HEALTH AND SAFETY MANAGEMENT AND PERFORMANCE AMONG CONSTRUCTION CONTRACTORS IN SOUTH AFRICA

By
Patrick Nwabueze Okonkwo

Dissertation presented for the degree of Doctor of Philosophy in the Faculty of Engineering at Stellenbosch University

Supervisor:
Professor Jan Wium

April 2019

Declaration

By submitting this thesis/dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

P.N Okonkwo

April 2019

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Plagiaatverklaring / Plagiarism *Declaration*

1 Plagiaat is die oorneem en gebruik van die idees, materiaal en ander intellektuele eiendom van ander persone asof dit jou eie werk is.

Plagiarism is the use of ideas, material and other intellectual property of another's work and to present is as my own.

2 Ek erken dat die pleeg van plagiaat 'n strafbare oortreding is aangesien dit 'n vorm van diefstal is.

I agree that plagiarism is a punishable offence because it constitutes theft.

3 Ek verstaan ook dat direkte vertalings plagiaat is.

also understand that direct translations are plagiarism.

4 Dienooreenkomstig is alle aanhalings en bydraes vanuit enige bron (ingesluit die internet) volledig verwys (erken). Ek erken dat die woordelikse aanhaal van teks sonder aanhalingstekens (selfs al word die bron volledig erken) plagiaat is.

Accordingly, all quotations and contributions from any source whatsoever (including the internet) have been cited fully. I understand that the reproduction of text without quotation marks (even when the source is cited) is plagiarism.

5 Ek verklaar dat die werk in hierdie skryfstuk vervat, behalwe waar anders aangedui, my eie oorspronklike werk is en dat ek dit nie vantevore in die geheel of gedeeltelik ingehandig het vir bepunting in hierdie module/werkstuk of 'n ander module/werkstuk nie.

I declare that the work contained in this assignment, except where otherwise stated, is my original work and that I have not previously (in its entirety or in part) submitted it for grading in this module/assignment or another module/assignment.

Abstract

The construction industry is of vital importance to the economies of nations. It employs about seven percent of the global workforce but accounts for between 30 and 40 percent of all work-related fatalities, with developing countries recording more fatalities when compared to developed countries. The economic cost of construction accidents is also significant in terms of compensation claims, lost productivity, and overruns on project schedule and cost. Health and safety management within the construction industry has not developed at the same pace as in other industries and with technological advances within the industry itself. The failure of health and safety management systems and the lack of safety culture within contractor organisations have been highlighted as factors responsible for the high rate of construction accidents in developing countries such as South Africa.

Previous studies have focused on construction phase health and safety management interventions. Few studies have investigated health and safety management within the construction industry from the organisational/enterprise perspective. In this study, the aim was to identify and compare the effectiveness of the different H&S management arrangements employed by construction contractors in South Africa. In the context of this study, a health and safety management arrangement is defined as:

> the organisational structure, planning activities, responsibilities, procedures, processes, resources and practices for managing the health and safety risks associated with the business of an organisation.

This study uses a mixed methods research design that combined qualitative descriptive research and quantitative research approaches to achieve the research objectives.

The broad spectrum of health and safety management arrangements (HSMA) within medium to large size contractor organisations in South Africa were categorised into three distinct types – (1) traditional/compliance motivated, (2) systematic/compliance motivated, and (3) systems/best practice motivated. Areas of strengths and weaknesses in the strategically developed policies and procedures, as well as their implementation were identified for each type.

Top management leadership, operational managers' leadership, safety professionals' leadership were identified as critical factors responsible for variations in the safety performance of the three HSMA types. Top management leadership was identified as an important factor to building systems that support effective health and safety management. Safety professionals' leadership and operational managers' leadership were identified as factors that positively impacted health and safety management practices and workers' behaviour respectively.

The study concludes that to improve the safety performance within the South African construction industry, health and safety management practices and safety related behaviour of construction workers within the industry must improve. Achieving this requires emphasis on policies that improve safety professionals' leadership and operational managers' leadership within contractor organisations.

The uniqueness of this study is the adoption of a holistic organisational perspective to investigating health and safety management efforts of construction contractor organisations. The value of this study lies in the improved understanding of the different types of health and safety management arrangements within contractor organisations in South Africa, their characteristics and their relative effectiveness. It is believed that this study will draw greater attention to the study of construction safety challenges from an organisational perspective and inform actions that strengthen identified weaknesses in the health and safety management efforts of contractor organisations.

Key words: Accidents, Health and safety management, construction industry, contractor organisation, developing countries, South Africa.

Opsomming

Die konstruksiebedryf is van uiterste belang vir die ekonomieë van lande. Sowat sewe persent van die wêreldwye arbeidsmag word daardeur in dien geneem, maar verteenwoordig tussen 30 en 40 persent van alle werkverwante sterftes, met ontwikkelende lande wat meer bydra tot die statistiek. Die ekonomiese koste van konstruksie ongelukke is ook beduidend in terme van vergoedingseise, verlies in produktiwiteit, en oorskryding op projek skedule en koste. Veiligheidsbestuur in die konstruksiebedryf het nie teen dieselfde tempo ontwikkel as in ander nywerhede nie en ook nie soos tegnologiese vooruitgang binne die bedryf self nie. Die mislukking van veiligheidsbestuurstelsels en die gebrek aan ŉ veiligheidskultuur binne konstrukie-organisasies word algemeen uitgelig as faktore wat verantwoordelik is vir die hoë vlak van konstruksie ongelukke in ontwikkelende lande soos Suid-Afrika.

Vorige studies het gefokus op konstruksiefase veiligheidsbestuursintervensies. Min studies het egter veiligheidsbestuur in die konstruksiebedryf vanuit die organisatoriese/ ondernemingsperspektief ondersoek. In hierdie studie was die doel om die effektiwiteit van die verskillende beroepsveiligheid bestuursreëlings van konstruksiekontrakteurs in Suid-Afrika, te identifiseer en te vergelyk. In die konteks van hierdie studie word 'n gesondheids- en veiligheidsbestuursreëling gedefinieer as:

> die organisatoriese struktuur, beplanningsaktiwiteite, verantwoordelikhede, prosedures, prosesse, hulpbronne en praktyke vir die bestuur van die gesondheids- en veiligheidsrisiko's wat verband hou met die besigheid van 'n organisasie.

Hierdie studie gebruik 'n samestelling van verskillende navorsingsmetodes, wat kwalitatiewe beskrywende navorsing en kwantitatiewe navorsingsbenaderings, kombineer om die navorsingsdoelwitte te bereik.

Die breë spektrum van veiligheidsbestuursreëlings in medium tot groot kontrakteursorganisasies in Suid-Afrika is in drie hoof tipes gekategoriseer, naamlik: (1) tradisionele/nakoming gemotiveer, (2) sistematiese/nakoming gemotiveer, en (3) stelsels/beste praktyk gemotiveer. Areas van sterk punte en swakpunte in die

strategies ontwikkelde beleide en prosedures, sowel as die implementering daarvan, is vir elke tipe geïdentifiseer.

Hoofbestuursleierskap, leierskap van operasionele bestuurders, en professionele veiligheidsbeamptes se leierskap is geïdentifiseer as kritiese faktore verantwoordelik vir variasies in die veiligheidsgedrag van die drie veiligheidsbestuurstipes. Hoofbestuursleierskap is geïdentifiseer as 'n belangrike faktor vir die bou van stelsels vir veiligheidsbestuur. Professionele veiligheidsbeamptes en operasionele bestuurders se leierskap is geïdentifiseer as faktore wat die veiligheidsbestuurspraktyke en werkers se gedrag beïnvloed.

Die studie het tot die gevolgtrekking gekom dat om die veiligheidsgedrag binne die Suid- Afrikaanse konstruksiebedryf te verbeter, moet veiligheidsbestuurspraktyke en veiligheidsverwante gedrag van konstruksiewerkers binne die bedryf verbeter. Dit benodig klem op leierskap van operasionele bestuurders en leierskap van professionele veiligheidsbeamptes.

Die uniekheid van hierdie studie is die holistiese perspektief waar veiligheidsbestuur op n organisatoriese vlak ondersoek word vir konstruksie kontrakteursorganisasies, eerder as op ‘n projekvlak. Die waarde van hierdie studie lê in ’n beter begrip van die verskillende tipes veiligheidsbestuursreëlings binne kontrakteursorganisasies in Suid-Afrika, hul eienskappe en hul relatiewe effektiwiteit. Hierdie studie sal meer aandag vestig op konstruksieveiligheidsuitdagings vanuit 'n organisatoriese perspektief, en ondersteun aksies wat in die veiligheidsbestuurspogings van kontrakteursorganisasies kan versterk.

Sleutelwoorde: Ongelukke, gesondheids- en veiligheidsbestuur, konstruksiebedryf, kontrakteursorganisasie, ontwikkelende lande, Suid-Afrika.

Acknowledgements

I will like to acknowledge and extend my gratitude to all those who supported me throughout this journey:

The God of love, nature and the universe for the inspiration and means to complete this academic journey.

My supervisor, Professor Jan Wium for his mentoring and support. I could not have wished for a better supervisor.

Mr Deon Bester and Mr Louis Coetzee for facilitating access to stakeholders within the South African construction industry. Without their support, getting the data used in this study would have been a lot more difficult.

Fancy Mpho Ramathavha, for her encouragement, support and humour through the many revisions of the proverbial “chapter four”.

Respondents to the interviews and questionnaires for this study for taking time out from their busy schedules to answer my questions.

My family, for their prayers and support while on this journey.

Division of Civil Engineering, colleagues and friends for their encouragement and material support throughout my stay at the University.

Dedications

To the safety conscious construction worker.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ACHASM	Association of Construction Health and Safety Management
AS/NZS	Australia/New Zealand
BoQ	Bill of Quantities
CEO	Chief Executive Officer
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CIDB	Construction Industry Development Board
COID	Compensation for Occupational Injuries and Diseases
CR	Construction Regulations
DoL	Department of Labour
ECC	European Consumer Centre
EME	Established Market Economies
FEMA	Federated Employers' Mutual Assurance
FIFA	Federation Internationale de Football Association
FSE	Former Socialist Economies
GDP	Gross Domestic Product
H&S	Health and Safety
HSE	Health and Safety Executive
HSMA	Health and Safety Management Arrangement
HSMP	Health and Safety Management Practices
HSMS	Health and Safety Management System
ILO	International Labour Organisation
ISO	International Standards Organisation
JSE	Johannesburg Stock Exchange
LAC	Latin America and the Caribbean
LTI	Lost Time Injury
LTIFR	Lost Time Injury Frequency Rate
MANCO	Management Committee
MBA	Master Builders Association

MCL	Management Commitment and Leadership
MEC	Middle East Crescent
MIMIC	Multiple Indicator Multiple Cause
MMR	Mixed Methods Research
MNL	Multinomial Logit
MVA	Motor Vehicle Accident
NDP	National Development Plan
NHBRC	National Home Builders Regulatory Council
OHS	Occupational Health and Safety
OHSA	Occupational Health and Safety Act
OHSAS	Occupational Health and Safety Assessment Series
OHSM	Occupational Health and Safety Management
OMCL	Operational Managers' Leadership
PPE	Personal Protective Equipment
PwC	Price Waterhouse and Coopers
QCA	Qualitative Content Analysis
RDP	Reconstruction and Development Project
REC	Research Ethics Committee
RMSEA	Root Mean Square Error of Approximation
SACPCMP	South African Council for the Project and Construction Management Profession
SAFCEC	South African Forum of Civil Engineering Contractors
SAQA	South African Qualification Authority
SBF	Safety Behaviour Factor
SC	Safety Compliance
SD	Standard Deviation
SE	Standard Error
SEM	Structural Equation Modelling
SHEQ	Safety Health Environment and Quality
SM	Safety Motivation
SME	Small and Medium Enterprise

SP	Safety Participation
SPC	Standardised Path Coefficient
SPL	Safety Professionals' Leadership
SYS	Systems for Health and Safety Management
TLI	Tucker-Lewis Index
TQM	Total Quality Management
TSM	Total Safety Management
UAI	Universal Assessment Instrument
VFL	Visible Felt Leadership
WLSMV	Weighted Least Squares Mean and Variance

CHAPTER ONE

INTRODUCTION

1.1 Construction Health and Safety Management and the Challenges with Safety Performance

Health and safety management in the construction industry has not developed at the same pace as in other industries and with technological advances within the construction industry itself (Zahoor et al. 2015). This is evident in accident statistics and compensation claims recorded within the industry, earning it the reputation of one of the most dangerous industries to work in (Awwad et al. 2016). Concerted efforts have been made by various stakeholders, including government departments responsible for regulating occupational health and safety (OHS), building and civils contractors' trade bodies, and the academia, to improve safety performance in the construction industry. This is evident in the proliferation of health and safety management guideline documents and regulations. Despite these efforts, it is common knowledge that accident rates within the industry remain at unacceptably high levels (Kamardeen 2013).

The poor health and safety performance within the construction industry is a global phenomenon. The construction industry employs about seven percent (7%) of the global workforce but accounts for between 30 and 40% of all work-related fatalities (Sunindijo & Zou 2012). One in six fatal work-related accidents globally involves a construction activity (cidb 2009). Zhou et al. (2015) presents statistics that show that the construction industry in the United States, United Kingdom, China, Singapore, Australia and Korea is a major contributor of work-related fatalities in these countries. It has been reported that these statistics are worse in developing countries, with studies showing that developing countries record about three times as many fatalities as developed countries (Hämäläinen et al. 2006).

An on-going commitment by governments worldwide towards improving safety performance within construction organisations has led to the increased adoption of performance-based health and safety legislation that encourage greater self-regulation (Mohamed, 1999). Self-regulation implies that company management takes greater responsibilities for devising, implementing and monitoring their own health and safety management programs. The implementation of health and safety management systems (HSMS) is now being canvassed by both the government and the private sector as a strategy to eliminate construction related accidents (Ng et al. 2005; Tam et al. 2002; Zhou et al. 2015). In South Africa, however, the legislative framework governing construction H&S management focuses on project level interventions and places no obligation on the contractor to implement H&S management systems at the organisational level or maintain H&S management competencies within their organisation.

Notwithstanding this increased interest in HSMS, there remains the challenge of standardisation as safety management practices vary from site to site, and different organisations have different scales of systems for managing health and safety (Tam et al. 2002). While ISO (International Organisation for Standardization) standards for quality management (ISO 9001) and environmental management (ISO 14001) have existed for over two decades, a similar standard for health and safety management (ISO 45001) was only released in March 2018 and will replace the currently dominant OHSAS 18001 over the next three years. Past attempts at developing an ISO standard for health and safety management have been unsuccessful due to disparate stakeholder views on the merits and appropriateness of such a standard (Dyjack & Levine, 1996). The absence of a generally accepted standard for health and safety management perhaps explains the scatter-gun or random approach to health and safety management often with limited value in industry (HSE, 2001:6).

Given this lack of uniformity in health and safety management programs and practices within the construction industry, the primary goal of this study is to investigate how construction contractors in South Africa manage H&S and to compare the effectiveness of the different H&S management arrangements employed by construction contractors. For this thesis, a health and safety management arrangement is defined as:

> the organisational structure, planning activities, responsibilities, procedures, processes, resources and practices for managing the health and safety risks associated with the business of an organisation.

The term “management arrangement” should not be interpreted in the context of management style found in the field of business management.

1.2 Background to the Study

Two peer-reviewed journal papers that conducted a systematic review of occupational health and safety (OHS) studies were identified in the literature. Both papers provided an overview of topics of interest and projected future trends in the occupational health and safety research domain.

The first paper by Fan et al. (2014) reviewed 128 publications across numerous industries between 1996 and 2012 with an emphasis on operations management, a second paper by Zhou et al. (2015) reviewed 439 construction industry specific health and safety management studies. Both papers indicated a tremendous increase in the number of academic publications in the research from the year 2007 and identified safety culture/climate and safety management processes/systems integration as OHS research domains that have received the most attention. A high proportion of the studies in both papers focused on European countries, United States of America, Hong Kong, Australia, China and South Korea in that order. Only five studies involved the construction industry in Africa and only one reflected the South African construction environment. Zhou et al. (2015) identified that half of all construction safety studies focused on the project level, 90% of publications focused on the construction phase, 8% of the publications focused on the company/enterprise level. Zhou et al. (2015) identified the excessive focus on construction phase as a research gap and recommended the study of construction safety from other dimensions.

The under-representation of developing countries in international journal publications is not unique to health and safety research alone. Similar trends can be seen in the medical sciences even though the highest burden of occupational accident and disease is concentrated in developing countries. According to Mulenga (2014:61), the South African construction industry represents a different context, work population and work experiences that differentiates it from studies conducted in other climes and, therefore, presents an opportunity for the investigation of health and safety phenomena within the industry.

A review of local construction safety academic publications reveal a primary focus on the following themes: (1) Understanding the impact of the existing legislative framework (particularly the construction regulation) on the construction health and safety environment (Jacobs 2010; Smallwood & Haupt 2007); (2) Assessing management commitment and attitude to health and safety management (Agumba &

Haupt 2009b; Smallwood & Emuze 2016); (3) Assessing the effectiveness and performance of the OH&S inspectorate of the department of labour (DoL) in enforcing existing health and safety legislations (Geminiani & Smallwood 2008); (4) Improving the project level audit processes by emphasising health and safety programs that contribute to positive safety performance (Smallwood 2015); (5) Investigating dominant causes of construction fatalities such as motor vehicle accidents (MVA) (Emuze & Smallwood 2012); (6) Investigating the impact and influence of other industry stakeholders on construction health and safety management (Smallwood 1998; Smallwood 2004). Mulenga (2014) developed an explanatory model of health and safety climate in the South African construction industry and identified construction health and safety management systems as one of the safety climate themes that have not been adequately researched in South Africa. The model identified the presence of a health and safety management system as a predicator of a positive health and safety climate. However, the study did not investigate health and safety management systems within the construction industry in detail.

Since the publication of the Construction Regulation in 2003, attention to occupational health and safety has increased within the South African construction industry (Geminiani & Smallwood 2008), however the safety culture and performance of contractors still has a long way to go (Agumba & Haupt, 2009a; Mulenga, 2014:65). This disconnect has been attributed in part to the legislative framework governing health and safety (H&S) (which focuses attention at the level of the construction site, and specifically on construction phase health and safety activities and documentation) and the weak institutional structures (lack of capacity within the health and safety inspectorate of the department of labour) that enforce it (Geminiani & Smallwood 2008:5).

The safety practices of the contractor during construction alone have been observed to be "reactionary in nature, by necessity, and inadequate to ensure safety of workers" (Dharmapalan et al. 2014). Choudhry, Fang, & Mohamed (2007) therefore, argued that health and safety management should not be isolated to projects alone but should be entrenched within the day to day operations of a construction organisation. In practice, the scope of the H&S management arrangement of an organisation is often predicated on the special requirements of the domestic industry (Ismail et al. 2012) and the requirements of the management standards that describe them. These differences in the building blocks of a H&S management arrangement confer on them different properties. It is therefore, illogical to believe that they will be effective to the same degree, especially when applied to different industrial context.

From the review of the literature conducted by this author, it is inferred that no empirical study has holistically investigated the effectiveness of organisational/enterprise level health and safety management at contractor organisations in South Africa. There remains a knowledge gap on the effectiveness of organisational level health and safety management arrangements within the construction industry, especially with regards to the question of whether all H&S management arrangements are equally effective or whether one type of arrangement is more effective than another.

1.3 Problem Statement

Construction accidents have profound adverse consequences, they lead to many human tragedies, de-motivate workers, disrupt site activities, result in project schedule and project cost overruns, affect productivity, and the reputation of the construction industry (Mohamed 1999). The economic cost of workplace accidents is also significant. The construction industry in South Africa has the worst claim records relative to other industries (Pillay & Haupt 2008), accident compensation claims according the figures from the department of labour rose from R2.2 billion in 2008/2009 to R2.7 billion in 2010/2011 (Ramutloa 2012). The escalating direct and indirect costs associated with workplace injuries and fatalities warrants the recognition of H&S management as a strategic human resource objective by contractor organisations in South Africa.

The South African Construction Industry Development Board (*cidb*) identified the failure of construction H&S management systems and the lack of safety culture within construction organisations as factors responsible for the high rate of construction accidents in South Africa (Irma 2009). Despite this identified organisational level failures, the focus of government, researchers and contractor employers' association in South Africa, appears to be on project level health and safety management interventions.

To understand why construction H&S performance is poor in South Africa, it is important to interrogate how contractor organisations manage health and safety. This study uses a mixed methods research design which combines qualitative descriptive research approach and quantitative research approach to identify and compare the effectiveness of the distinct health and safety management arrangements within contractor organisations in South Africa.

1.4 Research Objectives

The aim of this thesis is to describe, analyse and compare health and safety management arrangements within construction contractor organisations in South Africa. The specific objectives of this study are:

1. To construct a typology* that groups the broad spectrum of health and safety management arrangements within construction contractor organisations into types.
2. To evaluate the effectiveness of the various health and safety management arrangement types identified.
3. To demonstrate the effect-relationships between the critical factors that distinguish the identified health and safety management arrangements.

* A typology is a classification scheme that groups together the health and safety management arrangements based on their similarities and differences across attributes to be defined in chapter three.

1.5 Scope of Research

Studies have shown that organisational characteristics influence the adoption of formalised arrangements for managing health and safety. Lin & Mills (2001) found that small contractor organisations do not have the capacity to implement sophisticated systems due to the high costs involved and resource limitations. Moreover, these small contractors often act as subcontractors to larger contractors and are often absorbed into the H&S management arrangements of the large contractors (Awwad et al. 2016).

This study investigates the health and safety management arrangements of medium to large size construction organisations (*cidb* Grade 7 to 9 contractors) in South Africa. The rationale for selecting this grade of contractors is that they account for seventy five percent of construction projects in South Africa (in monetary value) and are the only category of contractors able to tender for government contracts over R13 million. According to the construction industry board (*cidb*), eighty percent (80%) of all construction contracts in South Africa are valued over R13 million. Client requirements on projects of that magnitude places some degree of emphasis on the presence of formalised health and safety management arrangement as well as the need to demonstrate good safety performance.

The focus of this study is limited to organisational level health and safety management roles and functions, policies, procedures and practices put in place for managing health and safety. This focus on organisational level health and safety management is consistent with the identified research gap.

The South African context presented in this study may be considered reflective of the approach and models of health and safety management adopted by construction contractor organisations in developing countries particularly countries in Sub-Saharan Africa.

1.6 Research Design

This section presents an overview of the research philosophy and experimental methods applied in this study. It describes the methods adopted, the rationale for their adoption and the how these methods were coherently linked to arrive at valid research outcomes. Detailed description of methodology (data collection and analysis) for each phase of this study are presented within the chapters addressing that phase.

This study adopts a mix methods research (MMR) design. Historically, MMR has been described as any research that has both qualitative and quantitative components, or integrates qualitative and quantitative methods based on the principle of "triangulation" (Nassaji 2015; Clark P et al. 2007). According to Jick (1979), this perspective emphasised the use of triangulation for the convergent validation of constructs. More recent definitions of MMR emphasise "holistic triangulation" (Denzin 2012; Turner et al. 2017). Holistic triangulation assumes that certain methods are better suited for assessing particular aspects of a phenomenon or judging particular attributes of a theory, therefore, by combing methods a more *complete, holistic and contextual portrayal of the unit(s) under study* is achieved (Jick 1979; Turner et al. 2017). Teddlie & Tashakkori (2006) citing the *Journal of Mixed Methods Research (Sage Publications), defined* Mixed Methods Research as*:*

> …research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry.

According to Doyle et al. (2009) the rationales for undertaking a *holistic triangulation* focused MMR study include:

1. Using a combination of research methods to achieve a completer and more complete picture of the study phenomenon.
2. Help answer research questions that cannot be answered by qualitative or quantitative methods alone.
3. Use of one research method to explain the data generated from a study using another research method.
4. Using qualitative approach to identify items for inclusion in a questionnaire to be used in a quantitative phase of a study.

The design of a mixed method research is also contingent on three factors namely:

1. Theoretical purpose,
2. Methodological requirements, and
3. The linking process.

(Turner et al. 2017).

Linking refers to the process by which qualitative and quantitative research methods are brought together within a research study to realise the theoretical purpose of the study (Turner et al. 2017; Guest 2007). The linking process could be focused on: (1) convergent triangulation, (2) holistic triangulation or (3) convergent and holistic triangulation.

Theoretical purpose could be theory generation, theory elaboration, theory testing, developing a taxonomy or a measurement instrument (Turner et al. 2017; Doyle et al. 2016). The theoretical purpose of a study imposes specific methodological requirements and informs the research methods and linking process to be selected by the researcher as discussed by Nassaji (2015) and Kong et al.(2016). For example, interviews and surveys are better suited for capturing naturalistic data i.e. studying case(s), behaviours or phenomenon in their naturally occurring settings without any intervention or manipulation of the variables/investigated parameters (Nassaji 2015;

Turner et al. 2017). While interviews are effective at capturing behaviours, surveys are effective for precision measurement of the study variables/investigated parameters in an authentic context (Nassaji 2015; Turner et al. 2017).

Turner et al. 2017 citing McGrath (1982,195) suggested that the choice of a research methodology should also be based on the extent to which the given methodology can accomplish any of three objectives: (1) maximise generalisability with respect to a population, (2) precision in control and measurement of variables related to the case(s) of interest, (3) provide authenticity of context for the observed case(s).

The relationships between these core elements of a mixed methods research design are captured in Figure 1.

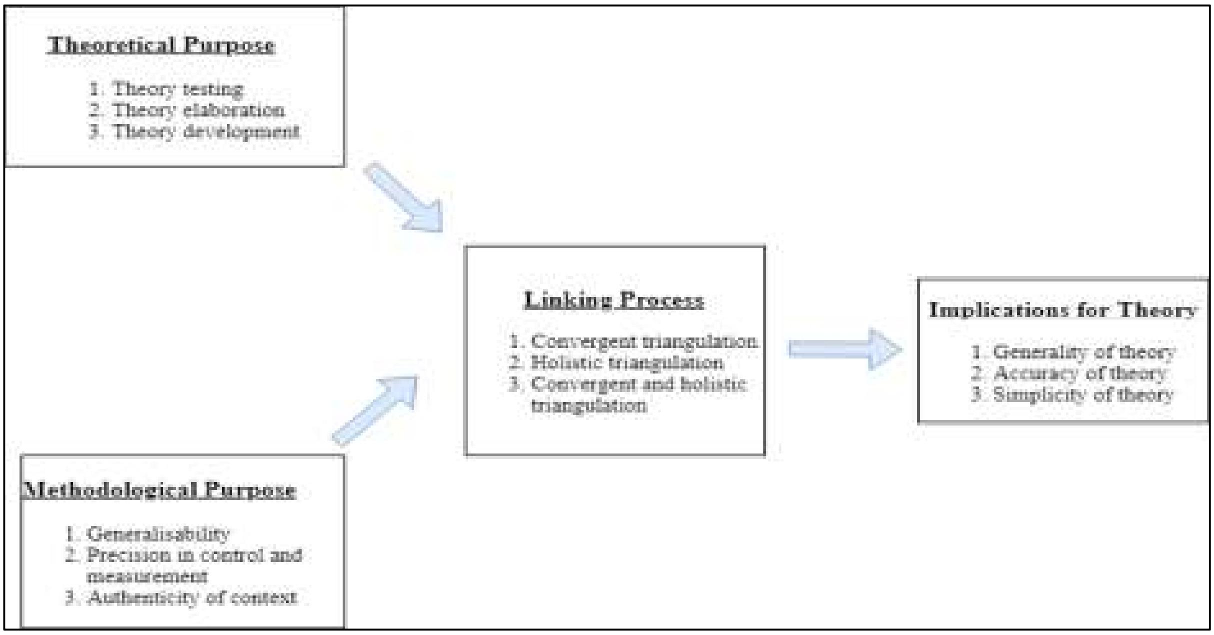

Figure 1: Building blocks mixed methods research (Turner et al. 2017)

1.6.1 Rationale for Choosing Mixed Method Research Design for this study

The theoretical purpose for this study is a better understanding of organisational health and safety management arrangements within contractor organisations in South Africa. This entails the development of a taxonomy (categorisation) of health and safety management arrangement (HSMA) and evaluating their effectiveness.

A qualitative method is considered most suitable for investigating the configuration of HSMA within contractor organisations. Qualitative methods are suited for problems or issues which need to be explored, either to identify variables that cannot be easily measured, or to have a detailed understanding of the issue (Creswell 2013). A quantitative approach is most suited for evaluating the effectiveness of the various types of health and safety management arrangements identified through the qualitative method.

Several authors have noted three important methodological issues to be considered by researchers when undertaking a MMR study (Doyle et al. 2009; Kong et al. 2016; Guest 2007):

1. Timing for collecting data – whether to conduct the qualitative and quantitative data collection concurrently or sequentially.
2. Relative weight of the methods – deciding the priority relationship between the qualitative and quantitative approach.
3. Linking/mixing process – deciding where the mixing of the qualitative and quantitative data will occur (either at the integration or analysis stages).

Figure 2 illustrates the methodological considerations in a MMR design.

Due to the diverse possible combination of considerations of these methodological issues involved in a MMR design, Teddlie & Tashakkori (2006) argued that it is impractical to develop an exhaustive typology (grouping into types) for MMR designs. They however, recommended four important criteria that authors may use to describe their MMR design:

(1) Number of methodologies,
(2) Number of phases,
(3) Type of implementation process, and
(4) Stage of integration of approaches.

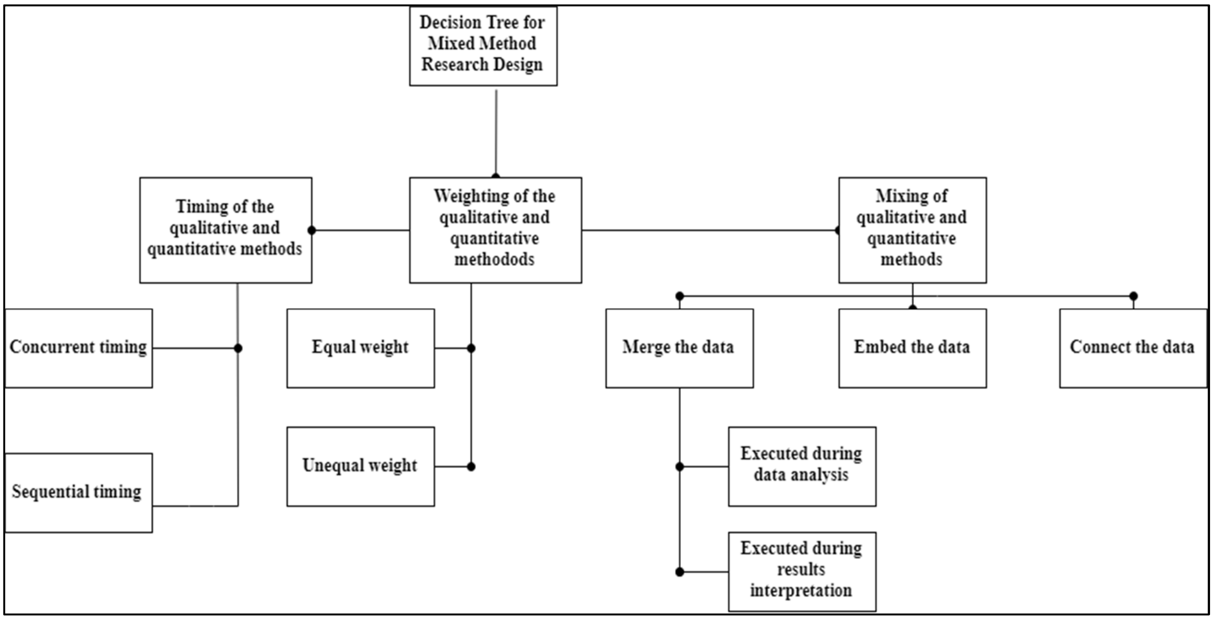

Figure 2: Decision Tree for MMR Design (Doyle et. al. 2009)

Using these criteria, the research design for this study is explained under the subheadings below.

Number of methodologies

This study combines two research methods - qualitative and quantitative research methods. Qualitative data was collected through case study interviews, as well as through observations on construction sites. This data was analysed using a qualitative content analysis method. The purpose of this method was to collect data to describe and group the features specific to organisational level health and safety management arrangements. This was necessary because there was insufficient information in the literature to achieve this.

Quantitative data was collected through two cross-sectional questionnaire surveys. The first survey targeted custodians of H&S management with contractor organisations, while the second survey targeted frontline construction workers. Extensive consultations with a panel of eight H&S experts was involved in developing the questionnaire instruments used in the survey. The survey data was analysed using two different quantitative data analysis techniques. The first was analysed using a multinomial *logit* regression model (see section 6.3.2 for a detailed discussion of a multinomial logit regression model), while the second was analysed using a structural equation modelling framework. The quantitative approach was necessary because the evidence gained from the qualitative method alone is not sufficient to achieve the second and third research objectives. The measurement and comparison of performance between groups is best achieved through a research quantitative method.

Detailed descriptions of the research methodologies used for each component of the study are presented in the chapter discussing the applicable component.

Number of phases

The two research methods mentioned above were implemented in two phases. The qualitative research method was implemented first. The outcome from this stage is a conceptual framework for the categorisation of H&S management arrangements into types and the identification of elements of H&S management most relevant to the South African context. These results formed the basis for the second phase of the study.

This was followed by the quantitative evaluation of the of the effectiveness of the health and safety management arrangement types identified in the first phase, as well as the effect-relationships between the key distinguishing traits of the health and safety management arrangements.

Type of implementation

A sequential implementation strategy was employed in this study where the qualitative phase, including qualitative data collection and analysis preceded the quantitative phase of the study.

Stage of integration of approaches

The method of integration of the qualitative and quantitative data is such that the conclusion from the qualitative phase leads to the formulation of questionnaire items, data collection and data analysis for the quantitative phase. However, the final inferences for this study is based on the connection of the results from the qualitative and quantitative phases.

In summary, this MMR design fits the description of *Sequential Mixed Research Design* described in Teddlie & Tashakkori (2006). This design is recommended for answering exploratory questions chronologically or in a pre-determined order, where the second phase of the study builds on the evidence obtained from the first phase of the study (Teddlie & Tashakkori 2006). Creswell et al. (2007) and Doyle et al. (2009)

reported that this design is suitable for developing a taxonomy and for developing and testing instruments. The MMR design employed in this study is presented diagrammatically in Figure 3.

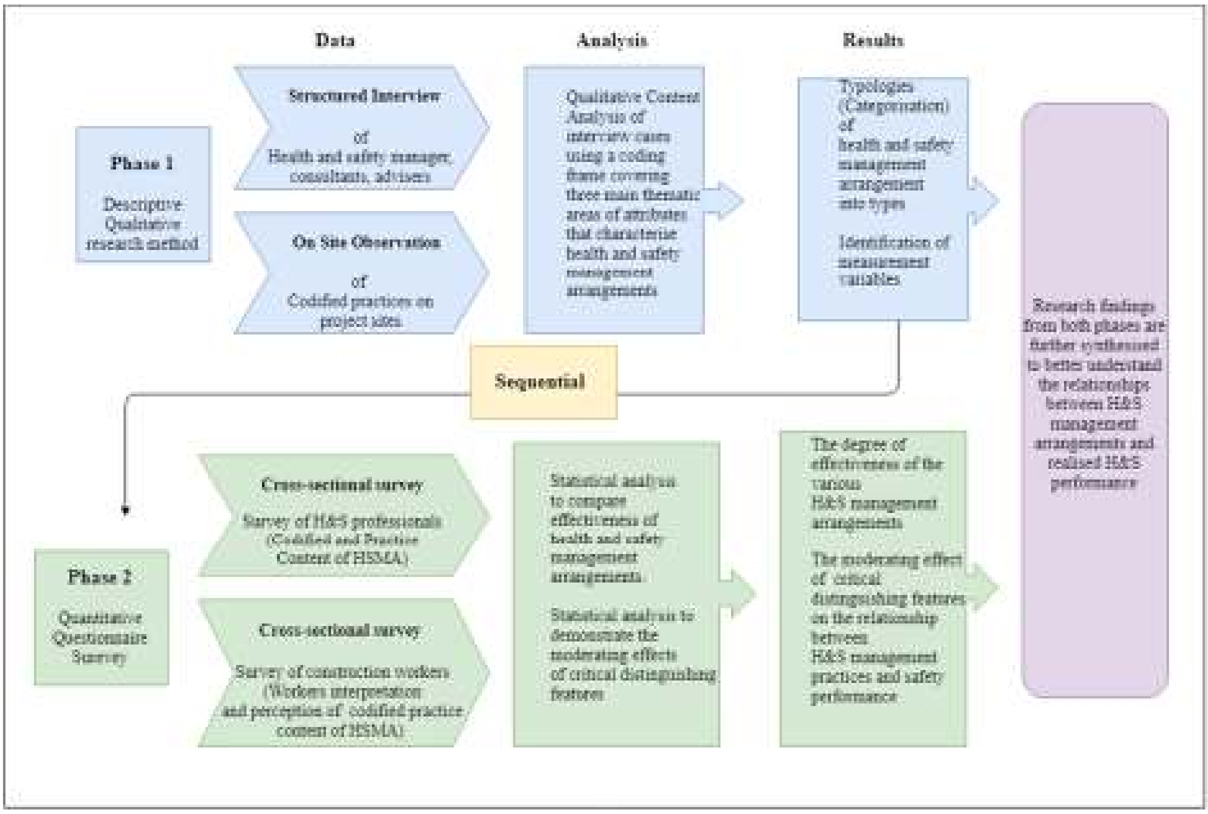

Figure 3:Research design for Study

1.7 Brief Chapter Overviews

This thesis consists of the two parts – part one (chapter 1 to 4) which focused on the categorisation of HSMA within the construction industry into types. Part two (chapter 5 to 7) focused on the evaluating and comparing the effectiveness of the HSMA types identified in phase one. For clarity, part one of the study addressed the first research objective, while part two of the study addressed the second and third objectives of the study.

Three different studies are reported on in this dissertation, and a paper-based writing approach is adopted such that each chapter reports on a specific research theme or objective and the research methodology used. However, all chapters are connected by the golden thread running through the dissertation. An overview of the chapters that make up this dissertation is presented below.

Chapter 2

Chapter two presents the contextual background for this study. Features of the local construction environment including regulatory, labour relations and economic context are discussed. The chapter also presents an overview of the safety performance of the South African construction industry in terms of accident statistics, and how it compares to other developing and developed countries. The chapter concludes by highlighting the unique characteristics of the construction industry that differentiates it from other better structured industries and how this impacts H&S management efforts within the construction industry.

Chapter 3

Chapter three presents the conceptual framework through which health and safety management arrangements in the context of the South African construction industry will be categorised into types. The conceptual framework is based on the review of the literature to identify sources of diversity in H&S management, as well as themes in the literature relevant to the categorisation of HSMA into types. An output from this chapter is a framework for the categorisation of HSMA into types.

Chapter 4

Chapter four applies the conceptual framework developed in chapter 3 in analysing interviews conducted with H&S professionals and custodians of H&S management within the construction industry in South Africa. A qualitative content analysis approach was adopted in analysing the interviews and the result is the identification of three distinct HSMAs within the South African construction industry.

Chapter 5

Chapter five presents the theoretical framework from phase two of the study. The chapter provides the framework for the adoption of multilevel and strategic management theory in the evaluation of the effectiveness of a health and safety management arrangement. The chapter identifies the strategically develop policies and procedures and their implementation counterpart as two constructs through which the effectiveness of a health and safety management arrangement may be evaluated and compared.

The strategically developed component of an HSMA is hypothesised to be made up of 14 H&S management dimensions, while an eight-factor structure is hypothesised for the HSMA implementation component.

Chapter 6

Chapter six describes the methodology and results of a study that evaluated and compared the effectiveness of the three HSMA types identified in chapter four from the perspective of the their strategically developed policies and procedures. The strategically developed policies and procedures were assessed through 14 health and safety management dimensions hypothesised to make up the strategically developed component of a HSMA. Data was collected through a questionnaire survey of custodians of H&S management at *cidb* grade 7 to 9 registered contractor organisations, and a multinomial *logit* regression model was used to analyse the data.

Chapter 7

Chapter seven describes the methodology and results of an aspect of this study that evaluated and compared the effectiveness of the three HSMA types identified in chapter four from the perspective of the implementation of the strategically developed policies and procedure. The implementation component of a HSMA is assessed through workers' perception of the eight factors hypothesised to makeup HSMA implementation construct. Data was collected through a questionnaire survey of frontline construction workers at *cidb* grade 7 to 9 registered contractor organisations, and a structural equation modelling method was used to analyse the data. This chapter also demonstrated the effect-relationships between the critical factor identified to differentiate the three HSMA types.

Chapter 8

Chapter eight presents a synthesis of the preceding seven chapters highlighting key findings and contribution to knowledge in the study field. It also presents the conclusions and recommendations drawn from this dissertation.

CHAPTER TWO

RESEARCH CONTEXT – CONSTRUCTION INDUSTRY IN SOUTH AFRICA

2.1 Introduction

This chapter describes the South African construction environment through a review of relevant literature. The objective of this chapter is to highlight contextual factors that are likely to influence H&S management practices of construction contractors. The rationale for the health and safety management arrangement adopted by construction contractors is often motivated by: (1) the legal framework governing health and safety, (2) the economic and business climate, and (3) the characteristics of the labour market. These factors have been identified in studies conducted in other climes to impact the way H&S management programs are implemented as well as safety performance (Teo et al. 2005; Gillen et al. 2004; Kheni et al. 2010). These factors also distinguishes developing countries from developed countries, because countries within the same level of development tend to share similar characteristics in terms of technology, construction methods, cultural environment and regulations (Kheni et al. 2010).

Johns (2006) defined context *as situational opportunities and constraints that affect the occurrence and meaning of organisational behaviour as well as functional relationships between variables.* It is therefore important to state the context of a phenomenon under investigation, because context possesses implicit factors that can influence the variables under study (Mulenga 2014:62).

2.2 Overview of the South African Construction Industry

The construction industry is of vital importance to the economies of nations. The construction industry contributes significantly to the Gross Domestic Product (GDP) of developed and developing countries (Anaman & Osei-Amponsah 2007; Razak et al. 2010). In South Africa, the construction industry is one of the largest employers of labour and a key pillar of the National Development Plan (NDP) in terms of job creation. The industry is estimated to create 4 formal and 2 informal jobs directly, and another 3 indirect jobs for every ZAR 1 million invested (cidb 2015a). The industry accounts for around 8% of total formal employment and around 17% of total informal employment in the country (cidb 2015b), it also contributed about 9.6% on average to GDP between 2008 and 2016 (cidb 2017b).

The construction industry in South Africa has, however, faced numerous challenges since the business boom that heralded the country's hosting of the 2010 FIFA world cup. This includes decline in financial performance due to a sluggish local economy (PwC 2013). The industry has also suffered a damaged reputation resulting from the successful prosecution of some of the big players in the industry by the competitions commission for tender malpractices on some world cup projects in 2010 (Wilson 2015). According to the 2015 *SA construction report (3rd edition),* the South African construction industry has been struggling in the years following 2008, and it is currently a *harsher operating environment* as construction companies are exposed to the following risks:

- Non-compliance with employment equity and transformation requirements.
- Industrial unrest.
- Liquidity and cash constraints.
- Growth and expansion challenges arising from declining business confidence and reduced government spending on infrastructure.
- Talent management and staff retention.
- Health, safety and environmental sustainability.

(Naidoo et al. 2015:13)

Informal recruitment is a dominant feature of the industry in South Africa as most construction companies do not have formal company recruitment policies for unskilled and semi-skilled workers. Large contractors often employ only supervisory staff on a full-time basis and subcontract their labour requirements to smaller specialist subcontractors or labour only subcontractors (cidb 2015b:16). Labour laws, Broad - Based Black Economic Empowerment and transformation targets, as well as high levels of unionization of workers in the country are emerging challenges for contractors in the country (Naidoo et al. 2016).

A *cidb* report on the state of subcontracting within the industry described the phenomenon as "prevalent", and an "integral component of the industry" such that about 70% of all building works, and 30% of all civil construction projects are subcontracted out (cidb 2013). Furthermore, the report considered subcontracting to be a business strategy used by main contractors to reduce operating cost and enhance competitiveness.

Two agencies of government are responsible for regulating the construction industry: (1) Construction Industry Development Board (*cidb*) and (2) National Home Builders Regulatory Council (NHBRC). The *cidb* is an agency under the department of public works and is established by an Act of Parliament (Act 38 of 2000). All contractors undertaking projects for the public sector are required to be registered with the *cidb.* Contractors are registered within categories which gives an indication of their size, financial and technical capacity. Table 1 presents a summary of cidb registration categories.

Table 1:CIDB grades and contract thresholds

GRADE	***Tender Value Range (less than or equal to)***	***Characteristics***
2	R650,000	
3	R2,000,000	
4	R4,000,000	Local
5	R6,500,000	
6	R13,000,000	Local/regional
7	R40,000,000	
8	R130,000,000	Provincial/regional
9	No limits	National/international

Source: (cidb 2017a)

The NHBRC is more of a consumer protection body responsible for protecting the interest of housing consumers. It was established in accordance with the provisions of the Consumer Protection Measures Act (Act No. 95 of 1998). Its role is limited to regulating the home building industry. Home builder (residential building contractors) are required to be registered with the NHBRC.

2.3 Overview of the Legislative Framework for Construction Health and Safety in South Africa

The occupational health and safety Act, 1993 (Act 85 of 1993), the incumbent regulations particularly the Construction Regulations (2013), and Compensation for

Occupational Injuries and Diseases Act (COID Act) are noted to provide the legislative frameworks governing construction health and safety management in South Africa.

The occupational health and safety Act (OHSA) is consistent with global principles of being performance based and seeks to engender a philosophy of shared responsibility, cooperation and communication between employees and employers in maintaining workplace safety. The Construction Regulations (CR) is made up of a set of ancillary regulations specific to the construction industry. It among other things assign health and safety responsibilities to various project stakeholders (specifically the client, designer and contractor), specifies procedures for the control of the physical work environment, and provides for a statutory body for the regulation of construction industry professionals.

Section 7 of the CR explicitly mandates the contractor to demonstrate to the client a *"suitable, sufficiently documented and coherent site-specific health and safety plan, based on the client's documented health and safety specification".* It further requires the client to ensure that the contractor makes sufficient provision in their tender for health and safety measures during the construction process. This positions the client as a strategic stakeholder in the management of construction health and safety, at least at the project level. Client characteristics and actions have therefore, been reported to influence the health and safety performance of contractors within the construction industry in South Africa and other developing economies (Smallwood 1998; Kheni et al. 2010).

It should be noted that the legislative framework governing construction health and safety in South Africa focuses on the site level/construction phase. No obligation is made on the contractor to implement health and safety management systems at the organisational level.

2.4 Safety record of the construction industry in South Africa

It is common knowledge that the construction industry is one of the most hazardous industries to work in judging by the number of accidents and fatalities recorded within the industry. The South African construction industry is no different as the industry contributes disproportionately to workplace injuries and fatalities in the country (cidb 2009). However, the absence of a timely credible national reporting system for occupational accidents hampers the proper understanding of construction health and safety in South Africa (Jacobs 2010).

In terms of the COID Act, statistics on construction related occupational accidents are recorded by the Compensation Commissioner of the Department of Labour and the Federated Employers' Mutual Assurance (FEMA). The Department of Labour is however, challenged in discharging this function (Irma 2009), the last available comprehensive compensation statistics available on the DoL website as at September 2017, was from 1999. A source of regular H&S statistics for the South African construction industry is the FEMA accident database, but FEMA data accounts for only about 20% of contractors, and its membership account for about 50% of all contractor employees in the country. Therefore, accident statistics from FEMA records should be interpreted with caution because they present a skewed picture of the safety performance of the South African construction industry.

National statistics for the years 2014, 2015 and 2016 according to FEMA records, show that while accidents recorded marginal decreases, the number of fatalities and disabling injuries were on the increase. Table 2 and figures Figure 4, Figure 5, and Figure 6 present a summary of FEMA statistics for years 2014, 2015 and 2016.

Table 2: National H&S performance statistics

Accident Category	2016	2015	2014
Number of accidents	8326	8472	8687
Number of fatal accidents	74	67	64
Permanent disability	926	806	648

Source: FEMA

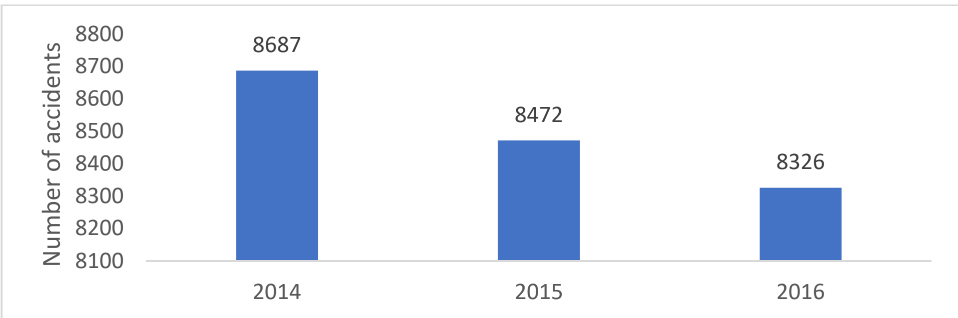

Figure 4: National accidents by year (FEMA)

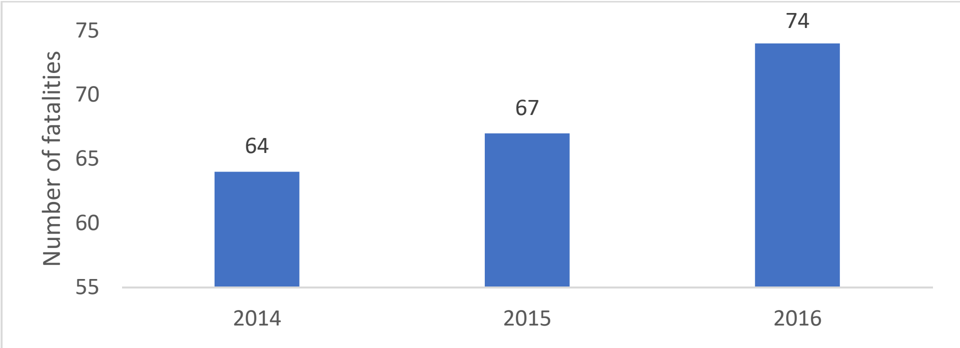

Figure 5: National fatalities by year (FEMA)

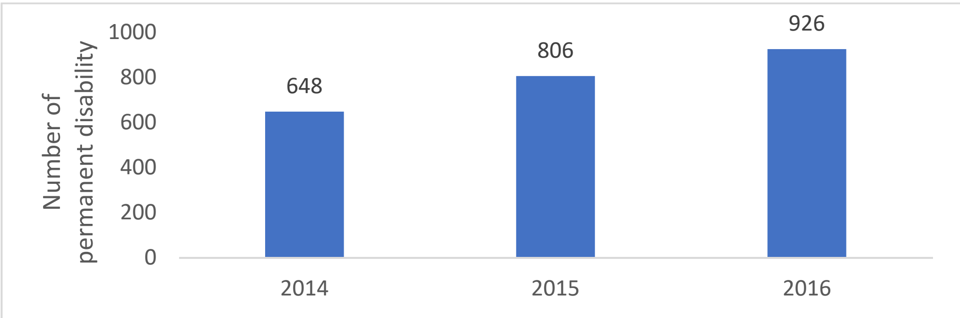

Figure 6: National permanent disabling injuries by year (FEMA)

A comparison of the safety performance of the construction industry in South Africa with that of other climes is rather challenging because of the absence of credible and comprehensive national statistics. However, according to a *cidb* report from 2009, construction accident rates in South Africa were below those recorded in Asia and Sub-Saharan Africa regions, but higher than Established Market Economies (cidb 2009). This trend is further collaborated by Vekinis et al. (2010) who found that the annual construction industry fatality rates in South Africa were similar to those reported in other middle-income countries, but much higher than high-income countries. Both sources allude to a correlation between accident (and fatality rates) and the level of a countries development (using GDP per capita as an indicator). Table 3 presents a summary of construction accident rates by region.

Table 3: Construction fatality and accident rates per 100,000 workers in selected regions

Region	Fatality rate (per 100,000 workers)	Accident rate (per 100,000 workers)
Established Market Economies (EME)	4.2	3,240
Former Socialist Economies (FSE)	12.9	9,864
Other Asia and Islands (Excluding China and India)	21.5	16,434
South Africa	19.2	14,626
Sub-Saharan Africa (Including South Africa)	21.0	16,012
Latin America and the Caribbean (LAC)	17.2	13,192
Middle Eastern Crescent (MEC)	18.6	14,218
Singapore	9.8	7,452
Great Britain	1.62	3,080

Sources: cidb (2009) & HSE (2016)

Low levels of compliance with H&S standards and the high levels of subcontracting have been reported to be contributing factors to the poor safety performance of the construction industry in South Africa. Studies have shown that the construction industry has a less that 50% compliance rate with health and safety standards (Naidoo et al. 2016). Windapo (2011) using audit scores from a construction site audit exercise that assessed the compliance levels of construction contractors to the requirements of the OHSA and the CR found that only 25.5% of construction sites audited achieved satisfactory audit scores.

A *cidb* study found evidence to suggest that the increasing use of subcontracting within the industry has led to deteriorating safety conditions. Many subcontractors were noted to have poor safety practices and were reluctant to train their employees. The selection of subcontractors by main contractors was observed to be a commercial decision with little or no consideration for health and safety requirements (cidb 2013). Studies in other climes have highlighted the negative impact of high degrees of subcontracting on H&S within the construction industry (see Mayhew et al. (1997) and Wong & So (2002)). Mulenga (2014:68) noted that subcontractors in South Africa do not have proper H&S procedures, lack the capacity to properly supervise their workers, and these occurrences are sources of accidents and injuries on construction sites.

2.5 The nature of construction work

Compared to well-structured, high-risk, technical industries such as nuclear, aviation, chemical, oil and gas industries where health and safety management systems have found extensive application, the construction industry is "*less structured and loosely coupled system*" (Mitropoulos et al. 2005). When one considers the employment relationship within the construction industry and work locations in which construction work is done, it becomes apparent that construction organisations are continuously managing "change". The nature of the construction industry is such that hazards are constantly changing and difficult to quantify (Awolusi & Marks 2016), most workers have employment contracts of limited duration, and each construction project is unique.

Construction works typically include building works or civil engineering works. Building works are characterised by the construction of vertical structures such as commercial, industrial and domestic buildings. Civil engineering works on the other hand are characterised by large mainly horizontal projects such as roads, bridges and dams. Construction works require a wide range of activities such as site clearing, excavation, demolition, lifting, handling of hazardous substance and operating of heavy machinery. Many of these activities are high risk and involve hazardous operations. The construction "workplace" is also complex and varies from indoor work such as working in confined space to outdoor work that involves exposure to the elements, working at fall risk positions and in areas with high vehicular traffic.

The temporary and constantly changing environment of the construction worksite, coupled with the multiparty fragmented structure of project organisations (consisting of multiple contractors, subcontractors, consultants and client agents) create coordination and communication challenges that can hamper strategies put in place to control and manage construction hazards. The demographic of construction workers is such that young unskilled and semi-skilled workers out number skilled and supervisory staff on construction sites (Rowlinson 2004). Unskilled and semi-skilled workers typically have low levels of education and require some training and close supervision. Supervision is however, only effective when supervisor-worker ratio is low allowing supervisor establish personal and positive relationships with workers (Alhajeri 2011:22).

Construction contracts are mostly awarded through competitive tendering processes in which case the lowest bid price determines who gets awarded the contract. Competitive tendering is generally acknowledged to engender price-based competition among contractors. Muiruri & Mulinge (2014) reported that the use of competitive tendering in developing countries is detrimental to health and safety within the construction industry as contractors are compelled to reduce prices by cutting costs. The health and safety budget has been identified as the first item that suffers in competitive bidding systems (Rowlinson 2004:5).

All of these factors namely nature of construction workplace, temporary nature of construction projects, high levels of subcontracting, low level of education of the construction workforce, inadequate supervision, and competitive tendering have been highlighted as major contributing factors to the poor safety record of the construction industry (Rowlinson 2004).

2.6 Health and Safety Management in Construction

In a study of organisations experiencing continuous “change” and with many different sites, Koivupalo et al. (2015) found that managing health and safety as a complete entity was a challenge. Even though management standards developed at the corporate level determine and describe the processes for managing health and safety at these organisations, practices and tools were found to vary significantly between the sites, and in some cases varied greatly from the main corporate health and safety management standards. Communication, leadership, competency and social factors were found to be moderating factors for the proper implementation of corporate H&S standards at the site level (Koivupalo et al. 2015).

Lin & Mills (2001) discussed the impact of firm size and subcontracting on H&S management within the construction industry. The attitude of construction firms to H&S management was found to vary with firm size. In relative terms, large construction firms with more resources and experience tend to have more robust management systems for health and safety when compared to small construction firms. The cost of implementing health and safety management systems as well as the formal documentation procedures required for them, have been found to be prohibitive for small firms (Lin & Mills, 2001). In regions where subcontracting is common, subcontractors are usually small firms, and the workforce of the subcontractor do carry out many of the tasks on projects (Wong & So, 2002). Problems of communication and supervision have been found to exacerbate H&S management challenges on projects with many subcontractors (Mayhew, Quintan & Ferris, 1997).

Health and safety management in the construction industry is often characterised as a project level activity. Mitropoulos et al. (2005) noted that the traditional approach of H&S management in construction which is focused on prescribing and enforcing “defences” in the form of physical and procedural barriers that reduce the workers' exposure to hazards has its limitations, because ‘compliance’ approach to H&S management is costly and does not ensure safety. Also, construction accident causality studies have reinforced the idea that loose health and safety management systems targeted at only managing safety risks on construction sites are inadequate (Gibb et al. 2014; Leveson 2015).

These considerations above make the application of health and safety management systems within the construction industry somewhat more complicated when compared to other better structured industries. Recent literature has reported that construction firms are not vigorously seeking to implement a certified management system for health and safety (such as OHSAS 18001) compared to their appetite for certified quality management systems (Yoon et al. 2013; Zeng et al. 2008). The trend in the industry has been that construction firms develop documented procedures for the management of safety on construction sites (Zeng, Tam & Tam, 2008). In jurisdictions where, national standards for H&S management exist, construction firms adopt these standards in a limited form with specific focus on the construction site (Ismail, Doostdar & Harun, 2012).

This chapter has provided the reader with background on the nature of the industry that is the focus of this dissertation and the unique challenges and opportunities associated with H&S management. A legislative framework that focuses on construction site level health and safety management activities, low levels of compliance with health and safety standards, informal recruitment and limited duration employment contracts, extensive use of subcontracting, and price-based competition are the main characteristics of the construction industry in South Africa.

The next chapter will present the reader with a conceptual framework through which health and safety management arrangements within the construction industry in South Africa will be categorised into types.

CHAPTER THREE

CONCEPTUAL FRAMEWORK FOR THE CATEGORISATION OF HEALTH AND SAFETY MANAGEMENT ARRANGEMENTS INTO TYPES

3.1 Chapter Introduction

In this chapter, a conceptualisation of a health and safety management arrangement (HSMA) in the context of this dissertation will be developed based on a review of the literature. A health and safety management arrangement is defined as:

> the organisational structure, planning activities, responsibilities, procedures, processes, resources and practices for managing the health and safety risks associated with the business of an organisation.

According to Rocco & Plakhotnik (2009), the goal of a conceptual framework is *to categorise and describe concepts relevant to the study and to map relationships among them.*

The chapter begins with a review of the literature on contemporary health and safety management paradigms. Sources of diversity in health and safety management approaches are then discussed followed by themes in the literature relevant to the analysis and categorisation of HSMA into types identified. The chapter concludes with the presentation of a conceptual framework that guides the categorisation of HSMA within contractor organisations into types.

3.2 Models of health and safety management

The literature on health and safety management highlights two broad approaches to health and safety management – an old "traditional" approach based on Heinrich's scientific management principles (Ray et al. 1993; Costella et al. 2009), and a new systematic approach that is based on systems thinking principles (Bluff 2003; Niskanen et al. 2016). The traditional approach is characterised by the application of health and safety management practices in a fragmented manner that isolates people, technology and organisational components, while the systematic approach focuses on bringing these components together to create a mutual interface of people, technology and work (Costella et al. 2009). The traditional approach was dominant before the year

2000, but the systematic approach gained international prominence following the publication of the guideline of the international labour organisation on health and safety management systems (ILO 2001).

Zwetsloot (2000) situates the traditional and systematic approach to occupational health and safety management (OHSM) as stages in the evolution of an organisation from unsafe to safe. Zwetsloot identified four stages of evolution as follows:

- *Ad hoc stage:* at this stage, an organization is not interested in H&S and pays little attention to H&S management. The strategy is to react to acute H&S problems such as accidents, issues raised from labour inspections and other internal H&S conflicts when they occur. The organization has little H&S management expertise.
- *Systematization stage:* this stage involves a periodic risk assessment that is followed by developing and implementing an action plan for addressing identified risks. In this stage H&S awareness and H&S management competencies begin to develop within the organization and external expertise is often crucial.
- *Systems stage:* at this stage, the focus of the organization is the implementation and maintenance of a H&S management system. The H&S management strategy is risk prevention and control. Health and safety policy, procedures and accountability mechanisms are communicated to everyone within the organization. Periodic auditing of the system is organized to evaluate H&S performance. At this stage H&S management competencies are fairly well developed within the organization and there is less dependence on external consultants.
- *Proactive stage:* the focus shifts from risk prevention and control to continuous improvement of H&S and this is demonstrated by the setting of positive H&S performance goals. The organization begins to integrate the H&S management system with its other business operations and management systems such as quality and environment. The H&S management expertise within the organization is matured, and continuous collective learning is fostered.

Elements of the traditional approach can be identified in the H&S management activities of an organisation at the ad hoc and systematisation stages. The systems and proactive stages are characterised by a systematic approach.

Gallagher (2000:73) characterised the traditional approach as being reactive, focused on technical control of hazards, with health and safety specialists and supervisors being critical actors in the health and safety management arrangement, while employee input and participation is of marginal importance. A study by Agumba & Haupt (2009a) suggested that this approach to health and safety management is prevalent among small and medium size organisations within the South African construction industry.

A systematic approach to H&S management has become internationally accepted best practice for health and safety management. According to Saksvik & Quinlan (2003), a health and safety management system can best be viewed as a wide array of programmatic measures adopted by employers in an effort to meet systematic health and safety management requirements.

More recently, there has been much confusion about what a health and safety management system (HSMS) is. Robson et al. (2007) noted that there is no consensus on what a HSMS is, and that its scope is potentially wide. Finding meaning to what a HSMS is will therefore, require a discussion on the sources of HSMS diversity found in literature.

3.3 Health and Safety Management Systems – Definitions and Sources of Diversity

In the recent literature and everyday discourse, “health and safety management system” is commonly used to describe the totality of activities and programs adopted by organisations in managing health and safety. For example, Koivupalo et al. (2015) viewed a HSMS as encompassing all activities aimed at planning and implementing the health and safety policy of a company. Similarly, Goh et al. (2014) considered a HSMS to be the totality of management processes, structures and policies employed to eliminate hazards and minimise risk associated with the operations of an organisation. These definitions of a health and safety management system are considered misleading as not all health and safety management arrangements found within organisations are systematic or systems based.

Models for a systematic approach to health and safety management as found in the literature, as well as standards and guideline documents for implementing HSMS emphasise two underlying principles: (1) integration of processes and, (2) continuous improvement. A systematic approach to health and safety necessitates a "staying up to date" such that when safety goals are reached, new goals and plans are formulated for continuous improvement (Inan et al. 2017). Standards and guideline documents describing health and safety management system describe a structure that integrates several elements based on the of the Deming's circle principle of Plan-Do-Check-Act (Haas & Yorio 2016) depicted in Figure 7.

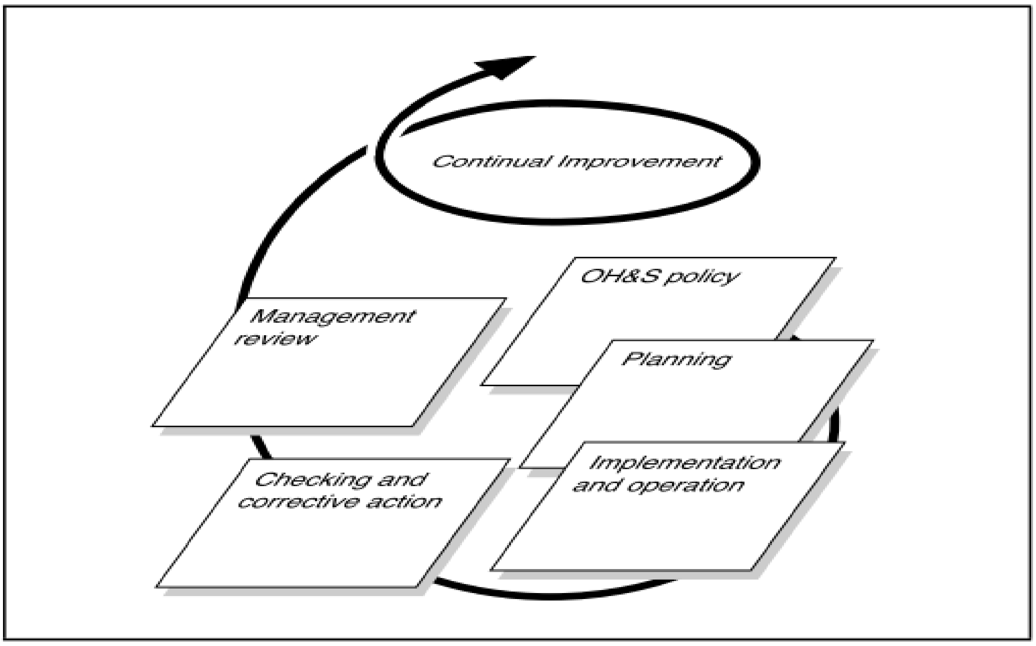

Figure 7: HSMS model for OHSAS 18001 (2007) standard (Source: Haas & Yorio, 2016)

Considering the above, a broader term – *health and safety management arrangement* will be adopted in this dissertation to refer to both traditional and systematic health and safety management efforts.

Health and safety management arrangements have been reported to differ in their method of implementation which could be voluntary or mandatory. They range from privately disseminated, voluntary HSMS models described in standards such as British Standard OHSAS 18001, to HSMA shaped by regulations that consist of a limited number of mandated principles such as those mandated under the European Union framework directive 89/391 EEC (Rocha, 2010). Voluntary HSMS are more thoroughly specified and complex to implement, and are most frequently observed in large companies because they are considered too complex for most small companies

(Robson et al. 2007). Mandatory HSMA on the other hand are designed to be simpler to implement in terms of demands placed on an organisation as they target all workplaces, big and small (Gallagher et al. 2001). Factors associated with the national institutional environment such as strength of workers' union, level of education of workforce and consultative arrangements between labour market actors have been identified to shape the program elements of mandatory HSMA (Mylett & Markey, 2007; Rocha, 2010). These national institutional factors are not uniformly found in all countries, it is therefore logical to expect to find different variants of HSMS across industries and national boundaries.

Frick & Wren (2000:3) distinguished between health and safety 'management systems', and the 'systematic management' of health and safety. With the former being a product of highly formalised, prescriptive, market-based, voluntary management standards promoted by consulting firms. Systematic management of health and safety on the other hand, are home grown solutions to health and safety management that are in response to systematic regulatory requirements. They focus on the risk management principles of hazard identification, hazard assessment and control, continuous evaluation and review of control measures to ensure effective implementation (Gallagher et al. 2001). Systematic management of health and safety requires less documentation and often excludes elements of planning and accountability that are essential to management systems in large businesses (Gallagher et al. 2001).

Two models of neoliberalism have been identified to also shape health and safety management arrangements. The first is the managerialist model that is characterised by managerial prerogatives, and an alternative model of social democracy characterised by partnership and worker participation (Mylett & Markey, 2007). The managerialist model stems from bureaucratic models of organisation (Taylor 1911), and is associated with a top-down managerial style that is driven by formal policies, procedures, and processes, with limited roles for workers in health and safety management functions. The managerialist approach considers worker participation as an add on, worker's involvement if any is generally limited to helping vet the systems rather than active involvement in their design and operation (Mylett & Markey, 2007). Most voluntary standards for HSMS reflect a managerialist theme (Gallagher, Rimmer & Underhill, 2001). Participative models of health and safety management on the other hand, are characterised by a bottom-up managerial style. These models came about in response to the Robens reforms that advocated joint regulation of health and safety by employers and labour (Robens, 1972). The main idea is an expanded role for workers in the design and operation of the HSMS of an organisation, especially with regards to the risk management processes and the design of hazard control measures, as well as active engagements through consultative arrangements (Mylett & Markey, 2007).

3.4 Themes differentiating Health and Safety Management Arrangements

Description and analysis of health and safety management arrangements into types is scarce in the literature. However, management perspective defined by the position of management and employees in the execution of H&S management functions, as well as the safety control strategies employed are two defining themes in the literature.

3.4.1 Management perspectives

García Herrero et al. (2002) identified two management perspectives most commonly applied to health and safety management - (1) the traditional management perspective and (2) the philosophies of Total Quality Management (TQM) in conjunction with safety.

Traditional management perspective

This management perspective is characterised by: (1) centralisation of H&S management responsibilities in the hands of a H&S specialist (García Herrero et al. 2002) and (2) an emphasis on the prevention of repetition of accidents that have already occurred with a focus of identifying accident causality factors (Booth & Lee 1995). The common features of this management perspective is the setting and enforcement of safety rules, and a devotion to compliance with minimum safety laws and regulations (Xueyi et al. 2012).

A major shortcoming of the traditional approach is that they are focused on technical requirement, and the safety programs implemented by the organisation are isolated and not integrated with other management functions (García Herrero et al. 2002). Traditional management perspective is characterised by the absence of formal H&S management structures, safety professionals or owner-manager assume centralised responsibilities of ensuring that workers adhere to safety standards and regulation, as well as responsibility for operating safety programs within the organisation (Champoux & Brun 2003; García Herrero et al. 2002; Xueyi et al. 2012).

Booth & Lee (1995) noted two key features of the traditional management perspective to safety management based on accident causation to include:

- the search for the primary cause of the accident and
- the debate on whether the primary cause was an unsafe act or an unsafe condition

This search for the cause of accident often blamed the workers' behaviour and would often result in the preparation of safety rules designed to prevent a reoccurrence. However, due to a lack of consultation with workers, safety rules often conflict with the needs of workers to get the job done, resulting in a tactful evading of the prescribed rules or physical safe guards (Booth & Lee 1995). Figure 8 provides an illustration of the focus of the traditional H&S management perspective.

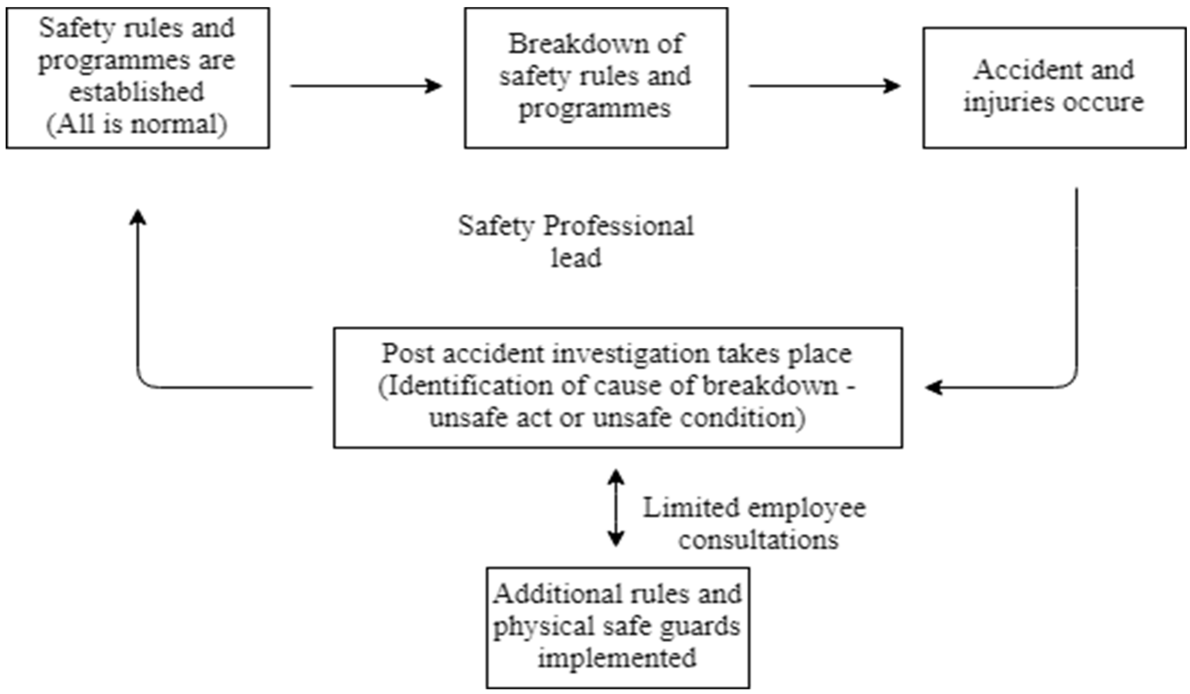

Figure 8: Traditional safety management perspective (adapted from Xueyi et al. 2012)

Total Safety Management Perspective

Total safety management perspective is characterised by the application of TQM principles in safety management. This management perspective is also referred to as Total Safety Management (TSM) by several authors, and is described as more self-regulatory and performance oriented (García Herrero et al. 2002; Xueyi et al. 2012;

Kontogiannis et al. 2017). According to Herrero *et al.,* "TSM is safety management written and practiced using principles of TQM".

This management perspective is characterised by (1) the integration of H&S management activities with broader management activities, (2) de-centralised and shared H&S responsibilities between managers and employees, and (3) the presence of H&S management policies, structures and written prevention programs (Champoux & Brun 2003). García Herrero et al. (2002) identified three components required to facilitate a TSM philosophy in practice:

- A committee with the responsibility for defining H&S policies, rules, safe work procedures, providing resources, and approving recommendations for safety improvement
- A team with the responsibility for identifying and recommending improvements to the work environment
- A safety professional preferably of the top management cadre with responsibility for H&S, and implementing approved safety programs

Unlike the traditional management perspective, the underlying philosophy of the TSM is that accidents and injuries are caused more by faulty planning of work (including procedures and environment) than by the behaviour of workers.

3.4.2 Safety control strategy

The control strategies for managing safety according to Gallagher could be either focused on behavioural modification generally referred to as the 'safe person' strategy or focused on the control of hazards generally referred to as the 'safe place' strategy. Law et al. (2006) enumerated the defining attributes of a safe person and safe place safety control strategy to include:

- Attributes of a safe person approach:
  - Safety training
  - In house safety rules
  - Personal protective programme
  - Safety and health awards
  - Occupational health and safety assurance programme

- Attributes of a safe place approach:
    - Inspection programme
    - Job hazard analysis
    - Accident control and hazard elimination

The building blocks of the safety place and safe person safety control strategies are extensively discussed in Makin and Winder (2008, 2009).

A safe place/safety person dichotomy in safety control strategy is practically evident in the management perspectives discussed in section 3.4.1, while traditional management perspective lean towards enforcement of rules and directing the worker (safe person), the TSM methods lean towards controlling the work environment.

Some authors have argued that the safe person and safe place strategies are complementary and have canvassed for their integration to produce modular management system for health and safety (DeJoy 2005; Makin & Winder 2009).

Figure 9 presents a summary of the major themes differentiating HSMS in the literature.

Traditional management perspective

- The 'key persons' is the owner-manager or safety professional
- A low level of integration of health and safety into broader management systems and practices
- Employee participation is limited
- Reactive and focused on compliance with legislation

Total safety management perspective

- Senior and line managers have a key role in health and safety
- A high level of integration of health and safety into broader management systems and practices
- High level employee involvement
- Proactive and focused on self-regulation and continuous improvement

Safe Person Control Strategy

- Prevention strategy focused on the control of employee behaviour

Safe Place Control Strategy

- Prevention strategy focused on the control the work environment

Figure 9: Features of defining HSMS themes

3.4.3 Health and safety management typologies

One academic source was identified that attempted developing a framework for categorising/grouping HSMS into types. Based on the features of the safe person/safe place safety control strategies, and the traditional and TSM perspectives, and the overlap observed between the categories in practice, Gallagher (2000:81) proposed a cross-typology which distinguishes four types of HSMS. Figure 10 depicts this cross-typology, while Figure 11 shows the key characteristics of each type.

TSM/safe person "Sophisticated behavioural"	**Innovative/safe place** "Adaptive hazard managers"
Traditional/safe person "Unsafe act minimisers"	**Traditional/safe place** "Traditional engineering and design"

Figure 10: Types of Health and Safety Management Systems (Gallagher, 2000)

Sophisticate Behavioural • Prevention activity predominantly upstream and employee related • Higher level managers are key management players • High level of employee involvement • A higher level of integration, or alignment, of health and safety with broader management systems
Adaptive Hazard Managers • Prevention activity centred on the control of hazards at source • Higher level managers are key management players • A high level of employee involvement • A high level of integration, or alignment, of health and safety with broader management systems
Unsafe Act Minimisers • Emphasis on unsafe acts • Health and safety specialists, supervisors, or lower level managers have the key management roles • Emphasis on supervision of employee behaviour and on rules to prevent employee risk-taking • Limited, or lower level, integration of health and safety into broader workplace systems
Traditional Design and Engineering • Prevention activity centred on the control of hazards at source • Employee may be involved but they are not central to the operation of the health and safety management arrangement • Health and safety specialists, supervisors or lower level managers have the key management roles • Limited, or lower level of integration of health and safety into broader workplace systems

Figure 11: Key Characteristics of HSMS types (Gallagher, 2000:81 - 82)

A fundamental drawback of the typology proposed by Gallagher is the exclusion of elements of continuous improvement from the categorisation framework.

3.5 Elements of Health and Safety Management Arrangements

In practice, the HSMA at companies are often modelled against the requirements of management system standards such as:

- OHSAS 18001:2007. Occupational Health and Safety Management Systems – Requirements (BSI 2007)
- Australia/New Zealand AS/NZS 4801/4804 Occupational Health and Safety Management System (Standards Australia 2001a, b)
- International Labour Organisation (2001) - Guidelines on Occupational Safety and Health Management Systems (OHS-MS)

A universal HSMS assessment instrument (UAI) developed at the University of Michigan identified 27 elements to be representative of the broad scope of management system standards for health and safety management (H Dalrymple et al., 1998). These 27 elements were grouped into five organising categories namely – (1) initiation, (2) formulation, (3) implementation, (4) evaluation and (5) improvement/integration. Table 4 shows the basic elements of such a health and safety management system as detailed in the UAI.

Table 4: Elements of HSMS

HSMS Elements under UAI Structure

Initiation (OHS Inputs)
1. Management commitment and resources
    a. Regulatory compliance
    b. Accountability, responsibility and authority
2. Employee participation
Formulation (OHS Process)
1. OHS policy
2. OHS goals and objectives
3. Performance measures
4. System planning and development
    a. Baseline evaluation and hazard/risk assessment
5. HSMS manual and procedures
Implementation/Operations (OHS process)
1. Training system
    a. Technical expertise and personnel qualifications
2. Hazard control system
    a. Process design
    b. Emergency preparedness and response system
    c. Hazardous agent management system
3. Preventive and corrective action system
4. Procurement and contracting
Evaluation (feedback)
1. Communication system
    a. Document and record management system
2. Evaluation system
    a. Auditing and self-inspection
    b. Incident investigation and Root Cause Analysis
    c. Health/medical program and surveillance
Improvement/integration
1. Continual improvement
2. Integration
3. Management review

Not every element described in management system standards are implemented in practice. Law et al. (2006) reported that it was impractical for organisations to implement all or most of the elements contained in management system standards especially for small and medium size organisations with limited resources. Organisations however, try to implement as far as possible, elements applicable to their industry. The choice of element to implement by organisations is informed by:

- Client requirements
- Insurance company requirements
- Employee requirements
- Cost effectiveness
- Intensity of price-based competition
- Rate of unionisation
- Manual nature of workers' tasks

(Law et al. 2006; Arocena & Núñez 2010)

A synthesis of the elements of a HSMA and the main themes that characterise HSMA typologies provides a framework for the categorisation of construction health and safety management arrangement into types. This framework is presented in the next section.

3.6 Framework for the Analysis of Construction Health and Safety Management Arrangements

Elements of health and safety management arrangement can be grouped under three thematic areas:

1. Determinants of management perspective
   - Traditional or TSM perspectives
2. Determinants of OHS control strategy
   - Safe person or safe place
3. Components of Continuous improvement
   - Systematic and non-systematic

Figure 12 shows the grouping of HSMA elements under these three thematic areas. This forms the basis for the conceptual framework proposed for the categorisation of HSMA into types.

Grouping of HSMS elements in thematic areas
Determinants of management perspective 1. Organisational structure (responsibility and authority) 2. Top management commitment and involvement 3. Employee consultation and participation ***Determinants of OHS control strategy*** 1. Hazard control procedures 2. Health and safety training and competencies 3. Accountability mechanisms ***Continuous improvement components*** 1. Audits 2. H&S performance measurement and reporting 3. Performance review by management

Figure 12: Grouping of HSM elements under the three thematic areas of HSMA analysis

3.7 Conceptual framework

Considering the literature review presented above, a conceptual framework providing direction for the rest of this study is presented in Figure 13. This conceptual framework is made of an a priori component based on the literature presented above, and a posteriori component informed by evidence from the qualitative and quantitative data to be obtained in this study.

The conceptual framework considers a HSMA to be a strategically designed, context specific organisational asset. The features of a specific HSMA type are based on the management perspective, health and safety control strategy, and mechanisms for continuous improvement. This much has been established from the literature. Findings from the qualitative and quantitative aspects of the study will provide evidence on the number of HSMA types that can be identified within the contractor organisations and the specific features of each HSMA type, as well as their relative efficacy.

Figure 14 shows the conceptualised relationship between an organisational HSMA and safety performance. Distal safety outcomes are the expected tangible benefits to an organisation for managing health and safety risks. These outcomes give face validity of the effectiveness a health and safety management arrangement. The relationship between distal safety outcomes and the health and safety management arrangement of an organisation is mediated by the safety culture that exist within the organisation.

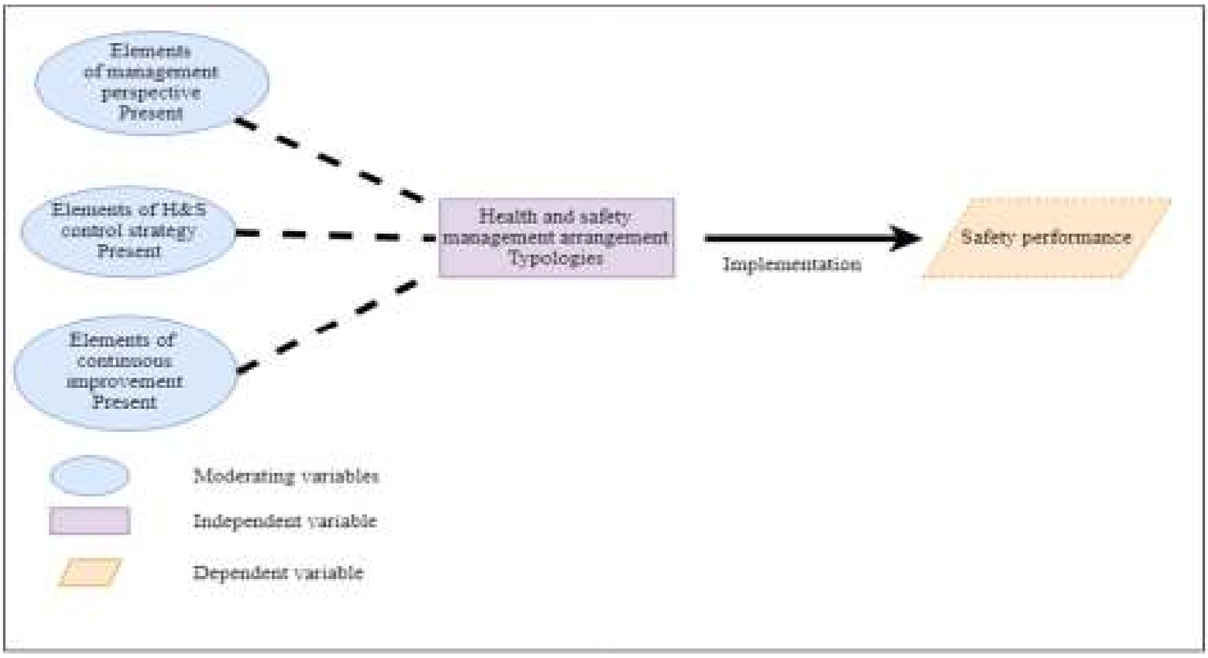

Figure 13: Conceptual framework for Phase one of study

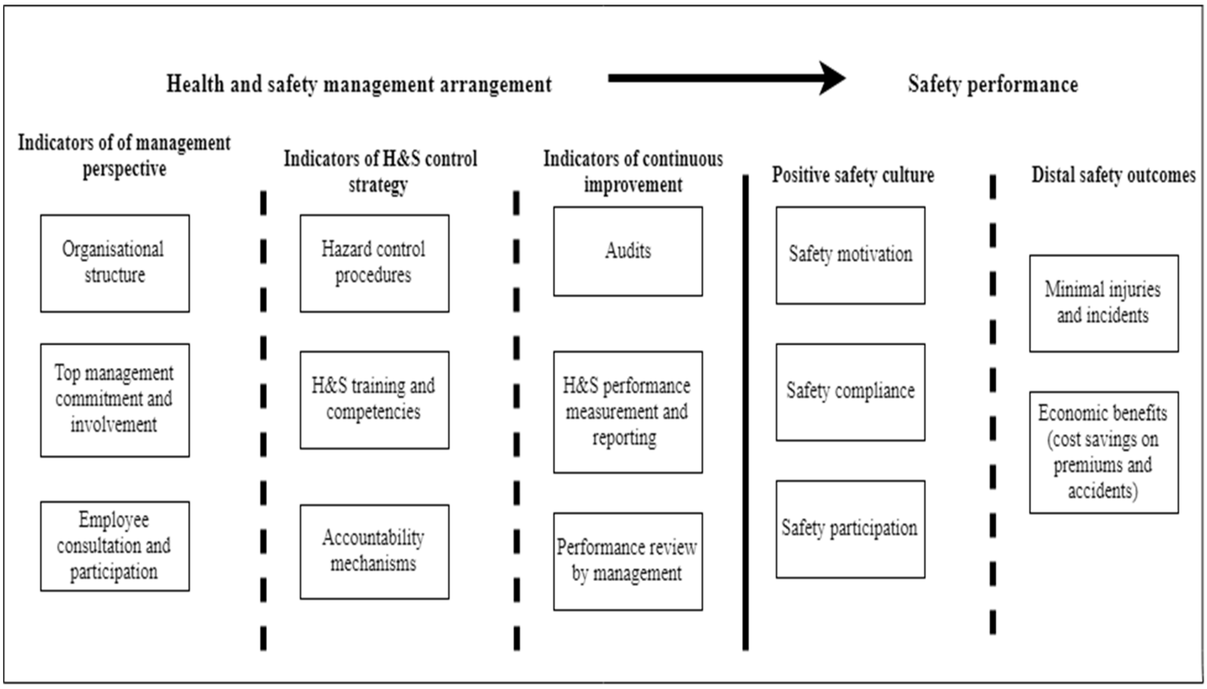

Figure 14: Conceptualisation of the relationship between HSMA and safety performance

3.8 Chapter summary

In this chapter, the concepts of traditional and systematic approaches to health and safety management were explored. Systems requirements that distinguish systematic health management from traditional health and safety management were identified. These systems requirements include (1) institutionalised and interacting strategic management programs that work together in an integrated way and (2) mechanisms for continuous safety improvement.

Two themes – (1) management perspective (traditional management or total safety management perspectives) and, (2) safety control method (safe place or safe person) were identified in the literature to characterise HSMS types. Traditional management perspective is characterised by low levels of integration and employee involvement. Total safety management perspective on the other hand is characterised by high levels of integration of health and safety into broader management systems, high levels of employee and senior management participation, as well as elements of continuous improvement. Safe person control strategy focuses on controlling employee behaviour through the enforcement of safety rules, while the safe place strategy focuses on the elimination of hazards by applying risk and hazard management principles.

Three thematic areas were identified to be most relevant for the categorisation of construction HSMA into types in this dissertation and they are: (1) management perspective, (2) H&S control strategy and (3) mechanisms for continuous improvement. A conceptual framework to guide the categorisation of HSMA into types was proposed in this chapter and will guide the rest of the study.

CHAPTER FOUR

CATEGORISATION OF CONSTRUCTION HEALTH AND SAFETY MANAGEMENT ARRANGEMENTS – A QUALITATIVE ANALYSIS

4.1 Chapter Introduction

Chapter three introduced broadly contemporary health and safety (H&S) management paradigms. Traits of systematic and non-systemic health and safety management strategies as well as themes relevant to the categorisation of health and safety management arrangements into types were also discussed.

The fluid and fragmented nature of the construction industry presented in chapter two suggests that health and safety management arrangements within the construction industry will be different from health and safety management arrangements found in other more structured industries. Hence the need to identify the characteristics of health and safety management arrangements found within contractor organisations.

In this chapter, qualitative data obtained through case studies of 14 contractor organisations, as well as interviews with health and safety consultants and advisors are analysed to explore the attributes that characterise health and safety management arrangements within contractor organisations. The case studies provided multiple sources of evidence for the management perspectives, safety control strategies and mechanisms for continuous improvement that characterise health and safety management arrangements at medium to large contractor organisations.

This evidence came from two sources, namely, interviews with custodians of H&S management within these organisations and on-site observation that recorded physical evidence and behaviour (Figure 15).

The objective of this chapter is to apply the conceptual framework proposed in chapter three to analyse qualitative data collected from case studies and interviews, and based on the analysis of the interviews, categorise health and safety management arrangements within contractor organisations into types. The chapter begins with a description of the research methodology applied to obtain and analyse the qualitative data. The interview cases are examined in relation to the nine moderating variables identified in the conceptual framework presented in chapter 3.

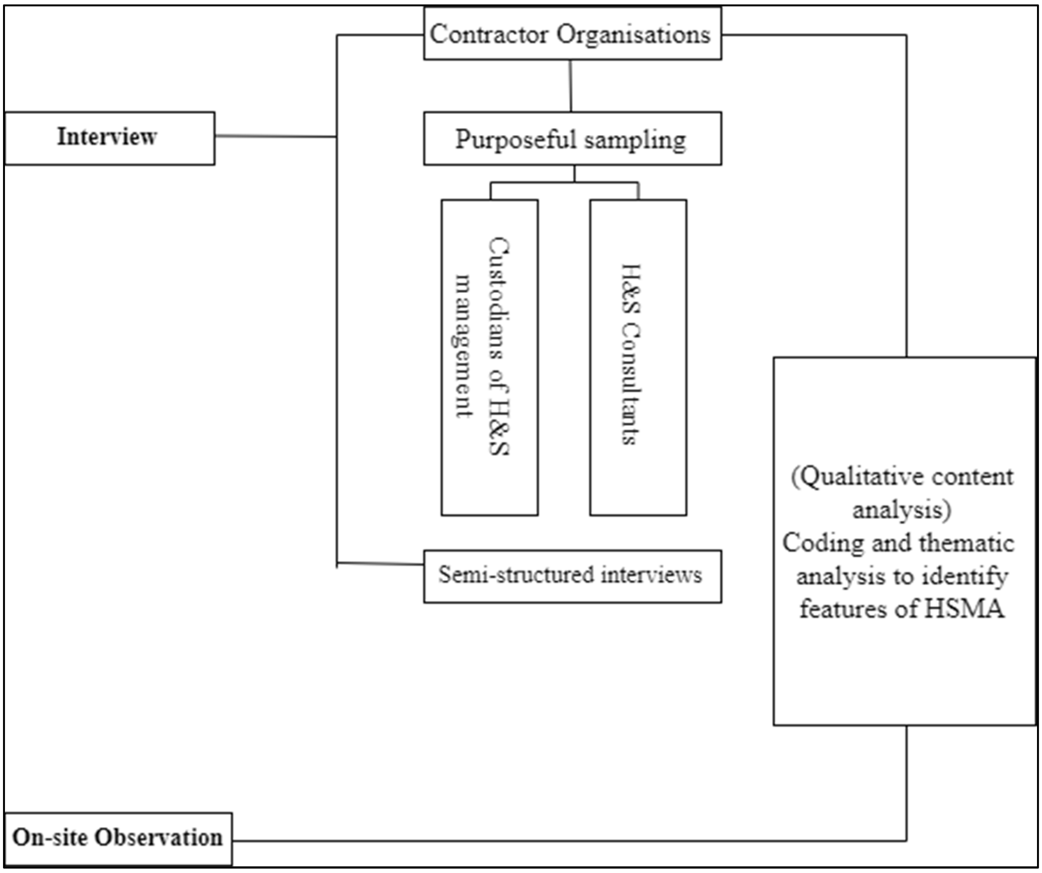

Figure 15: Qualitative Research Outline

Firstly, the cases are considered in relation to the management perspective in terms of organisational structure, top management commitment and involvement, and employee consultative arrangements and participation. Secondly, the cases were considered in relation to the safety control strategy in terms hazard control procedures, H&S competencies and training, and accountability mechanisms. Thirdly, the cases are considered in relation to mechanisms for continuous improvement in terms of audits, performance measurement and reporting, and management review. Finally, findings from the analysis of the cases that reveal areas of distinctions and similarities are summarised revealing three HSMA types representing the broad spectrum of HSMA within contractor organisations.

A health and safety management arrangement (HSMA) in the context of this study is defined as:

> the organisational structure, policies, procedures, planning activities, responsibilities, practices and resources for managing the health and safety risks associated with the business of an organisation.

4.2 Research Methodology

A qualitative research methodology was considered most suitable for investigating the characteristics of health and safety management arrangements adopted by construction contractors in South Africa. According to Creswell (2013), qualitative methods are suited for problems that need to be explored to obtain a detailed understanding.

Interviews were first conducted with H&S advisors at the two major contractor employer associations in South Africa namely the Master Builder Association (MBA) and the South African Forum of Civil Engineering Contractors (SAFCEC) to get an overview of H&S management strategies of their members. An interview was also conducted with the chief underwriter for a mutual insurer of contractor under the COID Act to obtain information on whether health and safety management practices of a contractor influence their insurance premiums. It was learnt that insurance premiums are independent of H&S management arrangement as the insurer does not audit the health and safety management arrangements or project sites of its members.

Feedbacks from these interactions and the literature review conducted informed the design of an interview guide for this study. A copy of the interview guide is presented in Annex A. Fourteen contractor organisations were selected as case studies. A purposeful sampling technique was used to select these organisations. These organisations were registered with the *cidb* between grades 7 and 9. The selected organisations are also members of the MBA or SAFCEC.

Semi-structured interviews were conducted with managers charged with the responsibility of health and safety within the selected organisations, and each interview was at least an hour long. The interview process was accompanied by site visits to observe physical aspects of the construction H&S management implementation. Table 5 presents a summary of the profile of the contractor organisations represented in the case study interviews. The selected contractor organisations included medium to large construction organisations, as well as building, civils and specialist subcontractors.

In addition to the 14 case study organisations, two reputable health and safety consultants who provided consulting services to the construction industry were also interviewed. These consultants provided a unique perspective reflecting the position of contractor organisation who employ the services of external H&S consultants. Interviews were conducted until information saturation was achieved according to the criteria discussed by Schreier (2014:77), which is the point where no new information was being obtained from the interviews.

Table 5: Details of case studies and interview respondents

Interview Case	CIDB Grading of Organisation	Area of Business Operation	Respondent Designation within organisation
Contractor A	9	Marine engineering (Offshore and subsea)	H&S manager
Contractor B	9	Commercial building	H&S manager
Contractor C	9	Civil engineering – highways and pavement	H&S manager
Contractor D	9	Commercial building	H&S manager
Contractor E	9	Marine engineering	H&S manager
Contractor F	9	Civil, road and building	SHEQ manager
Contractor G	8	Civils and building	H&S manager
Contractor H	7	Industrial flooring	Operations manager
Contractor I	9	Building	H&S coordinator
Contractor J	8	Fabrication and erection of structural steel	Project H&S manager
Contractor K	7	Scaffolding supply and erection	H&S manager
Contractor L	9	Commercial Building	Divisional H&S manager
Contractor M	8	Specialist Geotechnical services	Supervisor/H&S coordinator
Contractor N	9	Commercial building	H&S coordinator
H&S Consultant A	N/A	H&S consultancy	Managing consultant
H&S Consultant B	N/A	H&S consultancy	Managing consultant
Mutual Insurer	N/A	Insurer under the COID Act	Chief underwriter
Master Builders South Africa	N/A	Employer association representing building contractors	H&S adviser
South African Forum of Civil Engineering Contractors	N/A	Employer association representing civils contractors	H&S adviser

These interviews yielded information from industry experts on the H&S management practices within the construction industry. Ethics approval was obtained from the Research Ethics Committee (REC) of Stellenbosch University for the conduct of the study.

4.2.1 Data Analysis

A Qualitative Content Analysis (QCA) technique was used to analyse the interviews. Qualitative content analysis is a method of analysing text in qualitative research. The method systematically describes the meaning of qualitative data by classifying materials as instances of categories of a coding frame (Schreier 2014). The steps followed in the analysis process are:

1. Transcribing of audio interviews
2. Building a coding frame
3. Analysing interview transcripts according to the coding frame developed

The data analysis process began with the verbatim transcription of audio recordings of interviews. All transcripts were proof read for accuracy and consistency with the audio version of interview. Following the transcribing process, a coding frame was developed to enable the analysis of the transcribed interviews. A coding frame provide a road map for structuring the interview data and consists of main categories and subcategories. The main aspects of the research topic which the researcher chooses to focus on make up the main categories; subcategories provide descriptions for the main categories based on what was said in the interviews. Schreier (2014) and Neuendorf (2002) provide a detailed description on coding frames and this will not be repeated here. The literature suggests three methods of developing a coding frame:

(1) Concept driven/deductive/directed - building a coding frame from existing theory or prior research already known to the researcher.
(2) Data-driven/inductive/conventional - building a coding frame from the emergent messages distilled from the material analysed.
(3) Summative – a combination of the above two methods

(Neuendorf 2002; Schreier 2014; Hsieh & Shannon 2005).

A concept driven/deductive method to developing a coding frame was adopted in this study. According to Hsieh and Shannon (2005), a concept driven method is appropriate if the research goal is to identify and categorise instances of a phenomenon, as is the case in this study. Schreier (2014) recommends a concept driven approach for cases where an interview guide was used to collect the data. The choice of concept driven method is also informed by the advantage of increased coding reliability.

The coding frame for this study is populated using the three thematic areas distilled from the literature and upon which the interview protocol was based. Figure 16 presents the coding frame for this study.

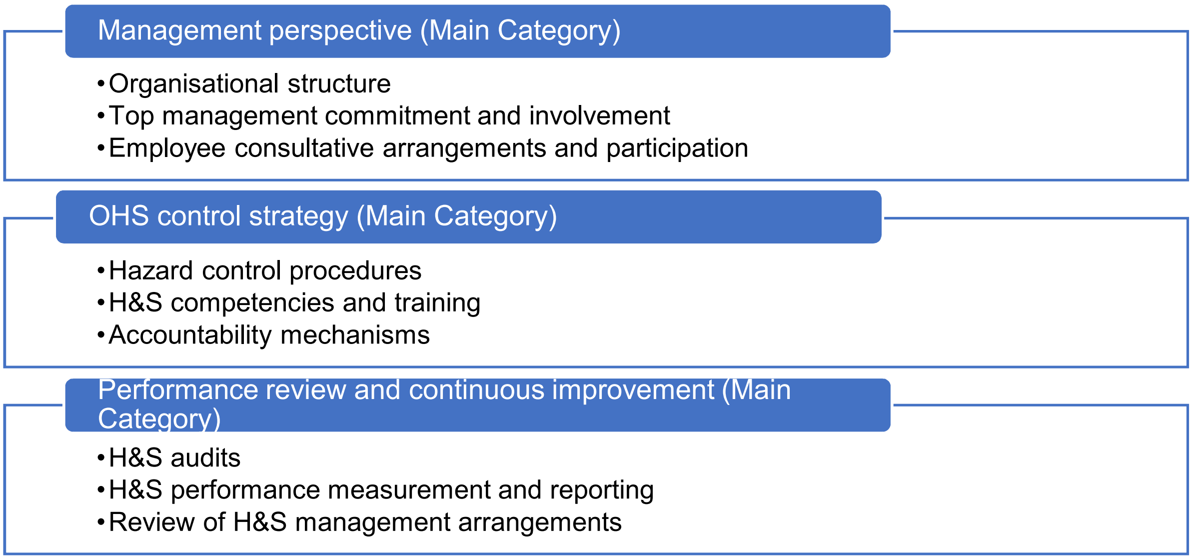

Figure 16: Coding frame structure for content analysis of interviews

In analysing the content of the interviews, a thematic analysis perspective discussed by Joffe & Yardley (2003) is adopted, this is because it is well-suited to deductive coding frames. Thematic analysis focuses on the patterns in the data related to the subcategories under the coding frame. The next sections present the analysis of the interviews.

4.3 Management Perspective

This section presents an analysis of the interview cases in relation to the management perspective at these organisations with regards to H&S management. There is consensus in the literature on the identifiers of management perspective to health and safety management. These identifiers include the position of top management and employees in the health and safety management arrangement, as well as avenues for consultation (Inan et al. 2017).

The management perspective adopted by contractor organisations towards health and safety management will be defined by four key variables. The first, is the organisational structures that coordinate H&S management activities. Second, is the position of top management in the H&S management arrangement. The third, is degree of employee participation and consultation in health and safety decision making. Finally, the allocation of financial resources for H&S management. The allocation of resources to health and safety management was not a thematic area in the coding frame, but a theme that emerged from the data analysis process.

4.3.1 Organisational Structure

An important source of distinction between H&S management arrangements was the motivation for the health and safety management efforts of the organisation. Two sources of motivation as identified from the interviews are:

1. Compliance: *"There are three things the contractor must always comply with; one is the legislation, the second is the client's safety specification and the third is the negotiated safety plan for the site"* (Safety Manager, contractor C).
2. Best practice: *"Our health and safety management is not purely dependent on the client… we have our own set of rules as a group to play with… our set of rules are those certificates that are hanging there; ISO 9001, OHSAS 18001, and ISO 14001"* (SHEQ manager, contractor B).

Compliance motivated organisations perceive health and safety to be a project only function and are characterised by the absence of an elaborate organisational structure for the management of health and safety. The organisational structure for health and safety management at compliance motivated organisations can also be described as revolving around the health and safety specialist, who is either employed within the organisation or is an external consultant. In organisations where the health and safety specialist are external to the organisation, a person in operational middle level manager such as a foreman or supervisor was found to be a liaison between the organisation and the consultant, assuming responsibility for H&S in addition to other technical functions. This point is substantiated in the consultations:

> *You see the issues with contractors of that size is that they want to price for safety for the project and they don't essentially want safety within their company set up. They only want it for that particular project. Okay, the health and safety officer component, they do not have that, that is where we come in. They will provide us with the necessary*

> *connections on site. So, their staff and supervisors on site will then be told to work with us* (H&S consultant A).
>
> *We do have a safety department, but I am the only one in the department* (H&S officer, Contractor J).

Best practice motivated organisations appeared to be driven by the need to meet international standards and portray a good corporate image believed to be "good for business", especially at organisations with international operations or shareholders. A safety manager at one of the large contractors recently acquired by an international brand had this to say about their management system for health and safety:

> *We were recently acquired by **** of Australia. Our management system for health and safety and their own are not the same because they have things that we don't have, and we have things that they don't have. So, we started with the gap analysis where we brought these two systems together to make it one system, at the end of the project we will have one system that is more of theirs.* (H&S manager, contractor A).

The organisational structure for H&S management at best practice organisations was found to be defined chiefly by the requirements of OHSAS 18001 management standard. Organisational structures for health and safety management at these organisations featured dedicated health and safety management departments. Organisations that had OHSAS 18001 certified management system for health and safety in place were also found to have ISO certified systems in place for managing quality and environment. These systems on the surface appear integrated under an integrated management system (IMS) often called a SHEQ system (safety, health, environment and quality). However, consultations reveal that the operationalisation of IMS by contractors remains a challenge. This is evident in the misalignment of production and H&S priorities observed on their projects, with production being top priority among construction managers and supervisors.

4.3.2 Top management commitment and involvement

Management commitment in practice was found to differ from management involvement in health and safety management. Management "commitment" to health and safety management refers to management support for health and safety activities. Management "involvement" refers to participatory roles of management in health and safety management activities within the organisation. While management involvement speaks to “who does what”, management commitment gives an indication of “how well it is likely to be done”.

The voluntary adoption of HSMS was considered a clear indication of top management commitment to health and safety. There was a consensus especially among representatives of employer organisations that top management commitment to H&S is linked to a broader range of “good business principles” that are traits of successful construction businesses. The level of top management commitment was linked to the mind-set of the CEO:

> *Some CEOs just want to comply, other want to exceed compliance and achieve excellence. This attitude of an organisation towards excellence, is also related to their attitude towards H&S* (H&S Adviser, MBA).
>
> *I mean in the history of the company, the company was working, working and working and at a point we realised that the injuries were just too much - were causing us production problems, it was causing like a morale problem on site as well… We had a gear change, that was in 2012 and the gear change was that our senior management - I am talking now about CEOs, director level people they decided that we need to do something here* (SHEQ Manager, Contractor F).

From the perspective of external supply chain pressures for HSMA adoption, there is a widely-held notion among the H&S consultants interviewed that some category of contractors perceives H&S to be a nuisance and would engage a H&S consultant to deal with it. This attitude towards H&S management was attributed to a lack of knowledge and skill. Regulations especially with regards preparing a H&S file was noted to be a daunting exercise for most owner/managers of construction organisation. Their organisational set ups are not suited to carry out these clerical and administrative functions, therefore these contractors outsource the preparation of the safety file, and often do not have the capacity to quality control the content of the safety file.

The level of senior management participation in health and safety management from the consultations was found to be linked to the organisational structure for health and safety management. The presence of a dedicated health and safety management department was found to not always translate into active participation of senior managers in health and safety management. Health and safety roles and functions were often found to be concentrated within these departments. However, the position of the health and safety manager within the organisational hierarchy differed between organisations. At some organisations, the health and safety managers occupied senior management positions and were part of the highest decision-making organs of the organisation. This was the case at contractor organisations A, B, D and F. At some other organisations, the safety manager occupied middle level management positions and had limited decision-making powers. Generally, top management outside of the health and safety department were noted to play limited roles in health and safety management.

A reliance on health and safety consultants was observed to be indicative of an organisation with limited roles for senior management in health and safety management activities. The role of these consultants was to a large extent advisory and administrative. Lower level managers such as supervisors were ultimately responsible for health and safety management activities at these organisations.

4.3.3 Employee consultative arrangements and participation

Legislation backed health and safety committees that are comprised of nominated employee representatives was found to be the main mechanism for consultation on health and safety issues within contractor organisations in South Africa. Generally, two levels of consultation were identified: (1) Project level safety committees and (2) Organisational level H&S forums.

The composition of a project level committee was found to be limited to site H&S officers, construction managers, and employee nominated representatives often through their trade unions, and conspicuously excluded members of top management within the organisation. These project level committees serve as avenues for identifying health and safety issues and communicating them to management through the safety officers on site.

Above the project level, organisational level H&S forums serve as avenues for escalating H&S issues raised by the project level H&S committee to the appropriate level of management. The configuration of the organisational level H&S forums was found to differ between organisations in terms of the extent of top management and employee representation. While at some organisations the forum is exclusively populated by safety officers, safety managers and top management representatives, at other organisations, employee representatives were found to be part of the forum. Some description of employee consultative arrangement from the consultations include:

> *We have got two layers of safety meetings. The first layer is on site. On the project itself… Now from that meeting, one of those guys must attend my - higher level internal safety meeting. The group safety meeting… Then on that meeting we wouldn't necessarily have the safety reps, they can be some, no reason why not. But not necessarily. We usually have the safety officers at the group safety meeting. And they report back from what happened from their sites and what were the problems, what are the challenges et cetera* (H&S manager, Contractor C).

> *… a SHEQ forum is being held whereby the divisional managers on safety, the group safety manager and then the director that is appointed by our CEO overlooking safety all form part of this SHEQ forum. They discuss problems coming from the ground level and filter it back through us (to the safety committee on site)* (H&S manager, Contractor D).

It was generally observed that at most contractor organisations top management were only notified about H&S issues but did not take active part in frequent consultative meetings with employees. However, they would get briefings on the safety performance of the organisation as an agenda item at management meetings.

The mode of employee participation in H&S management within contractor organisations interviewed was generally found to be representational and not direct. Lower level employees were generally found to play no role in the development and review of H&S management systems. Impediments to effective participation of lower level employees in H&S management within contractor organisations as identified from the consultations include:

- Low level of education of most construction workers and
- Temporary employment relationship that characterise labour hiring within the industry.

In organisations where attempts at engendering employee participation in H&S management processes was observed, the extent of their participation was found to be limited to hazard identification as part of the risk assessment process. Risk assessment activities as witnessed within contractor organisations encouraged workers to bring to the attention of the H&S department, emerging hazards in their work environment. In one organisation where employee involvement in risk assessment was found to be deeply entrenched, the process of Hazard Identification and Risk Assessment (HIRA) is carried with line managers and supervisors taking the lead for the work area under their supervision.

4.3.4 Resource allocation to health and safety management

Adequate resourcing of health and safety management has been identified in the literature as an indicator of top management commitment to health and safety and vital to the success of OHS activities and programs (Mohammadfam et al. 2016). Sections 5(g) and 7(c)(ii) of the Construction Regulations mandates that both principal contractors and subcontractors make adequate provisions for the cost of health and safety in their tenders.

Peculiar characteristics of the South African construction business environment was found to make adequate resourcing of health and safety management by contractors challenging and problematic. The widespread practice of subcontracting and price-based competition were identified from the consultations as two key factors that undermine health and safety funding.

While the provisions of the Construction Regulations were generally believed to be observed by many reputable clients, its effective implementation appears to be undermined by the absence of a Bill of Quantities (BoQ) system for costing health and safety for the industry. The implications of this is the absence of a thorough and uniform basis for costing health and safety when tendering for projects. Therefore, many contractors interviewed said they took a cautious approach in costing for health and safety as it could become a deciding factor in determining the winning tender. The following responses substantiates this point.

> *One of the issues is that we do not have a standard bill of quantities to price health and safety. So that is a big problem within the industry because we cannot compare apples with apples* (Division H&S manager, Contractor L).

> *The problem is stemming from the client in terms of not understanding the cost of H&S and not accepting it readily because it can become a game changer or the difference between first and second on a tender, if you understand. Your health and safety budget and allowable could throw you out of the running* (H&S manager, Contractor G).

A second observation was that while principal contractors' price for health and safety in their tenders to clients, subcontractors of principal contractors pointed out that their pricing for work done for principal contractors was in the form of rates. These rates in many cases do not factor in the cost of health and safety. A safety manager from a large contractor shared this view:

> *We ask for rates... It is a reality, unfortunately. Because if they had to take in everything considering health and safety, medical surveillance, PPE, health and safety consultant, or full-time safety officer. You include that in your rates, you will be pricing yourself out of the market* (Health and safety manager, Contractor B).

The tender price for large contractors is often based on quotes received from their subcontractors. The non-inclusion of the cost of health and safety in subcontractor rates was observed to often cascade up to the final tender price of the principal contractor. The implication of this on project health and safety management efforts is summed up in the following response:

> *…our initial price is based... yes, off the subcontractor's prices. I do not see a specific cost on any tender that says I have allowed for X, Y and Z for whether it is training, whether it is PPEs or anything like that. And a lot of the time it actually shoots us in the foot, because the contractor comes to site and he is not fully conversant with the requirements and we start to provide safety harnesses, life line, things like that... which they need to have but cannot provide* (Divisional H&S manager, Contractor L).

Conclusions drawn from the interview is that financial resource allocation to health and safety management by contractor organisations in South Africa is in most cases project dependent and influenced by the client. Most respondents were of the view that the industry considers health and safety a project cost and not an organisational cost. Many of the contractors interviewed did not have specific annual budgets for proactive health and safety management. However, organisations that had in place certified management system for health and safety, did allocate financial resources to periodic compliance assessment audits and re-certification exercises. The implication of this is the lack of resources to fund critical component of proactive health and safety management such as training and building internal capacity for health and safety within the organisation.

4.4 OHS Control Strategy

This section presents an analysis of the interview cases in relation to the safety control strategy at these organisations. It has been reported in the literature that the safe person and safe place perspectives to controlling safety are not mutually exclusive (Gallagher 2000:88), however, either of the two can be dominant in the approach of an organisation to controlling or preventing workplace hazards depending on the hazard profile of the organisation (Makin & Winder 2009). The safe place focus of occupational health and safety legislations has been widely reported in the literature to skew the H&S control strategies of organisations that strive to comply with legal requirements in favour of safe place controls activities (Sarkus 2001; Bluff 2003; Gallagher 2000).

Safe place strategies according to Makin and Winder (2008) are underpinned by (1) hazard identification and risk assessment procedures and (2) focused on the control of the physical environment through the elimination of physical hazards from the workplace.

Safe person strategies on the other hand are focused on (1) the control of employee behaviour, and (2) equipping workers with the knowledge and skills to identify situations that have the potential to cause harm and avoid creating dangerous scenarios. Gallagher (2000) added that a reliance of 'lower order' controls specifically the use of Personal Protective Equipment is indicative of a safe person perspective.

The characterisation of the H&S control strategies within contractor organisations will be analysed in terms of three identifiers – (1) health and safety procedures, (2) health and safety training and competencies, and (3) accountability mechanisms.

4.4.1 Hazard control procedures

Hazard control procedures here refers to documented guidelines that allocate responsibilities, explains what is to be done, how and when it should be done with regards to controlling the workplace. The amount of documentation involved in the H&S management process was observed to differentiate best practice motivated organisations from compliance motivated organisations. OHSAS 18001 certified contractors were observed to have more extensive documentation requirements when compared to compliance motivated organisations. Compliance motivated contractors limit their documented procedures to the requirements of the law as explained here:

> *If something really is not really asked for in the law number 1, number 2 it is just a stupid thing, we don't do it.* (H&S manager, Contractor C).

Hazard control procedures within contractor organisations from the interview cases was found to be largely influenced by the requirement of the occupational health and safety Act 85/1993 and Construction Regulations. The construction regulations (CR) emphasises hazard identification and risk assessment procedures, as well as safe work procedures covering the entire scope of work to be carried out. This is indicative of a safe place perspective.

From the consultations, risk assessment and safe work procedures for the control of hazards on the construction site was found to be standard and well entrenched practice within the industry. Much of resources and energy was observed to be committed into preparing health and safety plans that document hazards identified, the risk assessment and the developed safe work procedures for mitigating and controlling risk associated with every project.

The logic and principles associated with preparing health and safety plans were found to be consistent across the industry. The process for developing a health and safety plan was found to begin with the method statement for the work to be carried out. This is followed by hazard identification, and then risk assessment. Based on the identified hazards and risks, a safe work procedure is developed for each task to be conducted. This process is observed from the consultations to be the industry accepted standard.

Two areas where organisations were however observed to differ from one another are:

1. Who prepares and how the plan is developed.
2. The capacity to adhere to the documented plan.

Some contractors contract external health and safety consultants to satisfy these documentary requirements. There was evidence to suggest that cases of generic health and safety plans were more common with contractors who enlisted the services of external health and safety consultants. One respondent paints this picture of his organisations experience:

> *When contractors come on site, they submit their plan and we will review it and give them final approval for implementation. But they bring us a lot of generic stuff. So, it*

will either refer to a previous job or if it is a bricklayer, they will start talking about tower cranes. (Safety manager, contractor D)

The importance of organisational structures to the safety control planning exercise was highlighted in the consultations. Health and safety plans developed by external consultants was observed to be restricted by technical information on how the work is done as they often begin with hazard identification without a method statement. The presence of organisational structures for health and safety management was suggested to facilitate effective hazard identification and risk assessment, as the organisation can draw from its institutional memory and experience to progressively improve its safe work procedures.

While the health and safety procedures are developed at the individual organisational levels, they are implemented under varying project circumstances. The challenge across the industry was found to be adherence to these procedures. The effectiveness of health and safety procedures under project circumstances was found to be weakened by the following factors:

1. Poor supervisory capacity: Operational managers such as supervisor and foremen are ultimately responsible for ensuring adherence to safe work procedures. However, observations on site reveal that most supervisors do not have adequate knowledge to appreciate the issues. This point is substantiated by the following response.

    There is a lack of commitment by supervisors to H&S responsibilities, but If you don't have the knowledge, the training and the experience to be able to fulfil your functions, you are going to be reluctant to do it (H&S coordinator, Contractor I).

2. Inadequate financial resource to implement the requirements of safe work procedures: Most subcontractors interviewed were observed to emphasize demonstrating legal compliance through documentary evidence such as the safety file and de-emphasize resource intensive components of their health and safety plan such as purchase of safety equipment, and trainings essential for implementing safe work procedures. To substantiate this point, a respondent argued:

    I think they will be much more interested in doing health and safety if they were properly compensated for it (H&S Consultant A).

4.4.2 Health and safety competencies and training

The Construction Regulations make extensive reference to “appointments in writing of ‘competent’ persons” into planning and supervisory positions for the purposes of executing aspects of the formulated project level health and safety plan. The regulations further define a competent person as one with the required *(1) knowledge, (2) training and (3) experience* with respect to the work to be performed and who is familiar with the OHS Act. These three attributes of competency have in practice proven to be ambiguous and difficult to evaluate for certain categories of appointments. Under the CR, two main categories of appointments were identified: (1) competent health and safety professionals and, (2) competent operational managers.

Health and safety professionals under the CR are appointed to perform administrative, planning and specialised functions related to the implementation and management of the construction health and safety plan. Operational managers such as construction managers, supervisors and foremen under the OHS Act and Construction Regulations have health and safety supervisory obligations to ensure the proper execution and implementation of health and safety procedures for tasks in their work area.

The 2013 amendment to the CR created a framework for regulating the practice of health and safety professionals by including health and safety agents, managers and officers to the list of construction professional to be registered with the South African Council for the Project and Construction Management Professions (SACPCMP). The consensus among respondents interviewed is that there is a shortage of competent health and safety professionals in the country. One respondent paints this picture:

> *…there is scarcity of proper safety officers. You cannot just employ a person and he will be able to develop a system for your company if he hasn't got the experience of doing that. And there is cost involved, I mean a senior person to develop a system for a contractor. That is about thirty thousand rands (a month) for a person like that* (H&S consultant A).

For operational managers the picture is a little different as there is still no national framework for determining their competencies in terms of health and safety. From the consultations, the focus appears to be on technical competence for their trade and less emphasis on competency to perform their health and safety responsibilities.

There is therefore, a general sense of confusion in the industry on who is competent and what H&S proficiencies are required of a construction supervisor.

A best practice standard found among some contractors interviewed was that supervisors within their organisation did receive training on their legal liabilities, on hazard identification and risk assessment procedures, as well as incident investigation. However, there were no systems in place for assessing proficiency and certifying competence in these health and safety knowledge fields.

Operational managers play a critical role in ensuring compliance with legal and operational requirements as they are the link between senior management and workers (Nkhungulu Mulenga et al. 2011). Choudhry (2014) identified qualified supervisors as essential to successful safety programs on construction sites because of their ability to provide examples and reinforce safety promoting behaviours. Sheehan et al. (2016) demonstrated the moderating influence of middle managers on the association between organisation health and safety procedures and reported incidents. It is therefore, important that operational managers possess the competencies required to discharge health and safety responsibilities expected of them.

For operational managers, the consensus among respondents is that very little effort has been channelled towards providing supervisors with health and safety competencies to enable them to play the role envisaged for them under the CR. A safety manager at one of the big contractors painted this picture:

> *There is a big lack (of competency) in the industry. I have done a study on key competency requirements for supervisors during my studies now. And what I have picked up within our organisation… if you work strictly with the requirements of the Construction Regulations in terms of competencies, then none of our supervisors in South Africa are competent. Because they don't have the SAQA registered trainings which is available. The regulation requires this great picture of what the supervisor is, but we can't provide them with the competencies to fulfil those functions* (H&S coordinator, Contractor I).

In terms of the average construction worker, the literature highlights the importance of trained and competent employees to accident prevention (Inan et al. 2017), the basic assumption is that employees with the knowledge, training and experience to fulfil their functions will carry out their duties in a safe manner. The construction regulations mandate that the employer "*ensures that all employees under his or her control are informed, instructed and trained by a competent person regarding any hazard and the related work procedure before any work commences".* This requirement is covered under the induction and risk assessment trainings which are common place in the industry. The attitude of the industry to induction and risk assessment trainings however, is summed up below:

> *Everyone on site are supposed to attend risk assessment and induction training, and I know sometimes it does not happen especially with supervisors. They always think they are above the law. When you get to management, they don't want to listen to the safety officer discussing risk assessment* (H&S manager, Contractor M).

Consultations revealed a growing concern about the dearth of properly trained artisan/tradesmen in the country. Low barriers to entry from the perspective of skills requirement and the growth of precarious temporary duration employment is some segments of the construction industry, coupled with other socio-economic factors continue to pose a threat to competency levels of the average construction worker in South Africa. Apart from workers involved in high risk operations such as working at fall risk positions, deep-sea diving, and operators of mechanised plants and equipment, very little competency requirement is expected of the typical construction worker in South Africa.

In assessing the training arrangements among contractors, the structures and processes for managing employee training was found to differ between organisations. The role of the contractor as either predominantly principal contractor or subcontractor was found to be a major determinant of the training efforts of that organisation. Principal contractors often execute only a small portion of the construction works and, are closely under the scrutiny of clients and government. Therefore, their training efforts are focused on being legally compliant from the perspective of their health and safety appointments. Subcontractors on the other hand are often specialist or trade specific contractors providing most of the artisan labour and their health and safety requirement are often dependent on the standards and requirements of the principal contractor. The training focus of subcontractors was found to be limited to the standard induction and risk assessment training mandate by legislation.

A dichotomy between registered and unregistered health and safety related training efforts was also identified. Registered trainings are South African Qualification Authority (SAQA) accredited trainings. Registered trainings certify proficiency in two of the three competency criteria under the Construction Regulations – namely knowledge and skill. Unregistered trainings are those provided on site usually by a health and safety practitioner, usually a safety officer. The uptake of registered training was observed to be more at principal contractor organisations and heavy on specialised areas of health and safety such as fall protection planning, risk assessment, first aid, firefighting and safety representative training. Most trade specific trainings within the country can be characterised as unregistered. Safety managers at some organisations reported a lack of accredited training providers for trade related training therefore, these trainings were provided in house.

Time pressure and resource constraints were key factors reported by safety managers for the poor level of training provided to tradesmen in South Africa. A safety manager has this view on the challenges with providing off-the-job registered training to the construction worker:

> *It (training) is time related and very consuming of financial resources where we must train the [workers]. And I think the biggest problem is the fact that they may be three months or four months, six months on a project and that time line does not always allow for that training and that education* (Divisional H&S Manager, contractor L).

In summary, the health and safety training emphasis was found to be in favour of legal compliance and favours the health and safety professional, and not at providing tradesmen and supervisors with the information and training required to facilitate their participation in health and safety management activities.

4.4.3 Accountability mechanisms

Accountability mechanisms refers to contingent reinforcements that increase the probability of desirable health and safety behaviours. This together with competent and trained employees is widely regarded as the cornerstones of a safe person safety control strategy (Makin & Winder 2008; Cox & Jones 2006; DeJoy 2005; Ford & Tetrick 2008; Choudhry 2014). According to Choudhry (2014) safety training concentrate on changing people's attitude on the assumption that by changing attitude, employee behaviour towards safety will change. Accountability mechanisms on the other hand is based *"on the principle that behaviour is a function of consequences and the frequency of desirable behaviour can be increased by positively reinforcing safe behaviour"* (Choudhry 2014).

From the interviews, it can be deduced that coercive and incentivised interventions were the most commonly used accountability mechanisms within contractor organisations. The following coercive and incentivised programs were identified:

1. Consequence management for violation of life saving rules and safety controls
2. Safety as a component of performance appraisal for operational managers.
3. Project level health and safety recognition and reward programs.
4. Bonus incentive linked to Lost Time Injury (LTI) targets.

While these mechanisms may exist in policy and principle, the degree of implementation at the project level was observed to be dependent on the resolve of the construction manager, health and safety specialist, and the number of eyes involved in spotting unsafe behaviours and H&S rules infringements on construction sites.

Consequence management was observed to be unpopular among H&S managers consulted. They reported a dislike for instituting disciplinary procedures except for serious violations that result in an incident. H&S managers described it as negative considering the psychosocial and socio-economic realities of the typical construction worker. Rather incentivising the project team with bonuses tied to Lost Time Injury Frequency thresholds was popular. This suggests collective accountability for high accident rates and not individual accountability for unsafe behaviour. The typical H&S accountability mechanism was described as follows:

> *We certainly have disciplinary procedures, but I try to move away from punishment a bit more because it is a bit negative… We try to be positive about the thing. We have a trust and the trust have got several values. We try to measure those values. If the companies disabling injury frequency rate is below a certain threshold, then there is so many points for that. We look at care of equipment and we give points for that. And according to that, bonuses go into the trust. It is voluntary, but you will be stupid if you are not part of it because you can only get benefits from it* (H&S manager, Contractor C).

The linking of performance bonus to LTI targets is believed by some respondents to engender a culture of secrecy where incidents are not reported to suppress actual LTI numbers. This is clearly explained by a H&S consultant as follows:

> *Yes, I focus on my audits, I don't focus on accidents numbers, because of failure to report or there are ways and means of pressuring down the LTIs especially with the companies where Lost Time Injury Frequency Rates is linked to their production bonuses or their end of the year bonuses. So, they try and keep those rates as low as possible. So, it is not actually the correct reflection (H&S consultant A).*

Project level incentivised reward and recognition programs were observed to be inconsistent and subject to project H&S budget as describe in the interviews:

> *We don't do incentives unless it is a specific requirement of the client* (H&S manager, Contractor B)

> *Again, it is (incentives) something we don't budget for. We determine it or plan it based on the project and what sort of monies we have available. And really it is quite small* (Divisional H&S manager, contractor L)

In addition to coercive and incentivised interventions, non-coercive interventions were observed at best practice motivated organisations in the form of *'just culture"* models and "*visible felt leadership"* programs that are more inclined to teach, coach and educate before actual sanctions are applied. Under these interventions, top management and operational managers are positioned to model desirable safety behaviour and to engage constructively with worker whenever unsafe acts are observed. Monthly targets are set for senior members of the organisation on the number of observations to be recorded. Feedback received from these programs were analysed to reveal trends in unsafe behaviours which are then discussed at site meetings.

There is evidence from the consultation to suggest that accountability for H&S is generally lacking specifically with subcontractors. Only when things go wrong do people really ask questions. Two main factors were identified as being responsible for this.

1. A "buddy" approach to recruitment: The accountability mechanisms of most contractor organisations were noted to begin failing at the early stage of subcontractor selection. Because subcontractor selection within the industry is

to a large extent a commercial decision based on established business relationships and cost consideration, with little or no consideration for health and safety performance. Many subcontractors therefore do not find the incentive for health and safety improvement. There is evidence to suggest that there is little or no consequence for poor safety performance by subcontractors on projects as they believe they will get repeat jobs with the same principal contractor provided they deliver on key project objectives of quality and cost targets and demonstrate minimum documentary compliance to legislated health and safety requirements.

2. Rise in precarious temporary duration employment: Construction work in South Africa is replete with precarious (unstable employment with no permanent employee rights) temporary duration employments sustained by several employment arrangements such as client nominated local labour, labour only subcontractors, and daily paid workers. These categories of construction workers include skilled workers such as bricklayers, painters, plasterers and welders, and unskilled workers such as cleaners, flagman/woman, and general labourers. Consultations reveal that because of the momentary nature of these employment arrangements, contractor organisations find it difficult to integrate these categories of employees into their health and safety management programs. Two main issues were distilled from the interviews as being responsible for the difficulties associated with controlling the behaviour of these categories of workers in relation to health and safety. First is the pressure to impress employers. This was explained by a safety manager at a large contractor organisation as follows:

   > *"I think they (casual workers) are any safety officer's headache. But you know it is so difficult for the simple reason that these guys on a temporary contract often want to impress you and they want to do more than you ask from them and that is when you get the accidents. They are so eager, and I have got sympathy with them because I can see they want to show what they are able to do and then they get hurt because they start doing things that they are not trained for. That is one area where we get our most incidents, it is with our temporary labour* (H&S manager, Contractor C).

   Second is a perceived mutual mistrust and lack of loyalty between employers and temporary duration workers. Employers are cautious about investing in temporary duration workers from the perspective of health and safety, this makes it difficult for employers to show and project their care values. This concern of employers is reflected in the comment of a safety consultant interviewed:

> *I think client nominated local labour is a great initiative, but again it comes down to finances. With government jobs you are required to have say a thirty percent local employee margin… You provide them with PPEs, you provide them with medicals, you know you get a set up cost of R1,500. That person works for a fortnight and he has never experienced construction before and he leaves... But he leaves with your R1,500. Now you have to get another guy and that happens a lot. Unfortunately, the contractor has to fork out for that, not the client* (H&S consultant B).

Temporary duration workers on the other hand consider their stay within the organisation as transient and feel no long-term commitment to the organisation. It was common to hear complaints from supervisors of not being listened to by casual workers under their supervision.

In summary, the degree to which organisations are successful at engendering safe work behaviour on their project was observed to depend to a large extent on the charisma of the construction manager and health and safety officer on the project, and their ability to activate the project team for health and safety. It was not uncommon to observe variations in the level of safe work behaviours on different projects executed by the same contractor.

4.5 Continuous Improvement

In this section, the interview cases will be analysed in relation to mechanisms for continuous improvement of health and safety performance. Effective monitoring and review mechanisms have been highlighted in the literature as indicative of a proactive and systematic approach to health and safety management (Fernández-Muñiz et al. 2009; Sheehan et al. 2016). Management system standards for health and safety dictate that organisations implement procedures to monitor and measure health and safety performance on a regular basis. This includes proactive measures that monitor conformance with system and legislative requirements, as well as reactive measures such as incidents and near misses.

The continuous improvement mechanisms at the interview cases will be analysed in terms of three identifiers: (1) health and safety audits, (2) health and safety performance measurement and reporting and, (3) system reviews.

4.5.1 Health and safety Audits

Audits were observed to be the most common method of monitoring health and safety performance among contractors consulted. Monthly site audits are a legal requirement for principal contractors under the Construction Regulations. The objective of this audit as envisioned under the Construction Regulations and as observed in practice, is to ensure that the contemplated health and safety plan is implemented and maintained by the contractors on site.

From the consultation and observation on sites, monthly H&S site audits are perceived to be in many cases a paper work exercise focused on administration and legal requirements and is prioritised over monitoring of processes and physical assessment. The site health and safety audit exercise were described in this way during the consultations.

> *Our monthly internal audits or monthly subcontractor audits give us an overview of the compliance level for the specific subcontractor, the system is a bit extensive in terms of paper work requirements. So, you don't really get out there* (H&S manager, contractor G).

> *We look at their safety files every month which is a legal requirement, and make sure there is legal compliance in terms of the paper work side of it* (Divisional H&S manager, L*).*

> *... within that documented safety plan, there is a compliance percentage they need to achieve on a monthly basis and that is 90%. So, our safety officers audit them on a monthly basis. If they have any findings for now conformance raised during that audit, they will be given two weeks to close it* (H&S Manager, contractor B).

The site audit requirements of the principal contractor were observed to significantly influence the health and safety practices of their subcontractors, as their site health and safety plan is tailored to meet the principal contractors audit requirements. Some contractors interviewed assessed health and safety performance of their organisation based on their performance in the audits over any other measure of safety performance.

A second type of audit was observed at organisations whose management systems for health and safety are OHSAS 18001 certified. Unlike site audits, these audits are targeted at appraising the implementation of documented processes and procedures for compliance with the requirements of the management system standard. Management system audits were described as follows during the consultations.

> *So, we work in accordance with that standard (OHSAS 18001) and then we get audited every year whether it be a surveillance audit or a re-certification. Re-certification is once every three years (H&S manager, contractor E).*

> *We conduct external audits on a yearly basis from an ISO accredited company that we are accredited with. And they will do a yearly check and then every three years is a recertification (H&S manager, contractor D).*

The outcomes of these audits were reported to inform changes and improvements in the management system for health and safety at the organisation.

4.5.2 Health and safety performance measurement and reporting

Health safety performance reporting here refers to the process by which health and safety performance statistics recorded by an organisation are communicates on a regular basis to its employees and the public. Central to health and safety performance reporting is collecting health and safety performance data.

The literature advocates collecting data on leading and lagging indicators of health and safety performance. Lagging indicators provide information on health and safety performance in the form of injuries statistics and near misses. Leading indicators measure health and safety performance in terms of aspects of the health and safety management system considered precursors to harm, and provide early warning of potential health and safety failures (Sheehan et al. 2016; Shea et al. 2016). From the perspective of construction, Hinze, Thurman and Wehle (2013) characterised leading indicators as a set of measures that describe the level of effectiveness of the safety management process, and they suggested that leading indicator *measures should ideally reflect the performance of the different entities on the jobsites such as the workers, management personnel and subcontractors.*

From the consultations, mechanisms for collecting health and safety performance data are underpinned by workers self-reporting of incidents and near misses and data gather from non-coercive accountability programs discussed earlier. Contractors with dedicated organisational structures for H&S management reported having in place processes for reporting near misses and incidents that are well known to employees. Flash reports (a concise one page document) that communicates to all employees within the organisation the nature of a major incidents or near misses were observed to be a standard practice and popular within the industry. Lost Time Injury Frequency Rate (LTIFR) was observed to be the favourite lagging indicator measure among contractor organisations consulted. In contrast, contractors that employed the services of external H&S consultants did not collect or track their H&S performance.

While data on health and safety performance was generally observed to be collected and statistically analysed at most of the contractor organisations represented in the interviews, the reporting of these statistics throughout the organisation and to the public was found to be limited. A culture of secrecy was observed where these statistics are only available to a section of the organisation and are not shared publicly. However, two of the contractors represented in these interviews that are listed on the Johannesburg Stock Exchange (JSE) did report on their H&S performance (LTIF and fatality rates) in their annual financial report. Making information on health and safety performance available to lower level employees and to the public was found to be limited and closely guarded within some contractor organisations consulted.

The following responses reflect of health and safety reporting practices at some contractor organisations interviewed:

> *There is a coastal safety report… Stats are included, incidents are included, VFLs are included and it is circulated to everyone within the CM (contract management) meeting, I then filter it down to safety officers* (H&S manager, contractor B).

> *We just do a report for every MANCO (Management Committee) or every executive meeting we would do a summary report* (SHEQ manager, contractor F).

> *I don't think it is just a matter of sharing it, I think what we are lacking in the industry is collaboration. Okay. So, we hold everything close to us and we don't want to share and maybe not embarrass ourselves and stuff like that* (Divisional H&S manager, contractor L).

> *It is always difficult to get figures out of industry, I am sure you would have seen that. We tried it through SAFCEC [South African Forum of Civil Engineering Contractors] or forums nowadays, and we tried to get the members to report, it didn't happen* (H&S manager, contractor C).

4.5.3 Management Reviews

The review of health and safety management performance at regular intervals creates an avenue for organisations to identify opportunities for improvement and change in order to ensure that its health and safety management system is sustainably suitable, adequate and effective (Inan et al. 2017).

From the consultations, the review of H&S performance and activities was common at organisations with formalised H&S management structures. However, H&S reviews across the industry was found to differ in terms of:

- the level of review
- frequency of review
- input information for the review.

Two levels of reviews were identified, organisational level reviews and project level reviews. Organisational level reviews are focused on codified policies and procedures guiding the implementation of H&S management activities within the organisation. Organisational level review required top management participation and permission as they often lead to changes to documented policies and procedures. Organisation level reviews are associated with certified management systems such as OHSAS 18001 and are conducted at defined intervals. These reviews are re-certification requirements and are in response to system audits conducted by external consultants.

Project level reviews on the other hand can best be described as amendments to site-specific health and safety plan of the contractor in response to non-conformance audit reports, complaints from the workers or a major incident. The contractors project level health and safety team were found to be responsible for project level reviews. Project level reviews were typically carried out on an ad hoc basis.

The management review process at one of the best practice motivated organisation represented in the interviews was described as follows:

> *We have annual reviews by senior management like our directors, SHEQ managers and people like that… And then we have monthly reviews at the project level.*
>
> *We have got internal audits and that will automatically trigger these reviews. If there is any changing legislation that we hear about or if there is an incident or accident or near miss that caused so much problems, then it will also trigger review. But normally it is*

> *being reviewed on a yearly basis. The full system. So, every year it gets a full revision* (H&S manager, Contractor D).

At organisations where the health and safety management are motivated by the need for legal compliance, the review process was found to be ad hoc and described as follows:

> *Obviously if there is any change in law, our system will be reviewed. Then we look at all the incidents that were reported and we would try to see what [are] the causes. We try to get the management involved to change that aspect so that we have less of that specific incident* (H&S manager, Contractor C).

In summary, the processes for the review of health and safety management arrangements can be said to be shaped by legislative requirements at the project level and management system standard requirements at the organisational level.

4.6 Synthesis of findings from analysis of case studies

A synthesis of findings from the interviews reveals three dominant types of H&S management arrangement within contractor organisations in South Africa:

1. Traditional/compliance motivated H&S management arrangement.
2. Systematic/compliance motivated H&S management arrangement.
3. System/best practice motivated H&S management arrangement.

A traditional/compliance motivated H&S management arrangement is characterised chiefly by the outsourcing of H&S management responsibilities to external H&S management consultant. These H&S safety consultants assume responsibility for satisfying project level client H&S specifications and complying with relevant H&S regulations on behalf of the contractor. A systematic/compliance motivated H&S management arrangement is characterised by the presence of internal H&S competencies and organisational structures to carry out H&S management functions and responsibilities. However, the H&S management programs and activities within the organisation are home grown and dictated by legislative requirements. System/best practice motivated H&S management arrangements are characterised by H&S management activities modelled after the requirements of OHSAS 18001 management system standard. This H&S management arrangement is highly formalised and documented.

Table 6 summarises the key defining features of the three HSMA types in terms of the three thematic areas and identifiers contained in the conceptual framework for the study presented in section 3.6 and section 3.7.

Table 6: Critical identifying characteristics of H&S management arrangements

Identifiers	**Traditional/Compliance motivated**	**Systematic/Compliance motivated**	**System/Best practice motivated**
Management perspective to Health and Safety Management			
Organisational structure	H&S management is approached as a project function H&S management responsibilities are outsourced External H&S consultant is 'key person' in H&S management arrangement	H&S management is approached as a project function Dedicated department for coordinating H&S activities H&S management planning tailored in line with legislative requirement and characterized by a low degree of documentation May have a SHEQ system if the organization is ISO 9001 (Quality) and ISO 14001 (Environment) certified	H&S management is approached as an organisational function Dedicated department for coordinating H&S activities H&S management planning tailored in line with OHSAS 18001 standard requirement, and characterised by a high degree of documentation SHEQ system that attempts to integrate H&S with broader management system (ISO 9001 and ISO 14001
Top Management commitment and involvement	Management commitment is influenced by supply chain pressures Operational managers such as supervisors are liaison between organisation and external H&S consultant	Management commitment is influenced by legislative liability as well as supply chain pressures H&S specialists occupy middle level management positions with limited decision-making powers	Management commitment is defined by voluntary adoption of H&S management 'best practice' Health and safety specialists can be found in senior management with high decision-making powers

Identifiers	Traditional/Compliance motivated	Systematic/Compliance motivated	System/Best practice motivated
Employee consultation and participation	Project level H&S committees are only consultative arrangement Limited participation of employees in H&S management efforts	Project level H&S committees and organizational level forums Organizational level forum has representation from lower level employees Employee participation is representational Employee participation in H&S management planning limited to hazard identification	Project level H&S committees and organizational level H&S forums Health and safety forums exclusive to management representatives Employee participation dependent on the specifics of behavioural based safety programs in place within the organisation Employee participation in H&S management planning limited to hazard identification
Resource allocation to health and safety management	Absence of dedicated budget for proactive H&S management Financial resources committed to H&S are dependent on project requirements	Financial resources committed to H&S are dependent on project requirements May have an annual budget for proactive H&S management activities such as training	Financial resources committed to H&S are dependent on project requirements. May have an annual budget for proactive H&S management activities such as training Annual budget for management system maintenance (e.g. recertification exercise)
Occupational Health and Safety Control Strategy			
Hazard control procedures	Focused on site level risk assessment, hazard identification and safe work procedures in compliance the Construction Regulations	Focused on site level risk assessment, hazard identification and safe work procedures in compliance the Construction Regulations	Documented procedures for both system maintenance and site level risk assessment, hazard identification and safe work procedures in compliance the Construction Regulations

Identifiers	**Traditional/Compliance motivated**	**Systematic/Compliance motivated**	**System/Best practice motivated**
Health and safety training and competencies	Limited internal competencies for H&S management H&S training efforts limited to induction and risk assessment trainings conducted by external H&S consultant	Health and safety specialists within organisation Operational managers are trained on legal liability, risk assessment and hazards identification. In addition to induction and risk assessment trainings	Health and safety specialists within organisation Operational managers are trained on legal liability, risk assessment and hazards identification. In addition to induction and risk assessment trainings
Accountability mechanisms	No accountability mechanisms for H&S in place	Focused on enforcement of H&S rules and/or incentives programs	Behavioural based safety programs in addition to enforcement of H&S rules and/or incentives programs
Performance Review and Continuous Improvement			
Health and safety audits	External party audit of project level H&S safety plans	Internal and external audits of H&S management processes at project levels	Internal and external audits of H&S management processes at project and organisational levels
H&S performance measurement and reporting	Only incidents reportable to DoL may be recorded	H&S performance data are recorded and reported on at management meetings	H&S performance data are recorded and reported on at management meetings and in annual or more frequent reports
Performance review by management	Review of project level H&S plan informed by no-conformance raised in audits	Reviews are ad hoc in response to audit findings, safety committee observation and H&S performance measures	System is reviews at defined intervals informed by annual system audits and H&S performance measures

4.7 Chapter Summary

In this chapter, health and safety management arrangements within contractor organisations were investigated with the objective of identifying areas of differences and similarities in order to categorise them into types. The investigation was guided by three thematic areas namely: management approach, OHS control strategy and mechanism for continuous improvement.

Using a Qualitative Content Analysis methodology, three categories of H&S safety management arrangements were identified from the analysis of the interview data: (1)

traditional/compliance motivated, (2) systematic/compliance motivated, and (3) system/best practice motivated.

A traditional/compliance motivated H&S management arrangement is characterised chiefly by the outsourcing of H&S management responsibilities to external H&S management consultants. These H&S safety consultants assume responsibility for preparing safety plans and documentation that satisfy client H&S specifications and complying with relevant H&S regulations on behalf of the contractor on projects. A systematic/compliance motivated H&S management arrangement is characterised by the presence of internal H&S competencies and organisational structures to carry out H&S management functions and responsibilities. The H&S management programmes and activities within these organisations are home grown and dictated by legislative requirements. System/best practice motivated H&S management arrangements are characterised by H&S management activities modelled after the requirements of OHSAS 18001 management system standard. This H&S management arrangement is highly formalised and documented.

Employee participation and consultative arrangements at traditional/compliance motivated organisations was found to be limited to project level H&S committees. Systematic/compliance and system/best practice organisations showed signs of greater employee participation and involvement in the H&S management process as consultative arrangements that included management were observed. However, employees played limited roles in H&S management planning activities.

Resource allocation to H&S management was identified as a problematic issue as H&S is considered a project cost. Annual budgeting for proactive H&S was not common practice within organisations interviewed.

Not much difference was observed in the H&S control strategies of the three H&S management arrangements. A preference for the control of the physical work environment over the control of employee behaviour was observed at all contractor organisations interviewed. Risk assessment, hazard identification and safe work procedures were observed to be the dominant strategy of controlling hazards for all three system types. However, differences were observed in the capacity to adhere to the requirements of the safe work procedures developed.

Traditional/compliance motivated organisations lacked internal mechanism for continuous improvement. Internal H&S audit and performance review mechanisms were observed at systematic/compliance motivated and system/best practice motivated organisation. However, they differed in terms of focus and intervals. While systematic/compliance motivated organisations reported monthly site H&S audits, system/best practice organisation reported annual management system in addition to monthly site H&S audits. These annual audits informed system review processes at system/best practice motivated organisations. System reviews at systematic/compliance motivated organisation were less defined and ad hoc and often in response to changes in H&S legislation.

In part two of this dissertation which starts from the next chapter, comparisons will be made between the effectiveness of the three HSMA types identified in this first part of the dissertation.

CHAPTER FIVE

THEORETICAL FRAMEWORK FOR PHASE TWO OF STUDY

EVALUATING THE EFFECTIVENESS OF HEALTH AND SAFETY MANAGEMENT ARRANGEMENTS THROUGH A MULTILEVEL STRATEGIC MANAGEMENT PERSPECTIVE

5.1 Chapter Overview

The first phase of this study identified three distinct health and safety management arrangements (HSMA) employed by contractor organisations in South Africa namely:

1. traditional/compliance motivated (Type1)
2. systematic/compliance motivated (Type2) and
3. system/best practice motivated (Type3).

For the remainder of this document, these three HSMA types will be referred to as Type1, Type2 and Type3 respectively.

The safety control strategy for the three arrangements were observed to be similar and strongly influenced by the requirements of the Construction Regulations and is predominately 'safe place' oriented. They were however, observed differences in terms of (1) the status of the H&S specialist within the organisational hierarchy, (2) organisational structure with responsibility for coordinating H&S management activities, (3) as well as procedures for continuous improvements. This satisfies the first objective of the study.

Part two of this dissertation focuses on the second and third objectives of the study which are:

1. To evaluate the effectiveness of three health and safety management arrangements identified in part1 of this study.
2. To demonstrate the effect-relationship between the factors that distinguish the identified health and safety management arrangements.

The chapter begins with identifying the weaknesses associated with traditional methods of safety performance evaluation that are based on accident statistics and justifies the adoption of an alternative safety performance assessment approach in this study. Following this, a theoretical framework for evaluating the effectiveness of the identified health and safety management arrangements based on the multilevel and strategic management theory proposed by Yorio et al. (2015) is presented.

The framework considers a HSMA as composed of two distinct constructs – strategic HSMA that exist at the strategic level of the organisation, and the implemented practices that exist at the level of the workgroup. The chapter concludes by identifying dimensions of H&S management relevant to safety performance evaluation through a multilevel and strategic management perspective.

5.2 Challenges with Traditional Methods of Safety Performance evaluation

In the literature, safety performance remains the consistent indicator of the effectiveness of health and safety management interventions. According to Haas & Yorio (2016), the measurement of safety performance and the monitoring of safety activities are important to determine if health and safety management interventions are functioning as designed and in evaluating their effectiveness. Safety performance has been defined as the “overall performance of an organisation’s safety management system in safe operation” (Hsu et al. 2012). That is to say that safety performance provides information on the quality of a HSMA in terms of development, implementation and safety outcomes (Sgourou et al. 2010).

Nevertheless, the theoretical and practical perspectives of safety performance measurement is still being debated in the literature (Haas & Yorio 2016). A prominent feature of current discourse on safety performance measurement is the dichotomy between leading and lagging indicators of safety performance. While lagging indicators are generally recognised to measure outcomes of activities or event that have already happened, a consensus is yet to be reached on the definition of leading indicators even though their benefits are widely acknowledged (Reiman & Pietikäinen 2012).

The traditional approach to safety performance measurement is the use of lagging indicators in the form of collecting and statistically analysing data on accident frequency and severity. However, this appears to be a fading paradigm particularly in academic research. The use of lagging indicators in academic research has been criticised for being failure focused, based on past events, and offering no benefits to continuous improvement efforts (Hinze, Thurman, Wehle, et al. 2013; Shea et al. 2016; Wu et al. 2015). Lagging indicators are retrospective, measuring system failure without revealing cause-effect relationships that would drive system improvement and therefore give little productive value in terms of understanding safety performance outcomes (Wu et al. 2015).

Obtaining data on H&S related incidents and accidents has also proven to be challenging especially in the construction industry where a culture of secrecy and under-reporting of accidents has been noted to prevail (cidb 2009; Sgourou et al. 2010). Contractors who diligently report and investigate accidents are disadvantaged in comparison to less scrupulous contractors who under report accident occurrence (Ng et al. 2005). This makes the use of lagging indicators in academic research in most cases unreliable and unrealistic. However, accident statistics give the greatest face validity in that they are the most easily understood by managers.

More recently, the focus of academic research on safety performance measurement has turned to leading indicators. Leading indicators measure actions, behaviours and perceptions, and are associated with active positive steps taken by organisations to avoid OHS incidents (Sheehan et al. 2016). From the review of the literature, leading indicators can be seen to serve two main functions. The first is in evaluating the effectiveness of H&S management systems (Reiman & Pietikäinen 2012) as is observed in safety culture and safety climate studies. The second is in the process safety literature where leading indicators provide early warning signals of potential failures since they are usually precursors to harm or safety failure (Sinelnikov et al. 2015).

Several authors have linked leading indicators as measures of safety performance to safety climate and safety culture constructs (see Zohar 2000; Cooper 2000; Al-Refaie 2013; Choudhry et al. 2007). The consensus in the literature is that safety culture and safety climate are antecedents of safety performance, and therefore they predict safety performance (Vinodkumar & Bhasi 2010; Mulenga 2014; Wu et al. 2010). Recent studies have used safety climate dimensions as leading indicators in the measurement of safety performance, this is based on empirical findings that show that safety climate is directly correlated with accident levels within organisations (Wu et al. 2008; Neal & Griffin 2006; Zohar 2000).

Considering the limitations associated with the use of lagging indicators in the form accident statistics, an alternative approach to evaluating the effectiveness of HSMA based on leading indicator measures is justified. This alternative perspective based on multilevel and strategic management theory is presented in the next section.

5.3 A Multilevel and Strategic Management Perspective to Safety Performance Measurements

Empirical measurement of organisational phenomena such as a health and safety management arrangement(HSMA) for the purpose of understanding its effect on organisational performance outcomes such as injuries has become prominent in recent academic literature (Yorio et al. 2015; Renkema et al. 2017). Robson et al. (2007) conducted a systematic review of the literature that explored the effectiveness of HSMS and found that a common methodological limitation across studies was a lack of consistency in measurement techniques and the underreporting of potential biases that the techniques introduced.

Yorio et al. (2015) was of the view that these limitations are problematic from both the research and policy perspectives, while noting that the distinct HSMS measurement approaches observed in academic literature imply different operational definitions of the construct. Yorio et al. (2015) subsequently proposed the adoption of multilevel and strategic management theory in the assessment of the attributes of a health and safety management systems. A key feature of this theoretical perspective is the differentiation between strategy and implementation.

Previously, H&S phenomena such as HSMS have been considered at a single level of analysis, either as a top-down management construct or a bottom-up emergent construct (Zohar 2008). The top-down management perspective is consistent with the practical conceptualisation of a HSMS as a set of distinct but complementary policies and procedures directed at protecting workers, the public and the environment from harm (Mearns et al. 2003). The choice of which elements to include in the HSMS of an organisation is determined by the values of strategic organisational leaders and is within the purview of management (Yorio et al. 2015). The bottom-up perspective is consistent with the conceptualisation of a HSMS as an artefact of organisational safety culture extensively discussed in Zohar (2000, 2008) and Zohar & Luria (2005). Both perspectives (top-down and bottom-up) give rise to two distinct measurement methodologies identified in the literature and summarised in Table 7.

Table 7: HSMS Measurement levels (Adapted from Yorio et al., 2015)

HSMS level of measurement	Characteristics of Measurement Level	Theory behind measurement level	Example of Studies
Manager level	Entails obtaining information from managers on elements that constitute the HSMS of the organisation	HSMS is a top-down management derived structural construct	(Bottani, Monica & Vignali, 2009:155; Smallwood, 2015:528);
Worker level	Entails obtaining information from individual workers on their perception of work practices within their organisation	HSMS is a bottom-up worker-derived perpetual construct	(McDonald, Lipscomb, Bondy & Glazner, 2009:53; Vinodkumar & Bhasi, 2010:2082)

Multilevel strategic management perspective seek to mitigate methodological weaknesses associated with the top-down and bottom-up perspective, as well as reduce conceptual ambiguity and measurement error (Zohar & Luria 2005; Zohar 2008; Mearns et al. 2003; Yorio et al. 2015). The application of multilevel strategic theory to the study of organisational constructs has the advantage of enabling a more integrated understanding of the phenomena (construct) across levels within the organisation (Kozlowski & Klein 2000). Multilevel strategic management research is underpinned by the following principles:

(1) organisations are multilevel in nature, in order words, organisations are comprised of layers of nested subunits (individual, workgroups, departments and divisions)

(2) constructs/phenomena existing or occurring at one hierarchical level does influence organisational outcomes at the same or lower hierarchical levels within the same organisation

(Kozlowski & Klein 2000; Renkema et al. 2017).

This multilevel strategic perspective has implications for the measurement of organisational constructs/phenomena and gives rise to the notions of *level of* *measurement* and *level of analysis*. Rousseau (1985:4) defined the level of measurement "as the [organisational] unit to which the data are directly attached [obtained from]" and the level of analysis as "the [organisational] unit to which the data are assigned [aggregated to] for statistical analysis". Through a multilevel strategic perspective, an organisational construct could be described as either a *global construct* or an *emergent construct* depending on the level of measurement and analysis associated with the construct.

Global constructs are phenomena that exist at the macro (higher) level of the organisation and influence micro-features of the organisation (individual attitudes and behaviours); while emergent constructs are macro level constructs that emerges through the interaction and dynamics of micro-features of the organisation" (Renkema et al. 2017). Emergent constructs are measured at the micro level and then aggregated up to macro level for analysis, while global constructs are measured and analysed at the macro level (Yorio et al. 2015).

Global constructs are "objective and observable characteristics of a group, they vary between groups but not within groups" (Yorio et al. 2015). The practical conceptualisation of a HSMS as a top-down management construct is more consistent with the definition of a global construct than an emergent one. However, Mearns et al. (2003) argued that a HSMS is more than the policies and procedures specified in the "paper system" but includes the actual practices, roles and function associated with remaining safe. In other words, HSMS also includes the implementation activities.

With this understanding, the application of multilevel strategic management theory to the study of H&S phenomena, distinguishes between *policies, procedures* and *practices* as building blocks of a HSMS. According to Zohar & Luria (2005), policies are strategic goals and the means for attaining these goals. Procedures provide tactical guidelines for action related to achieving policy goals. Top managers are concerned with formulating policies and establishing procedures to facilitate their implementation. Policies and procedures can therefore be considered as global constructs because they do not vary within the organisation but may vary between organisations. Practices on the other hand relates to the execution of policies and procedures across subunits of an organisation by supervisory leaders across the organisational hierarchy, and because procedures rarely cover all areas of work, supervisory discretion is often required (Zohar 2008). This gives rise to variation in practices between workgroups within the same organisation. The degree of variation in practices between subunits within an organisation is restricted by the boundaries imposed by the instituted policies and procedures [narrow or wide, clear or ambiguous] (Zohar & Luria 2005). This implies that practices can be considered as emergent constructs because it is shaped by workers perception of the codified policies and procedures, and by supervisory emphasis and execution (Zohar 2008).

Yorio et al. (2015) proposed a conceptual model for the adopting multilevel strategic management theory in the study of health and safety management systems. The proposed model considers a HSMS within organisations as two distinct constructs:

(1) Strategically developed HSMS that represents the decreed and codified policies and procedures designed by the strategic leaders and top managers of the organisation.

(2) And the implementation counterpart which is comprised of the actual front-line supervisor and workers H&S related practices and behaviour based on their perceptions and interpretation of the strategically developed HSMS.

Both constructs have been related to organisational safety culture. It is generally regarded in H&S academic literature that the strength of the strategically developed HSMS and the corresponding perception, interpretation and implementation of it by supervisors and individual workers within the organisation are a manifestation of the organisation's safety culture (Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al. 2007; Edwards et al. 2013). According to Mearns et al. (2003), the strength of the strategically developed policies and procedures is a more accurate indicator of safety culture of upper management, while the perception and behaviour of workers is a more accurate indicator of safety culture among the work force.

These two distinct constructs are now discussed in detail below.

5.4 Measurement of the strategically developed component of a HSMA

The program contents/elements that characterise H&S management within an organisation gives an indication of how advanced the H&S management arrangement of an organisation is (Fernández-Muñiz et al., 2007). Several studies have proposed models of what should constitute an effective health and safety management system and developed instruments for assessing the nuances of H&S management policies and procedures within organisations. While there is no consensus among these studies on the specific elements of a strategically developed management system for H&S, the specifications contained in international standards and national guideline documents such as Australia & Zealand (2001) and British Standards Institution (2007) have provided guidance. Fourteen key dimension of health and safety management employed in these studies are summarised in Table 8.

A health and safety management dimension in the context of this study refers to a collection of health and safety management elements (policies, procedures, roles and functions) that define the characteristics of a specific aspect of health and safety management within an organisation.

Table 8: Strategic H&S management dimensions

Indicator	Description/Theoretical Framework	Selected Authors
Safety policy	Top management defines and authorises the organisational safety policy. Major components of this dimension include: • The policy should state the philosophy of management towards safety • Sets clear and measurable safety performance objectives • Prioritises safety equally as production • Safety policy should be written and signed by a top management representative • Safety policy should be communicated to all stakeholders within and outside the organisation (employees and subcontractors)	(Inan et al. 2017; Mohammadfam et al. 2016)
Top management leadership and involvement	Responsibility for H&S management ultimately lies with top management. This dimension requires visible and demonstrated commitment and involvement of top management in H&S activities by: • Ensuring availability of resources for H&S management • A member of top management is assigned specific responsibility for H&S irrespective of other business responsibilities	(Inan et al. 2017; Mohammadfam et al. 2016; Costella et al. 2009)

Indicator	Description/Theoretical Framework	Selected Authors
Strategic H&S planning	This dimension emphasises planning and development of programmes aimed at achieving objectives captured in approved H&S safety policy. This should lead to a formal H&S plan that: • takes into consideration, legal, financial, operational and business requirements as well as technological options • is developed in sync with business planning cycles Two types of H&S planning were identified – (1) preventive planning and (2) emergency planning • Preventive planning identifies possible hazards in the operations of an organisation, analyses the risks and develops procedures for managing the identified risk • Emergency planning involves organising resources required to rapidly contain and limit the consequences of an emergency event	(Costella et al. 2009; Inan et al. 2017; Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al. 2007)
Employee representation, consultation and participation	This dimension emphasises employee representation, consultation and participation in safety decision making. This dimension facilitates the empowering of worker to take ownership of H&S management, strengthens social exchange and reinforces positive safety behaviour. This dimension requires the active participation of employees in: • the formulation of H&S policies and procedures • planning activities especially hazard identification and risk assessment (HIRA), and incident investigation activities	(Awwad, El Souki, & Jabbour, 2016; Kines et al., 2011)

Indicator	Description/Theoretical Framework	Selected Authors
Accountability and incentives for participation	This dimension is about a workplace culture that facilitates a sense of shared responsibility for H&S. Central to fostering accountability is the clear delegation of H&S responsibilities and authority. Accountability mechanisms should: • apply to all levels of the workforce • clearly defined sanctions for violation of safety policy, rules and procedures which is communicated to everyone within the organisation • holding operational managers accountable for the implementation of H&S policies and procedures in their work area • including H&S responsibilities as key component of job description and performance appraisals • rewarding superior safety performance Positive feedback and recognition have been found to reinforce high safety performance. Rewards for low incident and accident frequency rates may however, lead to under-reporting of incidents and injuries. The use of incentives, rewards and recognitions to motivate employees to work safely is an accepted feature of both behavioural-based safety management and total safety management models. Incentives have been recommended to be used together with employee empowerment activities for it to be effective.	(Shea, De Cieri, Donohue, Cooper, & Sheehan, 2016; Vinodkumar & Bhasi, 2010; Wachter & Yorio, 2014; Wu, Liu, Zhang, Skibniewski, & Wang, 2015)

Indicator	Description/Theoretical Framework	Selected Authors
H&S communication	This dimension is distinct from safety training and emphasises the transmission of H&S information throughout the organisational hierarchy and obtaining feedback from the workforce. Characteristics of effective H&S communication includes: • a two-way open and transparent engagement between management and workforce devoid of hierarchical constraints • dissemination of risk information and instructions “to the right people, at the right time, and through the right communication media” • feedback from workforce on residual risks, delays and weakness of control systems in place • media of communication such as toolbox talks, newsletters, safety alerts, e-communication channels and audio-visual presentations, safety awareness days.	(Kontogiannis, Leva, & Balfe, 2017(Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al. 2007))
Risk management procedures	This dimension emphasises written procedures for administering H&S management within the organisation and managing occupational risk. Documented procedures should cover the following areas: • job placement and promotion • disciplinary actions • method statements/ standard operating procedures for carrying out all routine tasks • material handling of all hazardous substances associated with the operations of the organisation • incident investigation • reporting of near misses	(Hohnen & Hasle, 2011; Vinodkumar & Bhasi, 2011)

Indicator	Description/Theoretical Framework	Selected Authors
Management of subcontractors	H&S risk related to subcontractors are a significant business risk faced by contractor. The main contractor should have oversight over the health and safety management of the subcontractor. The management of subcontractors involves the following: • incorporating of H&S requirements into contract specifications • incorporating subcontractors into the H&S management arrangement of the principal contractor • ensuring that subcontractor establish and implement safety programs that adhere to the H&S specification of the principal contractor throughout the contract duration	(Ivensky 2008; Arocena & Núñez 2010; Walters & James 2011; Choudhry 2014)
Defined H&S responsibilities for operational managers	In addition to top management taking ultimate responsibility for H&S, assigning operational managers with the responsibility of executing the H&S policy and procedures of the organisation in the work area under their supervision has been reported to facilitate effective H&S management. Assigning H&S responsibility to operational managers such as supervisors and foremen and holding them accountable reinforces positive behaviour and increase compliance with safety rules and procedures.	(Haas & Yorio, 2016; Inan et al., 2017)

Indicator	Description/Theoretical Framework	Selected Authors
Knowledge Management for H&S	Knowledge management is concerned with collecting and disseminating H&S related knowledge. It relies on the knowledge capital of managers and operators within the organisation and enables the organisation to learn from previous experiences. Relevant knowledge areas include: • technical knowledge in the handling of plants and complex equipment • recognition of failure modes • matching skill and task requirement and • implementation of standard operating procedures. The benefits of knowledge management to H&S management includes: • more efficient analysis of tasks and hazards • better management and transfer of safety related data necessary for risk quantification • better monitoring of safety measures and • organisational capacity to learn from experience. An effective knowledge management system breaks down knowledge silo within subunits of an organisation and creates a single repository where members of the organisation can find information required to safely perform their functions	(Floyde, Lawson, Shalloe, Eastgate, & D ’cruz, 2013; Kontogiannis et al., 2017)

Indicator	Description/Theoretical Framework	Selected Authors
Employee competence and training	This dimension is concerned with providing workers with information on risks in their work area and procedures available to prevent and manage them. However, a competent worker is not guaranteed by training alone, technical skill and experience are key components of competence. Training as a strategy for improving safety assumes that workers' attitude will positively change if they know what to do. This dimension of H&S management involves the following procedures: • training needs assessment to identify training requirement for each job function • consideration of language proficiency and literacy levels of workers in developing training programs • continuous training to keep safety information up to date • safety orientation of new workers • job specific training • training of workers when they are assigned new tasks or when operations change	(Choudhry, 2014; Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al., 2007; Inan et al., 2017)
H&S audits and inspections	This dimension is a critical component of continuous H&S performance improvement. Audits evaluate the functional levels of H&S controls (policies, procedures and programs) in place within the organisation, while inspections evaluate physical conditions of the work environment and practices of workers for compliance with established procedures. It has been recommended that supervisor and employees be involved in audit and inspection activities, as well as monitoring and detecting situations and behaviours that may not be in line with laid down safety policies and procedures. Audits also served as the basis for certified H&S management systems, they are undertaken to demonstrate that internal procedures, documentation and controls within an organisation comply with H&S management specifications. This would usually involve external auditing bodies.	(Hohnen & Hasle, 2011; Smallwood, 2015)

Indicator	Description/Theoretical Framework	Selected Authors
H&S record control and reporting	H&S record control and reporting is essential for benchmarking the H&S performance of an organisation against those of other organisations within the same industry. This enables an organisation identify strengths and weakness in its policies, procedures and processes. Effective record control and reporting involves: • written documentation of all H&S activities including minutes of safety meetings • procedure for identification, storage, protection, retrieval, retention and disposal of records • preparing and disseminating regular reports on the H&S performance indicators to internal and external stakeholders	(Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al., 2007; Inan et al., 2017)
Management review	This dimension emphasises frequent meetings to review H&S management policies, procedures and performance by top management. Management reviews ensures sustainability and suitability, adequacy and effectiveness of the entire H&S management arrange and reveals opportunities for improvement. Management review entails: • An analysis of trends, incidents and audit findings • Assessment of progress made against set policy objectives • Assessment of challenges to implementation of documented procedures and policies	(Inan et al., 2017; Mohammadfam et al., 2016)

According to Yorio et al. (2015), because top management is "responsible for strategically developing, articulating, recording, and communicating the strategic organisational HSMS", the strength of the strategic HSMS of an organisation is most appropriately assessed through key informants responsible for its design and development (manager level measurement).

5.5 Measurement of HSMA Implementation

The implementation of the strategically developed HSMA represents the execution of paper policies and procedures into workplace practices. It is through these workplace practices at the workgroup and individual worker level that positive safety performance (reduced injuries, illnesses and safety incidents) are expected to be realised (Yorio et al. 2015). Health and safety management practices within an organisation are shaped by workers' perception and interpretation of the codified policies and procedures that constitute the strategic HSMS. Safety climate is a measure of this shared perception of policies and procedures relating to safety (Neal & Griffin 2002). Safety climate in theory therefore, is an organisational level construct which emerges from a shared perception of employees, and is a result of formal policies and procedures, their communication, and the priority placed on safety relative to other organisational functions (Ford & Tetrick 2008).

Safety climate is commonly cited as a predictor of safety performance and by extension injury occurrence, and an antecedent of HSMS implementation (Clarke 2006; Neal & Griffin 2006; Pousette et al. 2008; Yorio et al. 2015; Zohar 2000). Two contesting schools of thought on the definitions of safety climate can be found in the literature. One school of thought conceptualises safety climate as the aggregate perception of employees about the state of safety within an organisation at any point in time based on their assessment of the priority place on safety by top management manifested in the safety related policies, procedures and rewards (Griffin & Neal 2000; Pousette et al. 2008). The other school of thought conceptualises safety climate to be a manifestation of an organisation's safety culture in the behaviour and expressed attitude of employees (Mearns et al. 2003; Cheyne et al. 1998). The latter school of thought considers safety climate to be a multidimensional construct (Zohar 2000), while the former considers safety climate to be a unidimensional construct (Neal & Griffin 2006).

The confounding of climate (group perception) with attitude and behaviour is the difference between the multidimensional and unidimensional perspectives of safety climate. The implication of these contrasting schools of thought is a varying understanding of the factor structure(dimensions) of the safety climate construct. As Pousette et al. (2008) observed, many studies lacked a clear distinction between safety climate and individual behaviour. In providing further clarity to this debate, Kines et al. (2011) citing Schneider (1975), differentiated between perception of organisational policies and procedures (descriptive) and reactions to those policies and procedures (affective), pointing out that organisational climate is descriptive rather than affective.

Neal & Griffin (2002) borrowing from theories of work performance and organisational climate proposed a model to explain the nexus between safety climate, safety behaviour and safety performance. The model makes distinction between components, determinants and antecedents of safety performance (see Figure 17). Safety performance is considered as a subset of work performance and it is defined by the "extent to which an individual performs behaviours that increase the safety of the individual and organisation and avoids behaviours that decrease safety of oneself and the organisation" (Ford & Tetrick 2008). Neal & Griffin identified *safety compliance* and *safety participation* as two work behaviours relevant to safety performance.

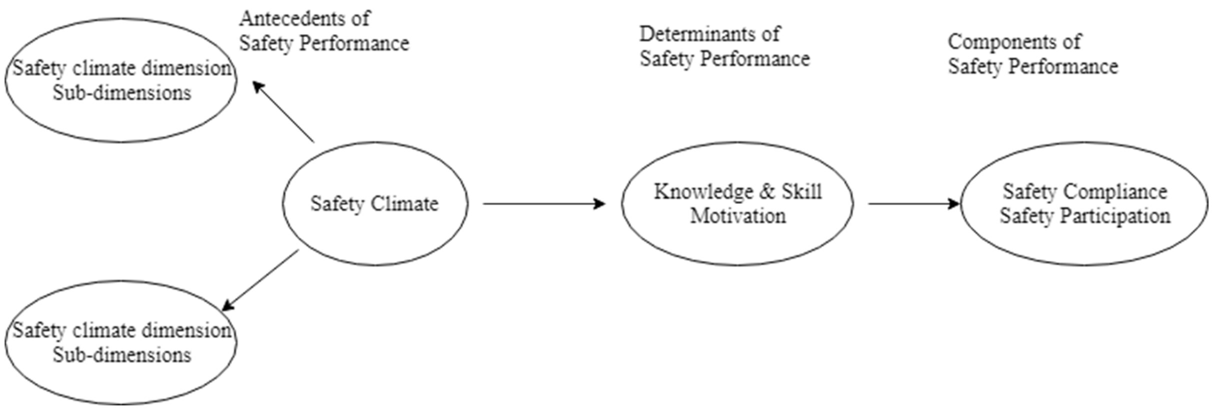

Figure 17: Model depicting relationship between safety climate and safety performance (Neal & Griffin, 2002)

Determinants of safety performance represent those factors that are directly responsible for variability in the behaviour of workers such as competence (knowledge and skill) and motivation. These determinants mediate the influence of safety climate (worker's interpretation and perception of policies and procedures) on the behaviour of workers. As an example, if a worker lacks the necessary skills or motivation to apply and comply with laid down policies and procedures, he or she is unlikely to be able to perform their task safely.

In this study, the construct *HSMA implementation* is hypothesised to be a multidimensional construct that is assessed through perception (descriptive) and reaction (affective) dimensions. The implementation component of a HSMA will therefore be evaluated through workers perception (safety climate) and behaviours (work performance) towards codified policies and procedures.

5.6 Dimensions of HSMA implementation for this Study

Several dimensions have been assigned to the safety climate construct in various studies based on practical convenience and objectives of the studies and there is currently not consensus regarding the key dimensions of safety climate (Griffin & Neal 2000; Wen Lim et al. 2018). The review of the literature on safety climate research shows that the most common objective of many of these studies was to develop industry specific safety climate measurement tools as advocated by Zohar (2010), and attempted by Mulenga (2014) for the South African construction industry. The choice of safety climate and safety performance factors as dimensions of HSMA implementation in this study is based on the following considerations:

1. Dimensions that are consistent with previous empirical safety climate and safety performance evaluation studies in South Africa.
2. Dimensions that reflect strategic management level attributes pertinent to shaping safety climate.
3. Dimensions that have been demonstrated in previous empirical studies to directly affect/influence H&S performance.
4. Dimensions that are observed sources of differences among the various H&S management arrangements identified in phase one of this study.

Eight dimensions are identified as appropriate for evaluating the implementation of strategically developed policies and procedures in this study:

1. H&S management practices
2. Top management commitment and leadership
3. Operational manager leadership (supervisors and foremen)
4. Systems for H&S management
5. Safety professionals' leadership.
6. Safety motivation
7. Safety compliance
8. Safety participation

The first five dimensions are safety climate dimensions while the last three are safety behaviour dimensions (Wen et al., 2018; Griffin and Neal, 2000). These eight dimensions are discussed below.

5.6.1 Health and Safety management practices

Fundamentally, the H&S management practices of an organisation are shaped by its *safety model* and *safety development* (Reiman & Pietikäinen 2012) both of which are contingent on the H&S management arrangement of an organisation. Theories of organisational climate suggests that members of a workgroup form consensual conceptions on expected role behaviour, based on their perception of acceptable practices (Kines et al. 2011), and this shared conception in turn influences safety performance (Vinodkumar & Bhasi 2010; Griffin & Neal 2000). The H&S management practices within an organisation have also been reported to influence worker's motivation to perform safety behaviour or voluntarily comply with H&S requirements so as to receive a reward or avoid punishment (Ford & Tetrick 2008); the higher the positive perception of H&S practices, the higher the level of safety motivation (Wen Lim et al. 2018).

5.6.2 Top management commitment and leadership

This dimension is the most commonly assessed in the safety climate research domain, and it relates to employees perceptions of the attitudes and behaviour of management in relation to safety (Flin et al. 2000). The commitment of management to safety has been identified as a major factor in the success of the safety programmes of an organisation (Vrenderburgh 2002), and the effectiveness of all other safety climate factors has been reported to be dependent on the degree of top management commitment to H&S (Huang et al. 2006; Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al. 2007).

Safety behaviour of employees has been reported to be partly contingent on their perception of organisational priority placed on H&S as communicated by top management, as well as the behaviour of managers (Kines et al. 2011; Tappura et al. 2017). Wu et al. (2010) identified three safety roles to be played by top management:

(1) accountability function by ensuring the safety performance of middle management

(2) quality control function by ensuring the quality of safety management within the organisation, and
(3) visibility function by personally participating in safety activities.

Top management expressed commitment (in the form of safety communication and allocation of resources for safety activities) was reported to be crucial to activating and supporting lower-level managers' commitment to safety (Tappura et al. 2017). Top management commitment is generally assessed through workers perception of how much safety is valued within the organisation (Griffin & Neal 2000; Vinodkumar & Bhasi 2010)

5.6.3 Operational manager leadership

Managers who successfully project honest and consistent prioritisation of employee safety, build workers' trust in the importance of safety, which in turn motivates workers to behave safely (Jitwasinkul et al. 2016). From the perspective of the construction industry, Skeepers & Mbohwa (2015) in their survey of construction companies in South Africa found evidence to support the notion that operational managers' leadership behaviour, style and commitment directly contributed towards safety performance and reduction of accidents in the construction industry.

Middle level operational managers are the facilitators and enforcers of the policies, rules and procedures established by top management (Sheehan et al. 2016). Wu et al. (2010) identified three important roles played by middle managers in relation to influencing safety performance to include:

(1) safety interaction
(2) safety informing and
(3) safety decision-making

Wu et al. found that there is a key relationship between safety leadership provided by middle level operational managers and the safety climate of an organisation. Supervisory leadership from operational managers have been rated as particularly crucial as they provide the greatest influence on employee in terms of control of workers performance (Flin et al. 2000).

Mulenga (2014:89) citing Collinson (1999) reported that negative H&S behaviour emerged on construction sites where senior management was separated from line management and workers hierarchically and geographically. Management commitment at the level of operational managers is generally measures by respondents' satisfaction with supervision or their perception of the attitude and behaviour of supervisors with respect to safety (Flin et al. 2000).

5.6.4 System for Health and Safety

A system for health and safety management refers to a dedicated infrastructure within an organisation to manage H&S issues in a spirit of self-regulation (Rowlinson 2004). A system for H&S management is different from a broad range of safety programs developed by outside consultants with little knowledge and understanding of the organisation or projects for which these programs are developed. Typically, systems for H&S management are based on generic management system standards which are adapted to organisational characteristics, or home-grown systems organically developed within the organisation based on legislation and guideline documents. Central to these systems for H&S management, is the enactment of formal safety policies and the design of procedures for the attainment of safety policy goals. The presence of systems represents a shift in the H&S management strategy of a company from compliance with legislation to a self-regulation.

Systems for H&S management have been observed to come in different forms, with some configuration exerting greater effect than others do on the behavioural and situational factors that are involved in developing safety culture, and on the sub-systems of safety performance within an organisation (Cooper Ph.D. 2000). Many authors agree that systems for H&S management is a key aspect of safety climate because they enhance awareness, commitment, motivation and understanding among workers (Mearns et al. 2003; Cooper Ph.D. 2000; Bottani et al. 2009). This dimension has been reported as an important enabler of sustainable safety performance (Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al. 2007). Bottani et al. (2009) compared the performance of adopters and non-adopters of systems approach to H&S management and found that adopters of systems for H&S management outperform non-adopters in key areas of safety performance. In contrast, Choudhry & Fang (2008) reported on a study of a construction organisation with an up-to-date management system but still witnessed significant rates of accidents. They concluded that because rules and procedures are the core components of safety management systems, they can only directly influence structural and situational factors of safety performance but are unable to adequately influence psychological and social factors.

5.6.5 Safety professionals' leadership

According to Zohar (1980), management often view safety as a technical and independent aspect of the production process, and detached from other management operations, and as a result assign all safety responsibilities to specific safety personnel. The organisational status of safety personnel has been highlighted as an important indicator of the importance top management attaches to H&S (Zohar 1980; Kines et al. 2011).

Eckhardt (1993) in discussing the safety professionals place in the corporate social structure highlighted the unusual niche occupied by safety professional in industries like construction. Eckhardt was of the view that the safety professional is often considered by other members of the organisation as "inadequate" and "not part of the team". Eckhardt identified two factors responsible for this perception to include: (1) the isolation of the safety department and staff from mainstream production, and (2) technical inadequacies of some safety personnel resulting either from a lack of H&S curricula in most degree programs or a lack of knowledge of industry specific H&S issues. Many safety personnel therefore, encounter challenges building interpersonal skills and updating safety management skills to match the prevailing atmosphere in workplaces (Blair 1999). The ideal safety professional should have both technical and managerial skills, since appointing an unsuitable safety professionals will stagnate the organisation's safety culture (Tweeddale, 2001; Wu et al., 2010).

Several functions of the safety personnel have been identified as promoting safety culture. Wu et al. (2010) grouped these functions into: *the expert, the coordinator and, the regulator.* The safety expert role of the safety professional entails "selling latest H&S management best practice to top management" for adoption within the organisation (Sinelnikov et al. 2015); training of operational managers and providing them with information to enable them to discharge their H&S responsibilities (Tappura et al. 2017); and key decision making in the execution of specialised safety management activities such as hazard identification and risk assessment (HIRA) and incident investigation (Fung et al. 2012). Safety coordinator function involves coordinating the development of safety policies, safety information management and safety communication. Safety regulation function involves conducting safety inspections, safety audits, and administering safety incentive programs.

5.6.6 Safety motivation

Adopting self-determination theory (SDT) proposed by Ryan & Deci (2000), Wen Lim et al., (2018) showed that safety motivation mediates the relationship between safety climate factors and safety performance (safety compliance and safety participation) among construction workers. The SDT proposes that motivation exist in a continuum: *amotivation*, *controlled (extrinsic) motivation and autonomous (intrinsic) motivation*. According to Deci & Ryan (2000), amotivation refers to a state where a worker is not inclined or lacking the intention to comply with safety rules or participate in safety activities. Amotivation results from the worker not valuing safety, not feeling competent to participate in safety activities, or not expecting compliance with rules or participation in safety activities to yield the desired outcome. Controlled motivation is a state of motivation that is informed by either external or internal pressures that compels the worker to comply with safety requirement or perform safety behaviour. External pressures could be reward contingency or avoiding punishment, while internal pressure is contingent on self-esteem – the fear of alienation, avoiding guilt, anxiety or shame or to attain ego enhancement or pride. Autonomous motivation is a self-determined state of motivation that is informed by inherent satisfactions, personal endorsement and feeling of choice (Ryan & Deci 2000; Wen Lim et al. 2018).

According to Ryan (1995), a worker can attain a state of autonomous motivation when three psychological needs are satisfied: autonomy, competence and relatedness. Safety climate factors have been empirically proven that provide the supportive environment for these psychological needs to be nurtured (Neal & Griffin 2006; Griffin & Neal 2000). Safety climate factors have been identified as antecedents of varying safety motivation and performance among different groups of construction workers. According to Wen Lim et al. (2018), *When the perception of safety [by employees] is favourable, employees have higher level of safety motivation, and are more likely to produce better safety performance, reducing likelihood of accidents.*

5.6.7 Safety compliance

Safety compliance is a task-oriented performance that refers to rule-following in the performance of core functions within an organisation. According to Griffin and Neal (2000), safety compliance is the fundamental safety behaviour that needs to be performed by workers to ensure safety in the workplace. Safety compliance as a behaviour represents the core safety activities that need to be carried out by individual workers and includes activities such as wearing personal protective equipment, using the right tools and equipment for safety, and conforming to safety rules and laid down procedures.

5.6.8 Safety participation

In contract to safety compliance, safety participation involves greater voluntary elements characterised as organisational citizenship behaviours (OCB) and involves behaviours such as helping co-workers, promoting safety program within the workplace, and demonstrating initiatives aimed at improving safety in the workplace (Clarke 2006). This behaviour contributes to overall safety within an organisation by their impact on co-workers. Wen Lim et al. (2018) noted that safety participation is less likely to be rewarded, therefore workers who engage in this behaviour are autonomously motivated to satisfy a higher order need or in aligning work behaviour to safety values.

5.7 Chapter Summary

This chapter has provided a theoretical perspective through which the effectiveness of a H&S management arrangement will be assessed in this study. Safety performance was identified as the best indicator of the effectiveness of a H&S management arrangement. The use of traditional methods of safety performance evaluation based on accident statistics was found to be fraught with the challenge of obtaining credible data and limited theoretical application.

To circumvent the weaknesses associated with the use of accident statistics to evaluate effectiveness, a multilevel and strategic management perspective to safety performance measurement will be adopted for this study. The study of H&S management phenomena through a multilevel and strategic management perspective has the advantage of allowing a more integrated understanding of the phenomena across levels within an organisation, reducing conceptual ambiguity and measurement error. By applying this theoretical perspective, the effectiveness of a H&S management arrangement is assessed through the adequacy of the codified policies and procedures established by top management within the organisation, and the degree to which these codified policies and procedures translate into H&S practices at the level of workgroups within an organisation.

This chapter hypothesised a fourteen-factor structure for the strategically developed component of a HSMA, and an eight-factor structure for the HSMA implementation component. The strategically developed component is evaluated in terms of the of adequacy of strategically developed policies and procedures, while the implementation component is evaluated through workers' perception of the level of safety within their organisation.

The next two chapters will present the application of this theoretical perspective to evaluate the effectiveness for the three HSMA types under consideration. Firstly, in terms of the codified policies and procedures that constitute them, and secondly in terms of employee perception of the level of safety within their organisations.

CHAPTER SIX

A COMPARATIVE ANALYSIS OF THE 'STRATEGICALLY DEVELOPED COMPONENT' OF THE HEALTH AND SAFETY MANAGEMENT ARRANGEMENT TYPES

6.1 Chapter Introduction

Chapter five provided the theoretical perspective through which the effectiveness of a health and safety management arrangement (HSMA) will be assessed in this study. The theoretical perspective presented in chapter five identified the strategically developed policies and procedures, and their implementation as two aspects through which the effectiveness of a HSMA may be assessed.

The strategically developed component of a HSMA is conceptualised as a global construct that can vary between organisations but not within organisations. This component of a HSMA creates the objective context for H&S management practices within an organisation by specifying functions, roles, responsibilities and authorities in relation to H&S management. The nature of this construct means that it is best measured at the macro level (level of the manager).

The objective of this chapter is to evaluate and compare the effectiveness of the three HSMA types in terms of their strategically developed policies and procedures. Employing a multinomial *logistic* model, this chapter assessed the relative efficacy of each HSMA type in term of 14 H&S management policies and procedures conceptualised to make up the strategically developed component of a HSMA. This chapter is organised into two sections: the first section describes the research methodology and data analysis technique, while the second section reports and discusses the results from the data analysis process.

6.2 Research Methodology

The strategically developed component of the HSMA of contractor organisations was assessed through a questionnaire based survey targeting custodians of H&S management within these organisations. Enumerated below are the questionnaire design process as well as survey sample characteristics.

6.2.1 Design of survey questionnaire

The survey questionnaire aimed to assess the 14 dimensions hypothesised to constitutes the strategically developed component of a HSMA as presented in section 5.4. An exhaustive review of the literature was carried out to identify studies where scales had been developed to measure similar dimensions. These scales guided the questions included in the questionnaire. Following this, a draft survey questionnaire was developed and subjected to a refinement process to eliminate redundant questions resulting from analogous meanings and contextual incompatibility. The refinement process was carried out by considering the expert opinions of a panel of eight H&S professionals drawn from the Association of Construction Health and Safety Management (ACHASM), H&S advisors at the Master Builders Association (MBA) and the South African Forum of Civil Engineering Contractors (SAFCEC), and H&S directors at two large contractor organisations. At the end of the refinement process, 53 questions were identified as suitable measures for the fourteen H&S management dimensions.

The questionnaire was further streamlined to determine the most important questions to assesses each of the 14 dimensions. The panel of eight H&S professionals were also asked to rate the importance of each question on a six-point Likert scale, where 1 is "not important" and 6 is "very important". An even numbered scale was chosen over an odd numbered scale to force a choice between "important" or "not important", as the interpretation of a midpoint implied by an odd number scale could elicit undesirable response patterns such as neutrality or respondents being undecided.

A statistical one-tailed *t test* analysis was carried out to identify and eliminate insignificant/unimportant questions. The significance level (p value) for the one-tailed test was set at 0.05 and the threshold or cut off point above which a question is considered important was fixed at 4 ($\mu_0 = 4$). The *t test* result is shown in Annex B. At the end of refinement and streamlining processes, the final questionnaire contained 48 questions assessing 14 H&S management dimensions. These are presented in Table 9.

The final questionnaire contained two sections, the first section contained identification questions to enable the categorisation of participating organisations in terms of organisational characteristics, subcontracting practices and HSMA type (Annex C). The second section contained the 48 questions discussed above to which there were three possible responses – “Yes”, “Partial”, and “No”. Respondents were instructed to select a “Yes” if the requirement of a question was true throughout the organisation in terms of sites, personnel and procedures. A “Partial” if the requirements of a question had not reached all parts of the organisation or applied to most but not all employees within the organisation. A “No” if the requirements of a question are not present within the organisation. A points system was used to score the response to each question. A “Yes” response was award 10 points, a “Partial” 5 points, and no point was awarded for a “No” response.

Table 9:Questions assessing H&S management dimensions

	Safety Policy	
1	Pol 1	A clear corporate policy document on H&S that is signed by a top management representative and periodically reviewed
	Pol 2	Safety policy contains measurable safety goals and objectives with specific time frame targets for achieving them
	Pol 3	H&S policy document readily accessible on all work sites and to all employees
	Pol 4	Communication of organisation's H&S policy as an integral aspect of H&S induction of workers
	Top management leadership and involvement	
2	TMLI 1	Custodian of H&S management within organisation occupies senior management position
	TMLI 2	Regular visits by members of top management to project sites to assess H&S performance and communicate their commitment to H&S safety
	TMLI 3	Availability of annual budgetary provisions dedicated to funding H&S management requirements
	Strategic Health and Safety Planning	
3	SHSMP 1	A strategic H&S management plan/manual that covers all the organisation's operations and sites has been developed and is periodically reviewed
	SHSMP 2	The developed strategic H&S management plan is endorsed by top management
	SHSMP 3	The developed Strategic H&S management plan is published and available to the workforce at all work locations
	Employee representation, consultation and participation	
4	ERCP 1	H&S representatives are formally appointed in writing
	ERCP 2	H&S representatives are members of organisational level H&S safety forum/platforms
	ERCP 3	H&S representatives are involved in setting policy objectives and targets
	ERCP 4	Employees are involved in carrying out risk assessments, audits and incident investigations

	Accountability and incentives for participation	
	AIP 1	Formal procedures in place for acting upon failures by any employee to achieve expected health and safety performance
5	AIP 2	Individual health and safety performance of managers, supervisors and workers as an integral component of their performance appraisals
	Health and safety communication	
	HSC 1	Procedures are in place for communicating major safety events, incidents and accidents to top management and throughout the organisation
6	HSC 2	Procedures are in place for disseminating of internal and external audit report findings to top management and relevant members of the work force
	HSC 3	Procedures are in place for disseminating of information on progress against stated H&S performance targets throughout the organisation
	Risk management procedures	
	RMP 1	Documented safe work procedures for routine tasks are in place
	RMP 2	Documented procedures for hazard identification and risk assessment are in place
7	RMP 3	Documented procedures for incident investigation are in place
	RMP 4	Documented procedures for work site inspections are in place
	RMP 5	Documented procedures for incident reporting including near misses are in place
	RMP 6	Baseline annual medical checks for all employees are conducted
	Management of subcontractors	
	MoS 1	Previous H&S performance of subcontractors are a key selection criterion
	MoS 2	Subcontractors are required to show evidence of improving accident and lost time injury statistics
8	MoS 3	Subcontractors are required to establish mechanisms for managing H&S such as a H&S plan for work to be done
	MoS 4	Subcontractors are required to have requisite H&S personnel within their employment
	Defined health and safety responsibilities for operational managers	
	HSROM 1	All line managers have formally and in writing been given clear H&S responsibilities appropriate to their job function
9	HSROM 2	H&S competencies and risks associated with tasks are considered in the appointment of supervisors and operational managers

	Knowledge management for health and safety	
10	KM 1	Continuous monitoring of developments in the field of H&S management to ensure that organisational practices are up to date
	KM 2	Information management infrastructure that enables documentation of past experiences and communication of lessons learned from near miss incidents and accidents investigation
	KM 3	A H&S information repository infrastructure that ensures that all workers have access to H&S information they need for their work
	Employee competence and training	
11	ECT 1	Competency standards are set for all tasks performed by workers within organisation
	ECT 2	Procedures for identifying H&S training needs of new workers or when workers change work or aspects of their work change
	ECT 3	All those in supervisory roles have undergone training on hazard identification and risk assessment from accredited H&S training providers
	ECT 4	Procedures to ensure that all workers receive required H&S training relevant to task they perform
	Health and safety audits and inspections	
12	AI 1	Regular conduct of internal audit of H&S management arrangement at all sites
	AI 2	Regular audit of the H&S management arrangement of subcontractors
	AI 3	External audits of H&S management arrangement by external parties on a periodic basis
	AI 4	Periodic legal compliance audits
	Health and safety record control and reporting	
13	RCR 1	Near miss incidents, accidents are recorded, analyses and statistics reported on annually or more frequently
	RCR 2	Report of H&S statistics is internally disseminated to top management and all stakeholders within the organisation on an annual or more frequent basis
	RCR 3	H&S statistics report are made public or contained in annual financial report
	Management review	
14	MR 1	Incident/accident statistics are tracked and benchmarked against industry average
	MR 2	Top management have regular meetings to discuss H&S performance
	MR 3	Top management regularly meet to review H&S management arrangement to improve H&S performance

6.3 The Data

The target population for in this study was civil and building contractor organisations registered with the construction industry development board (*cidb*) between grade 7 and 9. This category of contractors were chosen because they represent medium to large contractor organisations who have an incentive to have in place strategies for managing H&S due to the number of employees they engage and value of contracts they are able to execute.

The unit/level of measurement was the custodian of H&S management within the organisation (these were either a safety director, a safety manager, safety officer, or employee responsible for liaising with external H&S consultants). Custodians of H&S management within organisations were chosen since they can be expected to have information and knowledge of the elements that constitute their organisation's H&S management strategies. Also, these individuals occupy an intermediate position between management and workers and therefore, the information they provide can be considered less biased.

The researcher was granted access to the *cidb* database of registered contractors and a total of 1,100 companies were identified to be registered between grades 7 to 9. Of this number, 426 companies were civil and building contractors. Using an online survey tool, an electronic version of the survey questionnaire was created and the link to the online questionnaire emailed to all 426 civil and building contractor organisations. The email contained a cover letter and instructions indicating that the questionnaire should be completed by a senior H&S professional within the organisation or an employee responsible for overseeing H&S management activities within the organisation. A total of 71 survey responses were received from 71 different contractor organisations representing a 17% response rate. The number of responses received is below the 203 required to achieve a 95% confidence level. However, this response rate is typical of H&S management related surveys distributed electronically (Teo et al. 2005; Fernández-Muñiz, Montes-Peón, Vázquez-Ordás, et al. 2007). Of this number, 12 questionnaires were not substantially completed and were discarded.

6.3.1 Descriptive Statistics

For the remainder of this chapter the following notation will be used in referring to the three HSMA types:

HSMA Type	Notation
Traditional/compliance motivated	Type1
Systematic/compliance motivated	Type2
System/best practice motivated	Type3

A breakdown of the complete responses shows that 18 respondents represented Type1 contractor organisations, 18 were Type2 contractor organisations, and 23 were Type3 contractor organisations. Further analysis of the data by main business areas reveals that a significant proportion of Type1 (39 percent) and Type2 (50 percent) contractor organisations operated mainly in the building construction market compared to 4 percent for Type3 contractor organisations. In terms of subcontracting practices, the degree of subcontracting can be seen to increase between Type1 and Type3 contractor organisations, with Type3 contractor organisations experiencing the highest levels of subcontracting and Type1 experiencing the lowest. All Type3 contractor organisations reported subcontracting some aspects of their work, in contrast, to 28 percent for Type1 and 17 percent for Type2 organisations reported rarely using subcontractors. Table 10 presents a summary of the main business and subcontracting characteristics of respondent organisation.

Table 10: Main business area and subcontracting practices

	Type1 [N = 18] %	Type2 [N = 18] %	Type3 [N = 23] %
Main business area of organisation:			
Civil construction	44%	28%	52%
Building construction	39%	50%	4%
Both civil and building	17%	22%	44%
Subcontracting:			
Rarely subcontract	28%	17%	0%
Less than half of all operations are subcontracted	61%	61%	74%
More than half but not all operations are subcontracted	11%	22%	26%

In analysing the second part of the questionnaire that assessed the 14 strategic health and safety management dimensions (see table 9), a points system was used to score the response to each question. A “Yes” response was awarded 10 points, a “Partial” 5 points, and no point was awarded for a “No” response. Based on the descriptive information provided in the first section of the questionnaire, the dataset was first sorted into the three HSMA categories. Following this, mean scores and standard deviations were computed for each of the 14 dimensions for each of three groups (HSMA types) of responses.

Table 11 reports the means and standard deviations of the survey responses. For all three groups, three dimensions namely: accountability and incentives for participation; management of subcontractors; and employee competence and training recorded the lowest mean scores. This suggests possibly, a general weakness in these H&S management dimensions across the industry. The dimension - risk management procedures, recorded the highest mean score suggesting a strong emphasis in the industry on putting in place documented procedures for managing work place hazards.

Table 11: Descriptive statistics of variables from survey responses

Variables	Means			Standard Deviations		
	Type1	Type2	Type3	Type1	Type2	Type3
Safety policy	0.89	0.87	0.94	0.14	0.14	0.08
Top management leadership and involvement	0.80	0.62	0.88	0.23	0.27	0.15
Strategic H&S planning	0.91	0.87	0.92	0.14	0.18	0.12
Employee representation consultation & participation	0.83	0.67	0.78	0.18	0.24	0.21
Accountability and incentives for participation	0.58	0.56	0.78	0.28	0.37	0.29
Health and Safety communication	0.91	0.87	0.99	0.24	0.22	0.05
Risk management procedures	0.96	0.95	0.97	0.10	0.10	0.07
Management of subcontractors	0.77	0.61	0.72	0.25	0.29	0.24
Defined H&S responsibilities for operational managers	0.96	0.76	0.89	0.13	0.29	0.17
Knowledge management for Health and Safety	0.81	0.75	0.88	0.29	0.32	0.18
Employee competence and training	0.79	0.74	0.79	0.26	0.25	0.18
Health and safety audits and inspections	0.83	0.77	0.91	0.32	0.27	0.16
Health and Safety record control and reporting	0.79	0.72	0.98	0.29	0.34	0.07
Management review	0.74	0.69	0.93	0.29	0.30	0.15
Number of observations (Total = 59)	**18**	**18**	**23**	**18**	**18**	**23**

6.3.2 Data Analysis – The Multinomial Logit Model (MNL)

Multinomial logit regression models are used to model relationships between an un-ordered categorical dependent variable and a set of multiple independent variables (Fang et al. 2006; Van Can 2013; Arocena & Núñez 2010). A logit function or log-odds gives the natural logarithm of the odds of an occurrence with probability *p* as follows:

$$logit\ p = log\left(\frac{p}{1-p}\right)$$

Readers are referred to Wooldridge (2003) for a detailed discussion on logit models and their advantages over linear probability models, a detailed discussion of the theory of multinomial logit models does not serve the purpose of this dissertation.

The objective of this chapter is to compare the effectiveness of the three HSMA types by evaluating their performance across the 14 dimensions that compose the strategically developed component of a HSMA. Consequently, the following hypothesis is tested:

> *H0: There are no significant difference in the performance of the HSMA types across the 14 safety dimensions.*
>
> *H1: There are significant differences in the performance of the HSMA types across the 14 safety dimensions.*

To test this hypothesis, a model of the following functional form is evaluated to analyse the data collected from the survey:

HSMA type = f (*Safety policy; Top management leadership and involvement; Strategic H&S planning; Employee representation consultation and participation; Accountability and incentives for participation; Health and safety communication; Risk management procedures; Management of subcontractors; Defined H&S responsibilities for operational managers; Knowledge management for health and safety; Employee competence and training; Health and safety audits and inspections; Health and safety record control and reporting; Management review*)

The dependent variable, HSMA type, is an unordered categorical variable that represents the three HSMA types under consideration and takes any of three values: 1 = Traditional/compliance motivated, 2 = Systematic/compliance motivated, 3 = System/best practice motivated. There are 14 independent variables representing the 14 HSMA dimensions. Each dimension is measured by the mean score of all the questions that make up that dimension.

To test the stated hypothesis, the categorical nature of the dependent variable requires the use of a regression model that takes into consideration the un-ordered, non-continuous nature of the dependent variable. According to (Greene, 2003:842), the multinomial logit (MNL) or multinomial probit (MNP) models are appropriate for evaluating models with un-ordered categorical dependent variables. While both models are technically similar, the MNL model yield more accurate estimates compared to the MNP model provided the assumption of independence of irrelevant alternatives (IIA) holds (Kropko 2008). To test that the IIA assumption holds, the *Hausman* and *LR* test proposed by (McFadden et al. 1977) and improved by (Small & Hsiao 1985) was run in Stata using the *mlogtest* post-estimation command developed by (Long & Freese 2006). The test confirms that the IIA assumption holds across all HSMA types, indicating the preferability of the MNL model for analysis.

The MNL model for this study is specified by the following regression specification (Dow & Endersby, 2004:109/10; Greene, 2003:842):

$$U_{ij} = \gamma z_{ij} + \varepsilon_{ij}$$

Where U_{ij} is the dependent variable capturing the 3 HSMA types for observation *i* and type *j*; z_{ij} represents the independent variables (i.e. 14 dimensions) that vary across HSMA types; γ represents the coefficient of the predictor; and ε_{ij} represents the error terms capturing unobserved factors. In the MNL specification, the probability that a given HSMA will be of type*1* is given by:

$$P_{i1} = P[U_{i1} > U_{i2}, U_{i1} > U_{i3}]$$

Such that for any *“m”* in the set of 1 to 3 HSMA types is given by:

$$P(m) = P[\varepsilon_{im} - \varepsilon_{ij} < (\gamma z_{ij} - \gamma z_{im}), j \neq m]$$

Where the errors are assumed to be independent and identically distributed following the cumulative distribution function of the logistic distribution so that the probability that observation *i* is of HSMA type *j* is given by:

$$P(type = j | \gamma, z_{ij}) = \frac{\exp(\gamma z_{ij})}{\sum_{k=1}^{3} \exp(\gamma z_{ik})}$$

6.4 Results and Discussion

This section presents the results from the Multinomial Logit regression comparing the three HSMA types in relation to the 14 variables (H&S management dimensions). Estimates of the logistic coefficients, robust standard error and level of significance are presented in Table 12. Column 1 through 3 compares the three HSMA types using HSMA Type3 as the base category, while column 4 through 6 uses HSMA Type1 as the base category.

Table 12:Multinomial logit regression results

	VARIABLES	(1) Type3	(2) Type2	(3) Type1	(4) Type2	(5) Type3	(6) Type1
1	*Safety policy*		0.437	1.621	-1.184	-1.621	
			(3.157)	(2.958)	(0.826)	(2.958)	
2	*Top management leadership and involvement*		-9.005***	-8.062***	-0.942	8.062***	
			(1.494)	(1.754)	(1.117)	(1.754)	
3	*Strategic H&S planning*		4.335***	1.385	2.951***	-1.385	
			(1.678)	(0.949)	(0.771)	(0.949)	
4	*Employee representation consultation & participation*		0.684	5.287	-4.603**	-5.287	
			(2.117)	(3.997)	(1.881)	(3.997)	
5	*Accountability and incentives for participation*		-3.418***	-3.915***	0.497**	3.915***	
			(0.507)	(0.562)	(0.216)	(0.562)	
6	*Health and Safety communication*		-14.52	-20.49**	5.970***	20.49**	
			(10.20)	(9.464)	(2.021)	(9.464)	
7	*Risk management procedures*		10.46	5.786	4.676	-5.786	
			(7.133)	(9.056)	(4.692)	(9.056)	
8	*Management of subcontractors*		-0.181	0.225	-0.406	-0.225	
			(1.081)	(0.819)	(0.266)	(0.819)	
9	*Defined H&S responsibilities for operational managers*		1.047	9.492***	-8.445***	-9.492***	
			(2.912)	(3.025)	(1.698)	(3.025)	
10	*Knowledge management for Health and Safety*		-2.640	-1.662	-0.978	1.662	
			(1.647)	(3.055)	(1.510)	(3.055)	
11	*Employee competence and training*		8.793**	8.490***	0.303	-8.490***	
			(3.557)	(1.703)	(2.323)	(1.703)	
12	*Health and safety audits and inspections*		2.579*	3.463***	-0.885**	-3.463***	
			(1.410)	(1.078)	(0.417)	(1.078)	
13	*Health and Safety record control and reporting*		-8.591***	-8.196***	-0.395	8.196***	
			(1.049)	(1.348)	(1.256)	(1.348)	
14	*Management review*		1.421	0.110	1.310***	-0.110	
			(0.930)	(1.386)	(0.478)	(1.386)	
	Constant		7.217	6.344	0.873	-6.344	
			(10.32)	(10.71)	(0.771)	(10.71)	
	Observations	59	59	59	59	59	59

Robust standard errors in parentheses (adjusted for clusters in HSMA types)

***** p<0.01, ** p<0.05, * p<0.1**

A logistic coefficient associated with an independent variable gives an indication of the odds ratio of an alternative HSMA type (dependent variable) occurring relative the base category (columns 1 and 6). To illustrate the above explanation, consider the case of the variable - accountability and incentives for participation [5]. A one unit increase in an organisation's score for this dimension decreases the likelihood/probability of the organisation being a Type2 organisation by 3.418, and being a Type1 organisation by 3.915, relative to being Type3 contractor organisation. In practical terms, this means that Type3 contractor organisation are more likely to have a higher score in this dimension when compared to Type2 and Type1 contractor organisations. The opposite is the case for a positive coefficient. However, it should be noted that only results above the 95 percent significance level are discussed (*** and **).

The results indicate that the Null hypothesis cannot be rejected for six of the 14 dimensions, as the values of the logistic coefficients associated with these dimensions are not statistically significant. These dimensions are: (1) safety policy [1]; (2) employee representation, consultation and participation [4]; (3) risk management procedures [7]; (4) management of subcontractors [8]; (5) knowledge management for health and safety [10]; (6) management review [14]. This implies that the mean scores associated with these dimensions do not significantly predict the HSMA types and therefore, the HSMA types cannot be differentiated on the bases of these dimensions

For the other eight dimensions, the null hypothesis is not supported and is therefore rejected. Statistically significant differences were observed for the following eight dimensions.

Top management leadership and involvement [2]: The logistic coefficients for this dimension indicate that Type3 contractor organisation are more likely to have in place policies and procedures that support and promote top management leadership and involvement in health and safety management activities relative to Type1 and Type2 contractor organisations. This is followed by Type1 contractor organisations and lastly Type2 contractor organisations.

This result is supported by the literature and findings from the qualitative assessment of the HSMA types presented in chapter 4. The voluntary adoption of H&S management best practice, coupled with H&S specialists occupying senior management position at Type3 organisation, suggests that H&S management at these organisations will be strongly driven by top management as a corporate objective. In contrast, supply chain pressure was found to be the key motivation for H&S management efforts at Type1 and Type2 contractor organisations. Higher levels of top management commitment and involvement at Type1 contractor organisations over Type2 contractor organisations can be expected considering that Type1 contractor organisation are less bureaucratic often allowing managers and owners to interface directly with external H&S consultants and frontline workers on issues of H&S. The level of bureaucracy often associated with Type2 contractor organisations and the limited decision-making powers of the H&S specialist who often occupy middle management may translate to members of top management being detached from H&S management efforts within such organisations.

Strategic Health and safety planning [3]: The results reveal that Type2 contractor organisations are more likely to score higher or have more effective procedures for strategic health and safety planning relative to Type3 and Type1 contractor organisations. Type1 and Type3 contractor organisations cannot be reliably differentiated in terms of their strategic health and safety planning procedures as no statistically significant difference was observed between them.

Strategic health and safety planning being more effective at Type2 contractor organisations relative to Type3 contractor organisations could be explained by the differences in their subcontracting practices. The heavy reliance on subcontractors by Type3 contractor organisations for a large proportion of their operations suggests that strategic H&S plans within these organisations may not cover all its operations. In contrast Type2 contractor organisations tend to be more specialised and employ less subcontracting when compared to Type3 contractor organisations, therefore, their strategic H&S planning is expected to be more predictable and comprehensive. The use of external H&S consultants by Type1 contractor organisation could mean that very little strategic planning happens as their H&S management planning happens on a project to project basis. However, their operations are more specialised and involves very limited subcontracting.

Accountability and Incentives for participation [5]: Type3 contractor organisations were found to be more likely to have in place effective accountability mechanisms and incentives for workers participation in H&S management when compared to Type2 and Type1 contractor organisations. Type1 contractor organisations were least likely to have in place accountability and incentive mechanisms. This outcome is to be expected considering that Type3 organisations are highly formalised and bureaucratic. From the qualitative assessment of the HSMA types presented in chapter 4, it was observed that employment relationship becomes less formalised as one moves from Type3 to Type1 contractor organisations with a concomitant weakening of the mechanism that ensures accountability for H&S. It should however, be noted that there is general poor performance by all three HSMA types in this dimension and this is reflected in the low mean scores recorded and findings from the qualitative analysis presented in chapter four.

Health and safety communication [6]: Type3 and Type2 contractor organisations were found to be more likely to have in place effective procedures for H&S communication relative to Type1 contractor organizations. Type3 and Type2 contractor organisations could not be differentiated in terms of this dimension, as no statistical difference was observed between these groups. This outcome is also to be expected and supported by the literature and qualitative assessment of HSMA types presented in chapter four. Type3 HSMA are tailored in line with the requirements certified management systems such as OHSAS 18001 which emphasises a high degree of documentation and a framework for the dissemination of information. Even though Type2 and Type1 HSMA are less formalised compared to Type3 HSMA, Type2 HSMA often have in place bureaucratic structure that define formal communication within the organisation, like what is observed in Type3 contractor organisation. Type1 contractor organisations are characterised by a low degree of documentation and bureaucratic structures, these attributes are believed to translate to poor H&S communication procedures at these organisations.

Defined H&S responsibilities for operational managers [9]: The results show that Type1 contractor organisations are more likely to have in place defined H&S responsibilities for operational managers relative to Type2 and Type3 contractor organizations. No statistically significant difference was observed between Type2 and Type3 contractor organisations for this dimension. At Type1 contractor organisations, operational managers such as supervisors and foremen were observed from the qualitative assessment of HSMA types conducted in chapter four, to serve as liaisons between their sites and the external H&S consultant. They were also observed to assume more H&S management functions in addition to their technical functions, when compared to Type2 and Type3 contractor organisations who may have full time H&S specialists within the organisation and who often assume sole responsibility for H&S.

Employee competency and training [11]: The results indicate that Type2 and Type1 contractor organisations were more likely to have in place effective procedures for employee competency and training compared to Type3 contractor organisations. No statistically significant difference is however, observed between Type2 and Type1 contractor organisations. The qualitative assessment conducted in chapter four revealed that the training focus of contractors is influenced by their subcontracting practices. The less subcontracting an organisation does, the more specialised its operations and artisan labour in its workforce. Type2 and Type1 contractor organisations can be seen to subcontract less when compared to Type3 HSMA organisations, and often act as subcontractors to Type3 organisations. This perhaps explains greater H&S training efforts by Type2 and Type1 organisations when compared to Type3 organisations. It should be note however, that the analysis of the mean scores for this dimension reveal a generally poor performance for all HSMA types.

Health and safety audit and inspections [12]: The results suggest that health and safety audits and inspections were more commonly associated with Type1 contractor organisations compared Type2 and Type3 contractor organisations. No statistically significant difference is observed between Type2 and Type3 organisations for this dimension. This result does not conform with anecdotal expectations and may require further investigation. This is because audits and inspection are fundamental to continuous improvement which is an important component of Type3 HSMA, it is therefore expected that Type3 organisations will be the top performers in this dimension. However, a plausible explanation for this pattern of result is the frequency of audits and inspections an organisation is subjected to. Organisations that are predominantly subcontractors perhaps experience a greater number of audits as they are audited and inspected by multiple parties including the principal contractor, the client's agent, and their external H&S consultant on a regular basis.

Health and safety record control and reporting [13]: Type3 contractor organisations found to be more likely to have procedures for H&S record control and reporting compared to Type2 and Type1 contractor organisations, with Type1 contractor organisations having the least likelihood of having in place these procedures. This result is to be expected considering the high degree of documentation associated with Type3 HSMA. Type1 HSMA is the least formalised and documented and should be expected to perform the least in this dimension.

6.4 Chapter summary

The objective of this chapter was to evaluate and compare the effectiveness of the three HSMA types under consideration from the perspective of the strategically developed policies and procedures. Fourteen H&S management dimensions were evaluated and compared using a multinomial logit regression model.

The results revealed variations in strengths and weaknesses across 14 H&S management dimensions. Across six dimensions, namely: *safety policy; employee representation, consultation and participation; risk management procedures; management of subcontractors; knowledge management for health and safety; and management review,* no statistically significant difference was observed between the three HSMA types.

Across the other eight dimensions, variations were observed in the occurrence of these dimensions between the three HSMA types under consideration. These variations are believed to be influenced by the subcontracting practices and the level of formalisation and documentation that characterise the various contractor organisations. Type3 contractor organisations, characterised by a high degree of formalisation and documentation, and a higher level of subcontracting, were found to most likely to have in place procedures that enabled four dimensions namely: *Top management leadership and involvement; accountability and incentives for participation; H&S communication, and H&S record control and reporting*. Type 2 and Type1 contractor organisations were however more likely to have in place procedures that enable the four other dimensions compared to Type3 contractor organisations. These dimensions are: *strategic H&S planning; defined H&S responsibilities for operational managers; H&S inspections; and employee competence and training.*

The next chapter will compare the three HSMA types from the perspective of their implementation component.

CHAPTER SEVEN

A COMPARATIVE ANALYSIS OF THE 'IMPLEMENTATION COMPONENT' OF THE HEALTH AND SAFETY MANAGEMENT ARRANGEMENT TYPES

7.1 Chapter Introduction

The theoretical framework presented in chapter five identified the strategically developed policies and procedures and their implementation component as two aspects through which the effectiveness of a Health and Safety Management Arrangement (HSMA) may be assessed. A comparative analysis of the three HSMA types under review from the perspective of their strategically developed component, was presented in chapter six.

This chapter presents a comparative analysis of the implementation component of the three HSMA types. A structural equation modelling (SEM) framework was used to analyse quantitative data collected through a cross sectional questionnaire survey of frontline construction workers on twelve construction sites. Using a SEM path analysis model, the effect-relationships between safety climate and safety performance factors hypothesised to be indicators of HSMA implementation was demonstrated.

Recall, that the implementation component of a HSMA (discussed in section 5.5) involves translating strategically developed policies and procedures into workplace practices. This component is manifested in the safety practices of an organisation and the behaviours of frontline workers and managers towards H&S based on their perception and interpretation of the strategically developed policies and procedures. Because this construct is an emergent one, it is best measured at the micro level (level of the worker) (Yorio et al. 2015).

This chapter is organised into five sections: the first section describes the research methodology and data analysis technique employed. The second section reports on a confirmatory factor analysis (CFA) conducted to verify the hypothesised factor structure of the HSMA implementation construct. The third section reports on a group comparison test conducted using a multiple indicator multiple causes (MIMIC) model. The fourth section reports on a path analysis that examined the effect-relationships between the hypothesised HSMA implementation factors. This chapter concludes with a synthesis of the findings from the analysis of CFA, MIMIC and path analysis models.

7.2 Research Methodology

The implementation component of a HSMA is assessed through a questionnaire survey that measured construction workers' perception of eight H&S management dimensions within their organisation. Descriptions of the survey questionnaire design and the survey process and sample are presented in the next two sections.

For the remainder of this chapter the following notation will be used in referring to the three HSMA types being investigated.

HSMA Type	NOTATION
Traditional/compliance motivated	Type1
Systematic/compliance motivated	Type2
System/best practice motivated	Type3

7.2.1 Measures

The survey measured eight dimensions of HSMA implementation discussed in section 5.6:

1. H&S management practices - HSMP
2. Top management commitment and leadership - MCL
3. Operational managers' leadership - OMCL
4. Systems for H&S management - SYS
5. Safety professionals' leadership - SPL
6. Safety motivation - SM
7. Safe compliance - SC
8. Safety participation - SP

Please note the above notation as reference will be made to them extensively for the remainder of this chapter. The hypothesised model depicting the factor structure of the HSMA implementation construct is shown in Figure 18.

The questionnaire items assessing the eight HSMA implementation factors were adapted from previous studies that measured safety climate dimensions. One of such studies by Mulenga (2014), proposed a safety climate model for the construction industry and developed an instrument for measuring several safety climate dimensions. Similar studies by Vinodkumar & Bhasi (2010), Neal & Griffin (2006) and Wen Lim et al. (2018) also developed measurement instrument that assessed safety climate dimensions.

All the questionnaire items used in this study were adapted from the four studies mentioned above. The questionnaire structure is as follows:

1. Top management commitment and leadership (MCL) factor was measured by five questionnaire items
2. Operational managers' leadership (OMCL) factors was measured by five questionnaire items
3. Systems for health and safety management (SYS) factor was measured by four questionnaire items
4. Safety professionals' leadership (SPL) factor was measured by nine questionnaire items
5. Health and safety management practices (HSMP) factor was measured by 14 questionnaire items
6. Safety motivation (SM) factor was measured by three questionnaire items
7. Safety compliance (SC) factor was measured by three questionnaire items
8. Safety participation (SP) factor was measured by four questionnaire items

The survey questionnaire contained a total of 47 question items. All items were rated on a five-point Likert scale from which participants were asked to rate from 1 (strongly disagree) to 5 (strongly agree) how well each statement described their experience at the organisation they worked for.

The questionnaire also contained identification questions that captured information about respondent gender, age, duration of employment, work status, main business area of employer and characteristics of their organisation's HSMA. Two questions about occurrence of injuries were included at the end of the questionnaire to capture the injury experiences of respondents in the last 30 days. A sample of the survey questionnaire is attached in Annex D.

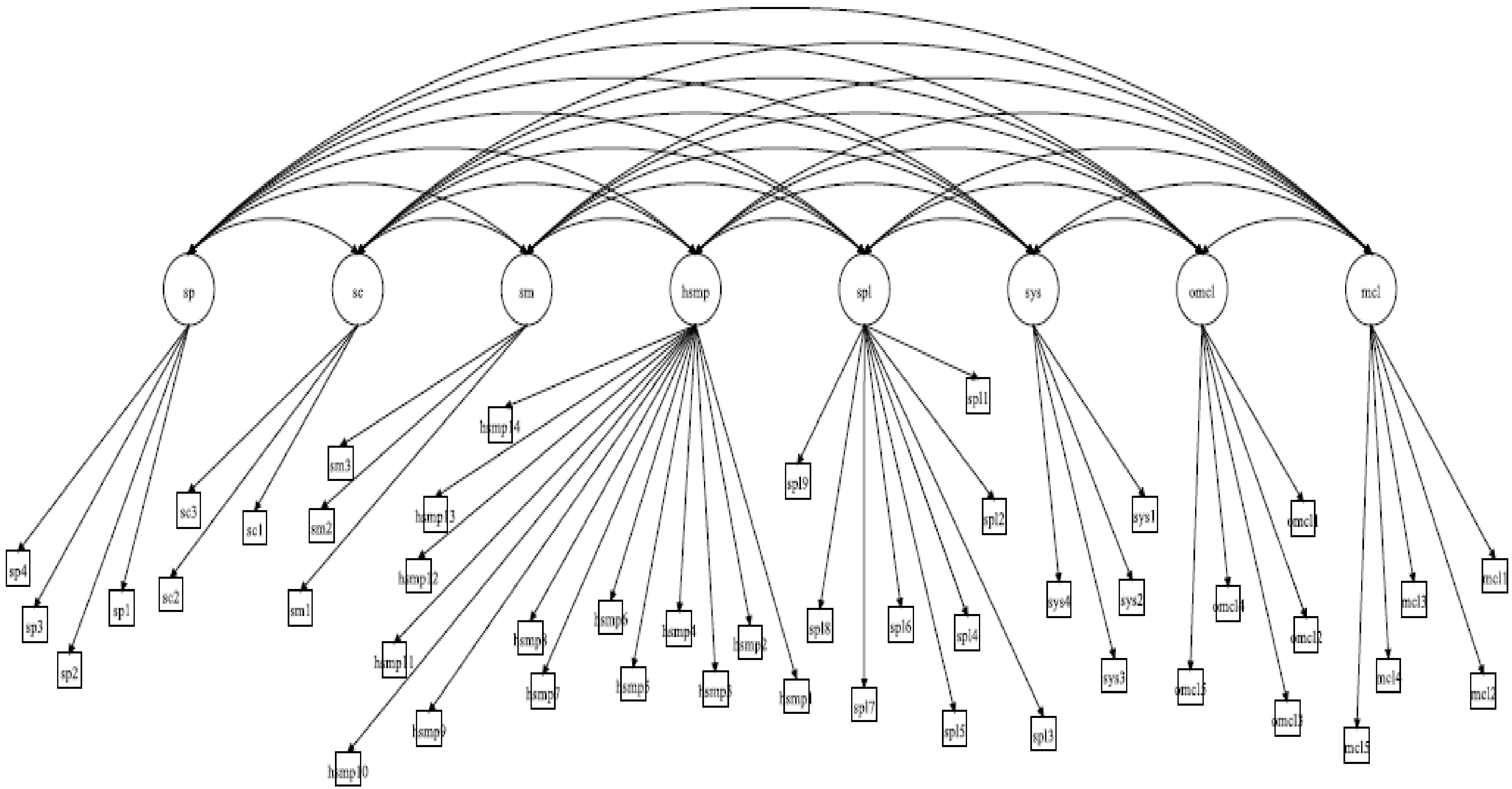

Figure 18: Hypothesis factor structure for the HSMA implementation construct

7.2.2 Description of the survey and sample

A survey was administered to a total of 350 participants who were employed by CIDB grade 7 to 9 registered contractor organisations in the Western Cape province of South Africa. Of this number, 262 valid responses were received resulting in an effective response rate of 74.8%. Of this number, 98 respondents worked for Type3 contractor organisations, 70 worked for Type2 contractor organisations and 94 worked for Type1 contractor organisations.

The survey was administered at 12 construction project sites, three of the projects were road construction projects, five were large commercial building projects, two were government Reconstruction and Development Project (RDP) low cost housing projects, and two projects were renovation of government buildings. The survey excluded managers and supervisors, only frontline workers were selected to complete the survey.

Participants attended a session of research briefing in groups of not more than 10 workers at a time. Each participant was given a questionnaire to complete during the research briefing session, however, not all workers who attended the briefing session agreed to participate in the survey or returned completed questionnaires. Because most of the workers had low levels of education, the research administrator and a translator ran through each question with the respondents during the briefing session to make sure they conveyed the accurate meaning of each questionnaire item to the participants. Steps were also taken to maintain privacy and anonymity of responses by asking participant not to write their names on the questionnaires and to return them in sealed envelopes provided along with the questionnaires.

7.3 Data Analysis

A structural equation modelling (SEM) approach was used to analyse the survey data in this study. According to Dion (2008), the primary objective of structural equation modelling *is to establish that a model derived from theory has a close fit to the sample data in terms of the difference between the sample and model-predicted covariance matrices.* The advantages of using a SEM include:

1. The ability to handle complex relationships among variables, some of which can be hypothetical or unobserved (latent variables).

2. SEM estimates all coefficients in the model simultaneously and thus, can assess the strength and significance of a particular relationship in the context of the complete model.
3. The hypothesised model can be tested statistically in a simultaneous analysis to determine the extent to which it is consistent with the data.
4. SEM allows for the assessment of direct and indirect effect of each variable on the other variables in a model.

(Wu et al. 2015; Dion 2008; Chinda & Mohamed 2008)

A confirmatory factor analysis (CFA) was first performed to verify the hypothesised factor structure of the HSMA implementation construct, i.e. the hypothesised relationships between the observed variables (questionnaire items) and the eight unobserved latent variables that make up the HSMA implementation construct. Model fit indices served as a guide at arriving at a factor model that fits the data set. Based on the CFA model that established a statistically acceptable factor structure for the HSMA implementation construct, a comparison of Type1, Type2 and Type3 contractor organisations was conducted using a MIMIC (multiple indicator multiple causes) model. The MIMIC model incorporates a covariate factor that accounts for the three HSMA types with the CFA model to access their effect of the covariate factor on the CFA model. Finally, a path analysis was conducted to investigate hypothesised relationships between the factors of the CFA model.

Structural equation modelling analyses were carried out using Mplus version 7.4 statistical software tool (Muthén & Muthén 2007). The Weighted Least Squares Mean and Variance adjusted (WLSMV) estimator was used for all the SEM analyses because it provides the best option for modelling ordered categorical (ordinal) data (Nussbeck et al. 2006).

7.3.1 The data

Prior to conducting the SEM analysis, descriptive statistical analysis was performed on the raw survey data to test for missing data, collinearity, normality and outliers in the dataset. Data screening and descriptive data analyses were carried out in the *R* statistical software tool. Results from the data screening process are reported below.

Missing data

Two cases of missing data were identified where no values were entered for two separate variables across two observations. The missing data cases were less than 5% of the whole dataset, and the missing data pattern is missing at random because two respondents skipped one question each in their completed questionnaires. The skipped questions were different for the two respondents. Multiple imputation technique available through the *mice* package in the *R* statistical software tool was used to estimate probable values for the two missing data cases. This is an acceptable method for dealing with missing data at random (Kline, 2016:87).

Collinearity and normality

Extreme collinearity in the data set was tested using pairwise correlation between all variables to identify variables with correlation above 0.95. The test revealed no correlation values between the variables above 0.90. Thus, the dataset satisfies the collinearity requirement.

Normality assumption was tested for the dataset by checking for skewness and kurtosis. The test reveal that the dataset follows a normal distribution with skewness values less than 3 and kurtosis values less than 10 (Kline, 2016:74).

Outliers

The dataset was screened for outliers using the Mahalanobis distance. The Mahalanobis distance was calculated using the Mahalanobis function available in the *R* statistics software package. A Mahalanobis distance of 82.7 was obtained for the dataset. Observations with Mahalanobis numbers greater than the 82.7 are considered outliers. Twenty-two (22) outlier cases were observed in the dataset.

However, it should be noted that no significant difference was observed in the analysis conducted using the datasets with and without outliers, therefore, the results reported below are from the dataset including outliers. This decision is taken to maintain statistical power considerations.

7.4 Results

7.4.1 Descriptive statistics

The mean (M), standard deviation (SD), skewness (SK), and kurtosis (K) of all questionnaire items are presented in Table 13. For the overall sample, the mean scores for the questionnaire items ranged from 2.702 to 4.489 indicating a variation between negative and positive responses. Skewness (Sk) and Kurtosis (K) values for all samples (overall, Type1, Type2 and Type3) suggests that the data does not violate the normality assumption as all Sk and K values fell below 3 and 10 respectively.

The covariance matrices for the dataset can be found in Annex E.

7.4.2 Confirmatory factor analysis

A confirmatory factor analysis (CFA) was conducted to verify the hypothesised eight factor structure of the HSMA implementation construct. Factor loadings, modification indices (MI) and model fit indices are used at arriving at an acceptable model structure that fits the data. Model fit-indices used in comparing models in this study include: the root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis Index (TLI), as well as the ratio of χ^2 (chi-square) to the degree of freedom. The recommended values for these model indices that indicate an acceptable model are: values greater than 0.90 for CFI and TLI and less than 0.08 for RMSEA and ratio of χ^2 (chi-square) to the degree of freedom less than 3 (Hu & Bentler 1999; Wen Lim et al. 2018).

The CFA conducted on the hypothesised model construct yielded statistically significant factor loadings except for item HSMP6 which had a factor loading of 0.483. The model fit indices also suggest a good fit of the model to the data. Attempts were made to further improve the hypothesised model by taking the following steps:

- four items namely SPL5, HSMP2, HSMP6 and HSMP7 were deleted from the model
- Item MCL 4 was recategorized as an observed variable for the HSMP factor
- three factors SM, SC and SP were grouped into one factor called safety behaviour factor, and
- the measurement errors for some items were correlated

Table 13: Descriptive Statistics of Questionnaire Items

Construct	Overall sample (n=262)				Type1 sample (n = 94)				Type2 sample (n = 70)				Type3 sample (n =98)			
Item	M	SD	SK	K	M	SD	SK	K	M	SD	SK	K	M	SD	SK	K
MCL1	4.038	1.123	-1.194	4.001	3.894	1.273	-1.086	3.406	4.014	1.135	-0.984	3.169	4.194	0.937	-1.298	4.601
MCL2	3.824	1.065	-0.848	3.608	3.521	1.123	-0.396	2.975	3.914	1.099	-1.146	3.821	4.051	0.912	-1.082	4.328
MCL3	3.763	1.041	-0.595	2.756	3.617	1.088	-0.402	2.502	3.700	1.107	-0.674	2.509	3.949	0.923	-0.609	2.923
MCL4	3.908	1.170	-0.998	3.568	3.553	1.332	-0.457	2.668	3.914	1.188	-0.981	3.056	4.245	0.862	-1.655	6.933
MCL5	3.557	1.185	-0.752	3.157	3.255	1.335	-0.447	2.428	3.443	1.246	-0.704	2.566	3.929	0.852	-0.465	2.620
OMCL1	3.985	0.970	-1.001	3.927	3.979	1.015	-0.885	3.232	3.914	1.086	-1.126	3.884	4.041	0.836	-0.820	3.894
OMCL2	3.924	0.987	-1.114	4.763	3.968	0.988	-1.278	5.132	3.771	1.181	-0.982	3.107	3.990	0.818	-0.661	3.701
OMCL3	3.672	1.134	-0.689	2.730	3.766	1.149	-0.772	2.191	3.429	1.291	-0.430	1.962	3.755	0.974	-0.703	3.359
OMCL4	3.981	0.980	-1.183	4.300	4.032	0.932	-1.662	5.427	3.857	1.183	-0.885	2.737	4.020	0.861	-0.817	3.708
OMCL5	3.805	1.048	-0.723	2.865	3.723	1.176	-0.683	2.527	3.700	1.107	-0.546	2.416	3.959	0.848	-0.635	2.957
SYS1	3.786	1.035	-0.952	4.006	3.500	1.198	-0.584	3.269	3.743	0.988	-1.192	4.439	4.092	0.800	-0.771	3.394
SYS2	3.885	0.968	-0.861	3.747	3.660	1.122	-0.770	3.675	3.843	0.878	-0.594	3.396	4.133	0.807	-0.716	3.074
SYS3	3.668	1.079	-0.685	2.981	3.468	1.179	-0.496	2.522	3.543	1.099	-0.538	2.747	3.949	0.901	-0.834	3.504
SYS4	3.763	1.133	-0.839	3.180	3.415	1.363	-0.370	2.480	3.714	1.065	-0.788	3.090	4.133	0.781	-0.885	3.803
SPL1	3.828	1.252	-0.986	3.469	3.340	1.541	-0.458	2.432	3.914	1.099	-0.685	2.640	4.235	0.822	-1.126	4.048
SPL2	3.763	1.192	-0.893	3.317	3.351	1.396	-0.500	2.574	3.786	1.178	-0.702	2.509	4.143	0.812	-0.845	3.423
SPL3	3.866	1.191	-1.049	3.418	3.447	1.388	-0.689	2.575	3.871	1.226	-0.749	2.245	4.265	0.753	-0.912	3.687
SPL4	3.744	1.203	-1.072	4.080	3.319	1.392	-0.655	3.265	3.729	1.214	-0.933	2.976	4.163	0.795	-1.039	4.761
SPL5	3.813	1.234	-0.987	3.329	3.372	1.466	-0.539	2.390	3.971	1.049	-0.853	2.863	4.122	0.976	-1.247	4.218

Construct Item	Overall sample (n=262)				Type1 sample (n = 94)				Type2 sample (n = 70)				Type3 sample (n =98)			
	M	SD	SK	K	M	SD	SK	K	M	SD	SK	K	M	SD	SK	K
SPL6	3.840	1.195	-1.008	3.608	3.362	1.443	-0.477	2.258	4.057	1.061	-1.065	3.199	4.143	0.837	-1.013	4.290
SPL7	3.809	1.188	-1.006	3.666	3.298	1.450	-0.465	2.455	3.971	0.932	-0.700	3.180	4.184	0.865	-1.128	4.322
SPL8	3.866	1.161	-1.089	3.902	3.426	1.447	-0.513	2.247	3.943	0.991	-0.875	3.556	4.235	0.770	-1.377	6.166
SPL9	3.660	1.245	-0.827	3.260	3.362	1.420	-0.475	2.190	3.529	1.200	-0.599	2.725	4.041	0.983	-1.323	4.862
HSMP1	3.710	1.167	-0.780	3.121	3.234	1.331	-0.325	2.273	3.843	1.030	-0.802	3.158	4.071	0.922	-0.934	3.522
HSMP2	3.840	1.011	-0.720	2.804	3.840	1.050	-0.853	2.655	3.686	1.148	-0.345	1.908	3.949	0.854	-0.801	3.760
HSMP3	3.947	0.996	-0.939	3.966	3.755	1.161	-0.798	3.585	3.971	0.900	-0.663	3.308	4.112	0.860	-0.998	4.092
HSMP4	3.481	1.240	-0.535	2.486	3.362	1.358	-0.365	2.165	3.229	1.264	-0.306	2.127	3.776	1.040	-0.810	3.292
HSMP5	3.580	1.137	-0.784	3.318	3.287	1.372	-0.477	2.436	3.671	1.017	-0.804	3.669	3.796	0.896	-0.625	3.145
HSMP6	2.702	1.305	-0.127	2.030	2.298	1.302	-0.727	2.240	2.614	1.365	-0.102	1.634	3.153	1.124	-0.259	2.639
HSMP7	4.019	0.890	-1.048	3.171	3.979	1.015	-1.195	3.088	4.014	0.842	-1.051	4.650	4.061	0.797	-0.600	2.987
HSMP8	3.645	1.203	-0.812	3.431	3.543	1.404	-0.790	3.164	3.557	1.223	-0.492	2.306	3.806	0.948	-0.770	3.675
HSMP9	4.034	1.098	-1.181	4.370	4.011	1.159	-1.144	4.183	3.871	1.284	-1.039	3.057	4.173	0.861	-0.922	3.727
HSMP10	4.004	0.944	-0.963	3.466	3.979	0.972	-0.944	3.307	3.943	1.088	-1.108	3.622	4.071	0.802	-0.489	2.610
HSMP11	3.721	1.207	-0.865	3.241	3.543	1.380	-0.717	2.805	3.543	1.212	-0.641	2.361	4.020	0.952	-0.904	3.621
HSMP12	3.729	1.071	-0.848	3.885	3.574	1.140	-0.730	3.434	3.571	1.174	-0.686	2.801	3.990	0.867	-0.837	4.172
HSMP13	3.576	1.241	-0.819	3.210	3.457	1.426	-0.639	2.739	3.229	1.287	-0.514	2.092	3.939	0.883	-0.874	4.112
HSMP14	3.382	1.301	-0.481	2.307	3.117	1.458	-0.246	1.861	3.271	1.250	-0.345	2.137	3.714	1.102	-0.668	2.735
SM1	4.321	0.814	-1.671	3.942	4.394	0.806	-1.941	1.544	4.343	0.814	-1.996	8.891	4.235	0.822	-1.238	4.996
SM2	4.489	0.715	-1.975	7.392	4.479	0.799	-1.960	2.330	4.514	0.696	-2.123	8.434	4.480	0.645	-1.770	9.714
SM3	4.466	0.819	-2.172	6.725	4.383	0.984	-2.047	4.470	4.500	0.775	-2.065	8.469	4.520	0.661	-1.899	9.532

Construct	Overall sample (n=262)				Type1 sample (n = 94)				Type2 sample (n = 70)				Type3 sample (n =98)			
Item	M	SD	SK	K	M	SD	SK	K	M	SD	SK	K	M	SD	SK	K
SC1	4.267	0.833	-1.407	3.332	4.160	1.008	-1.524	3.595	4.300	0.804	-0.927	3.154	4.347	0.643	-0.696	3.543
SC2	4.328	0.777	-1.475	3.520	4.319	0.870	-1.746	4.082	4.386	0.766	-1.552	6.767	4.296	0.691	-0.837	3.889
SC3	4.324	0.786	-1.539	3.449	4.330	0.834	-1.793	3.992	4.386	0.803	-1.478	5.874	4.276	0.729	-1.274	6.321
SP1	4.057	0.963	-1.222	5.051	3.883	1.095	-0.949	4.706	4.114	0.893	-1.329	5.476	4.184	0.853	-1.358	5.637
SP2	4.156	0.872	-1.279	4.551	4.074	1.059	-1.347	5.606	4.243	0.750	-1.253	6.313	4.173	0.746	-0.588	2.936
SP3	4.206	0.818	-1.024	3.588	4.266	0.917	-1.387	4.283	4.071	0.804	-0.633	3.023	4.245	0.718	-0.732	3.406
SP4	4.050	0.931	-1.125	4.544	4.096	0.995	-1.310	6.694	3.957	1.041	-1.309	4.605	4.071	0.776	-0.256	2.076

The rationale for these decisions is as follows:

1. Guided by the modification indices output from Mplus, item HSMP1 (Formal Health & Safety audits at regular intervals are normal in this company) cross-loaded reasonably with the SPL latent factor. It is observed that HSMP1 and SPL5 (Our safety officer(s)/professionals regularly carry out safety audits) both assessed auditing activities and are thus similar. Item SOPL5 was deleted and HSMP1 retained to address the cross-loading effect.
2. Guided by the modification indices output from Mplus, Item MCL4 (my company provides sufficient personal protective equipment for workers) was found to improve the model fit when loaded on the HSMP latent factor than on the MCL latent factor. The provision of personal protective equipment has been reported in the literature both as an indicator of top management support for health and safety (Vinodkumar & Bhasi 2010), and as an indicator of good health and H&S management practices within an organisation (Shea et al. 2016). The latter was adopted in this study.
3. Compared to other items, items HSMP6 (Those who act safely receive recognition or award) and HSMP7 (Managers, supervisors, and workers all know what behaviour will result in discipline) recorded the lowest factor loadings of 0.483 and 0.523 respectively. The meaning of both questions showed that they both assess H&S management accountability and incentive mechanisms which was revealed in chapter 6 to be an area of general weakness in the strategic developed HSMA component across the industry. These items were deleted because of their low factor loading relative to other items.
4. The SC and SP factors are found to be strongly correlated with a correlation factor of 0.821. SM factor is also strongly correlated to SC (a correlation factor of 0.822) and SP (a correlation factor of 0.725). This is supported by the theoretical framework presented in section 5.6 where safety compliance and safety performance are considered as two behaviours that constitute safety performance. Also, Griffin & Neal (2000) found that these three factors loaded onto a higher order factor. These factors are combined into one factor terms safety behaviour factor (SBF). This reduced the number of factors in the hypothesised model from eight to six.

5. Measurement errors were correlated for the following items: HSMP13 with HSMP14, HSMP9 with HSMP10, SM1 with SM2 and SC1 with SC2.

The modified CFA model had improved fit indices and is depicted pictorially in Figure 19. The modified model was run separately using the data from the three sample groups (Type1, Type2 and Type3). Table 14 presents model fit indices for the various models. All models exhibited good fit to the data. The results show that the modified model has a better fit to the data when compared to the hypothesised model. The modified model reasonably fitted the data for Type1 and Type2 samples but has an excellent fit to the data for the Type3 sample. Standardised factor loading statistics for the hypothesised and modified models can be found in Annex F.

Remember that the recommended model-fit indices that indicate an acceptable model are: values greater than 0.90 for CFI and TLI and less than 0.08 for RMSEA and ratio of χ^2 (chi-square) to the degree of freedom less than 3 (Hu & Bentler 1999; Wen Lim et al. 2018).

Table 14: Fit indices for models

Model	χ^2	**df**	χ^2**/df**	***p***	**CFI**	**TLI**	**RSMEA**
Hypothesised	2297	1006	2.28	<0.0000	0.946	0.942	0.07
Modified	1745	841	2.07	<0.0000	0.959	0.956	0.064
Modified (Type1 sample)	1413	841	1.68	<0.0000	0.956	0.953	0.085
Modified (Type2 sample)	1139	841	1.35	<0.0000	0.932	0.926	0.071
Modified (Type3 sample)	1042	841	1.23	<0.0000	0.982	0.980	0.049

The modified CFA model for the HSMA implementation construct will be used to compare the three HSMA types in the next section.

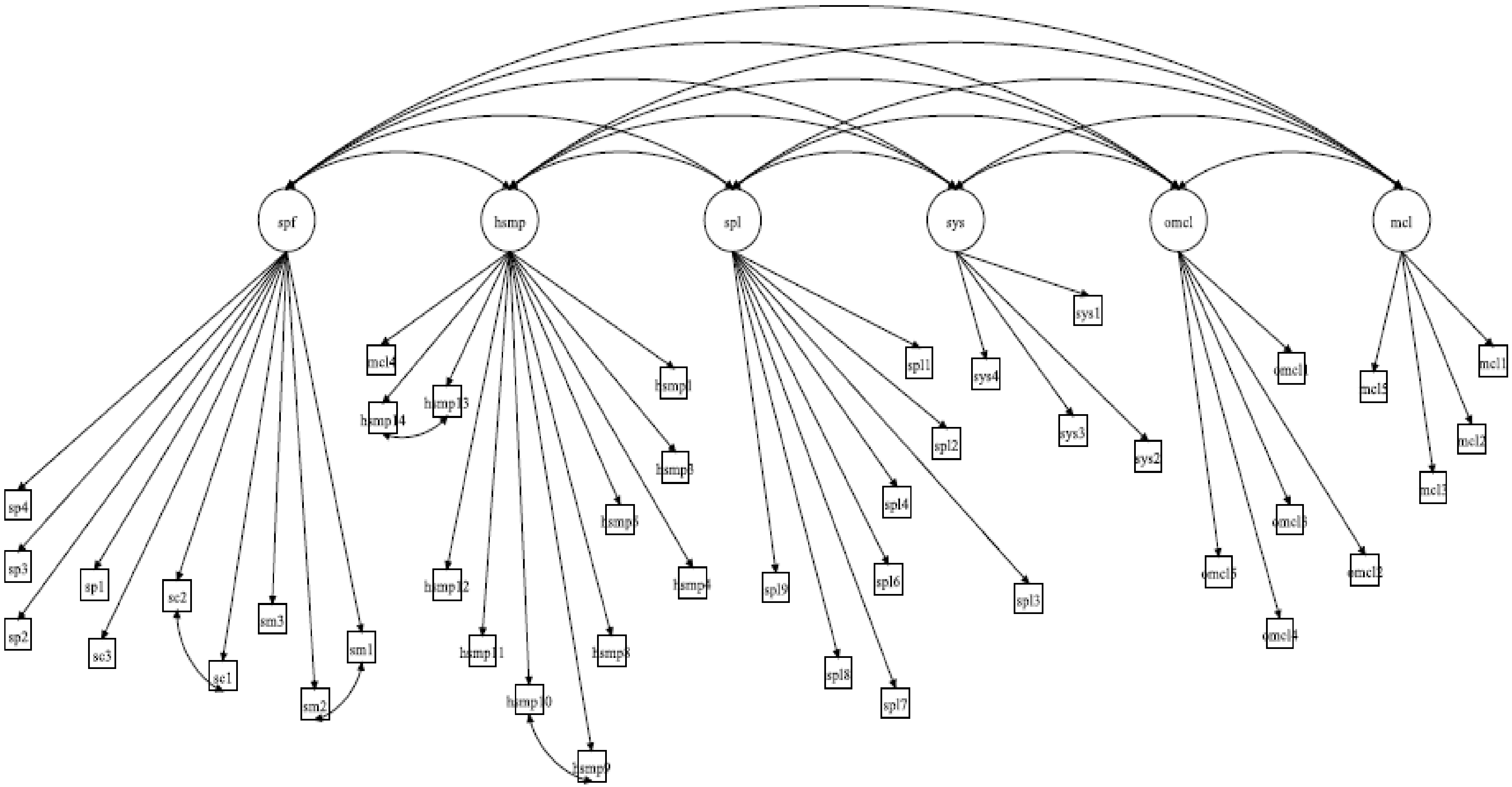

Figure 19: Modified factor structure model for the HSMA implementation construct

7.4.3 Group comparison

A multiple indicator multiple cause (MIMIC) model is employed to explore the differences in the level employee perception of HSMA implementation between the three groups. A MIMIC model is a type of structural equation model suitable for conducting group comparisons and differential item functioning (DIF) tests by integrating causal (observed exogenous) variables with a confirmatory factor analysis (CFA) model (Macintosh et al. 2003; Woods 2009). The small sample size of the three groups (Type1, Type2 and Type3) which is less than 100 in each case and the ordinal nature of the data, make the MIMIC model a preferred option for conducting group comparison in this study, as other methods such as multiple group invariance models require relatively large sample sizes (Woods 2009).

The MIMIC model estimated here examines the relationship between HSMA type and the six CFA model factors. Three different models are estimated to enable a comparison of the three HSMA types:

- Case 1 - HSMA type (0 = non-type2, 1 = type1)
- Case 2 - HSMA type (0 = non-type3, 1 = type1)
- Case 3 - HSMA type (0 = non-type3, 1 = type2)

The resultant MIMIC models show how each HSMA type performs against another. The model fit indices presented in Table 15 show that the MIMIC models have good fit to the data. Remember the recommended model-fit indices that indicate an acceptable model are: values greater than 0.90 for CFI and TLI and less than 0.08 for RMSEA and ratio of χ^2 (chi-square) to the degree of freedom less than 3 (Hu & Bentler 1999; Wen Lim et al. 2018).

Table 15: Model fit indices for MIMIC model

Model	χ^2	**df**	χ^2**/df**	***p***	**CFI**	**TLI**	**RSMEA**
Case 1	1606	878	1.89	<0.0000	0.944	0.940	0.071
Case 2	1594	878	1.81	<0.0000	0.961	0.958	0.065
Case 3	1330	878	1.51	<0.0000	0.961	0.958	0.055

Table 16 shows the path coefficients for the effect of the covariate (HSMA type) on the six factors in the MIMIC model.

Table 16: MIMIC model results

HSMA Implementation Dimension	Covariates	Coefficient Estimates (CE)	S.E.	CE/S.E.	P values
		CASE 1 (Type1 against Type2)			
MCL	Type1	-0.111	0.086	-1.280	0.201
OMCL	Type1	0.073	0.083	0.881	0.378
SYS	Type1	-0.087	-0.087	-0.993	0.321
SPL	Type1	-0.205	0.078	-2.612	0.009
HSMP	Type1	-0.044	0.084	-0.528	0.598
SBF	Type1	-0.013	0.084	-0.156	0.876
		CASE 2 (Type1 against Type3)			
MCL	Type1	-0.264	0.080	-3.292	0.001
OMCL	Type1	-0.011	0.081	-0.139	0.889
SYS	Type1	-0.303	0.076	-4.006	0.000
SPL	Type1	-0.339	0.070	-4.862	0.000
HSMP	Type1	-0.233	0.077	-3.022	0.003
SBF	Type1	0.007	0.081	0.087	0.931
		CASE 3 (Type2 against Type3)			
MCL	Type2	-0.131	0.085	-1.539	0.124
OMCL	Type2	-0.097	0.082	-1.183	0.237
SYS	Type2	-0.255	0.079	-3.213	0.001
SPL	Type2	-0.182	0.081	2.259	0.024
HSMP	Type2	-0.201	0.077	-2.614	0.009
SBF	Type2	0.019	0.082	0.238	0.812

The interpretation of the results is discussed in terms of the coefficient estimates and the P-values. The results are interpreted in terms of the magnitude and sign of the coefficient estimates and P-values less than 0.05 (indicating a 95% significance level).

A comparison of the results for the three cases show that top management leadership is perceived least positively at Type1 contractor organisations and most positively at Type3 organisations. However, the difference in perception is not statistically significant in the comparison between Type2 and Type3 contractor organisations, as well as between Type1 and Type2 contractor organisations. Statistically significant difference is observed between Type3 and Type1 contractor organisations. This result is consistent with the findings in chapter six (section 6.4) were Type3 contractor organisations were observed to be more likely to have in place procedures that enabled effective top management commitment and leadership to H&S management relative to Type2 and Type1 contractor organisations.

In terms of operational managers' leadership, no statistically significant difference was observed in workers perception between the three groups. However, the sign of the coefficients suggest that it is slightly more positive at Type3 contractor organisations, followed by Type1 contractor organisations and least positive at Type2 contractor organisations. This result supports the observation made in chapter four (section 4.4), where weak supervisory capacity and H&S competencies of operational managers in the industry were highlighted in the interview cases as challenges to effective H&S management in the industry.

The adequacy of systems for managing H&S was perceived most positively at Type3 contractor organisations compared to the other two groups. No statistical difference was observed between Type2 and Type1 contractor organisations in terms of adequacy of health and safety management systems. This result suggests that the framework provided by management system standards such as OHSAS 18001

Leadership by safety professionals was perceived more positively at Type3 contractor organisations compared to the other two groups. This is followed by Type2 contractor organisations and least positively at Type1 contractor organisations. This result is consistent with the observations in chapter four where the position of the safety professional in the organisational hierarchy was a key distinguishing feature between the three HSMA types. At Type3 contractor organisations, safety professionals were appointed in senior management cadre with significant authority and influence to discharge their H&S responsibilities. At Type2 contractor organisations safety professional occupied middle management positions with limited decision-making powers, while at Type1 contractor organisations. Safety professionals were external to the organisation.

In terms of health and safety management practices, it was perceived most positively at Type3 contractor organisations compared to the other two. No statistical difference was observed between Type2 and Type1 contractor organisations. The theoretical framework presented in chapter five (sections 5.3 and 5.6.1) showed that health and safety management practices within an organisation are shaped by the strategically developed policies and procedures that characterise the organisation's HSMA. With this understanding, worker's perception of this factor can be considered a barometer through which the effectiveness of the strategically developed component of a HSMA may be assessed.

In terms of safety behaviour, no statistically significant difference was observed between the three groups even though the sign of the coefficients suggest that Type2 contractor organisation witnessed better safety behaviour compared to the other two groups.

A summary of the results show that Type3 contractor organisations outperform the other groups in terms of workers perception of top management leadership, adequacy of system in place for managing health and safety, safety professionals' leadership, and health and safety management practices. No statistical difference is however, observed between the three groups in terms of operational managers' leadership and safety behaviour of workers.

Having established the differences in performance between the three HSMA types in terms of their implementation component, the next section will explore the cause effect-relationship between the six factors that constitute the HSMA implementation construct.

7.4.4 Relationship between HSMS implementation factors

A path analysis was conducted to examine the direction of the assumed relationships between the six latent variables that make up the HSMA implementation construct. The path analysis tested the following hypotheses:

H1: Top management leadership (MCL) positively affect operational manager leadership (OMCL).

H2: Safety professionals' leadership (SPL) positively affect operational manager leadership (OMCL).

H3: Top management leadership (MCL) positively affect health and safety management practices (HSMP).

H4: Safety professionals' leadership (SPL) positively affect health and safety management practices (HSMP).

H5: Operational manager leadership (OMCL) positively affect health and safety management practices (HSMP).

H6: Top management leadership (MCL) positively affect safety behaviour of workers (SBF).

H7: Safety professionals' leadership (SPL) positively affect safety behaviour of workers (SBF).

H8: Operational manager leadership (OMCL) positively affect safety behaviour of workers (SBF).

H9: Top management leadership (MCL) positively affect systems for health and safety management (SYS).

H10: Safety professionals' leadership (SPL) positively affect systems for health and safety management (SYS).

The model fit indices show that the path analysis model has good fit to the data: chi-square = 1750 (df = 842); RMSEA = 0.064; CFI = 0.959; TLI 0.956. Remember the recommended model-fit indices that indicate an acceptable model are: values greater than 0.90 for CFI and TLI and less than 0.08 for RMSEA and ratio of χ^2 (chi-square) to the degree of freedom less than 3 (Hu & Bentler 1999; Wen Lim et al. 2018). Figure

20 depicts the path analysis model pictorially and Figure 21 shows only the statistically significant path arrows for the same model. Table 17 presents the standardised path coefficients for the analysis.

Table 17: Standardised path coefficients from path analysis

Effects	Standardised Path coefficients (SPC)	Standard Error (S.E.)	SPC/S.E.	P-value
H1: MCL on OMCL	1.032	0.047	21.967	0.0000
H2: SPL on OMCL	-0.294	0.064	-4.564	0.0000
H3: MCL on HSMP	0.069	0.131	0.529	0.597
H4: SPL on HSMP	0.675	0.062	10.799	0.0000
H5: OMCL on HSMP	0.321	0.099	3.231	0.001
H6: MCL on SBF	-0.277	0.226	-1.222	0.222
H7: SPL on SBF	0.346	0.101	3.428	0.001
H8: OMCL on SBF	0.605	0.166	3.654	0.0000
H9: MCL on SYS	0.761	0.055	13.906	0.0000
H10: SPL on SYS	0.182	0.061	3.004	0.003

The interpretation of the results is discussed in terms of the standardised path coefficients and the P-values. The results are interpreted in terms of the magnitude and sign of the standardised path coefficients and P-values less than 0.05 (indicating a 95% significance level).

Results from the path analysis show that top management leadership had no significant direct effect on health and safety management practices and safety behaviour of workers. Therefore, Hypotheses H3 and H6 are rejected. The direct effect of safety professionals' leadership on operational managers' leadership was found to be negative and not positive as hypothesised, therefore, hypothesis H2 is rejected.

Safety professionals' leadership is observed to have a greater positive effect on health and safety management practices when compared to operational managers' leadership and top management leadership. Operational managers' leadership had a greater positive effect on safety behaviour of workers when compared to safety professionals' leadership. Top management leadership is observed to have the greater positive effect on the adequacy of systems for health and safety management when compared to safety professionals' leadership.

Even though top management leadership is observed not to have a significant direct effect on health and safety management practices and safety behaviour of workers, a positive indirect is observed through operational managers' leadership. The indirect effects of top management leadership on health and safety management practices and safety behaviour are presented in Table 18.

Table 18: Indirect effects of top management leadership

Effect	Indirect effect Via	Indirect effect	p-value
On HSMP			
Of MCL	OMCL	0.331	0.0009
On SBF			
Of MCL	OMCL	0.624	0.0003

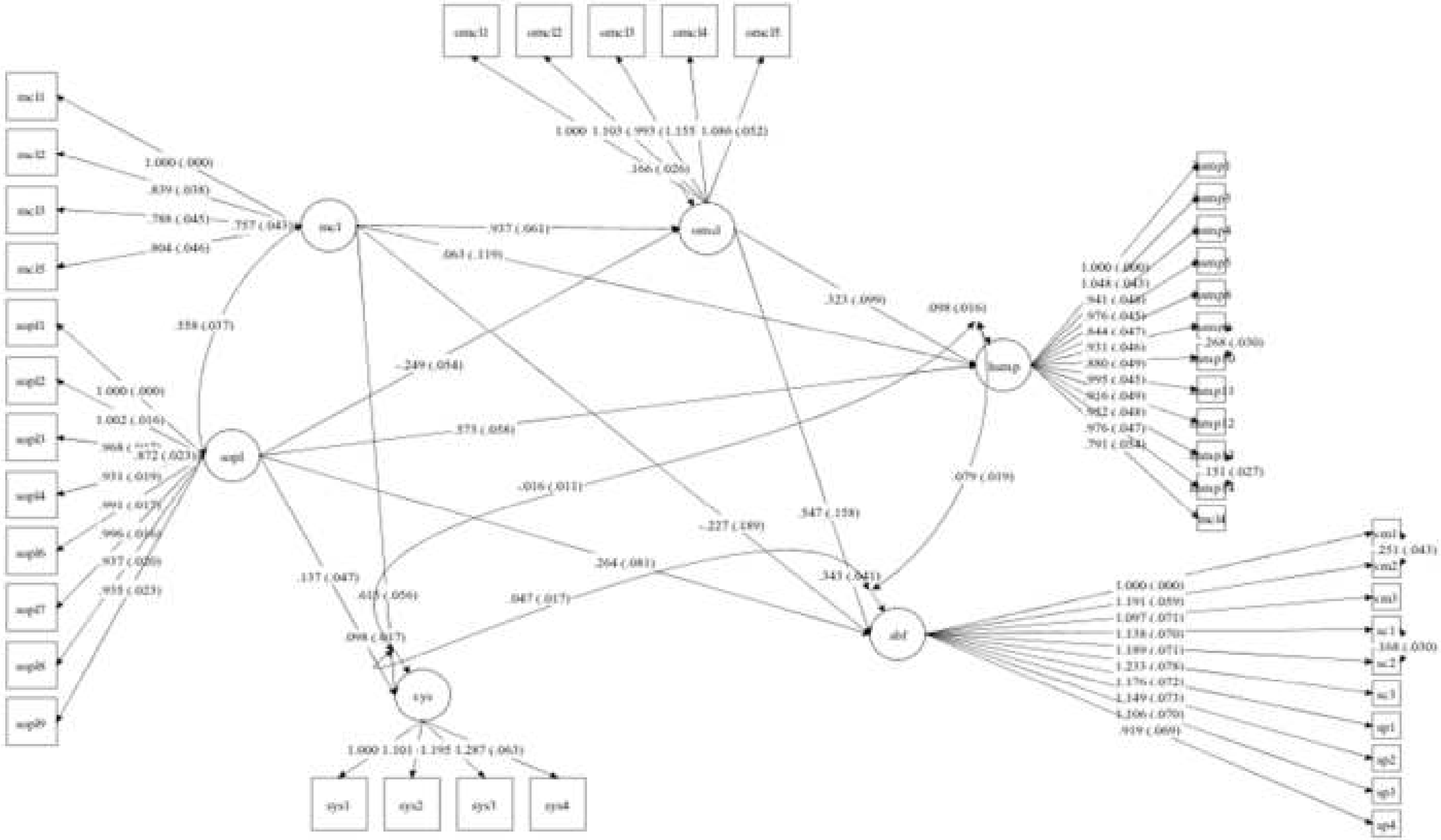

Figure 20: Path analysis model

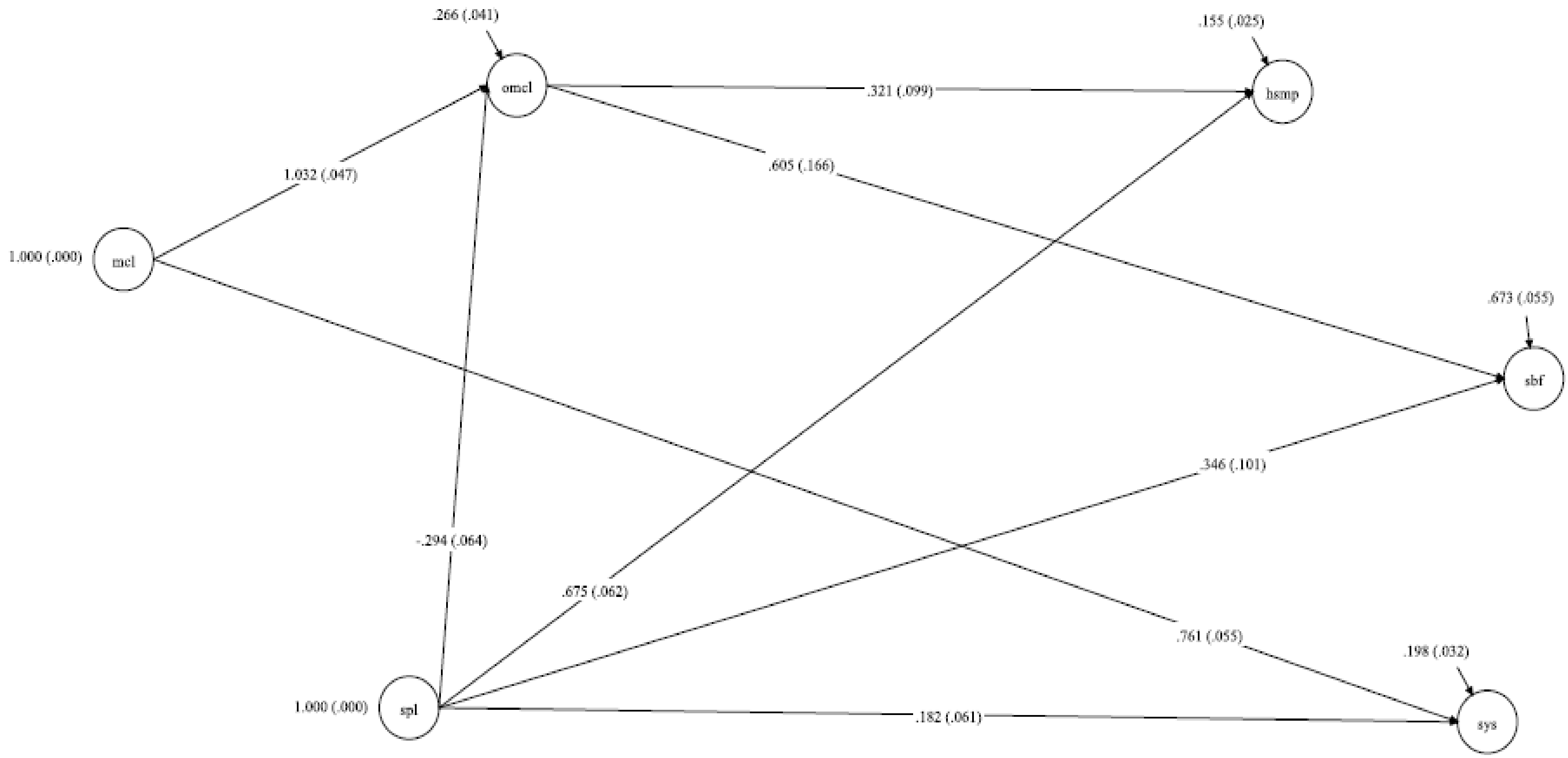

Figure 21: Path analysis model showing only statistically significant paths

7.5 Discussion

The results from the group comparison and the path analysis models confirm that safety professionals' leadership and operational managers' leadership are critical factors that shape health and safety management practices and workers behaviour among contractors. Top management leadership is confirmed to be critical to putting in place adequate systems for health and safety management.

An interesting observation from the results is that as safety professionals' leadership increases, operational managers' leadership decrease. This finding is supported by findings from the evaluation of the strategically developed component of HSMA types presented in chapter 6. There it was observed that HSMA types characterised by safety professionals occupying top management positions and wielding significant influence, performed poorly in terms of defined H&S responsibilities for operational managers. In contrast, HSMA types characterised by safety professionals occupying middle management positions with limited decision-making powers, or who are external to the organisation, performed better in terms of defined H&S responsibilities for operational managers. Limited influence of safety professionals in Type2 and Type1 contractor organisations is noted to be accompanied by operational managers with greater health and safety management functions and responsibilities. The presence of full-time safety professionals at Type3 contractor organisation is accompanied by operational managers with less health and safety management functions and responsibilities. The findings indicate an opportunity for contractor organisations to achieve greater safety performance by optimising both safety professionals' leadership and operational managers' leadership dimensions.

The absence of significant direct influence by top management leadership on health and safety management practices and safety behaviour, but an indirect influence through operational managers' leadership, reflect the significance of defined H&S management responsibilities for operational managers as an effective strategy for improving HSMA implementation. This finding is logical because while top management are often separated from frontline workers by organisational bureaucracies, operational managers interact daily with frontline workers and are uniquely positioned to model desirable safety behaviour and to ensure the execution of strategically developed policies and procedures (Sheehan et al. 2016; Wu et al. 2010).

In summary, the superior performance of Type3 contractor organisations over the other two groups in terms of health and safety management practices can be explained by its superior performance in terms of top management leadership and of safety professionals' leadership.

The absence of any significant difference in the safety behaviour of workers between the three groups can be perhaps be explained in part by the absence of any significance difference in operational managers' leadership between the three groups.

7.6 Chapter Conclusion

The aim of this chapter was to understand the differences in the implementation component of the three HSMA types and to demonstrate the relationships between the hypothesised factors that make up the HSMA implementation construct. Through a CFA, a six-factor structure was established to best describe the HSMA implementation construct, namely: (1) Top management leadership, (2) operational manager leadership, (3) Safety professionals' leadership, (4) systems for health and safety management, (5) health and safety management practices and (6) Safety behaviour. The results from the CFA supported the merging of three factors – safety compliance, safety motivation and safety participation into a single factor – safety behaviour factor. This reduced the number of factors describing the HSMA implementation construct from eight to six.

A group comparison between the three HSMA types using a MIMIC model revealed that Type3 contractor organisations outperform Type1 and Type2 contractor organisations in the areas of top management leadership, safety professionals' leadership, adequacy of systems for health and safety management and health and safety management practices. No significant difference was however, observed between the three HSMA types in terms of operational managers' leadership and safety behaviour of workers.

The path analysis conducted helped to explain the nuances in the performances of the three groups in terms of the HSMA implementation component. Health and safety management practices factor is found to be most influenced by safety professionals' leadership followed by operational managers' leadership, while safety behaviour of workers is most influenced by operational managers' leadership. Top management leadership is found to have no direct influence on health and safety management practice and safety behaviour of worker, but an indirect influenced mediated by operational managers' leadership.

The findings from this chapter indicate an opportunity for contractor organisations to achieve high HSMA implementation by optimizing safety professionals' leadership and operational managers' leadership factors.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

This dissertation adopted a holistic organisational perspective to answering the question: How do construction contractor organisations in South Africa manage health and safety and how effective are their health and safety management arrangements? The answers to this question are pertinent to identifying the areas of strength and weakness in the health and safety management efforts of construction contractor organisations in South Africa. The answers also provide insight into the effect-relationships between contextual and organisational factors that explain the identified areas strength and weakness. It is believed that this study provides a framework through which future research works can begin to engage construction safety from an organisational perspective.

Subcontracting practices, defined health and safety management roles and responsibilities for operational managers, leadership and commitment from top management, resource allocation, as well as the position of the safety professional within the organisational hierarchy are identified as factors that have the most defining influence on the health and safety management arrangement, practices and behaviour of frontline workers within construction contractor organisations in South Africa. This study had three main objectives, and the key conclusions draw from the study are presented in terms of these objectives below.

8.1.1 Conclusions in relation to research objective one

The first objective of this study was to construct a typology that groups the broad spectrum of health and safety management arrangements (HSMA) within the South African construction industry into types. Evidence from the data collected in this study supports the conclusion that the broad spectrum of health and safety management arrangements within medium to large size contractor organisations in South Africa can be grouped into three distinct types:

a. Traditional/compliance motivated HSMA - Type1.
b. Systematic/compliance motivated HSMA – Type2.
c. Systems/best practice motivated HSMA - Type3.

A traditional/compliance motivated H&S management arrangement is characterised chiefly by the outsourcing of H&S management responsibilities to external H&S management consultant. These H&S safety consultants provide advisory and administrative support for health and safety management within these organisations. This HSMA was observed predominantly among building contractors who operate as subcontractors to larger contractors.

A systematic/compliance motivated H&S management arrangement is characterised by the presence of internal H&S competencies and organisational structures to carry out H&S management functions and responsibilities. The H&S management programs and activities within these organisations are home grown and dictated by legislative requirements. This HSMA was observed predominantly among specialist contractors operating in both the building and civil construction markets.

System/best practice motivated H&S management arrangements are characterised by H&S management activities modelled after the requirements of OHSAS 18001 management system standard. This H&S management arrangement is highly formalised and documented. This is the predominant HSMA among large principal contractor operating mainly in the civil construction market.

The H&S legislative framework and supply chain pressure constitute institutional environmental factors that inform the choice of health and safety management arrangement adopted by construction contractors in South Africa. Large contractors who work for reputable public and private sector clients have an added incentive to adopt health and safety management best practices embodied by the requirements of health and safety management system standards such as ISO45001 and OHSAS18001. These large contractor organisations in turn through their supply chain requirements influence the health and safety management arrangement adopted by their subcontractors.

8.1.2 Conclusions in relation to research objective two

The second objective of this study was to compare the effectiveness of the identified health and safety management arrangements. Across the three HSMA types, critical deficiencies were identified in three main areas:

1. Management of subcontractors.
2. Accountability and incentive mechanisms that encourage the participation of workers in H&S management activities.

3. Workers competency and training.

The prevalence of subcontracting within the local construction industry makes the management of subcontractors an important health and safety management component, to avoid the fragmentation of health and safety management interventions on projects. In terms of managing subcontractors, the study showed that the focus of principal contractors is on avoiding legal liabilities by demonstrating compliance through documentation and audits. Less emphasis is placed on integrating the health and safety management procedures and processes of subcontractors with those of the principal contractor. This approach to subcontractor management yields no positive results in terms of developing the health and safety management capacity of emerging subcontractors particularly in the building construction segment of the industry.

Incentives and mechanisms that encourage employee participation in health and safety related activities are critical to cultivating safety culture within organisations. Across the three HSMA types, no statistically significant difference was observed in the health and safety related behaviour of workers in term motivation, compliance and voluntary participation. This suggests the absence of distinct safety cultures within the contractor organisations sampled in this study.

Previous studies have highlighted the lack of safety culture within contractor organisations in South Africa. In this study, high worker mobility occasioned by the prevalence of precarious employment contracts of short duration, and low health and safety competency levels of operational mangers and artisan workers are identified as factors hampering the cultivation of safety culture within construction contractor organisations in South Africa. Inadequate financial resource allocation to occupational health and safety training of frontline artisan workers by construction contractor organisations, and the absence of a standardised national curriculum and framework for providing basic health and safety training are identified as the two major factors responsible for the low levels of health and safety competencies in the industry.

From the interviews conducted, under-estimating the cost of health and safety management on construction tenders to gain competitive advantage is a common feature of the construction industry in South Africa. This situation is created by the absence of a standardised framework for pricing health and safety on most construction tenders, and cost-based contractor selection processes within the industry. Inadequate compensation for health and safety management negatively impact the capacity of construction contractors to deploy the required equipment and allocate sufficient resources to workers' training and other measures necessary for proactive health and safety management on projects and within their organisations.

8.1.3 Conclusions in relation to research objective three

The third objective of this study was to investigate the effect-relationships between factors that accounted for differences between the three HSMA types. The majority of organisations sampled in this study had in place organisational policies for health and safety management. This supports the conclusion that there is a high level of health and safety awareness among construction contractors in South Africa. However, the capacity to implement these policies is observed to vary between the three HSMA types. Four significant findings are worth emphasising:

1. Top management commitment and leadership was identified as the most critical factor in building systems that support effective health and safety management within contractor organisations.
2. Top management commitment and leadership has no direct positive effect on the health and safety management practices and behaviours of frontline workers. However, the effect of top management commitment and leadership on health and safety management practices and workers' behaviour is mediated by leadership by safety professionals and operational managers.
3. Leadership by safety professionals has the most positive impact on the health and safety management practices of contractor organisations.
4. Leadership by operational managers has the most positive impact on the health and safety related behaviour of workers.

These effect-relationships adequately explain the areas of strengths and weaknesses associated with each HSMA types. Superior top management leadership and bureaucratic controls at Type3 contractor organisations significantly explain their strength in health and safety management dimensions such as: health and safety communication, health and safety controls and reporting, accountability mechanisms, and health and safety management practices relative to the Type2 and Type1 contractor organisations.

Another important observation from the study is the negative effect-relationship between leadership by safety professionals and leadership by operational managers.

An increase in leadership by safety professionals was accompanied by a decline in leadership by operational managers and vice versa within the contractor organisations sampled. Type1 and Type2 contractor organisations are characterised by strong leadership by operational managers and weak leadership by safety professionals, the opposite is the case at Type3 contractor organisations. Type1 and Type2 contractor organisations are therefore, often unable to translate their health and safety management policies into effective health and safety management practices due to the absence of strong leadership by safety professional. At Type3 contractor organisations, the developed policies, procedures and practices do not significantly impact the behaviour of frontline workers due to the absence of strong leadership from operational managers.

8.2 Limitations of this Study

The interpretation of findings presented in this dissertation should be considered with the known limitations of the study. Two questionnaire surveys were conducted in this study, the first was at the level of the organisation and the second was at the level of the construction worker. The sample for both surveys was limited to grade 7 to 9 *cidb* registered contractor organisations and their workers in South Africa. The restriction of the sample population might have resulted in selection bias, because it excludes medium to large contractor organisations not registered with the *cidb* that may not adhere to the same regulatory standards.

The low response rate of the organisational level survey reported in chapter six presented a threat to the validity of study. This pattern of response rate is however, typical of construction safety studies and is considered satisfactory in view of the fact that the construction industry in South Africa has a reputation of reluctance to participate in questionnaire surveys (Ugwu & Haupt 2007). The low response rate is believed to have no significant impact on the validity of the findings, because the response did represent the three sample groups of interest. Also, the amount of data collected was sufficient for the data analysis technique used.

The number of responses received from the worker level survey reported in chapter seven was above 200, and this is considered sufficient to maintain statistical power for the structural equation modelling (SEM) analysis conducted considering the degree of freedom of the models analysed.

A third limitation to this study is the representation of only construction workers in the western Cape of South Africa in the worker level survey reported in chapter seven, which excludes the experience of construction workers in other provinces in the country. This limits the geographical extent of the findings of the study. Cost and time constraint limited the ability of the researcher to survey construction workers in other provinces in South Africa. Nevertheless, grade 7 to 9 contractors generally operate across South Africa and their systems and procedures apply country wide. The organisational level survey however, cover contractor organisations across the country because of the use of electronic survey tools to distribute the questionnaires.

8.3 Contribution to Knowledge

Most previous studies in the construction safety research domain have adopted a project focused perspective in their attempts to investigate reasons for poor safety performance in the construction industry. Previous studies have also sought to assess the effectiveness of health and safety management interventions using lagging indicators in the form of accident statistics with significant limitations in terms of understanding cause-effect relationships.

The uniqueness of this study is the adoption of a holistic organisational perspective to the investigation of health and safety management strategies adopted by construction contractors in South Africa. The application of the multilevel and strategic management model proposed by Yorio et al. (2015) to evaluate safety performance in this study is also a new contribution that allows for the evaluation of safety performance in terms of the strategically developed policies and procedures and its implementation components.

The major contributions of this study to the knowledge on construction safety are discussed in relation to academic research and benefit to industry. From the perspective of academic research, the following are the contributions to knowledge from this study:

1. By applying multilevel and strategic management theory, this study introduces a novel approach that is distinct from the use of lagging indicators to compare the effectiveness of the identified health and safety management arrangements in terms of their strategically developed policies and procedures, as well as their implementation. This approach revealed areas of strengths and weaknesses associated with each health and safety management arrangement type.

2. This study presents insightful observations on the health and safety management efforts of construction contractor organisations in the context of a developing country in sub-Saharan Africa, a research context that is under-represented in the health and safety management research domain.

From the perspective of benefit to industry, the following contributions are noteworthy:

1. This study identified areas of general weakness in the health and safety management efforts of construction contractors in South Africa. These are areas where there are opportunities for improvement across the industry.
2. The study reveals an opportunity to improve health and safety practices and workers' behaviour across the three health and safety management arrangement types by optimising leadership by safety professionals and operational managers within construction contractor organisations.

8.4 Recommendations

This study provides evidence of challenges to effective health and safety management within construction contractor organisations in South Africa and their impact on the safety performance of the industry. Based on the findings and conclusions reached in this study, the following recommendations are made for future studies and to improve health and safety management within the construction industry in South Africa:

1. The categorisation framework developed in this study only considered information obtained from medium to large size contractor organisations. Future studies should consider expanding this framework to accommodate the characteristics of organisational health and safety management interventions at small contractor organisations. This is expected to yield a more complete categorisation of health and safety management arrangements within contractor organisations.
2. This study was unable to survey construction workers in other provinces in South Africa, this is an identified limitation in terms of the generalisability of some findings. The generalisability of the findings from this study can therefore, be improved in future studies by capturing the perception of construction workers in other provinces in South Africa.
3. The introduction of multilevel and strategic management perspective in evaluating the efficacy of each HSMA types allowed for a more detailed interrogation of several health and safety management dimensions. This is

considered more valuable than the use of accident statistics as it allowed for the identification of areas of weakness and strength for each HSMA type as well as effect-relationships between the several factors identified to impact safety performance. This theoretical perspective however, did not allow for the comparison of the three HSMAs using one omnibus quantitative score that rates one HSMA type over another. This is considered a next-step for future studies.

4. The measurement scales used in this study to measure the strategically developed and implementation components of a HSMA could be refined to develop a measurement index that assesses the performance of the health and safety management arrangement of an organisation. A measurement index of this nature will be more useful to the local industry compared to accident statistics which is prone to under-reporting and provides no information that aids continuous improvement efforts.
5. The absence of an industry wide framework for pricing the cost of H&S and fairly adjudicating construction tenders permits price-based competition among construction contractors. This has a negative impact on health and safety management effort within the construction industry in South Africa. It is recommended that employer associations such as the South African Federation of Civil Engineering Contractors (SAFCEC) and the Master Builders Association (MBA) collaborate with the industry regulators and clients' organisations to develop a framework for the just and efficient costing of health and safety management requirements in tender documents.
6. Subcontractor organisations of Type1 should endeavour to provide for the cost of health and safety management in their rates to principal contractors and engage the services of a full-time health and safety management professional within their employment.
7. This study has identified a scarcity of suitably qualified and registered health and safety professionals in South Africa. Concerted efforts should be made by stakeholders such as Department of Labour, employer associations, tertiary education institutions, the Engineering Council of South Africa (ECSA), and the South Africa Council for the Project and Construction Management Professions (SACPCMP) to facilitate the training and accreditation of health and safety professionals to meet the needs of the construction industry.

8. A framework for training and certifying competence in the area of health and safety management for all construction workers in South Africa is needed. This should be considered against the backdrop of the low level of literacy of many construction workers which impacts their attitude to and perception of occupational health and safety risks. It is recommended that stakeholders including the Department of Labour, the SACPCMP, tertiary education institutions and labour unions facilitate the development of a suitable curriculum.
9. Employer Associations and the Construction Education Training Authority (CETA) will be required to make available financial resources to enable the training of all workers within their employment, including those with limited duration employment contracts.
10. Efforts should be made by the relevant regulators of the construction industry and the labour unions to limit the occurrence of precarious temporary employment contracts of short duration within the local construction industry.
11. Employer associations and construction contractor organisations in general should put in place managerial initiatives that assign responsibilities and engender greater participation of operational managers in the health and safety management activities within their organisations.
12. Principal contractors should improve their systems by putting in place mechanisms to more efficiently manage the health and safety of their subcontractors. Such mechanisms should in addition to satisfying legislation mandated documentation and audits, track and demand demonstrated improvements in health and safety performance.
13. Contractor organisations should adopt a policy of having in place an annual budget for funding proactive health and safety management interventions including purchase of equipment and health and safety training.

References

Agumba, J.N. & Haupt, T., 2009a. Construction Health and Saftey Culture in South African Small and Medium Enterprises. In *Built Environment Conference*. LivingStone, Zambia: Southern Africa Build Environment Research Centre (SABERC).

Agumba, J.N. & Haupt, T., 2009b. Evaluating management commitment to health and safety in small and medium construction enterprises. , pp.323–333.

Al-Refaie, A., 2013. Factors affect companies' safety performance in Jordan using structural equation modeling. *Safety Science*, 57, pp.169–178.

Alhajeri, M., 2011. *HEALTH AND SAFE TY IN THE CONSTRUCTION INDUSTRY: CHALLENGES AND SOLUTIONS IN THE UAE*. Coventry University.

Anaman, K.A. & Osei-Amponsah, C., 2007. Analysis of the causality links between the growth of the construction industry and the growth of the macroeconomy in Ghana. *Construction Management and Economics*, 25(9), pp.951–961.

Arocena, P. & Núñez, I., 2010. An empirical analysis of the effectiveness of occupational health and safety management systems in SMEs. *International small business journal*, 28(4), pp.398–419.

Australia, S. & Zealand, S.A. and S.N., 2001. AS/NZS 4808: occupational health and safety management systems - general guidelines on principles, systems and supporting techniques. *Standards Australia; Standards New Zealand, Homenush (NSW); Wellington*, Standards.

Awolusi, I.G. & Marks, E.D., 2016. Safety Activity Analysis Framework to Evaluate Safety Performance in Construction. *Journal of Construction Engineering and Management*, 143(3), p.5016022.

Awwad, R., El Souki, O. & Jabbour, M., 2016. Construction safety practices and challenges in a Middle Eastern developing country. *Safety Science*, 83, pp.1–11.

Blair, E.H., 1999. Which competencies are most important for safety managers? *Professional Safety*, pp.28–32.

Bluff, L., 2003. Systematic management of occupational health and safety. *National Research Centre for Occupational Health and Safety Regulation, Regulatory Institutions Network, Research School of Social Sciences, Australian National University*.

Booth, R.T. & Lee, T.R., 1995. The Role of Human Factors and Safety Culture in Safety Management. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 209(5), pp.393–400.

Bottani, E., Monica, L. & Vignali, G., 2009. Safety management systems: Performance differences between adopters and non-adopters. *Safety Science*, 47(2), pp.155–162.

British Standards Institution, 2007. OHSAS 18001:2007. Occupational health and safety management systems – Requirements. , Standards, p.34.

Van Can, V., 2013. Estimation of travel mode choice for domestic tourists to Nha Trang using the multinomial probit model. *TRANSPORTATION RESEARCH PART A*, 49, pp.149–159.

Champoux, D. & Brun, J.-P., 2003. Occupational health and safety management in small size enterprises: an overview of the situation and avenues for intervention and research. *Safety Science*, 41(4), pp.301–318.

Cheyne, A. et al., 1998. Modelling safety climate in the prediction of levels of safety activity. *WORK & STRESS*, 12(3), pp.255–271.

Chinda, T. & Mohamed, S., 2008. Structural equation model of construction safety culture. *Engineering, Construction and Architectural Management*, 15(2), pp.114–131.

Choudhry, R.M., 2014. Behavior-based safety on construction sites: A case study. *Accident Analysis and Prevention*, 70, pp.14–23.

Choudhry, R.M. & Fang, D., 2008. Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Construction Safety*, 46(4), pp.566–584.

Choudhry, R.M., Fang, D. & Mohamed, S., 2007. Developing a model of construction safety culture. *Journal of Management in Engineering*, 23(4), pp.207–212.

cidb, 2017a. *CIDB CONSTRUCTION MONITOR – SUPPLY AND DEMAND; APRIL 2017*, Pretoria.

cidb, 2009. *Construction Health and Safety in South Africa: Status and Recommendations*,

cidb, 2015a. *Construction Monitor - Employment Q3 2015*, Pretoria.

cidb, 2017b. *CONSTRUCTION MONITOR Employment Q3 2017*, Pretoria.

cidb, 2015b. *Labour and work conditions in the South African Construction Industry; Status and Recommendations*, Pretoria.

cidb, 2013. *Subcontracting in the south african construction industry; opportunities for development*, Pretoria.

Clark P, V.L.C.J. et al., 2007. *Designing and Conducting Mixed Methods Research*,

Clarke, S., 2006. The relationship between safety climate and safety performance: A meta-analytic review. *Journal of Occupational Health Psychology*, 11(4), pp.315–327.

Cooper Ph.D., M.D., 2000. Towards a model of safety culture. *Safety Science*, 36(2), pp.111–136.

Costella, M.F., Saurin, T.A. & de Macedo Guimarães, L.B., 2009. A method for assessing health and safety management systems from the resilience engineering perspective. *Safety Science*, 47(8), pp.1056–1067.

Cox, S. & Jones, B., 2006. Behavioural Safety and Accident Prevention. *Process Safety and Environmental Protection*, 84(3), pp.164–170.

Creswell, J.W., 2013. Qualitative inquiry and research design: choosing among five approaches. *Qualitative Inquiry and Research Design*, p.448.

Creswell, J.W. et al., 2007. Qualitative Research Designs: Selection and Implementation. *The Counseling Psychologist*, 35(2), pp.236–264.

Dalrymple, H. et al., 1998. Occupational health and safety management systems: review and analysis of international, national, and regional systems and proposals for a new international document. *International Labour Office, Geneva*.

DeJoy, D.M., 2005. Behavior change versus culture change: Divergent approaches to managing workplace safety. *Safety Science*, 43(2), pp.105–129.

Denzin, N.K., 2012. Triangulation 2.0 Contesting Mixed Methods Experimentalism. *Articles Journal of Mixed Methods Research*, 6(2), pp.80–88.

Dharmapalan, V. et al., 2014. Quantification and assessment of safety risk in the design of multistory buildings. *Journal of Construction Engineering and Management*, 141(4).

Dion, P.A., 2008. Interpreting Structural Equation Modeling Results: A Reply to Martin and Cullen. *Journal of Business Ethics*, 83, pp.365–368.

Dow, J.K. & Endersby, J.W., 2004. Multinomial probit and multinomial logit: A comparison of choice models for voting research. *Electoral Studies*, 23, pp.107–122.

Doyle, L., Brady, A.-M. & Byrne, G., 2009. An overview of mixed methods research. *Journal of Research in Nursing*, 14(2), pp.175–185.

Doyle, L., Brady, A.M. & Byrne, G., 2016. An overview of mixed methods research – revisited. *Journal of Research in Nursing*, 21(8), pp.623–635.

Eckhardt, R., 1993. The safety professional in the corporate social structure. *Professional Safety*, 38(May), p.31.

Edwards, J.R.D., Davey, J. & Armstrong, K., 2013. Returning to the roots of culture: A review and re-conceptualisation of safety culture. *Safety Science*, 55, pp.70–80.

Emuze, F.A. & Smallwood, J.J., 2012. Construction Motor Vehicle Accidents in South Africa: Preliminary Findings. In *Proceedings of CIB W099 International Conference 2012: Modelling and Building Health and Safety*. pp. 10–11.

Fan, D. et al., 2014. Occupational health and safety issues in operations management: A systematic and citation network analysis review. *International Journal of Production Economics*, 158, pp.334–344.

Fang, D., Chen, Y. & Wong, L., 2006. Safety Climate in Construction Industry: A Case Study in Hong Kong. *Journal of Construction Engineering and Management*, 132(6), pp.573–584.

Fernández-Muñiz, B., Montes-Peón, J.M., Vázquez-Ordás, C.J., et al., 2007. Safety management system: Development and validation of a multidimensional scale. *Journal of Loss Prevention in the Process Industries*, 20(1), pp.52–68.

Fernández-Muñiz, B., Montes-Peón, J.M. & Vázquez-Ordás, C.J., 2009. Relation between occupational safety management and firm performance. *Safety Science*, 47(7), pp.980–991.

Fernández-Muñiz, B., Montes-Peón, J.M. & Vázquez-Ordás, C.J., 2007. Safety culture: Analysis of the causal relationships between its key dimensions. *Journal of Safety Research*, 38(6), pp.627–641.

Flin, R. et al., 2000. Measuring safety climate: Identifying the common features. In *Safety Science*. pp. 177–192.

Ford, M.T. & Tetrick, L.E., 2008. Safety motivation and human resource management in North America. *The International Journal of Human Resource Management*, 19(8), pp.1472–1485.

Frick, K. & Wren, J., 2000. Reviewing occupational health and safety management: multiple roots, diverse perspectives and ambiguous outcomes. *Systematic occupational health and safety management: Perspectives on an international development*, pp.17–42.

Fung, I.W.H., Lo, T.Y. & Tung, K.C.F., 2012. Towards a better reliability of risk assessment: development of a qualitative & quantitative risk evaluation model (Q2REM) for different trades of construction works in Hong Kong. *Accident; analysis and prevention*, 48, pp.167–84.

Gallagher, C., 2000. *Occupational Health and Safety management systems: system types and effectiveness*. Australia: Deakin University.

Gallagher, C., Rimmer, M. & Underhill, E., 2001. *Occupational Health and Safety Management Systems [electronic Resource]: A Review of Their Effectiveness in Securing Healthy and Safe Workplaces*, National Occupational Health and Safety Commission.

García Herrero, S. et al., 2002. From the traditional concept of safety management to safety integrated with quality. *Journal of Safety Research*, 33(1), pp.1–20.

Geminiani, F. & Smallwood, J.J., 2008. A critical review of the effectiveness of the Department of Labour (DoL) Occupational Health and Safety (OH&S) Inspectorate in relation to the construction industry in South Africa. *Acta Structilia: Journal for the Physical and Development Sciences*, 15(2), pp.5–28.

Gibb, A. et al., 2014. Construction accident causality: learning from different countries and differing consequences. *Construction Management and Economics*, 32(5), pp.446–459.

Gillen, M. et al., 2004. Construction managers' perceptions of construction safety practices in small and large firms: A qualitative investigation. *Work*, 23, pp.233–243.

Goh, Y.M., Love, P. & Dekker, S., 2014. Editorial for special issue – 'Systems thinking in workplace safety and health'. *Systems thinking in workplace safety and health*, 68, pp.1–4.

Greene, W.H., 2003. *Econometric Analysis*,

Griffin, M.A. & Neal, A., 2000. Perceptions of Safety at Work: A Framework for Linking Safety Climate to Safety Performance, Knowledge, and Motivation. *Journal of Occupational Health Psychology*, 5(3), pp.347–358.

Guest, G., 2007. Describing Mixed Methods Research: An Alternative to Typologies. *Journal of Mixed Methods Research*, 7(2), pp.141–151.

Haas, E.J. & Yorio, P., 2016. Exploring the state of health and safety management system performance measurement in mining organizations. *Safety Science*, 83, pp.48–58.

Hämäläinen, P., Takala, J. & Saarela, K.L., 2006. Global estimates of occupational accidents. *Safety Science*, 44(2), pp.137–156.

Hinze, J., Thurman, S., Wehle, A., et al., 2013. Leading indicators of construction safety performance. *Safety Science*, 51, pp.23–28.

Hinze, J., Thurman, S. & Wehle, A., 2013. Leading indicators of construction safety performance. *Safety Science*, 51(1), pp.23–28.

HSE, 2016. *Health and safety in construction sector in Great Britain, 2014/15*, Hsieh, H.-F. & Shannon, S.E., 2005. Three Approaches to Qualitative Content Analysis BACKGROUND ON THE DEVELOPMENT OF CONTENT ANALYSIS. *QUALITATIVE HEALTH RESEARCH*, 15(9), pp.1277–1288.

Hsu, I.-Y. et al., 2012. Analysis of business safety performance by structural equation models. *Safety Science*, 50(1), pp.1–11.

Hu, L.T. & Bentler, P.., 1999. Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives, Structural Equation Modeling. *Structural Equation Modeling*, 6(1), pp.1–55.

Huang, Y.-H. et al., 2006. Safety climate and self-reported injury: Assessing the mediating role of employee safety control. *Journal of Accident Analysis and Prevention*, 38(3), pp.425–433.

ILO, 2001. Guidelines on Occupational Safety and Health Management Systems (OHS-MS). *Information Note. International Labour Organisation Office, Geneva*, p.26.

Inan, H.U., Gul, S. & Yilmaz, H., 2017. A multiple attribute decision model to compare the firms??? occupational health and safety management perspectives. *Safety Science*, 91, pp.221–231.

Irma, V., 2009. SA construction industry’s health and safety statistics in need of revamp - CIDB. , 2015(June/27). Available at: http://www.engineeringnews.co.za/article/sa-construction-industrys-health-and-safety-statistics-in-need-of-revamp-cidb-2009-06-11/article_comments:1.

Ismail, Z., Doostdar, S. & Harun, Z., 2012. Factors influencing the implementation of a safety management system for construction sites. *Safety Science*, 50(3), pp.418–423.

Ivensky, V., 2008. Safety Risk Management of Subcontractors: What is a standard of care? *Professional Safety*, 53(1), pp.43–46.

Jacobs, E., 2010. Health and Safety in South African construction: Status Quo. In *Proceedings 5th Built Environment Conference*. p. 20.

Jick, T.D., 1979. Mixing Qualitative and Quantitative Methods: Triangulation in Action. *Source: Administrative Science Quarterly Qualitative Methodology*, 24(4), pp.602–611.

Jitwasinkul, B., Hadikusumo, B.H.W. & Memon, A.Q., 2016. A Bayesian Belief Network model of organizational factors for improving safe work behaviors in Thai construction industry.

Joffe, H. & Yardley, L., 2003. Content and thematic analysis. *Research methods for clinical and health Psychology*, pp.56–68.

Johns, G., 2006. The essential impact of context on organizational behavior. *Academy of Management Review*, 31(2), pp.386–408.

Kamardeen, I., 2013. *OHS electronic management systems for construction*, Routledge.

Kheni, N., Gibb, A. & Dainty, A., 2010. Health and Safety Management within Small- and Medium-Sized Enterprises (SMEs) in Developing Countries: Study of Contextual Influences. *Journal of Construction Engineering and Management*, 136(10), pp.1104–1115.

Kines, P. et al., 2011. Nordic Safety Climate Questionnaire (NOSACQ-50): A new tool for diagnosing occupational safety climate. *International Journal of Industrial Ergonomics*, 41, pp.634–646.

Kline, R.B., 2016. *Principles and practice of structural equation modeling*,

Koivupalo, M. et al., 2015. Health and safety management in a changing organisation: Case study global steel company. *Safety Science*, 74, pp.128–139.

Kong, S.Y., Mohd Yaacob, N. & Mohd Ariffin, A.R., 2016. Constructing a Mixed Methods Research Design: Exploration of an Architectural Intervention. *Journal of Mixed Methods Research*, pp.1–18.

Kontogiannis, T., Leva, M.C. & Balfe, N., 2017. Total Safety Management: Principles, processes and methods. *Safety Science*, 100, pp.128–142.

Kozlowski, S.W.J. & Klein, K.J., 2000. A multilevel approach to theory and research in organizations: Contextual, temporal, and emergent processes. *Multilevel theory, research and methods in organizations: Foundations, extensions, and new directions*, (October 2012), pp.3–90.

Kropko, J., 2008. *Choosing Between Multinomial Logit and Multinomial Probit Models for Analysis of Unordered Choice Data*. The University of North Carolina.

Law, W.K., Chan, A.H.S. & Pun, K.F., 2006. Prioritising the safety management elements: A hierarchical analysis for manufacturing enterprises. *Industrial management and data systems*, 106(6), pp.778–792.

Leveson, N., 2015. A systems approach to risk management through leading safety indicators. *Reliability Engineering & System Safety*, 136(0), pp.17–34.

Lin, J. & Mills, A., 2001. Measuring the occupational health and safety performance of construction companies in Australia. *Facilities*, 19(3/4), pp.131–139.

Long, J.S. & Freese, J., 2006. *Regression models for categorical dependent variables using Stata*,

Macintosh, R., Hashim, S. & Trade, E.*, 2003. Variance Estimation for Converting MIMIC Model Parameters to IRT Parameters in DIF Analysis.

Makin, A.-M. & Winder, C., 2009. Managing hazards in the workplace using organisational safety management systems: a safe place, safe person, safe systems approach. *Risk Research*, 12(3–4), pp.329–343.

Makin, A.M. & Winder, C., 2008. A new conceptual framework to improve the application of occupational health and safety management systems. *Occupational Safety and Risk at ESREL 2006*, 46(6), pp.935–948.

Mayhew, C., Quintan, M. & Ferris, R., 1997. The effects of subcontracting/outsourcing on occupational health and safety: survey evidence from four Australian industries. *Safety Science*, 25(1), pp.163–178.

McFadden, D., Train, K.E. & Tye, W.B., 1977. An application of diagnostic tests for the independence from irrelevant alternatives property of the multinomial logit model. *Transportation Research Record*.

Mearns, K., Whitaker, S.M. & Flin, R., 2003. Safety climate, safety management practice and safety performance in offshore environments. *Safety Science*, 41(8), pp.641–680.

Mitropoulos, P., Abdelhamid, T.S. & Howell, G.A., 2005. Systems model of construction accident causation. *Journal of Construction Engineering and Management*, 131(7), pp.816–825.

Mohamed, S., 1999. Empirical investigation of construction safety management activities and performance in Australia. *Safety Science*, 33(3), pp.129–142.

Mohammadfam, I. et al., 2016. Evaluation of the quality of occupational health and safety management systems based on key performance indicators in certified organizations. *Safety and Health at Work*, 8(2), pp.156–161.

Muiruri, G. & Mulinge, C., 2014. Health and Safety Management on Construction Projects Sites in Kenya A Case Study of Construction Projects in Nairobi County. In *FIG Congress. Engaging the challenges - Enhancing the relevance*. Kuala Lumpur, Malaysia.

Mulenga, N.C.F., 2014. *Explanatory model of antecedents and outcomes of health and safety climate in the South African construction industry*. Cape Town, South Africa: University of Cape Town.

Muthén, L. & Muthén, B., 2007. *Mplus User's Guide. Seventh edition.*,

Naidoo, D. et al., 2015. *SA Construction*,

Naidoo, D. et al., 2016. *SA Construction*,

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

Neal, A. & Griffin, M.A., 2006. A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of Applied Psychology*, 91(4), pp.946–953.

Neal, A. & Griffin, M.A., 2002. Safety Climate and Safety Behaviour. *Australian Journal of Management*, 27(1_suppl), pp.67–75.

Neuendorf, K.A., 2002. Defining Content Analysis. In M. Seawell et al., eds. *The Content Analysis Guidebook*. California: Sage Publications, pp. 1–31.

Ng, S.T., Cheng, K.P. & Skitmore, R.M., 2005. A framework for evaluating the safety performance of construction contractors. *Building and Environment*, 40, pp.1347–1355.

Niskanen, T., Louhelainen, K. & Hirvonen, M.L., 2016. A systems thinking approach of occupational safety and health applied in the micro-, meso- and macro-levels: A Finnish survey. *Safety Science*, 82, pp.212–227.

Nkhungulu Mulenga, C., Bagraim, J.J. & Smallwood, J., 2011. Leadership and Work pressure as predictors of Health and Safety (H&S) Behaviour in the South African Construction Industry. *Ergonomics SA*, 23(1).

Nussbeck, F.W., Eid, M. & Lischetzke, T., 2006. Analysing multitrait-multimethod data with structural equation models for ordinal variables applying the WLSMV estimator: What sample size is needed for valid results? *British Journal of Mathematical and Statistical Psychology*, 59(1), pp.195–213.

Pillay, K. & Haupt, T., 2008. the Cost of Construction Accidents : an Exploratory Study. *14th International Conference on Evolution and Directions in Construction Safety and Health*, pp.456–464.

Pousette, A., Larsson, S. & Törner, M., 2008. Safety climate cross-validation, strength and prediction of safety behaviour. *Safety Science*, 46(3), pp.398–404.

PwC, 2013. *Highlighting trends in the South African construction industry*,

Ramutloa, L., 2012. DoL host stakeholders on the state of occupational health and safety in South Africa. , 2015. Available at: http://www.labour.gov.za/DOL/media-desk/media-statements/2012/dol-host-stakeholders-on-the-state-of-occupational-health-and-safety-ohs-in-south-africa.

Ray, P.S., Purswell, J.L. & Bowen, D., 1993. Behavioral safety program: Creating a new corporate culture. *International Journal of Industrial Ergonomics*, 12(3), pp.193–198.

Razak, A. et al., 2010. An investigation of the Status of the Malaysian Construction Industry. *Benchmarking: An International Journal Structural Survey Structural Survey*, 1714635771011036400(24), pp.294–308.

Reiman, T. & Pietikäinen, E., 2012. Leading indicators of system safety - Monitoring and driving the organizational safety potential. *Safety Science*, 50, pp.1993–2000.

Renkema, M., Meijerink, J. & Bondarouk, T., 2017. Advancing multilevel thinking in human resource management research: Applications and guidelines. *Human Resource Management Review*, 27(3), pp.397–415.

Robson, L.S. et al., 2007. The effectiveness of occupational health and safety management system interventions: A systematic review. *Safety Science*, 45, pp.329–353.

Rocco, T.S. & Plakhotnik, M.S., 2009. Literature Reviews, Conceptual Frameworks, and Theoretical Frameworks: Terms, Functions, and Distinctions. *Human Resource Development Review*, 8(1), pp.120–130.

Rousseau, D.M., 1985. Issues of Level in Organisational Research: Multi-level and Cross-level Perspectives. *Research in Organisational Behaviour*, 7(1), pp.1–37.

Rowlinson, S., 2004. Overview of construction site safety issues. In *Construction Safety Management Systems*. pp. 1–12.

Ryan, R. & Deci, E., 2000. Self-determination theory and the facilitation of intrinsic motivation. *American Psychologist*, 55(1), pp.68–78.

Saksvik, P.O. & Quinlan, M., 2003. Regulating Systematic Occupational Health and Safety Management. *La régulation de la gestion systématique de la santé et de la sécurité au travail : une comparaison de l'expérience australienne et norvégienne*, 58(1), pp.33–56.

Sarkus, D.J., 2001. Safety and psychology. *Professional safety*, 46(1), p.18.

Schreier, M., 2014. Qualitative Content Analysis. In *The SAGE Handbook of Qualitative Data Analysis*. pp. 170–183.

Sgourou, E. et al., 2010. Assessment of selected safety performance evaluation methods in regards to their conceptual, methodological and practical characteristics. *Safety Science*, 48(8), pp.1019–1025.

Shea, T. et al., 2016. Leading indicators of occupational health and safety: An employee and workplace level validation study. *Safety Science*, 85, pp.293–304.

Sheehan, C. et al., 2016. Leading and lagging indicators of occupational health and safety: The moderating role of safety leadership. *Accident Analysis &*, 92, pp.130–138.

Sinelnikov, S., Inouye, J. & Kerper, S., 2015. Using leading indicators to measure occupational health and safety performance. *Safety Science*, 72, pp.240–248.

Skeepers, N.C. & Mbohwa, C., 2015. A Study on the Leadership Behaviour, Safety Leadership and Safety Performance in the Construction Industry in South Africa. *Procedia Manufacturing*, 4(Iess), pp.10–16.

Small, K.A. & Hsiao, C., 1985. Multinomial Logit Specification Tests. *International Economic Review*.

Smallwood, J., 1998. Client influence on contractor health and safety in South Africa. *Building Research and Information*, 26(3), pp.181–189.

Smallwood, J., 2015. Optimising the elements of a construction health and safety (H&S) programme and audit system. *Procedia Engineering*, 123, pp.528–537.

Smallwood, J. & Emuze, F., 2016. Towards Zero Fatalities, Injuries, and Disease in Construction. *Procedia Engineering*, 164, pp.453–460.

Smallwood, J.J., 2004. The influence of engineering designers on health and safety during construction: technical paper. *Journal of the South African Institution of Civil Engineering= Joernaal van die Suid-Afrikaanse Instituut van Siviele Ingenieurswese*, 46(1), pp.2–8.

Smallwood, J.J. & Haupt, T.C., 2007. Impact of the South African Construction Regulations on construction health and safety: Architects' perceptions. *Journal of Engineering, Design and Technology*, 5(1), pp.23–34.

Sunindijo, R. & Zou, P., 2012. Political Skill for Developing Construction Safety Climate. *Journal of Construction Engineering and Management*, 138(5), pp.605–612.

Tam, C.M. et al., 2002. Non-structural fuzzy decision support system for evaluation of construction safety management system. *International Journal of Project Management*, 20(4), pp.303–313.

Tappura, S., Nenonen, N. & Kivistö-Rahnasto, J., 2017. Managers' viewpoint on factors influencing their commitment to safety: An empirical investigation in five Finnish industrial organisations. *Safety Science*, 96, pp.52–61.

Taylor, F.W., 1911. The principles of scientific management. *Management*, 6, p.144.

Teddlie, C. & Tashakkori, A., 2006. A General Typology of Research Designs Featuring Mixed Methods. *Research in Schools*, 13(1), p.12.

Teo, E.A.L., Ling, F.Y.Y. & Chong, A.F.W., 2005. Framework for project managers to manage construction safety. *International Journal of Project Management*, 23(4), pp.329–341.

Turner, S.F., Cardinal, L.B. & Burton, R.M., 2017. Research Design for Mixed Methods: A Triangulation-based Framework and Roadmap. *Organizational Research Methods*, 20(2), pp.243–267.

Tweeddale, H.M., 2001. Nourishing and poisoning a 'safety culture'. *Process Safety and Environmental Protection*, 79(3), pp.167–173.

Ugwu, O. & Haupt, T., 2007. Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective. *Building and Environment*, 42, pp.665–680.

Vekinis, D. et al., 2010. Work-related fatalities in the South African construction industry : 2004 to 2006.

Vinodkumar, M.N. & Bhasi, M., 2010. Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. *Accident Analysis and Prevention*, 42(6), pp.2082–2093.

Vrenderburgh, A.., 2002. Organization safety: Which Management Practices are Most Effective in Reducing Employee injury Rates? Journal of Safety Research,. , 33, p.259–276.

Walters, D. & James, P., 2011. What motivates employers to establish preventive management arrangements within supply chains?

Wen Lim, H. et al., 2018. Impact of Safety Climate on Types of Safety Motivation and Performance: Multigroup Invariance Analysis. *Journal of Management in Engineering*, 34(3), p.04018002.

Wilson, R., 2015. *Endemic Collusion in the South African Construction Industry: Reasons and Implications*,

Windapo, A.O., 2011. Investigation into the Level of Compliance to Construction Health and Safety Requirements within the South African Construction Industry. In *Proceedings of the CIB W009 Conference*. Washington D.C, pp. 23–25.

Wong, F. & So, L., 2002. Restriction of the multi-layers subcontracting practice in Hong Kong-Is it an effective tool to improve safety performance of the construction industry. In *Triennial Conference CIB W*.

Woods, C.M., 2009. Evaluation of MIMIC-Model Methods for DIF Testing With Comparison to Two-Group Analysis. *Multivariate Behavioral Research*, 44(1), pp.1–27.

Wooldridge, J.M., 2003. *Introductory Econometrics*, Mason, Ohio: Thomson, South=Western.

Wu, T.-C., Chen, C.-H. & Li, C.-C., 2008. A correlation among safety leadership, safety climate and safety performance. *Journal of Loss Prevention in the Process Industries*, 21, pp.307–318.

Wu, T.C., Lin, C.-H. & Shiau, S.-Y., 2010. Predicting safety culture: The roles of employer, operations manager and safety professional. *Journal of Safety Research*, 41, pp.423–431.

Wu, X. et al., 2015. Prospective safety performance evaluation on construction sites. *Accident Analysis and Prevention*, 78, pp.58–72.

Xueyi, Z., Chunming, L. & Chi, Z., 2012. Model of total safety management(TSM) and its application. *Procedia Engineering*, 45, pp.204–207.

Yoon, S.J. et al., 2013. Effect of Occupational Health and Safety Management System on Work-Related Accident Rate and Differences of Occupational Health and Safety Management System Awareness between Managers in South Korea's Construction Industry. *Safety and Health at Work*, 4(4), pp.201–209.

Yorio, P.L., Willmer, D.R. & Moore, S.M., 2015. Health and safety management systems through a multilevel and strategic management perspective: Theoretical and empirical considerations. *Safety Science*, 72(0), pp.221–228.

Zahoor, H. et al., 2015. A research framework for investigating the relationship between safety climate and safety performance in the construction of multi-storey buildings in Pakistan. *Procedia Engineering*, 118, pp.581–589.

Zeng, S.X., Tam, V.W.Y. & Tam, C.M., 2008. Towards occupational health and safety systems in the construction industry of China. *Safety Science*, 46(8), pp.1155–1168.

Zhou, Z., Goh, Y.M. & Li, Q., 2015. Overview and analysis of safety management studies in the construction industry. *Safety Science*, 72(0), pp.337–350.

Zohar, D., 2000. A group-level model of safety climate: testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of applied psychology*, 85(4), p.587.

Zohar, D., 2008. Safety climate and beyond: A multi-level multi-climate framework. *Safety Science*, 46(3), pp.376–387.

Zohar, D., 1980. Safety Climate in Industrial Organizations: Theoretical and Applied Implications. *Journal of Applied Psychology*, 65(1), pp.96–102.

Zohar, D., 2010. Thirty years of safety climate research: Reflections and future directions. *Accident Analysis and Prevention*, 42(5), pp.1517–1522.

Zohar, D. & Luria, G., 2005. A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. *Journal of Applied Psychology*, 90(4), pp.616–628.

Zwetsloot, G.I.J.M.G., 2000. Developments and debates on OHSM system standardisation and certification. *Frick et al.,(2000), Systematic occupational health and safety management, Perspectives on an international development, Pergamon, Elsevier Science*, (January 2000), pp.391–412.

ANNEXURES

Annex A (Chapter 4): Interview Guide

SEMI-STRUCTURED INTERVIEW SCHEDULE

Policy and Strategy

Does your organisation have a corporate policy document for health and safety that is signed by a top management representative?

When was this policy last reviewed?

How is the organisation's safety policy, communicated to all employees, including their OH&S rights and obligations?

Does your organisation have a dedicated SHEQ or Health and Safety department?

Does your orgnisation have a strategic safety management plan/manual document? When was this document last reviewed?

How was this strategic safety management plan document developed? Was it specifically developed by your organisation.

In the selection of sub-contractors, do your evaluate their previous safety performance as a selection criteria?

Safety Culture and Leadership

Do you have a health and safety committee in place?

What is the membership structure of the safety committee?

What are the avenues for consultation between top managememt and staff on health and safety?

Do top management representatives visit project sites to inspect health and safety?

How do top management give their feedback after such visits?

Do you have a safety awareness programme in place at this organisation?

What are the details of these programmes?

How would you guage management's commitment to health and safety at this organisation?

Resources Allocated for Safety

How is H&S funded at this organisation?

How much is spent of H&S as a percentage of turnover in the last financial year

Programmes, Processes and Procedures

Does your organistaion have safety procedures/instruction/rules for guiding the safe conduct of most routine jobs?

SEMI-STRUCTURED INTERVIEW SCHEDULE

What safety programmes do you have at this organisation for the following?

1. Incident reporting

2. Job hazard identification and risk assessment

3. Fit for duty and work site surveillance

4. Emergency preparedness and response

5. Documentation and Data Control

How were these programmes and procedures developed? Did you Adopted procedures contained in the construction regulation

How is compliance with these programmes, processes and procedures enforced?

How often are these programmes, processes and procedures reviewed?

When was the last time a review was carried out?

Roles and Responsibilities

Who is the most senior person ultimately responsible for H&S management for this organisation?

What roles do top management play in H&S management?

What roles do supervisors play in H&S management?

What roles do lower level employees play in H&S management?

Do you have trained employees who perform the following functions?

1. Trained key employees responsible for conducting job hazard identification and assessment

2. Trained key employees responsible for ensuring and assuring continuous compliance of the organisation's SMS with safety legislations?

3. Trained key employees responsible for conducting regular job site inspections

4. Key employees responsible for planning and cordinating safety trainings for the organisation

5. Key employees responsible for analysing, reporting and disseminating safety performance statistics and data

6. Trained key employees responsible for conducting accident investigation and recommending corrective actions

SEMI-STRUCTURED INTERVIEW SCHEDULE

7. Full time competent management cadre personnel responsible for implementing and advising on OH&S at the organisational level

Training and Competency

How are safety training needs for the organisation identified?

What methods of safety training are mostly employeed at this organisation? (In house training, On the Job training, External training from SAQA accredited trainers)

How are safety trainings evaluated to determine effectiveness?

Incentives for Participation

What means of accountability do you have in place to ensure thay every member of the organisation complies with safety rules and regulations?

How are lower level employees involved in the various safety programmes discussed earlier?

Do you have a programme to reward and recognised safe work behaviour?

If yes, please describe this reward and recognition programme?

Measurement and Evaluation

What framework do you have in place for constant measurement, evaluation and improvement of safety management efforts?

Annex B (Chapter 6): T-Test Result

Variable	Test of means against reference constant (value) (DATA 20160217.sta)							
	Mean	Std.Dv.	N	Std.Err.	Reference Constant	t-value	df	p
Pol 1	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
Pol 2	5.625	0.744024	8	0.263052	4	6.17748	7	0.000455
Pol 3	5.625	0.744024	8	0.263052	4	6.17748	7	0.000455
Pol 4	5.25	0.707107	8	0.25	4	5	7	0.001565
Pol 5	4	1.772811	8	0.626783	4	0	7	1
TMLI 1	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
TMLI 2	5.625	0.744024	8	0.263052	4	6.17748	7	0.000455
TMLI 3	5.375	0.916125	8	0.323899	4	4.24515	7	0.003816
SHSMP 1	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
SHSMP 2	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
SHSMP 3	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
ERCP 1	5.75	0.46291	8	0.163663	4	10.69268	7	0.000014
ERCP 2	5.75	0.46291	8	0.163663	4	10.69268	7	0.000014
ERCP 3	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
ERCP 4	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
ERCP 5	4.875	1.125992	8	0.398098	4	2.19795	7	0.063924
ERCP 6	5	1.309307	8	0.46291	4	2.16025	7	0.067583
AIP 1	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
AIP 2	5.5	0.755929	8	0.267261	4	5.61249	7	0.000805
A1P 3	5	1.414214	8	0.5	4	2	7	0.085619
HSC 1	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
HSC 2	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
HSC 3	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
RMP 1	5.375	0.744024	8	0.263052	4	5.2271	7	0.001216
RMP 2	5.375	0.744024	8	0.263052	4	5.2271	7	0.001216
RMP 3	5.5	0.92582	8	0.327327	4	4.58258	7	0.002536
RMP 4	5.375	0.916125	8	0.323899	4	4.24515	7	0.003816
RMP 5	5.25	0.886405	8	0.313392	4	3.98862	7	0.005266
RMP 6	5.75	0.46291	8	0.163663	4	10.69268	7	0.000014
Mos 1	5.75	0.46291	8	0.163663	4	10.69268	7	0.000014
Mos 2	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
Mos 3	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
MoS 4	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
HSROM 1	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
HSROM 2	5.75	0.46291	8	0.163663	4	10.69268	7	0.000014
HSROM 3	4.75	1.38873	8	0.49099	4	1.52753	7	0.170471
KM 1	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
KM 2	5.5	0.755929	8	0.267261	4	5.61249	7	0.000805
KM 3	5.375	0.744024	8	0.263052	4	5.2271	7	0.001216
ECT 1	5.125	0.834523	8	0.295048	4	3.81293	7	0.006603
ECT 2	5.125	0.991031	8	0.350382	4	3.21078	7	0.014842
ECT 3	5.25	0.707107	8	0.25	4	5	7	0.001565
ECT 4	5.25	1.035098	8	0.365963	4	3.41565	7	0.011201
AI 1	4.875	0.991031	8	0.350382	4	2.49727	7	0.041156
AI 2	5.75	0.46291	8	0.163663	4	10.69268	7	0.000014
AI 3	5.75	0.46291	8	0.163663	4	10.69268	7	0.000014
AI 4	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047

Variable	Test of means against reference constant (value) (DATA 20160217.sta)							
	Mean	Std.Dv.	N	Std.Err.	Reference Constant	t-value	df	p
RCR 1	5.625	0.517549	8	0.182981	4	8.88069	7	0.000047
RCR 2	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
RCR 3	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
MR 1	5.5	0.534522	8	0.188982	4	7.93725	7	0.000096
MR 2	5.375	0.744024	8	0.263052	4	5.2271	7	0.001216
MR 3	5.375	0.744024	8	0.263052	4	5.2271	7	0.001216

Annex C (Chapter 6): Finalised Questionnaire for Manager Level Survey

Construction Industry Health and Safety Management Survey

Academic research survey

INTRODUCTION

You are kindly requested to participate in a research study conducted by the Construction Engineering and Management division, Department of Civil Engineering at Stellenbosch University. This study is designed to evaluate the effectiveness of organisational level safety management efforts. The study aims to demonstrate the relationship between effort and performance with regards to safety management interventions employed by construction contractor organisations. This organisational level health and safety management questionnaire provides a frame work for assessing safety management efforts of construction contractors.

CONFIDENTIALITY

Information provided in this survey will be treated as confidential and will only be used for research purposes. Personal and organisational information that can be traced back to you or your organisation would be excluded from the final research document thereby ensuring anonymity of your responses.

GUIDE TO COMPLETING SURVEY

Each section consists of a series of statements describing factors which influences health and safety performance. There are three possible responses to each statement, i.e "Yes", "Partial" and "No".

It would be considered appropriate to select "Yes" if the statement is true for most (for example, approximately four-fifth (4/5)) of the organisation in terms of sites, employees, processes, procedures etc.

The "Partial" option is intended for organisations that are well on the way to achieving a "Yes". It would be appropriate, for instance, if there are several initiatives being undertaken across the organisation's operational units but have not quite reached all parts of the organisation; or that the programme applies to most (for example, two-third (2/3)) but not all of the workforce.

For each section please:
1. Consider each statment
2. Tick the box you consider most appropriate for your organisation for each statement

Reference has been made to the "Board" of the organisation in this questionnaire. The board here means a top management organ of the organisation responsible for directing and makings decisions for the day to day running of the organisation

IDENTIFICATION INFORMATION

1. **Name of organisation**
   This question is optional. You may choose to leave this question unanswered if you wish for your response be completely anonymous.

   ____

2. **Organisation's main operational region**
   Please indicate the operational region represented. Most construction organisations in South Africa are broken down into regional operations such as coastal region, Gauteng region, Kwa Zulu Natal region etc. If you represent head office please indicate "national", otherwise indicate the operating region you represent.

   ____

3. **Is your organisation registered with the Construction Industry Development Board (CIDB)?**
   Mark only one oval.

   ◯ Yes
   ◯ No

4. **If the answer to the last question is "yes", what is the CIDB grading for your organisation?**
   CIDB grading for construction organisations in South Africa range from 1 to 9

   ____

5. **What is your organisation's main business area?**
   You may tick more than one option
   Check all that apply.

   ☐ Civils construction
   ☐ Commercial building construction
   ☐ Domestic housing construction
   ☐ Other: ______________________________

6. **What is the approximate number of staff directly employed by your organisation?**

   ____

7. **What is your health and safety management related position within your organisation?**

   ____

8. **This organisation engages the services of health and safety consultants?**
   Mark only one oval.

   ◯ Yes
   ◯ No

9. **This organisation has a dedicated H&S management department and in-house H&S professionals**
Mark only one oval.

- Yes
- No

10. **This organisation is OHSAS 18001 certified**
Mark only one oval.

- Yes
- No

11. **Which of these statements best describes the subcontracting practices at your organisation?**
Mark only one oval.

- Almost all of the organisation's construction operations/maintenance services are carried out by subcontractors
- More than half (but not all) of this organisation's construction operations/maintenance is carried out by subcontractors
- Less than half (but more than 10%) of this organisation's construction operations/maintenance is carried out by subcontractors
- Less than 10% of this organisation's construction operations/maintenance services is carried out by subcontractors
- This organisation uses subcontractors rarely, if ever, and only for short duration on unusual projects

Safety Policy

12. **This organisation has a clear corporate policy document on health and safety that is signed by a top management representative**
Mark only one oval.

- Yes
- Partial
- No

13. **This organisation's health and safety policy has targeted objective with stipulated period for achieving them**
Mark only one oval.

- Yes
- Partial
- No

14. The health and safety policy document is published and readily accessible on all work sites and to all employees of this organisation

Mark only one oval.

- Yes
- Partial
- No

15. Communication of this organisation's health and safety policy is an integral aspect of health and safety induction for employees

Mark only one oval.

- Yes
- Partial
- No

Top management leadership

16. A member of of the board or top management has been allocated responsibility for health and safety management and proactively directs health and safety management

Mark only one oval.

- Yes
- Partial
- No

17. Members of top management visit project sites to assess health and safety and to communicate the organisation's commitment to health and safety to employees

Mark only one oval.

- Yes
- Partial
- No

18. This organisation has an annual budgetary provision dedicated to funding proactive health and safety management requirements/operations

Mark only one oval.

- Yes
- Partial
- No

Strategic H&S Management Planning

19. A health and safety management plan has been developed for this organisation and it covers all operations, activities and sites of this organisation

Mark only one oval.

- Yes
- Partial
- No

20. Health and safety management plans developed are endorsed by the board (or its equivalent) of this organisation

Mark only one oval.

- Yes
- Partial
- No

21. The developed Health and safety management plan is published and available to the workforce at all business areas and sites

Mark only one oval.

- Yes
- Partial
- No

Employee Representation and Involvement

22. This organisation formally and in writing appoints employee safety representatives

Mark only one oval.

- Yes
- Partial
- No

23. Employee safety representatives are part of the membership of organisational level H&S forum/committees

Mark only one oval.

- Yes
- Partial
- No

24. Employee safety representatives are involved in deciding and setting health and safety targets for the organisation

Mark only one oval.

- Yes
- Partial
- No

25. **Employees at this organisation are involved in risk assessment, audit and incident investigation activities**
Mark only one oval.
- Yes
- Partial
- No

Accountability and Incentives for Participation

26. **Health and safety performance is a component of employee performance appraisal**
Mark only one oval.
- Yes
- Partial
- No

27. **Procedures are laid down formally and in writing to identify and act upon failures by any employee to achieve adequate health and safety performance**
Mark only one oval.
- Yes
- Partial
- No

H&S Communication

28. **Procedures are in place for communicating major safety events, incidents and accidents to top management and throughout the organisation**
Mark only one oval.
- Yes
- Partial
- No

29. **Procedures are in place for disseminating internal and external audit reports findings to top management and relevant members of the workforce**
Mark only one oval.
- Yes
- Partial
- No

30. **Procedures are in place for disseminating information on progress against stated H&S performance targets throughout the organisation**
Mark only one oval.
- Yes
- Partial
- No

Risk Management Procedures

This section seeks to assess the presence of documented health and safety management procedures/instructions/standards customised to the organisation's needs that:
(1) Allocates specific responsibility
(2) Explains what is to be done
(3) How and when it is to be done
(4) Details the expected results for the following:

31. **Safe work procedures for the conduct of routine jobs**
Mark only one oval.

- Yes
- Partial
- No

32. **Job hazard identification and risk assessment; including occupational monitoring of employees exposed to hazardous conditions and materials**
Mark only one oval.

- Yes
- Partial
- No

33. **Incident investigation**
Mark only one oval.

- Yes
- Partial
- No

34. **Work site inspections**
Mark only one oval.

- Yes
- Partial
- No

35. **Incident reporting, including near misses**
Mark only one oval.

- Yes
- Partial
- No

36. **Baseline annual medical checks for all employees**
Mark only one oval.

- Yes
- Partial
- No

Management of subcontractors

37. **When considering the selection/re-selection of subcontractors or suppliers of services, this organisation considers their previous health and safety performance records as part of our selection criteria**

Mark only one oval.

- Yes
- Partial
- No

38. **This organisation require all key subcontractors to show evidence of improving accidents/lost time injury statistics**

Mark only one oval.

- Yes
- Partial
- No

39. **This organisation require all key subcontractors to have established mechanisms for managing health and safety such as developing a health and safety plan for work to be done**

Mark only one oval.

- Yes
- Partial
- No

40. **This organisation require all key subcontractors to have requisite health and and safety personnel in their employment such as a full time safety officer**

Mark only one oval.

- Yes
- Partial
- No

Defined H&S Responsibilities for Operational Managers

41. **All line managers are formally and in writing given clear health and safety responsibilities appropriate to their role on site**

Mark only one oval.

- Yes
- Partial
- No

42. **Health and safety competencies and risks associated with task are always considered in the appointment of supervisors and team leaders at this organisation**

Mark only one oval.

- Yes
- Partial
- No

Knowledge Management

43. **Developments in the field of health and safety management are continuously monitored to ensure that this organisation is aware of current best practices**

Mark only one oval.

- Yes
- Partial
- No

44. **This organisation has a information management system that enables it to learn from its experience by communicating the lessons learned from near miss incidents and accidents**

Mark only one oval.

- Yes
- Partial
- No

45. **A health and safety information repository infrastructure exists at this organisation that ensures that all workers have access to health and safety information they need for their jobs**

Mark only one oval.

- Yes
- Partial
- No

Employee Competence and Training

46. **Competency standards have been set for all health and safety related activities**

Mark only one oval.

- Yes
- Partial
- No

47. **Procedures are in place to identify health and safety training needs when personnel are recruited, change job roles or aspects of their work activities change**

Mark only one oval.

- Yes
- Partial
- No

48. **All those in supervisory roles (supervisors and team leaders) have undergone training on Hazard Identification and Risk Assessment (HIRA) from accredited trainers**

Mark only one oval.

- Yes
- Partial
- No

49. **All trades men within the direct employment of this organisation (such as bricklayers, concrete team) have the required formal/registered safety training to conduct their trade safely**

Mark only one oval.

- Yes
- Partial
- No

H&S Audits and Inspections

50. **This organisation has a process of internal audits of its health and safety management arrangement and sites**

Mark only one oval.

- Yes
- Partial
- No

51. **This organisation audits the health and safety management arrangement of its subcontractors**

Mark only one oval.

- Yes
- Partial
- No

52. **This organisation's health and safety management system is periodically audited by external bodies**

Mark only one oval.

- Yes
- Partial
- No

H&S Record Control and Reporting

53. This organisation prepares annual or more frequent reports of statistics on injury/incident rates

Mark only one oval.

- Yes
- Partial
- No

54. Reports of H&S statistics is internally disseminated to top management and all stakeholders within the organisation on an annual or more frequent basis

Mark only one oval.

- Yes
- Partial
- No

55. H&S statistics reports are made public or contained in annual financial reports

Mark only one oval.

- Yes
- Partial
- No

Management Review

56. The Incident/injury rates of employees of this organisation are tracked over time and bench marked against industry average rates and between sites

Mark only one oval.

- Yes
- Partial
- No

57. Top management of this organisation debates the implications of results of health and safety performance monitoring on a regular basis

Mark only one oval.

- Yes
- Partial
- No

58. Top management of this organisation regularly reviews this organisation's health and safety management arrangements in order to improve safety performance

Mark only one oval.

- Yes
- Partial
- No

Annex D(Chapter 7): Questionnaire Used for Worker Level Survey

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Questionnaire Survey

1. Please read and sign the Ethics consent form that comes with this questionnaire
2. Please do not write your name anywhere on this questionnaire
3. Participation in this survey is voluntary (not compulsory)
4. Information provided will not be revealed/shown to anyone but the student
5. Please write your answer in the box or mark a "X" in the box closest to your answer
6. After completing the questionnaire, please put it in the envolpe provided and seal the envelop before returning it

SECTION 1: CODING INFORMATION

1 Gender: Male ☐ Female ☐

2 Age: ☐

3 Number of years that you have worked for this company? ☐

4 Work status:

- Full time ☐
- Contract ☐
- Casual ☐

5 The company I work is a ______

Trade contractor	☐	Example: Plumbing, painting, carpentary, reinforcement steel works, bricklaying
Labour only contractor	☐	Example: Provides only labour workers to other contractors
Specialist contractor	☐	Example: Geotechnical, scaffolding, glass works, structural steel, demolition works
Building contractor	☐	Example: If your company constructs houses, malls and warehouses
Civils contractor	☐	Example: if your company constructs roads, bridges, dams etc

6 Which of these statements best describes the H&S management arrangement at this company?
Please mark against one of the three options that best describes your company

a My company IS NOT OHSAS 18001 certified, and our health and safety programs and safety files are designed and prepared by EXTERNAL health and safety consultants. ☐

b My company IS NOT OHSAS 18001 certified, however we have a health and safety management arrangement that is designed by our INTERNAL health and safety professionals/Officers. ☐

c My company is OHSAS 18001 certified, and our health and safety management arrangement is in accordance to OHSAS 18001 specifications. ☐

7 If the options in question 7 above does not accurately describe the health and safety management arrangement at your company, please provide a description of your organisation's health and safety management arrangement in the box below.

☐

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Questionnaire Survey

1. Please read and sign the Ethics consent form that comes with this questionnaire
2. Please do not write your name anywhere on this questionnaire
3. Participation in this survey is voluntary (not compulsory)
4. Information provided will not be revealed/shown to anyone but the student
5. Please write your answer in the box or mark a "X" in the box closest to your answer
6. After completing the questionnaire, please put it in the envolpe provided and seal the envelop before returning it

SECTION 2: SAFETY CLIMATE PERCEPTION MEASUREMENT

The next section seeks to assess your perception of (the way you understand) certain aspects of your company's health and safety management arrangement. For each statement, please mark against the box numbered 1 to 5 to indicate the extent to which you disagree or agree with the statements.

1 – Strongly disagree
2 – Disagree
3 – Neutral
4 – Agree
5 – Strongly agree

Please tick "3(Neutral)" if you neither disagree nor agree with a statement, or if you are unsure.

S/No	SAFETY CLIMATE DIMENSION	1	2	3	4	5
	Management commitment and leadership					
1	Safety is given high priority (taken very seriously) by management					
2	Top management views Health & Safety rules and procedures violation very seriously even when they don't result in any major incident, accident or damange to equipment					
3	Corrective action is quickly taken when management is told about unsafe practices or conditions					
4	My company provides sufficient personal protective equipment (PPE) for workers					
5	Members of top management often participate in Health & Safety management activities					
6	My foreman and/or supervisor frequently (normally) gives safety guidance to workers on how to perform a job safely					
7	My foreman and/or supervisor often (regularly) monitors that workers are working safely					
8	My foreman and/or supervisor normally commends a worker whenever they see a job done according to the Health & Safety rules					
9	My foreman and/or supervisor frequently encourages workers to be safe in their working behaviour					

10	My foreman and/or supervisor seriously considers any workers' suggestion that will improve safety					

S/No	*Systems for Health and Safety Management*	1	2	3	4	5
1	There are systems and procedures in place for preventing breakdown of health and safety in this workplace					
2	Safe work procedures have been developed for all routine task					
3	The health and safety procedures and practices in my workplace are enough to prevent incidents from happening					
4	The health and safety procedures and practices in my workplace are useful and effective					

	Safety Officer/Professional Leadership	1	2	3	4	5
1	Our safety officer(s)/professionals provide guidance and advice on hazard identification and risk management					
2	Our safety officer(s)/professionals provide guidance and advice on measuring safety performance levels					
3	Our safety officer(s)/professionals provide guidance and advice on injury prevention					
4	Our safety officer(s)/ professionals provide guidance and advice on incident investigation					
5	Our safety officer(s)/professionals regularly carry out safety audits					
6	Our safety officer(s)/professionals regularly carry out safety inspections					
7	Our safety officer(s)/professionals provide effective safety motivation					
8	Our safety officer(s)/professionals reularly share safety information with workers in this workplace					
9	Our safety officer(s)/professionals can influence managers to carry out necessary improvements and changes					

	Health and Safety Management Practices	1	2	3	4	5
1	Formal Health & Safety audits at regular intervals are normal in this company					
2	Everyone at this company appreciates ongoing Health & Safety improvement					
3	Workers and supervisors have the information they need to work safely					
4	Workers at this company are always involved in decisions affecting their health and safety					
5	Those in charge of Health & Safety have the authority, resources and support to make changes they have identified as necessary					
6	Those who act safely receive recognition or award					
7	Managers, supervisors, and workers all know what behaviour will result in discipline					
8	Discipline for safety violation is fair and consistent					
9	Workers in this workplace are free to report health and safety incidents and accidents					
10	Everyone has the tools and/or equipment they need to complete their work safely					
11	This company considers safety to be equally important as production					
12	All incidents, even minor ones, are thoroughly investigated if they have potential for serious injury					
13	Our training program ensures all employees who do the same job learn to do it the same way					
14	When asked to do a new job or task, I receive enough training to be able to do it safely					

	Safety Motivation	1	2	3	4	5
1	I feel that it is worthwhile to put in effort to maintain or improve my personal safety					
2	I feel that it is important to maintain safety at all times					
3	I believe that it is important to reduce the risk of accidents and incident in this workplace					

	Safety Compliance	1	2	3	4	5
1	I use all the necessary safety equipment to do my job					
2	I use the correct safety procedures for carrying out my job					
3	I ensure the highest levels of safety when I carry out my job					

	Safety Participation	1	2	3	4	5
1	I promote the safety program within this company					
2	I put in extra effort to improve the safety of the workplace					
3	I report safety incidents and accidents whenever I observe them					
4	I voluntarily carry out tasks or activities that help to improve safety in this workplace					

	Injuries	Yes	No
1	In the past one month, I have injured myself on a construction site but DID NOT need medical attention		
2	In the past one month, I have injured myself on a construction site and needed medical attention		

Annex E (Chapter 7): Covariance Matrices for SEM Dataset

COVARIANCE MATRICES FOR DATASET

HYPOTHESISED MODEL

MCL	0.745							
OMCL	0.530	0.621						
SYS	0.499	0.403	0.492					
SOPL	0.588	0.306	0.461	0.865				
HSMP	0.569	0.424	0.416	0.619	0.643			
SM	0.284	0.275	0.235	0.251	0.386	0.730		
SC	0.353	0.329	0.284	0.296	0.429	0.629	0.802	
SP	0.328	0.374	0.345	0.348	0.433	0.543	0.644	0.768

MODIFIED MODEL

MCL	0.807					
OMCL	0.557	0.623				
SYS	0.522	0.405	0.494			
SOPL	0.558	0.304	0.465	0.872		
HSMP	0.553	0.413	0.410	0.634	0.630	
SPF	0.288	0.292	0.260	0.271	0.347	0.509

MODIFIED MODEL TYPE1 SAMPLE

MCL	0.702					
OMCL	0.517	0.574				
SYS	0.422	0.330	0.355			
SOPL	0.637	0.232	0.341	0.905		
HSMP	0.593	0.350	0.299	0.760	0.698	
SPF	0.290	0.411	0.180	0.112	0.264	0.718

MODIFIED MODEL TYPE2 SAMPLE

MCL	0.885					
OMCL	0.737	0.747				
SYS	0.536	0.458	0.345			
SOPL	0.366	0.231	0.293	0.792		
HSMP	0.492	0.391	0.317	0.456	0.507	
SPF	0.210	0.169	0.146	0.330	0.337	0.608

MODIFIED MODEL TYPE3 SAMPLE

MCL	0.821					
OMCL	0.580	0.713				
SYS	0.639	0.578	0.777			
SOPL	0.689	0.581	0.741	0.951		
HSMP	0.584	0.530	0.614	0.689	0.681	
SPF	0.410	0.439	0.480	0.492	0.516	0.605

Annex F (Chapter 7): Standardised Factor Loading Statistics for SEM Models

STANDARDIZED RESULTS FOR HYPOTHESISED MODEL

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
MCL BY				
MCL1	0.863	0.025	34.402	0.000
MCL2	0.728	0.031	23.810	0.000
MCL3	0.679	0.035	19.255	0.000
MCL4	0.675	0.043	15.548	0.000
MCL5	0.692	0.037	18.804	0.000
OMCL BY				
OMCL1	0.788	0.029	26.796	0.000
OMCL2	0.872	0.023	38.490	0.000
OMCL3	0.782	0.030	26.200	0.000
OMCL4	0.913	0.022	41.508	0.000
OMCL5	0.860	0.026	33.402	0.000
SYS BY				
SYS1	0.702	0.034	20.934	0.000
SYS2	0.773	0.029	26.460	0.000
SYS3	0.842	0.028	29.959	0.000
SYS4	0.906	0.019	48.509	0.000
SPL BY				
SPL1	0.930	0.013	71.688	0.000
SPL2	0.935	0.012	80.395	0.000
SPL3	0.902	0.015	59.978	0.000
SPL4	0.867	0.018	48.933	0.000
SPL5	0.890	0.016	55.061	0.000
SPL6	0.931	0.010	90.283	0.000
SPL7	0.931	0.011	87.941	0.000
SPL8	0.871	0.018	47.902	0.000
SPL9	0.870	0.020	43.685	0.000
HSMP BY				
HSMP1	0.802	0.025	31.936	0.000
HSMP2	0.583	0.038	15.409	0.000
HSMP3	0.829	0.024	33.913	0.000
HSMP4	0.744	0.031	24.363	0.000
HSMP5	0.775	0.030	26.048	0.000
HSMP6	0.483	0.052	9.367	0.000
HSMP7	0.525	0.042	12.369	0.000
HSMP8	0.672	0.032	21.016	0.000
HSMP9	0.772	0.025	30.421	0.000
HSMP10	0.737	0.028	26.059	0.000
HSMP11	0.786	0.027	28.852	0.000
HSMP12	0.730	0.033	21.935	0.000
HSMP13	0.764	0.029	26.440	0.000
HSMP14	0.790	0.030	25.921	0.000

SM BY				
SM1	0.855	0.028	30.228	0.000
SM2	0.982	0.020	50.286	0.000
SM3	0.844	0.036	23.744	0.000
SC BY				
SC1	0.896	0.021	43.115	0.000
SC2	0.918	0.017	53.146	0.000
SC3	0.911	0.023	39.468	0.000
SP BY				
SP1	0.876	0.026	33.920	0.000
SP2	0.858	0.025	33.790	0.000
SP3	0.822	0.030	27.325	0.000
SP4	0.670	0.037	18.114	0.000
OMCL WITH				
MCL	0.779	0.031	25.147	0.000
SYS WITH				
MCL	0.823	0.026	31.884	0.000
OMCL	0.729	0.036	20.100	0.000
SPL WITH				
MCL	0.732	0.035	20.984	0.000
OMCL	0.417	0.045	9.282	0.000
SYS	0.707	0.033	21.501	0.000
HSMP WITH				
MCL	0.822	0.024	33.801	0.000
OMCL	0.670	0.033	20.152	0.000
SYS	0.740	0.032	23.262	0.000
SPL	0.829	0.019	43.545	0.000
SM WITH				
MCL	0.384	0.064	6.029	0.000
OMCL	0.409	0.059	6.980	0.000
SYS	0.392	0.056	7.031	0.000
SPL	0.316	0.052	6.080	0.000
HSMP	0.563	0.042	13.367	0.000
SC WITH				
MCL	0.457	0.055	8.234	0.000
OMCL	0.467	0.049	9.547	0.000
SYS	0.452	0.046	9.852	0.000
SPL	0.355	0.047	7.540	0.000
HSMP	0.597	0.037	16.220	0.000
SM	0.822	0.027	30.943	0.000
SP WITH				
MCL	0.433	0.061	7.078	0.000
OMCL	0.542	0.048	11.195	0.000
SYS	0.561	0.042	13.449	0.000
SPL	0.427	0.044	9.775	0.000
HSMP	0.617	0.037	16.582	0.000
SM	0.725	0.038	19.183	0.000
SC	0.821	0.025	32.559	0.000

R-SQUARE

Observed Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value	Residual Variance
MCL1	0.745	0.043	17.201	0.000	0.255
MCL2	0.530	0.044	11.905	0.000	0.470
MCL3	0.461	0.048	9.627	0.000	0.539
MCL4	0.455	0.059	7.774	0.000	0.545
MCL5	0.479	0.051	9.402	0.000	0.521
OMCL1	0.621	0.046	13.398	0.000	0.379
OMCL2	0.760	0.040	19.245	0.000	0.240
OMCL3	0.612	0.047	13.100	0.000	0.388
OMCL4	0.834	0.040	20.754	0.000	0.166
OMCL5	0.739	0.044	16.701	0.000	0.261
SYS1	0.492	0.047	10.467	0.000	0.508
SYS2	0.598	0.045	13.230	0.000	0.402
SYS3	0.709	0.047	14.979	0.000	0.291
SYS4	0.821	0.034	24.255	0.000	0.179
SPL1	0.865	0.024	35.844	0.000	0.135
SPL2	0.874	0.022	40.197	0.000	0.126
SPL3	0.813	0.027	29.989	0.000	0.187
SPL4	0.752	0.031	24.467	0.000	0.248
SPL5	0.792	0.029	27.531	0.000	0.208
SPL6	0.866	0.019	45.141	0.000	0.134
SPL7	0.868	0.020	43.970	0.000	0.132
SPL8	0.758	0.032	23.951	0.000	0.242
SPL9	0.758	0.035	21.843	0.000	0.242
HSMP1	0.643	0.040	15.968	0.000	0.357
HSMP2	0.340	0.044	7.705	0.000	0.660
HSMP3	0.687	0.040	16.956	0.000	0.313
HSMP4	0.554	0.045	12.181	0.000	0.446
HSMP5	0.601	0.046	13.024	0.000	0.399
HSMP6	0.233	0.050	4.684	0.000	0.767
HSMP7	0.276	0.045	6.185	0.000	0.724
HSMP8	0.452	0.043	10.508	0.000	0.548
HSMP9	0.595	0.039	15.210	0.000	0.405
HSMP10	0.543	0.042	13.030	0.000	0.457
HSMP11	0.618	0.043	14.426	0.000	0.382
HSMP12	0.533	0.049	10.968	0.000	0.467
HSMP13	0.584	0.044	13.220	0.000	0.416
HSMP14	0.623	0.048	12.961	0.000	0.377
SM1	0.730	0.048	15.114	0.000	0.270
SM2	0.963	0.038	25.143	0.000	0.037
SM3	0.713	0.060	11.872	0.000	0.287
SC1	0.802	0.037	21.558	0.000	0.198
SC2	0.842	0.032	26.573	0.000	0.158
SC3	0.831	0.042	19.734	0.000	0.169
SP1	0.768	0.045	16.960	0.000	0.232
SP2	0.736	0.044	16.895	0.000	0.264
SP3	0.675	0.049	13.663	0.000	0.325
SP4	0.448	0.050	9.057	0.000	0.552

STANDARDIZED RESULTS FOR MODIFIED MODEL

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
MCL BY				
MCL1	0.898	0.024	37.237	0.000
MCL2	0.751	0.030	25.399	0.000
MCL3	0.707	0.035	20.048	0.000
MCL5	0.722	0.038	19.044	0.000
OMCL BY				
OMCL1	0.790	0.029	27.177	0.000
OMCL2	0.871	0.022	38.898	0.000
OMCL3	0.784	0.030	26.439	0.000
OMCL4	0.913	0.022	42.025	0.000
OMCL5	0.858	0.026	33.482	0.000
SYS BY				
SYS1	0.703	0.033	21.124	0.000
SYS2	0.774	0.029	26.695	0.000
SYS3	0.841	0.028	29.916	0.000
SYS4	0.905	0.019	48.298	0.000
SPL BY				
SPL1	0.934	0.013	74.572	0.000
SPL2	0.935	0.011	81.593	0.000
SPL3	0.904	0.015	61.203	0.000
SPL4	0.869	0.017	49.718	0.000
SPL6	0.925	0.011	81.973	0.000
SPL7	0.930	0.011	84.667	0.000
SPL8	0.875	0.018	48.692	0.000
SPL9	0.873	0.020	43.925	0.000
HSMP BY				
HSMP1	0.794	0.026	30.486	0.000
HSMP3	0.831	0.024	34.257	0.000
HSMP4	0.747	0.030	24.593	0.000
HSMP5	0.774	0.030	26.052	0.000
HSMP8	0.669	0.032	20.633	0.000
HSMP9	0.739	0.028	26.703	0.000
HSMP10	0.699	0.031	22.222	0.000
HSMP11	0.790	0.027	29.171	0.000
HSMP12	0.727	0.034	21.474	0.000
HSMP13	0.756	0.030	25.558	0.000
HSMP14	0.775	0.032	24.266	0.000
MCL4	0.628	0.041	15.439	0.000
SPF BY				
SM1	0.714	0.041	17.252	0.000
SM2	0.850	0.027	31.105	0.000
SM3	0.783	0.040	19.772	0.000
SC1	0.812	0.027	30.068	0.000
SC2	0.849	0.025	34.537	0.000
SC3	0.880	0.025	35.145	0.000
SP1	0.839	0.028	29.513	0.000
SP2	0.820	0.028	29.317	0.000
SP3	0.789	0.030	26.633	0.000
SP4	0.656	0.039	16.935	0.000

OMCL WITH				
MCL	0.785	0.030	25.893	0.000
SYS WITH				
MCL	0.826	0.027	31.136	0.000
OMCL	0.729	0.036	20.095	0.000
SPL WITH				
MCL	0.666	0.038	17.555	0.000
OMCL	0.413	0.045	9.224	0.000
SYS	0.708	0.033	21.627	0.000
HSMP WITH				
MCL	0.775	0.028	27.491	0.000
OMCL	0.659	0.036	18.519	0.000
SYS	0.736	0.034	21.697	0.000
SPL	0.856	0.018	46.580	0.000
SPF WITH				
MCL	0.449	0.056	8.058	0.000
OMCL	0.519	0.047	10.944	0.000
SYS	0.519	0.044	11.916	0.000
SPL	0.407	0.044	9.298	0.000
HSMP	0.612	0.033	18.369	0.000
HSMP13 WITH				
HSMP14	0.365	0.048	7.534	0.000
SM1 WITH				
SM2	0.679	0.058	11.741	0.000
SC1 WITH				
SC2	0.544	0.054	9.988	0.000
HSMP9 WITH				
HSMP10	0.555	0.043	12.850	0.000

R-SQUARE

Observed Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value	Residual Variance
MCL1	0.807	0.043	18.618	0.000	0.193
MCL2	0.564	0.044	12.699	0.000	0.436
MCL3	0.500	0.050	10.024	0.000	0.500
MCL4	0.394	0.051	7.719	0.000	0.606
MCL5	0.521	0.055	9.522	0.000	0.479
OMCL1	0.623	0.046	13.589	0.000	0.377
OMCL2	0.758	0.039	19.449	0.000	0.242
OMCL3	0.615	0.047	13.219	0.000	0.385
OMCL4	0.834	0.040	21.012	0.000	0.166
OMCL5	0.736	0.044	16.741	0.000	0.264
SYS1	0.494	0.047	10.562	0.000	0.506
SYS2	0.599	0.045	13.348	0.000	0.401
SYS3	0.708	0.047	14.958	0.000	0.292
SYS4	0.819	0.034	24.149	0.000	0.181
SPL1	0.872	0.023	37.286	0.000	0.128
SPL2	0.874	0.021	40.796	0.000	0.126
SPL3	0.817	0.027	30.601	0.000	0.183
SPL4	0.755	0.030	24.859	0.000	0.245
SPL6	0.856	0.021	40.986	0.000	0.144
SPL7	0.865	0.020	42.333	0.000	0.135
SPL8	0.765	0.031	24.346	0.000	0.235
SPL9	0.763	0.035	21.962	0.000	0.237
HSMP1	0.630	0.041	15.243	0.000	0.370
HSMP3	0.691	0.040	17.128	0.000	0.309
HSMP4	0.558	0.045	12.296	0.000	0.442
HSMP5	0.599	0.046	13.026	0.000	0.401
HSMP8	0.448	0.043	10.316	0.000	0.552
HSMP9	0.546	0.041	13.352	0.000	0.454
HSMP10	0.488	0.044	11.111	0.000	0.512
HSMP11	0.623	0.043	14.586	0.000	0.377
HSMP12	0.528	0.049	10.737	0.000	0.472
HSMP13	0.571	0.045	12.779	0.000	0.429
HSMP14	0.600	0.049	12.133	0.000	0.400
SM1	0.509	0.059	8.626	0.000	0.491
SM2	0.723	0.046	15.553	0.000	0.277
SM3	0.613	0.062	9.886	0.000	0.387
SC1	0.660	0.044	15.034	0.000	0.340
SC2	0.720	0.042	17.269	0.000	0.280
SC3	0.774	0.044	17.573	0.000	0.226
SP1	0.705	0.048	14.757	0.000	0.295
SP2	0.672	0.046	14.659	0.000	0.328
SP3	0.623	0.047	13.317	0.000	0.377
SP4	0.430	0.051	8.468	0.000	0.570