client communicate specific H&S goals and requirements in appointments of all project stakeholders – consultants and contractors?					
CTE 2.3	Does the client communicate his or her commitment to health and safety to the contractors?					
CTE 2.4	Does the client demonstrate his or her involvement in health and safety to all project stakeholders?					
CTE 2.5	Does the client prescribe regular monitoring and reporting of performance of project stakeholders?					
CTE 2.6	Does the client impose penalties (punitive measures) and reward excellent health and safety performance?					
CTHS 3: Selection of Contractors						
CTE	**QUESTIONS**	**ALWAYS**	**OFTEN**	**SOMETIMES**	**SELDOM**	**NEVER**
CTE 3.1	Does the client prequalify contractors?					
CTE 3.2	Does the client consider health and safety in prequalifying contractors for bidding on projects?					
CTE 3.3	Does the client require and approve procedures for the appointment of sub-contractors with health and safety in mind?					
CTE 3.4	Does the client provide specific contractual health and safety goals and requirements to prospective contractors?					
CTE 3.5	Does health and safety have a high priority when selecting a contractor?					
CTE 3.6	Does the client include the explicit evaluation of the financial provisions and budget for implementing and monitoring health and safety measures when selecting a contractor?					
CTE 3.7	Does the client have specific procedures and/or requirements when adjudicating tenders to ensure adequate financial provision in tenders?					
CTE 3.8	Does the client have specific procedures and/or requirements when evaluating the adequacy of health and safety plans?					
CTE 3.9	Does the client understand what the health and safety file is and its purpose?					
CTE 3.10	Does the client have specific procedures and/or requirements to ensure that the health and safety file is adequate and handed over as part of final completion requirements?					
CTE 3.11	Does the client require notices and copies of minutes of all meetings and forums where project health and safety will be discussed?					
CTE 3.12	Does the client ensure that the contractor has all the required health and safety structures in place before awarding tenders such as health and safety representative/s, health and safety committees, etc.?					

CTHS 4: Contractual health and safety arrangement						
CTE	QUESTIONS	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
CTE 4.1	Does the client assign at least one full-time construction health and safety specialist on the project?					
CTE 4.2	Does the client provide the contractor with health and safety guidelines that must be followed?					
CTE 4.3	Does the client require contractors to submit the resumes of key health and safety personnel for the client's approval?					
CTE 4.4	Does the client require contractors to provide specific minimum health and safety training for workers?					
CTE 4.5	Does the client require contractors to submit a site-specific health and safety plan?					
CTE 4.6	Does the client require the contractor's employees at all levels to have specific health and safety responsibility integrated into work processes?					
CTE 4.7	Does the client require the contractor to submit a health and safety policy statement signed by its CEO?					
CTE 4.8	Does the client require the contractor to submit an emergency plan?					
CTE 4.9	Does the client require the contractor to submit and utilize an immediate reporting procedure for accidents and near-misses on this project?					
CTE 4.10	Does the client require the contractor to submit a mitigation plan for this project?					
CTE 4.11	Does the client require and approve an appropriate and adequate construction health and safety induction program?					
CTE 4.12	Does the client require that subcontractors be included in the health and safety program?					
CTE 4.13	Does the client make it clear that the contractor is ultimately responsible for the health and safety of his or her employees and other members of the project team and the general public?					
CTE 4.14	Does the client specify the actions that can be taken to contribute to health and safety performance in this project?					
CTE 4.15	Does the client require submission and approval of all requisite health and safety method statement?					
CTE 4.16	Does the client require regular inspections and audits to ensure implementation of the contractor's health and safety plan?					
CTE 4.17	Does the client enforce adherence to the approved health and safety plan?					
CTE 4.18	Does the client impose sanctions for non-approved deviations and failure to adhere to the health and safety plan?					
CTE 4.19	Does the client require approval of revised health and safety plans when changes or variations are made including adjustment of the financial provision for health and safety as required?					
CTHS 5: Client's involvement in health and health and safety before construction						
CTE	QUESTIONS	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
CTE 5.1	Does the client address health and safety issues in the feasibility study and conceptual design phases?					
CTE 5.2	Does the client require designers to consider construction health and safety during constructability/build ability reviews?					
CTE 5.3	Does the client require designers to conduct a review of the design for construction health and safety for this project?					
CTE 5.4	Does the client conduct a review of the design for health and safety?					
CTE 5.5	Does the client prefer to award the contract to a design-build contractor to promote health and safety performance?					
CTE 5.6	Does the client conduct the preconstruction meeting with contractor for health and safety issues?					

CTHS 5: Client's involvement in health and health and safety before construction						
CTE	QUESTIONS	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
CTE 5.1	Does the client address health and safety issues in the feasibility study and conceptual design phases?	☐	☐	☐	☐	☐
CTE 5.2	Does the client require designers to consider construction health and safety during constructability/build ability reviews?	☐	☐	☐	☐	☐
CTE 5.3	Does the client require designers to conduct a review of the design for construction health and safety for this project?	☐	☐	☐	☐	☐
CTE 5.4	Does the client conduct a review of the design for health and safety?	☐	☐	☐	☐	☐
CTE 5.5	Does the client prefer to award the contract to a design-build contractor to promote health and safety performance?	☐	☐	☐	☐	☐
CTE 5.6	Does the client conduct the preconstruction meeting with contractor for health and safety issues?	☐	☐	☐	☐	☐

CTHS 6: Monitoring contractor health and safety compliance						
CTE	QUESTIONS	ALWAYS	OFTEN	SOMETIMES	SELDOM	NEVER
CTE 6.1	Does the client assign a full-time site health and safety representative to this project?	☐	☐	☐	☐	☐
CTE 6.2	Does the client specify the responsibilities of the site health and safety representative?	☐	☐	☐	☐	☐
CTE 6.3	Does the client establish a construction health and safety unit to monitor contractor health and safety?	☐	☐	☐	☐	☐
CTE 6.4	How frequently does the client conduct health and safety meetings with the contractor's managerial and supervisory personnel?	☐	☐	☐	☐	☐
CTE 6.5	Does the client maintain statistics of contractor accidents and near misses?	☐	☐	☐	☐	☐
CTE 6.6	How frequently does the client communicate with the contractor's employees about health and safety on this project?	☐	☐	☐	☐	☐
CTE 6.7	How frequently does the client conduct health and safety audits on the contractor's processes?	☐	☐		☐	☐
CTE 6.8	Does the client initiate or implement a health and safety recognition/reward program in this project?	☐	☐	☐	☐	☐
CTE 6.9	How frequently does the client periodically discuss the health and safety audits of the contractor's operations with the contractor?	☐	☐	☐	☐	☐
CTE 6.10	Does the client follow up on ensuring that contractors remedy the deficiencies identified during the health and safety audit?	☐	☐	☐	☐	☐
CTE 6.11	Does the client conduct a post-construction review with all project stakeholders that includes health and safety performance?	☐	☐	☐	☐	☐

PLEASE PROVIDE ANY ADDITIONAL INFORMATION OR COMMENTS BELOW:

Thank you for your kind cooperation

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Part 3: Project H&S Performance Survey

HEALTH AND SAFETY PERFORMANCE CONSTRUCT					
Performance Measurements: FAIFR, MTIFR, LTIFR, RCR, AIFR					
Rating Scale: 1 = Poor 2 = Fair 3 = Good 4 = Very Good 5 = Excellent					
Project No.	FAIFR	MTIFR	LTIFR	RCR	AIFR
1					
2					
3					
4					
5					